Scotian Basin Exploration Drilling Project

Environmental Impact Statement

Volume 1: Environmental Impact Statement

October 2016

Executive Summary

BP Canada Energy Group ULC (BP Canada Energy Group ULC and/or any of its affiliates are hereafter generally referred to as "BP") is proposing to conduct an exploration drilling program on Exploration Licences (ELs) 2431, 2432, 2433, and 2434 known as the Scotian Basin Exploration Drilling Project (the Project). BP holds a 40% interest in the Nova Scotia Offshore ELs and will operate the exploration program. Partners, Hess Canada Oil and Gas ULC and Woodside Energy International (Canada) Limited, hold a 40% and 20% interest, respectively.

BP will drill up to seven exploration wells in phases over the term of the licences, from 2018 to 2022. A Mobile Offshore Drilling Unit (MODU) will be contracted to drill wells within the ELs. Logistics support will be provided through a fleet of platform supply vessels (PSVs) and helicopters. A supply base in Halifax will be used to store materials and equipment. It is expected that drilling activity for the first well in the program will commence in 2018. It is anticipated results from initial wells will inform the execution strategy for subsequent wells.

Offshore exploration drilling is a designated activity under the *Canadian Environmental Assessment Act, 2012* (CEAA, 2012). This document is intended to fulfill requirements for an environmental assessment (EA) pursuant to CEAA, 2012 as well as EA requirements of the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) pursuant to the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (hereafter referred to as the "Accord Acts"). This Environmental Impact Statement (EIS) has been prepared to satisfy Project-specific *Guidelines for the Preparation of an Environmental Impact Statement Pursuant to CEAA, 2012* (CEA Agency 2015a) which were developed by the Canadian Environmental Assessment Agency (CEA Agency) with input from other government departments and agencies, and the public.

The EA method is focused on the identification and assessment of potential adverse environmental effects of the Project on valued components (VCs). VCs are environmental attributes associated with the Project that are of particular value or interest because they have been identified to be of concern to Aboriginal peoples, regulatory agencies, BP, resource managers, scientists, key stakeholders, and/or the general public. The following six VCs were selected to facilitate a focused and effective EA process that complies with government requirements and supports public review:

- Fish and Fish Habitat;
- Marine Mammals and Sea Turtles;
- Migratory Birds;
- Special Areas;
- Commercial Fisheries; and
- Current Aboriginal Use of Lands and Resources for Traditional Purposes.

The assessment methods used in the preparation of this EIS included an evaluation of the potential environmental effects for each VC that may arise during the Project as well as from accidental events. The evaluation of potential cumulative effects considers whether there is potential for the residual environmental effects of the Project to interact cumulatively with the residual environmental effects of other past, present, or future (*i.e.*, certain or reasonably foreseeable) physical activities in the vicinity of the Project. In support of the EA process, additional studies were undertaken including acoustic modelling, drill waste dispersion modelling, oil spill fate and trajectory modelling, and a traditional use study. These additional studies are appended to the EIS.

Routine operations represent physical activities that would occur throughout the life of the Project and include the presence and operation of the MODU (including light and underwater sound emissions and establishment of a safety [exclusion] zone), waste management (including discharge of drill muds and cuttings and other discharges and emissions), vertical seismic profiling, supply and servicing operations (including helicopter transportation and supply/support vessel operations) and well abandonment. These activities reflect the scope of the Project as outlined in the EIS Guidelines and represent physical activities that would occur throughout the life of the Project forming the basis of the effects assessment.

Mitigation is proposed to reduce or eliminate adverse environmental effects. Most potential Project and cumulative effects will be addressed by standard mitigation measures and best management practices. With the implementation of these proposed mitigation measures, adverse residual environmental effects of routine Project activities and components are predicted to be not significant for all VCs.

Environmental effects associated with potential accidental events are assessed with the focus of the assessment on credible worst-case accidental event scenarios that could result in significant environmental effects. Accidental events that could potentially occur during exploration drilling and could potentially result in adverse environmental effects include small spills which could occur during MODU or PSV operations, and a subsea blowout event. Interactions with VCs are identified for these scenarios, and potential environmental effects are assessed. A description of the planned mitigation and contingency measures is provided, and a conclusion regarding the significance of potential residual environmental effects and their likelihood of occurrence is given.

In the unlikely event of a Project-related accidental event resulting in the large-scale release of oil (*e.g.*, a blowout incident), effects to Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries, and Current Aboriginal Land and Resource Use for Traditional Purposes have potential to be significant if the spill trajectory overlaps spatially and temporally with sensitive receptors. However, with the implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects are unlikely to occur.

In summary, the Project is not likely to result in significant adverse residual environmental effects, including cumulative environmental effects, provided that the proposed mitigations are implemented.

BP recognizes the challenge of managing and meeting growing worldwide demand for energy while addressing climate change and other environmental and social issues. The proposed Project will contribute to energy diversification and is expected to generate industrial, employment, and social benefits. The Project is also expected to contribute to technological and scientific knowledge sharing in Canada and Nova Scotia, advancing the understanding of deepwater drilling operations offshore Nova Scotia.

A concordance table is provided below (Table E.1.1) to demonstrate compliance with the final EIS Guidelines and indicate where requirements have been addressed in this EIS document.

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
PART I - BACKGROUND	
1 INTRODUCTION	
2 GUIDING PRINCIPLES	
2.1 Environmental Assessment as a Planning Tool	EIS submission
2.2 Public Participation	3 Stakeholder Engagement
2.3 Aboriginal Engagement	4 Aboriginal Engagement B Traditional Use Study (Appendix B)
2.4 Application of the Precautionary Approach	6.1 Scope of Assessment 7 Environmental Effects Assessment 8 Accidental Events
3 SCOPE OF THE ENVIRONMENTAL ASSESSMENT	
3.1 Designated Project	2 Project Description 6.1 Scope of the Assessment
3.2 Factors to be Considered	6.1.2 Factors to be Considered
3.3 Scope of Factors	6.1 Scope of the Project
3.3.1 Changes to the Environment	7.2 Fish and Fish Habitat 7.3 Marine Mammals and Sea Turtles 7.4 Migratory Birds 7.5 Special Areas 7.6 Commercial Fisheries 7.7 Aboriginal Use of Lands and Resources for Traditional Purposes 11.1 Changes to the Physical

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
	Environment 11.2 Effects of Changes to the Environment
3.3.2 Valued Components to be Examined	6.2.2 Selection of Valued Components
3.3.3 Spatial and Temporal Boundaries	6.2.3.4 Environmental Assessment Boundaries 7.2.4.1 Environmental Assessment Boundaries (Fish and Fish Habitat) 7.3.4.1 Environmental Assessment Boundaries (Marine Mammals and Sea Turtles) 7.4.4.1 Environmental Assessment Boundaries (Migratory Birds) 7.5.4.1 Environmental Assessment Boundaries (Special Areas) 7.6.4.1 Environmental Assessment Boundaries (Commercial Fisheries) 7.7.4.1 Environmental Assessment Boundaries (Current Aboriginal Use of Lands and Resources for Traditional Purposes)
4 PREPARATION AND PRESENTATION OF THE ENVIRONMENTAL IMPACT STATEMENT	
4.1 Guidance	1.3 Regulatory Framework and the Role of the Government 1.4 Applicable Guidelines and Resources
4.2 Study Strategy and Methodology	6 Environmental Effects Assessment Scope and Methods
4.3 Use of Information	
4.3.1 Scientific Advice	5 Existing Environment
4.3.2 Community Knowledge and Aboriginal Traditional Knowledge	3 Stakeholder Consultations and Engagement 4 Aboriginal Engagement 7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes B Traditional Use Study (Appendix B)
4.3.3 Existing Information	5 Existing Environment
4.3.4 Confidential Information	N/A

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
4.4 Presentation and Organization of the Environmental Impact Statement	Title Page Table of Contents List of Tables and Figures Concordance Table Acronyms 14 References
4.5 Summary of the Environmental Impact Statement	EIS Summary Document
PART 2 – CONTENT OF THE ENVIRONMENTAL IMPACT STATEMENT	
1 INTRODUCITON AND OVERVIEW	
1.1 The Proponent	
In the EIS, the proponent will: • provide contact information (*e.g.* name, address, phone, fax, email);	1.3.2 Proponent Contact Information
• identify itself and the name of the legal entity that would develop, manage and operate the project;	1.3 Proponent Information
• describe corporate and management structures;	1.3.1 How BP Operates
• specify the mechanism used to ensure that corporate policies will be implemented and respected for the project; and	1.3.1 How BP Operates
• identify key personnel, contractors, and/or sub-contractors responsible for preparing the EIS.	1.3.3 Project Team
1.2 Project Overview	
The EIS will describe the project, key project components and associated activities, scheduling details, the timing of each phase of the project and other key features. If the project is a part of a larger sequence of projects, the EIS will outline the larger context.	2.3 Project Components 2.3.1 Drilling Vessel 2.3.2 Offshore Exploration Wells 2.3.3 Supply and Servicing Components 2.4 Project Activities 2.4.1 MODU Mobilization 2.4.2 Drilling 2.4.3 Well Evaluation 2.4.4 Well Abandonment 2.4.5 Supply and Servicing 2.7 Project Schedule
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 UTM coordinates of the main project site;	2.2 Project Location (Table 2.2.1 Project Area Coordinates)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• current land use in the area;	2.2 Project Location 2.4.5 Supply and Servicing 5.3 Socio-Economic Environment 5.3.1 Land and Nearshore Ocean Use B Traditional Use Study (Appendix B)
• distance of the project facilities and components to any federal lands;	1.5.3 Other Applicable Regulatory Requirements
• the environmental significance and value of the geographical setting in which the project will take place and the surrounding area;	5 Existing Environment
• environmentally sensitive areas, such as national, provincial and regional parks, ecological reserves, wetlands, estuaries, and habitats of federally or provincially listed species at risk and other sensitive areas;	5.2.5.4 Species at Risk and Species of Conservation Concern (Marine Fish) 5.2.6.4 Species at Risk and Species of Conservation Concern (Marine Mammals) 5.2.7 Sea Turtles 5.2.8.3 Areas of Significance to Migratory Birds (Table 5.2.1.8 Important Bird Areas in and Adjacent to the RAA) 5.2.10 Special Areas (Table 5.2.20 Special Areas in the RAA) 11.1.1 Changes to Components of the Environment within Federal Jurisdiction
• local and Aboriginal communities; and,	2.2 Project Location 4.2 Aboriginal Organizations B Traditional Use Study (Appendix B)
• traditional Aboriginal territories, treaty lands, Indian reserve lands.	4.2 Aboriginal Organizations 4.3 Potential or Established Rights and Related Interests B Traditional Use Study (Appendix B)
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;	1.5 Regulatory Framework and the Role of Government 1.5.1 Offshore Regulatory Framework

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• the environmental and other regulatory approvals and legislation that are applicable to the project at the federal, provincial, regional and municipal levels;	1.5.2 Environmental Assessment Requirements 1.5.3 Other Applicable Regulatory Requirements
• government policies, resource management, planning or study initiatives pertinent to the project and/or EA and their implications;	1.6 Applicable Guidelines and Resources 1.6.1 Government Guidelines and Resources
• any treaty or self-government agreements with Aboriginal groups that are pertinent to the project and/or EA;	1.6.2 Aboriginal Policies and Guidelines 4.3 Potential or Established Rights and Related Interests B Traditional Use Study (Appendix B)
• any relevant land use plans, land zoning, or community plans; and	2.3.3 Supply and Servicing Components 4.2 Aboriginal Organizations
• 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.	1.5 Regulatory Framework and the Role of Government 6.2.3.3 Potential Environmental Effects, Pathways and Measureable Parameters 6.2.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance 7.2.1 Regulatory and Policy Setting (Fish and Fish Habitat) 7.3.1 Regulatory and Policy Setting (Marine Mammals and Sea Turtles) 7.4.1 Regulatory and Policy Setting (Migratory Birds) 7.5.1 Regulatory and Policy Setting (Special Areas) 7.6.1 Regulatory and Policy Setting (Commercial Fisheries) 7.7.1 Regulatory and Policy Setting (Aboriginal Use of Lands and Resources for Traditional Purposes)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
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.	2.1 Rationale and Need for the Project
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, if such effects are identified.	1.4 Benefits of the Project
2.2 Alternative Means of Carrying Out the Project	
The EIS will identify and consider the effects of alternative means of carrying out the project that are technically and economically feasible. 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.	2.9 Alternative Means of Carrying Out the Project 2.9.1 Options Analysis Framework 2.9.2 Identification and Evaluation of Alternatives
In its alternative means analysis, the proponent will address, at a minimum, the following project components: • choice of drilling fluid (*i.e.*, WBM or SBM); • management of drilling wastes (*i.e.*, disposal on seabed or into water column, recover and ship to shore, re-inject); and • alternative ways to light the platform at night (or flare at night when testing the well), to reduce attraction and associated mortality of birds, such as by installing flare shields.	2.9.2 Identification and Evaluation of Alternatives 2.9.2.1 Drilling Fluids Selection 2.9.2.2 Drilling Waste Management 2.9.2.3 Offshore Vessel Lighting 2.9.2.4 Well Test Flaring
The *Offshore Waste Treatment Guidelines*[1] 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	2.8 Emissions, Discharges and Waste Management 2.8.2 Drilling Waste Discharges 2.8.3 Liquid Discharges 2.8.4 Hazardous and Non-Hazardous Wastes

1 National Energy Board, Canada-Nova Scotia Offshore Petroleum Board and Canada-Newfoundland Offshore Petroleum Board. *Offshore Waste Treatment Guidelines*. December 2010. Available from: www.cnsopb.ns.ca

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
would enable it to achieve these objectives and adopt best practices in waste management and treatment.	
The *Offshore Chemical Selection Guidelines*[2] provide a framework for the selection of chemicals in support of offshore operations. 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[1] Pose Little or No Risk to the Environment (PLONOR) list of chemicals and have a PARCOM[2] 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. 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.	2.4.2 Drilling 2.8.2 Drilling Waste Discharges 2.9.3 Chemical Management 12 Environmental Management and Monitoring
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: • maps, at an appropriate scale, of the project location;	2 Project Description (Figure 2.2.1 Project Area and Regional Assessment Area) 2.3 Project Components 2.4 Project Activities
• the onshore and offshore project components;	2.3 Project Components
• boundaries of the proposed site with coordinates;	2.2 Project Location (Table 2.2.1 Project Coordinates)
• the major existing infrastructure;	N/A
• adjacent land uses; and	5.3 Socio-Economic Environment
• any important environmental features.	5.1 Marine Physical Environment 5.2 Marine Biological Environment

2 National Energy Board, Canada-Nova Scotia Offshore Petroleum Board and Canada-Newfoundland Offshore Petroleum Board. *Offshore Chemical Selection Guidelines*. April 2009. Available from: www.cnsopb.ns.ca

[1] Oslo and Paris Commissions

[2] Paris Commission

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
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.	N/A
In its EIS, the proponent will describe: • the Mobile Offshore Drilling Unit and its operations (drilling, testing, abandonment) in locations and water depths under consideration;	2.3.1 Drilling Vessel 2.3.2 Offshore Exploration Wells 2.4.1 MODU Mobilization 2.4.2 Drilling 2.4.3 Well Evaluation 2.4.4 Well Abandonment
• the type of vessels that will be used and navigation activities (*i.e.*, routes, number and frequency of trips);	2.3.3 Supply and Servicing Components 2.4.5 Supply and Servicing
• helicopters, including routes, number and frequency of trips;	2.3.3.2 Support Vessels and Helicopters 2.4.5.2 Helicopter Traffic and Operations
• vertical seismic profile surveys or any other in water work;	2.4.3.2 Vertical Seismic Profiling
• reagent requirements and uses (*e.g.*, volumes, storage, types);	2.8 Emissions, Discharges and Waste Management
• petroleum products (*e.g.*, source, volume, storage);	2.8.4 Hazardous and Non-Hazardous Wastes
• the management and disposal of wastes (*e.g.*, type and constituents of waste, quantity, treatment and method of disposal) including: o drilling muds, drill solids; o bilge and ballast water; o deck drainage; o cooling water; o fire control system test water; o operational discharges from subsea systems and the installation of subsea systems; o sewage and food wastes; o well treatment or testing fluids; and o other operational discharges.	2.4.2.1 Well Execution Strategy and Drilling Sequence 2.8 Emissions, Discharges and Waste Management 2.8.2 Drilling Waste Discharges 2.8.3 Liquid Discharges 2.8.4 Hazardous and Non-Hazardous Wastes 2.9.3 Chemical Management
• contributions to atmospheric emissions, including emissions profile (*i.e.*, type, rate and source) for activities including routine or upset flaring, routine drilling, shipping etc.;	2.8.1 Atmospheric Emissions
• sources and extent of light, heat and noise;	2.8.5 Sound and Light Emissions
• transfers of bulk materials (*e.g.*, mud) and fuel; and,	2.4.5.1 Supply and Servicing 2.8.4 Hazardous and Non-Hazardous Wastes 8.2.2 Bulk Spill

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• number of employees and transportation of employees.	2.4.5.2 Helicopter Traffic and Operations 2.6 Project Personnel
3.2 Project Activities	
The EIS will include descriptions of the drilling, well testing, and where relevant, decommissioning, and abandonment of the sites affected by the offshore component of the project.	2.4 Project Activities 2.4.1 MODU Mobilization 2.4.2 Drilling 2.4.3 Well Evaluation 2.4.4 Well Abandonment
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.	2.4 Project Activities 2.4.1 MODU Mobilization 2.4.2 Drilling 2.4.3 Well Evaluation 2.4.4 Well Abandonment
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 public concerns identified. Highlight activities that involve periods of increased environmental disturbance or the release of materials into the environment.	2.4.3.2 Vertical Seismic Profiling 2.4.3.3 Well Flow Testing 2.5 Well Control and Blowout Prevention 2.8 Emissions, Discharges and Waste Management
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, Aboriginal peoples, and the public.	11.3 Summary of Changes Made to the Project Since Originally Proposed
The EIS will include a detailed schedule including time of year, frequency, and duration for all project activities.	2.7 Project Schedule
The information will include a description of offshore and onshore activities:	2.4 Project Activities
3.2.1 Offshore Drilling	
• operation of the Mobile Offshore Drilling Unit, including: o drilling at various water depths and in locations under consideration; o well flow testing; o well abandonment; and o waste management.	2.3.1 Drilling Vessel 2.4.1 MODU Mobilization 2.4.3 Well Evaluation 2.4.4 Well Abandonment 2.8 Emissions, Discharges and Waste Management
• vertical seismic profile surveys	2.4.3.2 Vertical Seismic Profiling
3.2.2 Supply and Servicing	
• vessel support, including loading and operation of marine support vessels (*i.e.*, for transfer, re-supply and on-site safety during drilling activities)	2.3.3 Supply and Servicing Components 2.4.5 Supply and Servicing

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• helicopter support (*i.e.*, crew transport and delivery of supplies and equipment)	2.3.3 Supply and Servicing Components 2.4.5.2 Helicopter Traffic and Operations
• petroleum products (*i.e.*, source, volume, storage)	2.4.5 Supply and Servicing
4 PUBLIC CONSULTATION AND CONCERNS	
The EIS will describe the ongoing and proposed consultations and the information sessions that the proponent will hold or that it has already held 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 environmental assessment as well as describe any outstanding issues and ways to address them.	3 Stakeholder Consultation and Engagement (Table 3.3.1 Summary of Stakeholder Engagement Conducted for the Project and Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement)
5 ABORIGINAL ENGAGEMENT AND CONCERNS	
The EIS will describe the ongoing and proposed consultations and the information sessions that the proponent will hold or that it has already held 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 environmental assessment as well as describe any outstanding issues and ways to address them.	4 Aboriginal Engagement 4.4 Aboriginal Engagement Activities 4.5 Questions and Comments Raised During Aboriginal Engagement
• potential adverse impacts of the project on potential or established Aboriginal or Treaty rights.	7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes
With respect to the above matters and in addition to information requirements outlined in Part 2, Sections 6.19 and 6.35 of these guidelines, the EIS will document: • VCs suggested by Aboriginal groups for inclusion in the EIS, whether they were included, and the rationale for any exclusions;	6.2.2 Selection of Valued Components 4 Aboriginal Engagement B Traditional Use Study (Appendix B)
• each group's potential or established rights (including geographical extent, nature, frequency, timing), including maps and data sets (*e.g.*, fish catch numbers) when this information is provided by a group to the proponent or available through public records;	4.2 Aboriginal Organizations 4.3 Potential or Established Rights and Related Interests 5.3.6 Aboriginal Fisheries B Traditional Use Study (Appendix B)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• based on the proponent's perspective, the potential adverse impacts of each of the project components and physical activities, in all phases, on potential or established Aboriginal or Treaty rights. This assessment is to be based on a comparison of the exercise of the identified rights between the predicted future conditions with the project and the predicted future conditions without the project. Include the perspectives of Aboriginal groups where these were provided to the proponent by the groups;	7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes 11.2.1 Effects of Changes to the Environment on Aboriginal People B Traditional Use Study (Appendix B)
• based on the proponent's perspective, the measures identified to mitigate or accommodate potential adverse impacts of the project on the potential or established Aboriginal or Treaty rights. These measures will be written as specific commitments that clearly describe how the proponent intends to implement them;	7.7.8.2 Mitigation of Project-Related Environmental Effects (Current Aboriginal Use of Lands and Resources for Traditional Purposes)
• based on the proponent's perspective, the effects of changes to the environment on Aboriginal peoples or potential adverse impacts on potential or established Aboriginal or Treaty rights that have not been fully mitigated or accommodated as part of the environmental assessment and associated engagement with Aboriginal groups, including the potential adverse effects that may result from the residual and cumulative environmental effects. Include the perspectives of Aboriginal groups where these were provided to the proponent by the groups;	N/A
• specific suggestions raised by Aboriginal groups for mitigating the effects of changes to the environment on Aboriginal peoples or accommodating potential adverse impacts of the project on potential or established Aboriginal and Treaty rights;	7.2.2 The Influence of Engagement on the Assessment (Fish and Fish Habitat) 7.3.2 The Influence of Engagement on the Assessment (Marine Mammals and Sea Turtles) 7.4.2 The Influence of Engagement on the Assessment (Migratory Birds) 7.5.2 The Influence of Engagement on the Assessment (Special Areas) 7.6.2 The Influence of Engagement on the Assessment (Commercial Areas) 7.7.2 The Influence of Engagement on the Assessment (Current Aboriginal Use of Lands and Resources for Traditional Purposes)
• views expressed by Aboriginal groups on the effectiveness of the mitigation or accommodation measures;	4.5 Questions and Comments Raised During Aboriginal Engagement

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• from the proponent's perspective, any potential cultural, social and/or economic impacts or benefits to Aboriginal groups that may arise as a result of the project. Include the perspectives of Aboriginal groups where these were provided to the proponent by the groups;	11.2.1 Effects of Changes to the Environment on Aboriginal People
• comments, specific issues and concerns raised by Aboriginal groups and how the key concerns were responded to or addressed;	4 Aboriginal Engagement 4.4 Aboriginal Engagement Activities (Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project) 4.5 Questions and Comments Raised During Aboriginal Engagement (Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement)
• changes made to the project design and implementation directly as a result of discussions with Aboriginal groups;	4.5 Questions and Comments Raised During Aboriginal Engagement 11.3 Summary of Changes Made to the Project Since Originally Proposed
• where and how Aboriginal traditional knowledge was incorporated into the environmental effects assessment (including baseline conditions and effects analysis for all VCs) and the consideration of potential adverse impacts on potential or established Aboriginal or Treaty rights and related mitigation measures; and	5.3.6 Aboriginal Fisheries 7.2.2 The Influence of Engagement on the Assessment (Fish and Fish Habitat) 7.3.2 The Influence of Engagement on the Assessment (Marine Mammals and Sea Turtles) 7.4.2 The Influence of Engagement on the Assessment (Migratory Birds) 7.5.2 The Influence of Engagement on the Assessment (Special Areas) 7.6.2 The Influence of Engagement on the Assessment (Commercial Areas) 7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes 7.7.2 The Influence of Engagement on the Assessment (Current Aboriginal Use of Lands and Resources for Traditional Purposes) B Traditional Use Study (Appendix B)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• any additional issues and concerns raised by Aboriginal groups in relation to the environmental effects assessment and the potential adverse impacts of the project on potential or established Aboriginal and Treaty rights.	4.5 Questions and Comments Raised During Aboriginal Engagement (Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement)
5.1 Aboriginal Groups to Engage & Engagement Activities	
With respect to engagement activities, the EIS will document: • the engagement activities undertaken with Aboriginal groups 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 Aboriginal groups to understand the project and evaluate its effects on their communities, activities, potential or established Aboriginal or Treaty rights and other interests.	4 Aboriginal Engagement 4.4 Aboriginal Engagement Activities (Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project) 4.5 Questions and Comments Raised During Aboriginal Engagement (Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement)
6 EFFECTS ASSESSMENT	
6.1 Project Setting and Baseline Conditions	
Based on the scope of 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. Where environmental effects are predicted, the EIS should discuss the anticipated timeframe for a return to baseline conditions, if applicable. 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 3.3.3 (Part 1). As a minimum, the EIS will include a description of:	5 Existing Environment
6.1.1 Atmospheric Environment and Climate	
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: • ambient air quality in the project area including but not limited to the following contaminants: total suspended particulates, $PM_{2.5}$, PM_{10}, SOx, VOCs and NOx; • relevant weather parameters such as wind speed and direction, precipitation, visibility and storm events in the drilling area.	5.1.2 Atmospheric Environment 5.1.2.2 Air Quality (Table 5.1.2 Summary of Measured Air Contaminant Concentrations on Sable Island, Nova Scotia) 5.1.2.3 Wind Climate 5.1.2.4 Extreme Weather 5.1.2.5 Visibility and Fog
Relevant marine climate data sources should be consulted, such as the Sable Island weather station, the Environment Canada weather buoys project (the Lahave Bank, East Scotian Slope, Banquereau Bank, and Laurentian Fan buoys), the International Comprehensive Atmosphere Ocean Dataset (ICOADS), the United States of America National Oceanographic and Atmospheric	5.1.2 Atmospheric Environment 5.1.2.1 General Climate (Table 5.1.1 Temperature and Precipitation Climate Data, 1981-2010, Sable Island, Nova Scotia)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
Administration (NOAA) database of tropical cyclone activity in the North Atlantic and the Canadian Lightning Detection Network.	5.1.2.3 Wind Climate (Table 5.1.3 Buoy Data Used in Metocean Analysis)
6.1.2 Marine environment	
The EIS will describe the marine environment at the project site and within areas that could be affected by routine project operations or accidents and malfunctions, such as: • marine water quality; (*e.g.*, water temperature, turbidity, salinity and pH).	5.1.3 Marine Physical Oceanography 5.1.3.4 Water Mass Characteristics
• marine geology and geomorphology (*i.e.*, bottom sediments, including quality, thickness, grain size, and mobility);	5.1.1 Marine Geophysical Environment
• 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 shipping routes;	5.1.3.2 Ocean Currents 5.1.3.3 Wave Climate
• available bathymetric information for the site and along shipping routes if applicable;	5.1.3.1 Bathymetry
• ice climate in the regional study area, including ice formation and thickness, ridging, breakup and movement;	5.1.3.5 Sea Ice and Icebergs
• 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.	5.1.3.6 Ocean Sound 7.1.1.2 Underwater Sound
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 for the North Atlantic, long term hourly wave measurements from the Environment Canada weather buoys in the vicinity of the project area as well as Fisheries and Oceans Canada archives of hourly wave measurements from offshore platforms and co-located wave buoys operating on the Scotian Shelf and Slope.	5.1.3.3 Wave Climate
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: • describing the fish species present on the basis of the surveys carried out and the data available (*e.g.* government and historical databases, commercial fishing data). Identify the sources of the data and provide the information concerning the fishing carried out (*e.g.* location of sampling stations, catch methods, date of catches, species);	5.2.5 Marine Fish 8.5.1 Fish and Fish Habitat (Accidental Events)
• characterizing fish populations on the basis of species and life stage for affected waters;	5.2.5 Marine Fish

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• listing any rare fish or invertebrate species that are known to be present; and	5.2.5.4 Species at Risk and Species of Conservation Concern
• describing the physical and biological characteristics of the fish and fish habitat likely to be directly or indirectly affected by the project.	5.2.5 Marine Fish
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: • the location 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, growth, feeding, migration, overwintering). It is recommended that photos be attached to the description, if available;	5.2.4 Marine Plants 5.2.5 Marine Fish
• quality, thickness, grain size and mobility of bottom sediments;	5.1.1 Marine Geophysical Environment 5.2.2 Benthic Habitat
• available bathymetry information for the drilling site and maximum and mean depths;	5.1.3.1 Bathymetry
• a discussion of sea bottom stability at the project site; and	5.1.1 Marine Geophysical Environment 9.1.6 Sediment and Seafloor Instability and Other Geohazards
• 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).	5.2.2 Benthic Habitat 5.2.3 Corals and Sponges
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.	5.2.8 Migratory Birds 5.2.8.1 Overview
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: • abundance, distribution, and life stages of birds in the area, including species composition for each season;	5.2.8.2 Seasonal Distribution of Migratory Birds in Association with the Scotian Shelf and Slope 5.2.8.4 Species at Risk and Species of Conservation Concern (Migratory Birds)
• a characterization of year-round migratory bird use of the area (*e.g.* over-wintering, spring migration, breeding season, fall migration);	5.2.8.2 Seasonal Distribution of Migratory Birds in Association with the Scotian Shelf and Slope

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• areas of concentration of migratory birds, such as for breeding, feeding or resting;	5.2.8.2 Seasonal Distribution of Migratory Birds in Association with the Scotian Shelf and Slope 5.2.8.3 Areas of Significant to Migratory Birds
6.1.5 Species at Risk and Species Of Conservation Concern	
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 and provincially 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; • 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 special concern.[3] • any published studies that describe the regional importance, abundance and distribution of species at risk; • residences, seasonal movements, movement corridors, habitat requirements, key habitat areas, identified 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; and • recovery strategies for information on any critical habitat in the project area of endangered and threatened species and management plans for information on habitat use of species of special status.	5.2.5.4 Species at Risk and Species of Conservation Concern (Fish and Fish Habitat) 5.2.6.4 Species at Risk and Species of Conservation Status (Marine Mammals) 5.2.7 Sea Turtles 5.2.8.4 Species at Risk and Species of Conservation Concern (Migratory Birds) 5.2.9 Species at Risk
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: • marine mammal species that may be present, the times of year they are present, the ranges of the species and their migration patterns; and • 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.*).	5.2.6 Marine Mammals 5.2.6.1 Overview 5.2.6.2 Mysticetes 5.2.6.3 Odontocetes 5.2.6.4 Species at Risk and Species of Conservation Status 5.2.6.5 Phocids

[3] Proponents are encouraged to consult COSEWIC's annual report for a listing of the designated wildlife species: http://www.cosewic.gc.ca/eng/sct0/index_e.cfm#sar.

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
6.1.7 Marine Turtles	
The EIS will describe marine turtles and their habitat at the project site and within areas 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 • important areas in the vicinity of the drilling sites or supply routes (*e.g.*, for mating, breeding, feeding, nursing of young) or that could be impacted by the project (*e.g.*, routine discharges, spills, etc.).	5.2.7 Sea Turtles
6.1.8 Special Areas	
The EIS will describe special areas (*e.g.*, species at risk critical habitat, Important Bird Areas, Migratory Bird Sanctuaries, National Parks, ecological reserves, etc.) at the project site and within areas that could be affected by routine project operations or accidents and malfunctions, such as: • the Haddock Box-Haddock Spawning Area; • Ecologically and Biologically Significant Areas (EBSA), particularly the Scotian Slope EBSA and the Emerald-Western-Sable Island Bank Complex EBSA; • Sable Island National Park Reserve; • the Gully Marine Protected Area; • Northern Bottlenose Whale Critical Habitat; and • Sambro Bank and Emerald Bank Sponge Conservation Areas.	5.2.10 Special Areas (Table 5.2.20 Special Areas in the RAA)
The EIS will describe the distances between the edge of the project area (*i.e.* drill sites and shipping routes) and special areas. It shall state the rationale for designating specific areas as "special" (*i.e.* the defining environmental features of the special area).	5.2.10 Special Areas (Table 5.2.20 Special Areas in the RAA)
6.1.9 Aboriginal Peoples	

With respect to potential effects on Aboriginal peoples and the related VCs, baseline information will be provided for each Aboriginal group identified in section 5 (and any groups identified after these guidelines are finalized). Baseline information will describe and characterize the following, based on the spatial and temporal scope selected for the assessment:
• current use of lands and resources for traditional purposes on, near and offshore, including;
  o commercial and traditional (*e.g.* communal gathering of fish for feasts) fishing activity within the project's potential zone of influence, including licenses and maps;
  o fish, wildlife, birds, plants or other natural resources of importance for traditional use;
  o places where fish, wildlife, birds, plants or other natural resources are harvested;
	4.2 Aboriginal Organizations
	5.3.6 Aboriginal Fisheries
	7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes
	11.2.1 Effects of Changes to the Environment on Aboriginal People
	B Traditional Use Study (Appendix B)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
o access and travel routes for conducting traditional practices; o frequency, duration or timing of traditional practices; and o reliance on country foods.	
• any Project components and a description of any activities (*e.g.*, exclusion zones) that may affect commercial fisheries or other uses;	5.3.6 Aboriginal Fisheries 7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes 11.2.1 Effects of Changes to the Environment on Aboriginal People
• location of reserves and communities;	4.2 Aboriginal Organizations B Traditional Use Study (Appendix B)
• location of traditional territory (including maps where available);	4.2 Aboriginal Organizations B Traditional Use Study (Appendix B)
• cultural values associated with the area affected by the project and the traditional uses identified; and	7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes 11.1.2.3 Current Aboriginal Use of Lands and Resources for Traditional Purpose 11.2.1 Effects of Changes to the Environment on Aboriginal People B Traditional Use Study (Appendix B)
• physical and cultural heritage[4] (including any site, structure or thing of archaeological, paleontological, historical or architectural significance).	5.3.7 Physical and Cultural Heritage 7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes B Traditional Use Study (Appendix B)
Any other baseline information that supports the analysis of predicted effects on Aboriginal peoples will be included as necessary. The EIS will also indicate how input from Aboriginal groups 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.	B Traditional Use Study (Appendix B)

[4] Heritage resources to be considered will include but not be limited to, physical objects (*e.g.* middens, culturally-modified trees, historic buildings), sites or places (*e.g.* burial sites, sacred sites, cultural landscapes) and attributes (*e.g.* language, beliefs).

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
6.1.10 Human Environment	
With respect to potential effects on the human environment, non-Aboriginal people and the related VCs, baseline information will describe and characterize the following, based on the spatial and temporal scope selected for the assessment. At a minimum, this should include: • any federal lands and any lands located outside the province or Canada that may be affected by routine project operations or by accidents and malfunctions;	5.3 Socio-Economic Environment
• information on current and historical use of all waters that may be affected by routine project operations or by accidents and malfunctions, including: o current commercial and recreational fishing activity in the project area that may be affected, including licence holders and species fished; o any project components and a description of any activities (*e.g.*, exclusion zones) that may affect commercial or recreational fisheries or other uses; o recreational uses of near-shore waters (*i.e.*, swimming, canoeing, boating) that may be affected by the project; and o other ocean use (*e.g.* shipping, research, oil and gas, military activities, ocean infrastructure (*e.g.*, sub-sea cables).	5.3.1 Land and Nearshore Ocean Use 5.3.4 Ocean Use and Infrastructure 5.3.4.4 Tourism and Recreational Activities 5.3.5 Offshore Commercial Fisheries 10.1.1.3 Other Physical Activities
• location of and proximity of the Project to any permanent, seasonal or temporary residences;	5.3.1.1 Communities in Nova Scotia
• health[5] and socio-economic conditions, including information on 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;	5.3.2 Labour and Economy 5.3.3 Human Health
• human health, with respect to potential contamination of food sources and change in air quality;	5.3.3 Human Health 5.1.2.2 Air Quality
• physical and cultural heritage, including structures, sites or things of historical, archaeological, paleontological or architectural significance (*e.g.*, ship wrecks); and	5.3.7 Physical and Cultural Heritage
• the rural and urban settings that could be affected by routine project activities or accidents and malfunctions.	5.3.1.1 Communities in Nova Scotia
• The EIS should also discuss the potential to encounter unexploded ordnance (UXOs), based on consultation with the Department of National Defence.	5.2.2.2 Geohazard Baseline Review 5.3.4.6 Seabed Hazards Associated with Human Activities

[5] The proponent should refer to Health Canada's Useful Information for Environmental Assessments document in order to include the appropriate baseline information relevant to human health. This document can be obtained at http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/environ_assess-eval/index-eng.php.

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
6.2 Predicted Changes to the Physical Environment	
The assessment 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 (construction, operation, decommissioning, and abandonment) and are to be described in terms of the geographic extent of the changes, the duration and frequency of change, and whether the environmental changes are reversible or irreversible.	7.2 Fish and Fish Habitat 7.3 Marine Mammals and Sea Turtles 7.4 Migratory Birds 7.5 Special Areas 7.6 Commercial Fisheries 7.7 Current Aboriginal Use of Lands and Resources for Traditional Purposes
The EIS will include a stand-alone section that summarizes 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.	11.1.1 Changes to Components of the Environment within Federal Jurisdiction
The EIS will include a stand-alone section that summarizes 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).	11.1.1 Changes to Components of the Environment within Federal Jurisdiction 11.1.2 Changes to the Environment that Would Occur on Federal or Transboundary Lands
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).	11.1.3 Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions
In addition, the EIS will identify any changes related to the terrestrial environment, including: • landscape disturbance; • migratory bird habitat, including losses, structural changes, fragmentation of habitat and wetlands (cover types, ecological land unit in terms of quality, quantity, diversity, distribution and functions) used by migratory birds; • critical habitat for federally listed species at risk; and • key habitat for species important to Aboriginal current use of resources.	11.1.3.2 Terrestrial Environment
6.3 Predicted Effects on Valued Components	
6.3.1 Fish and Fish Habitats	
• effects on fish and fish habitat, including but not limited to: o the identification of any potential harmful alteration, disruption or destruction of fish habitat, including the calculations of any potential habitat loss (temporary or permanent) in terms of surface areas (*e.g.*, spawning grounds, fry-rearing areas, feeding). The assessment will include a consideration of: – effects on water quality;	7.2.7 Potential Project-VC Interactions (Fish and Fish Habitat) 7.2.8 Assessment of Project-Related Environmental Effects (Fish and Fish Habitat) 7.2.9 Determination of Significance (Fish and Fish Habitat)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
– 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); – underwater noise and vibration emissions from project activities (*i.e.*, drilling, vertical seismic profiling, offshore supply vessel operation, well abandonment); and – any potential imbalances in the food web in relation to baseline. o the effects of changes to the aquatic environment on fish and their habitat, including; – 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; and – any modifications in migration or local movements during and after drilling. o a discussion of how underwater noise and vibration caused by project activities, including drilling, may affect fish behaviour; o a discussion on 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; and o a description of how sediment deposition and acoustic monitoring data would be collected during and after drilling operations and how this would be used to verify effects predictions.	7.2.10 Follow-up and Monitoring 8.5.1 Fish and Fish Habitat (Accidental Events)
Disposal of drilling waste (*i.e.*, cuttings) is expected to be a primary cause of effects to marine benthos. The EIS should indicate the areal extent of drilling waste deposition 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.	C Sediment Dispersion Modelling (Appendix C)
6.3.2 Marine Plants	
• effects on marine plants.	6.2.2 Selection of Valued Components 7.2 Fish and Fish Habitat 8.5.1 Fish and Fish Habitat (Accidental Events)
6.3.3 Marine Mammals	
• effects on marine mammals, including but not limited to: o mortality and other effects from vessel collisions or disturbance; and	7.3.7 Potential Project-VC Interactions (Marine Mammals and Sea Turtles)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
o 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).	7.3.8 Assessment of Project-Related Environmental Effects (Marine Mammals and Sea Turtles) 7.3.9 Determination of Significance (Marine Mammals and Sea Turtles) 8.5.2 Marine Mammals and Sea Turtles (Accidental Events)
6.3.4 Marine turtles	
• effects on marine turtles, including but not limited to: o mortality and other effects from vessel collisions or disturbance; and o 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).	7.3.7 Potential Project-VC Interactions (Marine Mammals and Sea Turtles) 7.3.8 Assessment of Project-Related Environmental Effects (Marine Mammals and Sea Turtles) 7.3.9 Determination of Significance (Marine Mammals and Sea Turtles) 8.5.2 Marine Mammals and Sea Turtles (Accidental Events)
6.3.5 Migratory birds	
• effects on migratory birds, including but not limited to: o noise disturbance from seismic equipment including both direct effects (physiological), or indirect effects (foraging behaviour of prey species); o physical displacement as a result of vessel presence (*e.g.*, disruption of foraging activities); o 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); o exposure to spilled contaminants (*e.g.*, fuel, oils) and operational discharges (*e.g.,* deck drainage, gray water, black water); o 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; o physical harm or mortality from flaring on the drilling unit or other vessel based threats; o collision risk with the drilling unit and other project infrastructure; the effects of oil spills in the nearshore or that reach land on	7.4.7 Potential Project-VC Interactions (Migratory Birds) 7.4.8 Assessment of Project-Related Environmental Effects (Migratory Birds) 7.4.9 Determination of Significance (Migratory Birds) 8.5.3 Migratory Birds (Accidental Events)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
landbird species; o change in marine habitat quality from drill muds and cuttings and sedimentation; and o indirect effects caused by increased disturbance (*e.g.*, noise, light, presence of workers), relative abundance movements and changes in migratory bird habitat.	
6.3.6 Federal species at risk	
• effects on federally listed species at risk and those species listed by COSEWIC classified as extirpated, endangered, threatened or of special concern (flora and fauna) and their critical habitat; and • a discussion of migration patterns of federal species at risk and related effects (*e.g.*, displacement, increased risk of collision).	7.2.7 Potential Project-VC Interactions (Fish and Fish Habitat) 7.3.7 Potential Project-VC Interactions (Marine Mammals and Sea Turtles) 7.4.7 Potential Project-VC Interactions (Migratory Birds) 7.2.8 Assessment of Project-Related Environmental Effects (Fish and Fish Habitat) 7.3.8 Assessment of Project-Related Environmental Effects (Marine Mammals and Sea Turtles) 7.4.8 Assessment of Project-Related Environmental Effects (Migratory Birds) 7.2.9 Determination of Significance (Fish and Fish Habitat) 7.3.9 Determination of Significance (Marine Mammals and Sea Turtles) 7.4.9 Determination of Significance (Migratory Birds) 8.5.1 Fish and Fish Habitat (Accidental Events) 8.5.2 Marine Mammals and Sea Turtles (Accidental Events) 8.5.3 Migratory Birds (Accidental Events)
6.3.7 Aboriginal peoples	
• effects of changes to the environment on the current uses of land and resources for traditional purposes, including, but not limited to: o effects on food, social and ceremonial fishing and Aboriginal commercial fishing; o a discussion of how drilling activities correlates to key fisheries windows, and any potential impacts resulting from overlapping periods; o changes related to species important to Aboriginal current	7.7.7 Potential Project-VC Interactions (Aboriginal Use of Lands and Resources for Traditional Purposes) 7.7.8 Assessment of Project Related Environmental Effects (Aboriginal Use of Lands and Resources for Traditional Purposes)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
use of resources, including changes to key habitat o effects of alterations to access into the areas used for traditional uses and commercial fishing, including implementation of exclusion zones; o effects on cultural value or importance associated with traditional uses or areas affected by the project (*e.g.* inter-generational teaching of traditional practices); o how project activities correlates to the timing of traditional practices, and any potential impacts resulting from overlapping periods; o the regional value of traditional use of the project area and the anticipated effects to traditional practice of the Aboriginal group, including alienation of lands from Aboriginal traditional use; o indirect effects such as avoidance of the area by Aboriginal peoples due to increased disturbance (*e.g.* noise, presence of workers); and o an assessment of the potential to return affected areas to pre-disturbance conditions to support traditional practices.	7.7.9 Determination of Significance (Aboriginal Use of Lands and Resources for Traditional Purposes) 11.2.1 Effects of Changes to the Environment on Aboriginal People 8.5.6 Current Aboriginal Use of Lands and Resources for Traditional Purposes (Accidental Events)
• effects of changes to the environment on human health, considering, but not limited to potential changes in air quality, quality and availability of country foods and noise exposure.	6.2.2 Selection of Valued Components 11.2.1 Effects of Changes to the Environment on Aboriginal People
• effects of changes to the environment on socio-economic conditions, including but not limited to: o the use of navigable waters; o commercial fishing (*e.g.*, catch rates, exclusion zones, gear damage or loss, well abandonment, marketability of seafood products); and o recreational use.	6.2.2 Selection of Valued Components 7.6.7 Potential Project-VC Interactions (Commercial Fisheries) 7.6.8 Assessment of Project Related Environmental Effects (Commercial Fisheries) 7.6.9 Determination of Significance (Commercial Fisheries) 7.7.7 Potential Project-VC Interactions (Aboriginal Use of Lands and Resources for Traditional Purposes) 7.7.8 Assessment of Project Related Environmental Effects (Aboriginal Use of Lands and Resources for Traditional Purposes) 7.7.9 Determination of Significance (Aboriginal Use of Lands and Resources for Traditional Purposes) 8.5.5 Commercial Fisheries

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
	(Accidental Events) 8.5.6 Current Aboriginal Use of Lands and Resources for Traditional Purposes (Accidental Events) 11.2.1 Effects of Changes to the Environment on Aboriginal People
• effects of changes to the environment on physical and cultural heritage, and structure, site or thing of historical, archaeological, paleontological or architectural significance to Aboriginal groups, including, but not limited to: o the loss or destruction of physical and cultural heritage; o changes to access to physical and cultural heritage; and o changes to the cultural value or importance associated with physical and cultural heritage.	6.2.2 Selection of Valued Components 7.7.7 Potential Project-VC Interactions (Aboriginal Use of Lands and Resources for Traditional Purposes) 7.7.8 Assessment of Project Related Environmental Effects (Aboriginal Use of Lands and Resources for Traditional Purposes) 7.7.9 Determination of Significance (Aboriginal Use of Lands and Resources for Traditional Purposes) 11.2.1 Effects of Changes to the Environment on Aboriginal People
6.3.8 Air quality and Greenhouse Gas Emissions	
• changes to air quality;	2.8.1 Atmospheric Emissions 6.2.2 Selection of Valued Components 11.1.3.1 Atmospheric Environment
• changes to ambient noise levels;	2.8.5 Sound and Light Emissions 6.2.2 Selection of Valued Components 7.1.1.2 Underwater Sound D Acoustic Modelling Report (Appendix D)
• changes to night-time light levels; and	7.4 Migratory Birds (Changes in lighting levels and effects on migratory birds)
• an accounting of greenhouse gas emissions for all project phases and components.	2.8.1 Atmospheric Emissions
6.3.9 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),	7.6 Commercial Fisheries 8.5.5 Commercial Fisheries

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
gear loss or damage);	(Accidental Events)
• a discussion of how drilling activities correlates to key commercial fisheries windows, and any potential impacts resulting from overlapping periods;	7.6 Commercial Fisheries 8.5.5 Commercial Fisheries (Accidental Events)
• effects from subsea infrastructure that could be left in place (*e.g.* wellheads) following abandonment; and	7.6 Commercial Fisheries 8.5.5 Commercial Fisheries (Accidental Events)
• changes to habitat of commercial fish species (*e.g.* noise, water and sediment quality).	7.6 Commercial Fisheries 8.5.5 Commercial Fisheries (Accidental Events)
6.3.10 Special Areas	
• effects on special areas, including, but not limited to: o use of dispersants; – change to habitat quality (e.g. noise, light, water, sediment quality).	7.5 Special Areas 8.5.4 Special Areas (Accidental Events)
6.3.11 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 architectural value, including, but not limited to the following, as applicable: o recreational fishing activity (including near-shore); o other recreational uses of near-shore waters (*i.e.*, swimming, canoeing, boating); o other ocean uses; o socio-economic conditions; o human health; o physical and cultural heritage (*e.g.*, shipwrecks); o rural and urban settings.	5.3 Socio-economic Environment 6.2.2 Selection of Valued Components 8.5.4 Special Areas (Accidental Events) 10 Cumulative Effects 11.2.1 Effects of Changes to the Environment on Aboriginal People 11.2.2 Effects of Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions
6.4 Mitigation	
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 (including the measures directed at promoting beneficial or mitigating adverse socio-economic effects). 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	12.1 Environmental Management Plans 13.2 Summary of Mitigation, Monitoring and Follow-Up Commitments

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
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.	
The EIS will then describe mitigation measures that are specific to each environmental effect identified. Measures will be written as specific commitments that clearly describe how the proponent intends to implement them and the environmental outcome the mitigation is designed to address. Where mitigation measures have been identified in relation to species and/or critical habitat listed under the *Species at Risk Act*, the mitigation measures will be consistent with any applicable recovery strategy and action plans.	7.2.8.2 Mitigation of Project-Related Environmental Effects (Fish and Fish Habitat) 7.3.8.2 Mitigation of Project-Related Environmental Effects (Marine Mammals and Sea Turtles) 7.4.8.2 Mitigation of Project-Related Environmental Effects (Migratory Birds) 7.5.8.2 Mitigation of Project-Related Environmental Effects (Special Areas) 7.6.8.2 Mitigation of Project-Related Environmental Effects (Commercial Fisheries)
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 (drilling, testing, abandonment or other undertakings related to the project) to eliminate or reduce the significance of adverse effects. The impact statement 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.	12.2 Follow-Up and Monitoring 13.2 Summary of Mitigation, Monitoring and Follow-up Commitments
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 will be justified. The EIS will identify who is responsible for the implementation of these measures and the system of accountability.	2.9 Alternative Means of Carrying 12.2 Follow-Up and Monitoring 13.2 Summary of Mitigation, Monitoring and Follow-up Commitments
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 technology 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.	N/A

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
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. The residual effects, even if very small or deemed insignificant will be described.	7.2.8.3 Characterization of Residual Project-Related Environmental Effects (Fish and Fish Habitat) 7.3.8.3 Characterization of Residual Project-Related Environmental Effects (Marine Mammals and Sea Turtles) 7.4.8.3 Characterization of Residual Project-Related Environmental Effects (Migratory Birds) 7.5.8.3 Characterization of Residual Project-Related Environmental Effects (Special Areas) 7.6.8.3 Characterization of Residual Project-Related Environmental Effects (Commercial Fisheries) 7.7.8.3 Characterization of Residual Project-Related Environmental Effects (Current Aboriginal Use of Lands and Resources for Traditional Purposes)
The EIS will then provide an analysis of the significance of the residual environmental effects that are considered adverse, using guidance described in Section 4 of the Agency's reference guide *Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects*[6].	7.2.8.3 Characterization of Residual Project-Related Environmental Effects (Fish and Fish Habitat) 7.3.8.3 Characterization of Residual Project-Related Environmental Effects (Marine Mammals and Sea Turtles) 7.4.8.3 Characterization of Residual Project-Related Environmental Effects (Migratory Birds) 7.5.8.3 Characterization of Residual Project-Related Environmental Effects (Special Areas) 7.6.8.3 Characterization of Residual Project-Related Environmental Effects (Commercial Fisheries) 7.7.8.3 Characterization of Residual Project-Related Environmental Effects ((Aboriginal Use of Lands and Resources for Traditional Purposes)

6 Visit the Canadian Environmental Assessment Agency's website at: www.ceaa-acee.gc.ca/default.asp?lang=En&n=D213D286-1&offset=&toc=hide.

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
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, Aboriginal 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.	6.2.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance 6.2.3.7 Assessment of Project-Related Environmental Effects 7.2.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Fish and Fish Habitat) 7.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Marine Mammals and Sea Turtles) 7.4.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Migratory Birds) 7.5.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Special Areas) 7.6.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Commercial Fisheries) 7.7.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Aboriginal Use of Lands and Resources for Traditional Purposes)
The following criteria should be used in determining the significance of residual effects: • magnitude; • geographic extent; • duration; • frequency; • reversibility; • ecological and social context; and • existence of environmental standards, guidelines or objectives for assessing the impact.	6.2.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance 6.2.3.7 Assessment of Project-Related Environmental Effects 7.2.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Fish and Fish Habitat) 7.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Marine Mammals and Sea Turtles) 7.4.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
	(Migratory Birds) 7.5.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Special Areas) 7.6.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Commercial Fisheries) 7.7.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Aboriginal Use of Lands and Resources for Traditional Purposes)
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 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.	6.2.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance 6.2.3.7 Assessment of Project-Related Environmental Effects 7.2.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Fish and Fish Habitat) 7.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Marine Mammals and Sea Turtles) 7.4.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Migratory Birds) 7.5.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Special Areas) 7.6.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Commercial Fisheries) 7.7.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance (Aboriginal Use of Lands and Resources for Traditional Purposes)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
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 its environmental analysis.	7 Environmental Effects Assessment
6.6 Other Effects to Consider	
6.6.1 Effects of Potential Accidents or Malfunctions	
The failure of certain works caused by human error or exceptional natural events (*e.g.*, earthquake) could cause major effects. The proponent will therefore conduct an analysis of the risks of accidents and malfunctions, determine their effects and present emergency measures.	8 Accidental Events
Taking into account the lifespan of different project components, the proponent will identify the probability of potential accidents and malfunctions related to the project, in both the near-shore and offshore, 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 and the effects of these scenarios.	8.1 Potential Accidental Events
The geographical and temporal boundaries for the assessment of accidents and malfunctions will be broader than the assessment of routine operations in relation to specific VCs. 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*.	8 Accidental Events
The EIS will describe the safeguards that have been established to protect against such occurrences and the contingency and emergency response procedures in place if such events do occur.	8.1 Potential Accidental Events 8.2 Potential Spill Scenarios 8.3 Emergency Response and Spill Management
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 smaller-volume spills that may occur more frequently. These incidents may affect 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 by Aboriginal peoples, and the marketability of seafood products harvested in the Nova Scotia offshore may also be adversely affected by a spill or blowout incident. The effects of accidental spills and blowout incidents will therefore require assessment in the EIS, including trajectory modelling for worst-case large-scale spill scenarios that may occur. Results should be reported in a manner that illustrates the effects of varying weather and oceanographic conditions that may occur throughout the	8.2 Potential Spill Scenarios 8.4 Spill Fate and Behaviour 8.5 Environmental Effects Assessment (Accidental Events) H Spill Modelling (Appendix H)

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
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. 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 for spills (small and large) and blowout incidents 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. The EIS shall include a discussion on the use, availability, timing and feasibility of a capping stack to stop a blowout event 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 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.	8.3 Emergency Response and Spill Management 8.5 Environmental Effects Assessment (Accidental Events)
The potential to encounter shallow gas pockets, and associated implications, should also be discussed.	9.1.6 Sediment and Seafloor Instability and Other Geohazards
The EIS should also consider effects of accidents in the near-shore environment (*e.g.* spills and ship groundings) and of spills reaching shore (*e.g.* Nova Scotia and Sable Island National Park Reserve); including effects on species at risk and their critical habitat, colonial nesters and concentrations of birds, and their habitat.	8.1 Potential Accidental Events 8.2 Potential Spill Scenarios 8.5 Environmental Effects Assessment (Accidental Events) H Spill Modelling (Appendix H)
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 could adversely affect the project and how this in turn could result in impacts to the environment (*e.g.*, extreme environmental conditions result in malfunctions and accidental events). These events will be considered in different probability patterns (*i.e.*, 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	9 Effects of the Environment on the Project

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
of the environment on the project.	
6.6.3 Cumulative effects assessment	
In its EIS, the proponent will: • Identify and provide a rationale for the VCs that will constitute the focus of the cumulative effects assessment, emphasizing this 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: o Fish and fish habitat; o Marine Mammals and Sea Turtles; o Migratory Birds; o Special Areas; o Species at Risk; o Commercial Fisheries; and o Current Aboriginal Use of Lands and Resources for Traditional Purposes	10 Cumulative Effects 10.2 Cumulative Environmental Effects Assessment (Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project) 10.2.3 Assessment of Cumulative Environmental Effects on Fish and Fish Habitat 10.2.4 Assessment of Cumulative Environmental Effects on Marine Mammals and Sea Turtles 10.2.5 Assessment of Cumulative Environmental Effects on Migratory Birds 10.2.6 Assessment of Cumulative Effects on Special Areas 10.2.7 Assessment of Cumulative Effects on Commercial Fisheries 10.2.8 Assessment of Cumulative Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes
• 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.	10.1 Cumulative Environmental Effects Assessment Scope and Methods
• 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 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*.	10.2.2 Potential Cumulative Interactions between the Project and Past/Present/ sFuture Activities

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
• 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.	10.2.3 Assessment of Cumulative Environmental Effects on Fish and Fish Habitat 10.2.4 Assessment of Cumulative Environmental Effects on Marine Mammals and Sea Turtles 10.2.5 Assessment of Cumulative Environmental Effects on Migratory Birds 10.2.6 Assessment of Cumulative Effects on Special Areas 10.2.7 Assessment of Cumulative Effects on Commercial Fisheries 10.2.8 Assessment of Cumulative Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes 10.3 Follow-Up and Monitoring
• Determine the significance of the cumulative effects.	10.2 Cumulative Environmental Effects Assessment
• Develop a follow-up program to verify the accuracy of the assessment or to dispel the uncertainty concerning the effectiveness of mitigation measures for certain cumulative effects.	10.3 Follow-Up and Monitoring
7 SUMMARY OF ENVIRONMENTAL EFFECTS ASSESSMENT	
The EIS will contain a table summarising the following key information: • potential environmental effects; • proposed mitigation measures to address the effects identified above; and • potential residual effects and the significance of the residual environmental effects.	13.1 Summary of Potential Effects Table 13.1.1 Potential Project-VC Interactions and Effects Table 13.2.1 Summary of Commitments Table 13.3.1 Summary of Residual Effects for Routine Operations Table 13.3.2 Summary of Residual Effects for Accidental Events
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 not result in significant adverse environmental effects).	Table 12.2.1 Summary of Follow-Up and Monitoring Programs for the Scotian Basin Exploration Drilling Project Table 13.2.1 Summary of Commitments
8 FOLLOW-UP AND MONITORING PROGRAMS	
8.1 Follow-up Program	
The EIS shall present a preliminary follow-up program in particular	12 Environmental Management

Table E.1.1 Concordance Table

Final EIS Guidelines	EIS Reference
for areas where scientific uncertainty exists in the prediction of effects. This program 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 the 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 take advantage of the participation of Aboriginal groups and stakeholders on the affected territory, during the 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.	and Monitoring
8.2 Monitoring	
Specifically, the environmental impact statement shall present an outline of the preliminary environmental monitoring program including: • identification of the interventions that pose risks to one or more of the components and the measures and means planned to protect the environment; • 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; and • guidelines for preparing monitoring reports (number, content, frequency, format) that will be sent to the authorities concerned.	12 Environmental Management and Monitoring 13.2 Summary of Mitigation, Monitoring and Follow-Up Commitments (Table 13.2.1 Summary of Commitments)

Acronyms

ADW	Approval to Drill a Well
AFS	Aboriginal Fisheries Strategy
AHP	Atlantic Health Partnership
AICFI	Atlantic Integrated Commercial Fisheries Initiative
AMF	Automatic Mode Function
API	American Petroleum Institute
ATBA	Area to be Avoided
AZMP	Atlantic Zone Monitoring Program
AZOMP	Atlantic Zone Off-Shelf Monitoring Program
BAOAC	Bonn Agreement Oil Appearance Code
bbl	Barrels
BLM	Bureau of Land Management
Boi	Oil Formation Volume Factor at Initial Reservoir Pressure
BOP	Blowout Preventer
BP	BP Canada Energy Group ULC and/or any of its affiliates
bpd	Barrels per day
BSR	Blind Shear Ram
BST	Business Support Team
CCG	Canadian Coast Guard
CEA Agency	Canadian Environmental Assessment Agency
CEAA, 2012	*Canadian Environmental Assessment Act, 2012*
CEPA, 1999	*Canadian Environmental Act, 1999*
CETAP	Cetacean and Turtle Assessment Program
CFA	Crab Fishing Area
CHARM	Chemical Hazard and Risk Management
CHP	Conservation Harvesting Plans
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COSEWIC	Committee on the Status of Endangered Wildlife of Canada
cp	Centipoise
CRA	Commercial, Recreational and Aboriginal
CSAS	Canadian Science Advisory Secretariat
CSR	Comprehensive Study Report
CST	Country Support Team
CWS	Canadian Wildlife Services
CWS-EC	Canadian Wildlife Services – Environment Canada
dB	Decibel
DCC	Defence Construction Canada
DDT	Dichlorodiphenyltrichloroethane
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
DOM	Dissolved Organic Matter
DP	Dynamic Positioning
DPZ	Distinct Permeable Zones

DSL	Domestic Substances List
DST	Drill Stem Test
DWH	Deepwater Horizon
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Areas
ECA	Emission Control Areas
ECCC	Environment and Climate Change Canada
ECSAS	Eastern Canadian Seabirds at Sea
EEM	Environmental Effects Monitoring
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EL	Exploration Licence
EMO	Emergency Management Office
EPP	Environmental Protection Plan
ESSA	*Energy Safety and Security Act*
FNIHB	First Nations Inuit Health Branch
FSC	Food, Social and Ceremonial
GBR	Geohazard Baseline Review
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GPS	Global Positioning System
GWO	Global Wells Organization
HAZOPS	Hydrocardon Vents in all Hazardous Operations
HPI	Hydrocarbon Processing Industry
HQ	Hazard Quotient
HRM	Halifax Regional Municipality
H_s	Significant Wave Height
HSE	Health, Safety and Environment
HSSE	Health, Safety, Security and Environment
HVAC	Heating, Venting and Air Conditioning
HWC	Health Working Committee
Hz	Hertz
IADC	International Association of Drilling Contractors
IBA	Important Bird Area
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICS	Incident Command System
IFMP	Integrated Fisheries Management
IMO	International Maritime Organization
IMP	Incident Management Plan
IMT	Incident Management Team
IOGP	International Association of Oil and Gas Producers
IPIECA	International Petroleum Industry Environmental Conservation Association
IST	Integrated Supply Trading
IUCN	International Union for Conservation of Nature
IWCF	International Well Control Forum
JIP	Joint Industry Project
JRCC	Joint Rescue Coordination Centre
km	Kilometres
KPIs	Key Performance Indicators

LAA	Local Assessment Area
LC50	The lethal concentration required to kill 50% of the population in a given period of time.
LCA	Lophelia Conservation Area
LFA	Lobster Fishing Area
LJFL	Lower Jaw Fork Length
LMRP	Lower Marine Riser Package
LWD	Logging While Drilling
m	Metres
M&NP	Maritimes & Northeast Pipeline
MAH	Major Accident Hazards
MARLANT	Maritime Forces Atlantic
MARPOL	*International Convention for the Prevention of Pollution from Ships*
MBCA	*Migratory Birds Convention Act*
MBS	Migratory Bird Sanctuary
metocean	Meteorological and Oceanographic
MGO	Marine Gas Oil
MGS	Membertou Geomatics Solutions
ML	Local Magnitude (Associated with Richter Scale)
MMO	Marine Mammal Observer
MN	Nuttli Magnitude (Developed to Measure Seisms of Eastern Canada)
MoC	Management of Change
MODU	Mobile Offshore Drilling Unit
MPA	Marine Protected Area
MPFR	Maritime Province Fishery Regulations
MRI	Marshall Response Initiative
MSC	Meteorological Service of Canada
MSC50	Meteorological Service of Canada 50-year Hindcast
MSDS	Material Safety and Data Sheet
MTI	Mi'gmawe'l Tplu'taqnn Incorporated
MWD	Measurement While Drilling
NADW	North Atlantic Deep Water
NAFO	Northwest Atlantic Fisheries Organization
NAO	North Atlantic Oscillation
NAPS	National Air Pollutant Survey
NB	New Brunswick
NCNS	Native Council of Nova Scotia
NCPEI	Native Council of Prince Edward Island
NEB	National Energy Board
NEBA	Net Environmental Benefit Analysis
NEFSC	Northeast Fisheries Science Center
N-ENS	North-Eastern Nova Scotia
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observed Effect Concentration
NO_x	Nitrogen Oxides
NPA	*Navigation Protection Act*
NRCan	Natural Resources Canada
NS	Nova Scotia

NS ESA	Nova Scotia *Endangered Species Act*
NSDNR	Nova Scotia Department of Natural Resources
NSDOE	Nova Scotia Department of Energy
NSE	Nova Scotia Environment
NSEMO	Nova Scotia Emergency Management Office
NSHRF	Nova Scotia Health Research Foundation
NWPA	*Navigable Waters Protection Act*
O_3	Ozone
OA	Operations Authorization
OBIS	Ocean Biogeographic Information System
OCNS	Offshore Chemical Notification Scheme
OCSG	Offshore Chemical Selection Guidelines
OIM	Offshore Installation Manager
OLF	Norwegian Oil Industry Association
OMS	Operating Management System
OSCAR	Oil Spill Contingency and Response
OSPAR	Oslo and Paris Commission
OSRL	Oil Spill Response Limited
OWTG	Offshore Waste Treatment Guidelines
P&A	Plugged and Abandoned
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PCPA	*Pest Control Products Act*
PEI	Prince Edward Island
PIROP	Programme Intégré de Recherches sur les Oiseaux Pélagiques
PLONOR	Pose Little or No Risk
$PM_{2.5}$	Particulate matter with aerodynamic diameters less than or equal to 2.5 microns
PM	Particulate Matter
Psat	Saturation Pressure
psi	Pounds per Square Inch
psu	Practical Salinity Unit
PSV	Platform Supply Vessel
PTS	Permanent Threshold Shift
RAA	Regional Assessment Area
RMS	Root Mean Square
ROV	Remotely Operated Vehicle
rpm	Revolutions per Minute
Rsi	Initial Gas Solubility
rvb	Reservoir barrel
s	Seconds
S&OR	Safety and Operational Risk
SAR	Species at Risk
SARA	*Species at Risk Act*
SBM	Synthetic-based Mud
SCAT	Shoreline Clean-up Assessment Technique
scf	Square cubic feet (surface volume)
SCP	Sustained Casing Pressure
SDL	Significant Discovery Licence

SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
S-ENS	South-Eastern Nova Scotia
SFA	Scallop Fishing Area
SO_2	Sulphur Dioxide
SOCC	Species of Conservation Concern
SOCP	Statement of Canadian Practice
SOEP	Sable Island Offshore Energy Project
SO_x	Sulphur Dioxides
SPL	Sound Pressure Level
SPM	Suspended Particulate Matter
SRP	Spill Response Plan
SSDI	Subsea Dispersant Injection
SSIP	Scotian Shelf Ichthyoplankton Program
stb	Stock Tank Barrel
SWIS	Subsea Well Intervention Services
t	Tonnes
TAC	Total Allowable Catch
TC	Transport Canada
TD	Total Depth
THC	Total Hydrocarbons
T_p	Peak Spectral Period
TPH	Total Petroleum Hydrocarbon
T_s	Significant Wave Period
TSS	Total Suspended Solids
TTS	Temporary Threshold Shifts
TUS	Traditional Use Study
UINR	Unama'ki Institute of Natural Resources
UK	United Kingdom
ULSD	Ultra-low Sulphur Diesel
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States
UXO	Unexploded Ordnances
VC	Valued Component
VOC	Volatile Organic Compounds
VSP	Vertical Seismic Profiling
WATS	Wide Azimuth Towed Streamer
WBM	Water-based Mud
WCCD	Worst-Case Credible Discharges
WG	Working Group
WSL	Wellsite Leader

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1.0 INTRODUCTION

BP Canada Energy Group ULC (BP Canada Energy Group ULC and/or any of its affiliates are hereafter generally referred to as "BP") is proposing to conduct an exploration drilling program on Exploration Licences (ELs) 2431, 2432, 2433, and 2434 known as the Scotian Basin Exploration Drilling Project (the Project) (refer to Figure 1.1.1). BP holds a 40% interest in the Nova Scotia Offshore ELs and will operate the exploration program. Partners, Hess Canada Oil and Gas ULC and Woodside Energy International (Canada) Limited, hold a 40% and 20% interest, respectively.

Offshore exploration drilling is a designated activity under the *Canadian Environmental Assessment Act, 2012* (CEAA, 2012). This document is intended to fulfill requirements for an environmental assessment (EA) pursuant to CEAA, 2012 as well as EA requirements of the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) pursuant to the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (hereafter referred to as the "Accord Acts"). This Environmental Impact Statement (EIS) has been prepared to satisfy Project-specific *Guidelines for the Preparation of an Environmental Impact Statement Pursuant to CEAA, 2012* (CEA Agency 2015a; hereafter referred to as the "EIS Guidelines" and included as Appendix A) which were developed by the Canadian Environmental Assessment Agency (CEA Agency) with input from other government departments and agencies, and the public.

1.1 PROJECT OVERVIEW

BP will drill up to seven exploration wells in phases over the term of the licences, from 2018 to 2022. A Mobile Offshore Drilling Unit (MODU) will be contracted to drill wells within the ELs. Logistics support will be provided through a fleet of platform supply vessels (PSVs) and helicopters. A supply base in Halifax Harbour will be used to store materials and equipment. It is expected that drilling activity for the first well in the program will commence in 2018. At this time, it is anticipated that exploration drilling will be carried out in multiple phases so that initial well results can be analyzed to inform the execution strategy for subsequent wells. Information about the proposed Project that is assessed within the EIS can be found in Section 2.

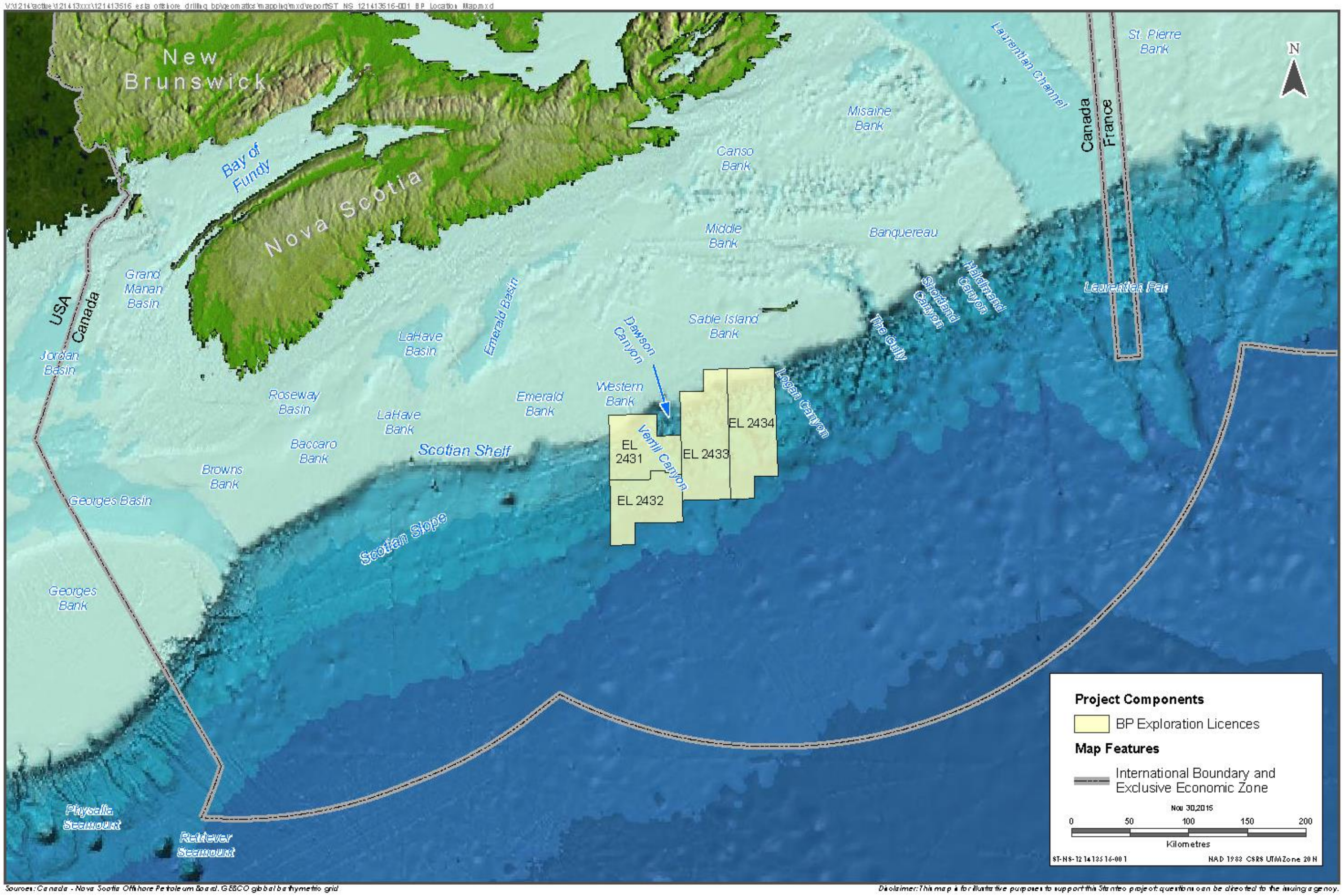

Figure 1.1.1. Scotian Basin Exploration Drilling Project Location

1.2 SCOPE OF THE EIS

The Project that is assessed within the scope of the EIS, in accordance with the EIS Guidelines includes:

- presence and operation of the MODU;
  - establishment of a safety (exclusion) zone, and light and sound emissions associated with MODU presence and operation; and
  - well drilling and testing operations;
- waste management;
  - discharge of drill muds and cuttings; and
  - other discharges and emissions (including drilling and well flow testing emissions);
- Vertical Seismic Profiling (VSP) operations;
- supply and servicing operations; and
  - helicopter transportation; and
  - PSV operations (including transit and transfer activities);
- well abandonment.

Some other components or activities which are not included within the scope of the EIS Guidelines may be described where necessary in relevant chapters for broader context.

The exact well locations have not yet been finalized, however will be confirmed as part of the regulatory approval process for each well in the program as described in detail in Section 1.5.1.

The EIS is defined by spatial boundaries to adequately consider potential adverse environmental effects from the Project. The Project Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbance to the marine benthic environment may occur, and includes ELs 2431, 2432, 2433, and 2434 (Figure 1.1.1). Additionally, a Local Assessment Area (LAA) and Regional Assessment Area (RAA) have also been defined to assess potential environmental effects which may occur beyond the Project Area. Section 6 of this EIS provides additional information on spatial boundaries used to evaluate potential environmental effects from the Project.

1.3 PROPONENT INFORMATION

BP is one of the world's leading international oil and gas companies with decades of experience managing the extraction of oil and natural gas in all types of environments around the world, both onshore and offshore. BP has operations in more than 70 countries across Europe, North and South America, Australasia, Asia and Africa.

BP in Canada focuses on developing energy from Canada's oil sands, home to the third-largest crude reserves in the world, and is also pursuing offshore opportunities in the Beaufort Sea, Newfoundland and Labrador, as well as Nova Scotia. BP's integrated supply and trading (IST) business in Canada spans the country and is one of the top oil and natural gas marketer and trading organizations in Canada, helping to supply customers with safe and reliable energy.

BP Canada's head office is based in Calgary, Alberta. BP has established an office in Halifax, Nova Scotia to oversee the Project. Technical resources will also be drawn from BP's Canadian headquarters in Calgary, Alberta and BP's global headquarters in the United Kingdom (UK) and Houston, Texas.

The overall Project will be managed by BP through a multidisciplinary Project Team based on a functional model to provide technical and management expertise to the Project. The Team will include members of BP's global wells organization who are responsible for delivering a consistent and standardized approach to the safe delivery of wells-related activity across the company. The Project Team will also include professionals responsible for health, safety, environment and emergency response management.

1.3.1 How BP Operates

BP is dedicated to maintaining values of Safety, Respect, Excellence, Courage and One Team, upholding these values in the areas it operates. The BP values are described in Table 1.3.1.

Table 1.3.1 BP Values

Safety
Safety is good business. Everything we do relies upon the safety of our workforce and the communities around us. We care about the safe management of the environment. We are committed to safely delivering energy to the world.
Respect
We respect the world in which we operate. It begins with compliance with laws and regulations. We hold ourselves to the highest ethical standards and behave in ways that earn the trust of others. We depend on the relationships we have and respect each other and those we work with. We value diversity of people and thought. We care about the consequences of our decisions, large and small, on those around us.
Excellence
We are in a hazardous business and are committed to excellence through the systematic and disciplined management of our operations. We follow and uphold the rules and standards we set for our company. We commit to quality outcomes, have a thirst to learn and to improve. If something is not right, we correct it.
Courage
What we do is rarely easy. Achieving the best outcomes often requires the courage to face difficulty, to speak up and stand by what we believe. We always strive to do the right thing. We explore new ways of thinking and are unafraid to ask for help. We are honest with ourselves and actively seek feedback from others. We aim for an enduring legacy, despite the short-term priorities of our world.
One Team
Whatever the strength of the individual, we will accomplish more together. We put the team ahead of our personal success and commit to building its capability. We trust each other to deliver on our respective obligations.

The BP code of conduct sets out the standards of behaviour and working in line with these values, and defines how to work at a group, team and individual level within the company. With clear and concise content setting out the principles and expectations on topics such as equal opportunities, human rights and conflicts of interest, it helps BP's workforce to operate in line with BP's values and maintain the company's commitment to high ethical standards throughout its activities and operations. The BP code of conduct applies to all BP employees, officers and members of the Board, and BP expects and encourages all contractors and their employees to act in a way that is consistent with the BP code of conduct.

One of BP's values is safety. Everyone who works for BP is responsible for ensuring his or her safety and the safety of colleagues, partners, suppliers and local communities. BP's policy on health, safety, security and environment (HSSE) sets out the company's goals of no accidents, no harm to people and no damage to the environment (shown in Figure 1.3.1). Safety is at the heart of everything BP does as a company, driven by leadership and applied across all operations through the operating management system (OMS), which is described below.

bp

BP's Commitment to **health, safety, security** and **environmental** (HSSE) performance

Our HSSE goals are simply stated – no accidents, no harm to people and no damage to the environment.

We strive to be a safety leader in our industry, a world-class operator, a good corporate citizen and a great employer.

Nothing is more important to us than the health, safety and security of our workforce and the communities in which we operate, and behaving responsibly towards our shared environment. We must be vigilant, disciplined and always looking out for one another.

We are committed to:

– Complying with applicable laws and company policies and procedures.
– Systematically managing our operating activities and risks.
– Reporting our HSSE performance.
– Learning from internal and external HSSE events.

Everyone who works for BP has a part to play in meeting our HSSE commitment.

Bob Dudley,
Group Chief Executive
29 September 2014

Figure 1.3.1 BP HSSE Policy

The OMS is a framework that brings together BP's global operating principles. It includes requirements for HSSE management, social responsibility and operational reliability, as well as requirements for other operational aspects, for example, maintenance requirements, contractor relations and organizational learning.

The OMS helps BP to manage and reduce risks throughout its activities globally, as well as continuously improve the quality of its operating activities. It sets out consistent principles and processes that are applied across BP Group. Together these are designed to simplify the organization, improve productivity and enable consistent execution and focus throughout BP. It sets out the requirements of what a BP operation needs to do across eight focus areas under the categories of people, plant, process and performance, shown below in the elements of operating component of OMS illustrated in Figure 1.3.2. The elements of operating are used to inform the performance improvement cycle which sets out how BP should operate.

The OMS includes requirements and guidance for the identification and management of environmental and social impacts within BP. These include topics such as management of drilling waste, wastewater and cultural heritage.

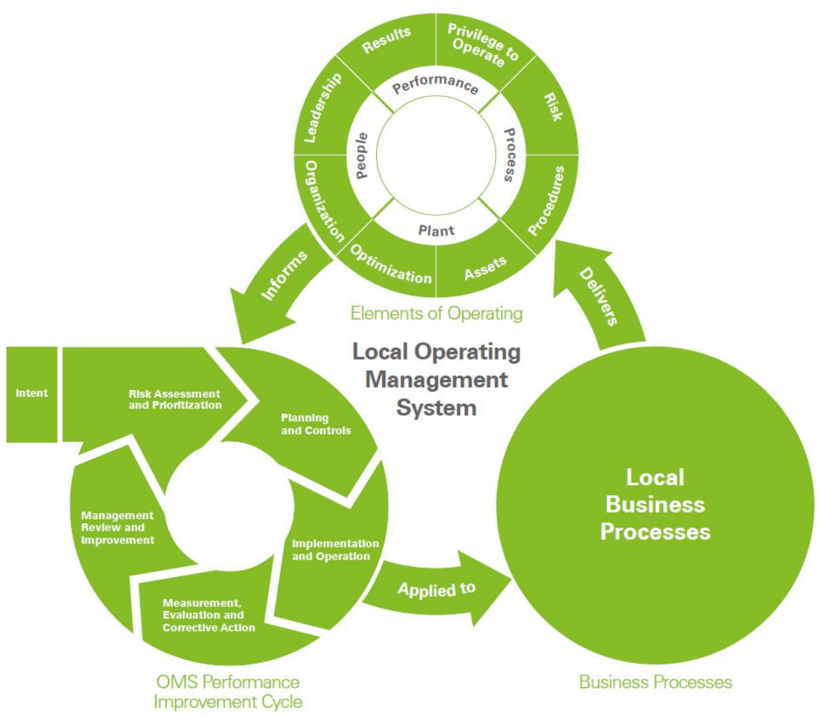

Figure 1.3.2 BP OMS Framework

BP's ability to be a safe and responsible operator depends in part on the capability and performance of contractors and suppliers. Contractors and suppliers can make up a major part of the workforce throughout the life of a project or operation.

BP's OMS defines requirements and practices for working with contractors. Contracts will include clear and consistent information, setting out specific details of BP's expectations. Contracts will be awarded following a bidding and contract tender evaluation process, which shall take account of factors such as safety, technical quality and cost. Contractors and subcontractors shall be required to demonstrate conformance with the requirements that have been established, including HSSE standards and performance requirements. Bridging documents are necessary in some cases to define how BP's safety management systems and those of BP's contractors will co-exist to manage risk on a site.

Contractors, such as drilling and well services contractors, will be accountable for the development and delivery of their safety management systems. Contractors will be responsible for carrying out self-verification activity to assess conformance with their contractual requirements. Contractor safety performance is typically assessed and reviewed by BP using a number of leading and lagging indicators. Additionally, BP will carry out reviews and assurance activity throughout the duration of the contract.

1.3.2 Proponent Contact Information

All communications regarding the EA for the Project, including this EIS, should be directed to the following contacts.

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1.3.3 Project Team

This EIS was prepared by BP and a consulting team led by Stantec Consulting Ltd. (Stantec). Stantec is a consulting firm with extensive experience conducting environmental assessments in Nova Scotia, Canada and internationally.

In addition to Stantec as the EIS lead, the following consultants provided key expertise and services in support of EIS preparation:

- JASCO Applied Sciences (Canada) Ltd. conducted acoustic modelling;
- Membertou Geomatics Solutions (MGS) and Unama'ki Institute of Natural Resources (UINR) completed the Traditional Use Study (TUS); and
- SayleGroup Inc. provided input regarding offshore regulatory requirements.

1.4 BENEFITS OF THE PROJECT

The Project is predicted to result in several economic, social and technological benefits realized on local, regional and national scales. The following describes some of the predicted benefits the Project will generate.

Energy Diversification and Sustainability

Energy demand is forecast to increase globally over the next 20 years, including in North America. Population growth and increases in per capita income are the key drivers behind the growth in energy demand, and Canada has been recognized as one of the areas within North America where demand is likely to grow the most (BP 2015). The global energy mix continues to shift as the balance of energy demand and supply varies, economies expand and contract and energy prices fluctuate. Political unrest and extreme weather continue to affect energy production and consumption patterns and emphasize the need for secure, sustainable energy supplies.

BP recognizes the energy challenge – managing and meeting growing worldwide demand for energy while addressing climate change and other environmental and social issues (BP 2014a). BP believes that a diverse mix of fuels and technologies can enhance national and global energy security while supporting the transition to a lower carbon economy. Oil and natural gas are likely to play a significant part in meeting energy demand for several decades. Exploration is a critical activity to enable continued oil and gas discoveries to maintain production to meet global demand for energy. The exploration licences in the Scotian Basin present potentially significant geological formations and hydrocarbon reserves.

Nova Scotia's 2009 Energy Strategy – *Toward a Greener Future* (NSDOE 2009a), highlights the importance of a sustainable energy mix, and the role that offshore hydrocarbon exploration and development plays within the province's ongoing energy strategy. In the strategy, Nova Scotia commits to "encourage renewed offshore exploration and development, with its enormous potential for building future prosperity". In order to achieve their stated goal, the province has stated that it will invest revenues from offshore hydrocarbon activity into expenditures that offer enduring benefits.

Economic Benefits

The Canada-Nova Scotia Offshore Petroleum Resources Accord (1986), promotes the early development of petroleum resources in the offshore area of Nova Scotia "for the benefit of Canada as a whole and Nova Scotia in particular" and recognizes Nova Scotia as "the principal beneficiary of the petroleum resources in the offshore area". The offshore oil and gas industry has generated billions of dollars in economic activity for the people of Nova Scotia through royalties, crown share adjustment payments, offshore accord payments, forfeiture payments from offshore licenses and rental payment from offshore exploration licenses (NSDOE n.d.).

Nova Scotia's 2009 Energy Strategy - *Toward a Greener Future*, recognizes that exploration and production activity has "contributed greatly to Nova Scotia's economy and provincial finances" which pay for public services such as health, education and debt reduction (NSDOE 2009a).

Industrial Benefits

BP is committed to investing in the areas where BP operates. The Project will contribute to the Nova Scotia economy through the procurement of equipment and services, referred to by the Nova Scotia Department of Energy (NSDOE) as industrial benefits. In 2012, BP committed to a total exploration expenditure of approximately $1.05 billion as part of its successful bid for the exploration licences in the Scotian Basin. The qualified work expenditures are associated with exploration activity, including seismic and drilling activity, in the exploration licences over the initial six-year period of the nine-year exploration licence. This exploration expenditure will contribute, in part, industrial benefits to the Nova Scotia economy. BP is committed to incorporating processes and procedures for Nova Scotia and Canadian businesses, manufacturers, consultants, contractors and service companies to receive a full and fair opportunity to provide goods and services to the program on a competitive basis.

Employment Benefits

It is likely that there will be some employment opportunities associated with the Project. These opportunities will be communicated to local and regional audiences, using methods such as local media. Where employment opportunities are identified, all hiring will be carried out according to BP's code of conduct and include a transparent hiring process. First consideration will be given to residents of Nova Scotia and Canada as a whole where they have the appropriate competencies.

BP has established a local office in Halifax. The office will be staffed with management and administrative support staff. During planning and operations, technical staff directly working on the Project will also work in the Halifax office. BP recognizes the importance of having a local presence and location known to stakeholders and local businesses.

Community Investment

BP's community investment strategy is to invest in people and programs that pursue sustainable and long-lasting progress. BP seeks to work closely with partner organizations so that BP can play an active, dedicated role in the communities we operate within.

The BP community investment program's main focus areas are:

- education;
- environment; and
- community.

Benefits Plan

In accordance with section 45 of the Accord Act, BP, as operator, will submit a benefits plan for approval to the CNSOPB. BP is required to have an approved benefits plan prior to the approval or authorization of any work or activity in the Nova Scotia offshore area (refer to Section 1.5.1). This plan will describe how BP shall provide benefits to Nova Scotia in terms of procurement opportunity for goods and services and employment opportunity. It will also address how BP will develop and implement an education, training, research and development expenditure program in Nova Scotia. The benefits plan will describe how BP will give first consideration to Canadian residents and organizations, particularly from Nova Scotia, where possible within the recruitment and procurement processes.

Knowledge Benefits

In addition to the economic and associated community and social benefits described above, the Project is likely to contribute to technological and scientific knowledge sharing and advancement in Canada and Nova Scotia.

The Scotian Basin includes water depths that extend to greater than 3,000 m. BP has deepwater drilling interests in a number of locations around the globe and can offer a wealth of experience in deepwater operations and technology.

BP will submit reports to the CNSOPB on environmental and operational performance which will also contribute to the understanding of deepwater drilling operations offshore Nova Scotia.

1.5 REGULATORY FRAMEWORK AND THE ROLE OF GOVERNMENT

1.5.1 Offshore Regulatory Framework

Petroleum activities in the Nova Scotia offshore environment are regulated by the CNSOPB, a joint federal-provincial agency reporting to the federal Minister of Natural Resources Canada and the provincial Minister of Energy. In 1986, the Government of Canada and the Province of Nova Scotia signed the Canada-Nova Scotia Offshore Petroleum Resource Accord to promote social and economic benefits associated with petroleum exploitation. The federal and provincial governments established mirror legislation to implement the Accord. The *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* are collectively referred to as the Accord Acts. Under the Accord Acts, the CNSOPB issues licences for offshore exploration and development, the management and conservation of offshore petroleum resources, and protection of the environment as well as the health and safety of offshore workers, while enhancing employment and industrial benefits for Nova Scotians and Canadians.

Offshore petroleum activities and the CNSOPB's decision-making processes are governed by legislation, regulations, guidelines and memoranda of understanding. Exploration drilling projects require an Operations Authorization (OA) under the Accord Acts. Prior to issuing an OA, the CNSOPB requires the following to be submitted:

- an Environmental Assessment report;
- a Canada-Nova Scotia Benefits Plan;
- a Safety Plan;
- an Environmental Protection Plan (including a waste management plan);
- Incident Management Plan and Spill Contingency Plans;
- financial security; and
- certificates of fitness for the equipment proposed for use in the activities.

For each well in the drilling program, a separate Approval to Drill a Well (ADW) is required. This authorization process involves specific details about the drilling program and well design.

There are several regulations under the Accord Acts, which govern specific exploration or development activities. There are also guidelines, some of which have been jointly developed with the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) and National Energy Board (NEB), which are intended to address environmental, health, safety and economic aspects of offshore petroleum exploration and development activities. Of particular relevance to the environmental assessment of this Project are the Offshore Waste Treatment Guidelines (OWTG) (NEB *et al.* 2010) and the Offshore Chemical Selection Guidelines (OCSG) for Drilling and Production Activities on Frontier Lands (NEB *et al.* 2009). Relevant regulations and guidelines that fall under the jurisdiction of the CNSOPB are summarized in Table 1.5.1. Additional legislation and regulations relevant to offshore exploration activity are discussed in Section 1.5.3. BP will comply with all applicable Canadian regulations and the terms and conditions for all permits, authorizations and licenses obtained in support of the Project.

Table 1.5.1 Summary of Key Relevant Offshore Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act and the *Canada-Nova Scotia Offshore Petroleum Resource Accord Implementation (Nova Scotia) Act* (Accord Acts)	Natural Resources Canada (NRCan)/ NSDOE	The Accord Acts give the CNSOPB the authority and responsibility for the management and conservation of the petroleum resources offshore Nova Scotia in a manner that protects health, safety and the environment while maximizing economic benefits. The Accord Acts are the governing legislation under which various regulations are established to govern specific petroleum exploration and development activities.	The regulatory approvals identified below may be required pursuant to section 142 of the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, section 135 of the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation* (Nova Scotia) *Act*, and the regulations made under the Accord Acts.
Nova Scotia Offshore Area Petroleum Geophysical Operations Regulations (and associated Guidelines)	CNSOPB	These regulations pertain to the geophysical operations in relation to exploration for petroleum in the Nova Scotia Offshore area and outline specific requirements for authorization applications and operations.	A Geophysical Operations Authorization may be required in support of the Project if walkaway VSP methods are employed in support of exploratory drilling activities, although currently BP plans to conduct zero offset VSP (refer to Section 2.4.2).
Nova Scotia Offshore Petroleum Drilling and Production Regulations (and associated Guidelines)	CNSOPB	These regulations outline the various requirements that must be adhered to when conducting exploratory and or production drilling for petroleum.	The primary regulatory approvals necessary to conduct an offshore drilling program are an Operations Authorization (Drilling) and a Well Approval (Approval to Drill a Well) pursuant to the Accord Acts and these regulations.
Nova Scotia Offshore Certificate of Fitness Regulations	CNSOPB	Pursuant to subsection 136(b) of the *Canada-Nova Scotia Offshore Petroleum Resources Implementation Act*, these regulations outline the associated requirements for the issuance of a Certificate of Fitness to support an authorization for petroleum exploration and or production drilling in the Nova Scotia Offshore Area.	A Certificate of Fitness will be required in support of the Project.

Table 1.5.1 Summary of Key Relevant Offshore Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
		More specifically, the Regulations are implemented to require that the equipment and/or installation of exploratory or production equipment is fit for the purposes for which it is intended to be used and may be operated safely without posing threat to persons or the environment in a specified location and timeframe.	
Offshore Waste Treatment Guidelines (OWTG)	NEB/CNSOPB/C-NLOPB	These guidelines outline recommended practices for the management of waste materials from oil and gas drilling and production facilities operating in offshore areas regulated by the Boards. 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 • sewage and food wastes • water for testing of fire control systems	Compliance with OWTG

Table 1.5.1 Summary of Key Relevant Offshore Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
		• discharges associated with subsea systems • naturally occurring radioactive material.	
Offshore Chemical Selection Guidelines (OCSG)	NEB/CNSOPB/ C-NLOPB	These guidelines provide a framework for chemical selection that minimizes 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 any work or activity related to offshore oil and gas exploration and production. The OCSG includes the following requirements (NEB *et al*. 2009): • the quantity of each chemical used, its hazard rating, and its ultimate fate (*e.g.*, storage, discharge, onshore disposal, downhole injection, abandonment in the well, or consumption by chemical reaction) must be tracked and reported • all products to be used as biocides must be registered under the *Pest Control Products Act* (PCPA) and used in accordance with label instructions • all chemicals other than those with small quantity exemptions must be on the Domestic Substances List (DSL) of approved substances pursuant to the *Canadian Environmental Protection Act, 1999* (CEPA, 1999), or must be assessed under the New Substances Notification process to identify any restrictions, controls, or prohibitions	Compliance with OCSG

Table 1.5.1 Summary of Key Relevant Offshore Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
		• any chemicals included on the List of Toxic Substances under Schedule 1 of CEPA, 1999 must be used in accordance with CEPA, 1999 risk management strategies for the substance and alternatives must be considered for any substances on the CEPA, 1999 Virtual Elimination List • any chemicals intended for discharge to the marine environment must o be included on the OSPAR Pose Little or No Risk to the Environment (PLONOR) List o meet certain requirements for hazard classification under the OCNS o pass a Microtox test (*i.e.*, toxicity bioassay) o undergo a chemical-specific hazard assessment in accordance with UK OCNS models o and/or have the risk of its use justified through demonstration to the Board that discharge of the chemical will meet OCSG objectives.	
Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (Compensation Guidelines)	CNSOPB/C-NLOPB	These guidelines describe compensation sources available to potential claimants for loss or damage related to petroleum activity offshore Nova Scotia and Newfoundland and Labrador; and outline the regulatory and administrative roles which the Boards exercise respecting compensation payments for actual loss or damage directly attributable to offshore operators.	Compliance with Compensation Guidelines
Environmental Protection Plan Guidelines (EPP Guidelines)	CNSOPB	These guidelines assist an operator in the development of an environmental protection plan (EPP) that meets the requirements of the Accord	Compliance with EPP Guidelines

Table 1.5.1 Summary of Key Relevant Offshore Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
		Acts and associated regulations and the objective of protection of the environment from its proposed work or activity.	
Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP)	Fisheries and Oceans Canada (DFO)/ Environment and Climate Change Canada (ECCC)/CNSOPB/ C-NLOPB	The SOCP specifies the minimum mitigation requirements that must be met during the planning and conduct of marine seismic surveys, in order to reduce effects on life in the oceans. These mitigation measures can be applied to VSP operations. These mitigation 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.	Compliance with SOCP
Guidelines Respecting Financial Responsibility Requirements	CNSOPB	Pursuant to the Accord Act, proponents wishing to conduct any work or activity in Nova Scotia offshore area are required to provide proof of financial responsibility in a form and amount satisfactory to the CNSOPB. These regulations and guidelines provide guidance to operators in providing proof of financial requirements regarding authorization being sought for any work or activity relating to drilling, development, decommissioning or other operations in the offshore areas.	Compliance with Regulations and Guidelines

Source: Modified from Stantec 2014a

Project activities and associated potential effects are not predicted to extend beyond provincial boundaries. However, if transboundary activities are required (*e.g.*, in the event of a spill which could extend beyond Canada's jurisdictional boundary and require spill response in international waters), then the appropriate regulatory authorities will be consulted, and BP will comply with additional regulatory requirements as applicable.

1.5.2 Environmental Assessment Requirements

The Project requires environmental assessment under CEAA, 2012. The Regulations Designating Physical Activities under CEAA, 2012 (amended October 24, 2013) specify the physical activities to which CEAA, 2012 applies. Based on the activities and location of the Project, it is classed as a "designated project" under section 10 of the amended regulations. Section 10 of the amended Regulations Designating Physical Activities includes:

> *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 Atlantic Accord Implementation Act or the Canada-Nova Scotia Petroleum Resources Accord Implementation Act.*

Although there have been other wells drilled in the Project Area (Shubenacadie H-100 drilled in 1982, Evangeline H-98 drilled in 1984, Newburn H-23 drilled in 2002 and Weymouth A-45 drilled in 2003), these wells were not associated with the current ELs issued to BP. The Project consists of the drilling, testing and abandonment of offshore exploratory wells within the ELs issued to BP by the CNSOPB.

A Project Description was filed by BP with the CEA Agency on July 15, 2015 (Stantec 2015). Following a public review and comment period on the Project Description, the CEA Agency determined that an EA under CEAA, 2012 would be required for the Project and subsequently issued a Notice of Commencement on September 16, 2015 to mark the beginning of the federal EA process. Draft EIS Guidelines were issued by the CEA Agency for public review and comment on the same date, and the final EIS Guidelines were issued on the CEA Agency website on November 4, 2015.

Following submission of this EIS to the CEA Agency, another public comment period will occur in conjunction with government review. The CEA Agency will prepare a draft EA Report which will take into consideration public and government comments and detail the CEA Agency's conclusions regarding the potential for environmental effects from the Project. The EA Report will be subject to public review and comment before being finalized. Following finalization of the EA Report, the Minister of the Environment will review the EA Report and issue an EA decision, which will include a determination of significance of environmental effects.

It is expected that the EIS completed to satisfy the CEAA, 2012 requirements will also satisfy the CNSOPB requirements for an EA as part of the OA review process under the Accord Acts.

A provincial EA under the Nova Scotia *Environment Act* is not required based on the proposed Project scope.

1.5.3 Other Applicable Regulatory Requirements

Project activities and components in the nearshore and offshore marine environment will take place within federal waters, which, under CEAA, 2012 constitutes "federal lands". Given the focus of offshore activities for this Project, the term "federal waters" is used although it is acknowledged that the Act does not differentiate between federal lands and federal waters. The Project is subject to various federal legislative and regulatory requirements (see Table 1.5.2).

Table 1.5.2 Summary of Key Relevant Federal Legislation

Legislation	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
Canada Oil and Gas Operations Act (R.S., 1985, c. O-7)	Natural Resources Canada (NRCan)	The Act is intended to promote, in respect of the exploration for and exploitation of oil and gas: (a) safety, particularly by encouraging persons exploring for and exploiting oil or gas to maintain a prudent regime for achieving safety; (b) the protection of the environment; (b.1) the safety of navigation in navigable waters; (c) the conservation of oil and gas resources; (d) joint production arrangements; and (e) economically efficient infrastructures.	No specific permitting requirements are anticipated under this legislation although new pending legislation (*Energy Safety and Security Act* (ESSA); *Regulations Establishing a List of Spill-treating Agents)* will have implications for spill prevention and response (see below).
Canadian Environmental Assessment Act, 2012 (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" has been added to the list of designated activities under CEAA, 2012. The CEA Agency determined that exploratory drilling for the Project requires an EA under CEAA, 2012. Under current legislation, the CEA Agency is the responsible authority for administering the EA process for projects in the two Atlantic offshore areas (Nova Scotia and Newfoundland and Labrador). However, the proposed *Federal Authority as a Responsible Authority for Designated Projects Regulations* would prescribe the CNSOPB as a responsible authority, thereby minimizing duplication of effort	The Project is contingent upon EA approval (*i.e.*, an EA Decision Statement that allows the Project to proceed).

Table 1.5.2 Summary of Key Relevant Federal Legislation

Legislation	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
		and harmonizing the review process of designated projects under CEAA, 2012 and the Accord Acts. It is anticipated that these changes would come into effect in 2016. The CEA Agency and CNSOPB are therefore working together on the EA process for the Scotian Basin Exploration Drilling Project to improve efficiencies and strive for a smooth transition of authority over the EA process for this Project.	
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 (ESSA)*(S.C. 2015, c. 4)*	NRCan	Introduced in Parliament as Bill C-22, ESSA received Royal Assent on February 26, 2015 and came into effect on February 26, 2016. ESSA aims to strengthen the safety and security of offshore oil production through improved oil spill prevention, response, accountability and transparency 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 (*e.g.*, CNSOPB) to enable them to conduct EAs under CEAA, 2012.	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.

Table 1.5.2 Summary of Key Relevant Federal Legislation

Legislation	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
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 any 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, 1994 (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 any other substance harmful to migratory birds in any waters or any area frequented by migratory birds.	The salvage of stranded birds during offshore Project operations would require a handling permit under section 4(1) of the *Migratory Birds Regulations* pursuant to the MBCA.
Navigation Protection Act (NPA)	Transport Canada (TC)	The NPA came into force in April 2014 and replaced the former *Navigable Waters Protection Act* (NWPA). The NPA is intended to protect specific inland and nearshore navigable waters (as identified on 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.	No applicable permitting requirements under the NPA have been identified for the Project, as the Project Area is located offshore, outside of the Scheduled Waters specified in the NPA.
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 under the *Oceans Act* have been identified for the Project.

Table 1.5.2 Summary of Key Relevant Federal Legislation

Legislation	Regulatory Authority	Relevance	Potentially Applicable Permitting Requirement(s)
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, proponents 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 minimize 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, any 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.
Regulations Establishing a List of Spill-treating Agents (proposed; Canada Gazette July 4, 2015)	ECCC	The Minister of the Environment has determined that certain spill treating agents (as listed in the proposed Regulations) are acceptable for use in Canada's offshore. As a result, upon the coming into force of the Regulations, the CNSOPB will be able to authorize the use of one or more of the spill treating agent products listed in the proposed Regulations under the conditions described above to respond to an oil spill.	Specific relevance to be determined, but likely to have specific implications for spill prevention and response.

Source: Modified from Stantec 2014a

1.6 APPLICABLE GUIDELINES AND RESOURCES

Other applicable guidelines and resources include federal government guidelines, Aboriginal policies and guidelines, and other relevant studies that will be used to inform the EA process. Project activities and components will be located in areas of the marine environment that are under federal jurisdiction and are not subject to provincial or municipal regulatory requirements.

1.6.1 Government Guidelines and Resources

In addition to the EIS Guidelines (CEA Agency 2015a) developed for the Project (refer to Appendix A), other guidance developed by the CEA Agency and federal government has been consulted during the preparation of the EIS.

- The Operational Policy Statement, *Determining Whether a Designated Project is Likely to Cause Significant Environmental Effects under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2015b) was considered in defining criteria or established thresholds for determining the significance of residual adverse environmental effects.
- The Operational Policy Statement, *Assessing Cumulative Environmental Effects Under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2013a) was taken into consideration during the development of the cumulative effects assessment scope and methods.
- The Operational Policy Statement, *Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2013b) was consulted with respect to the assessment of Project alternatives (refer to Section 2.9).
- The CEA Agency's *Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance under the Canadian Environmental Assessment Act*, 2012 (CEA Agency 2015c) was consulted with respect to the consideration of effects on heritage and culture.
- Health Canada's *Useful Information for Environmental Assessments* (Health Canada 2010) was consulted with respect to the consideration of effects on quality, noise and Aboriginal health.

The government has conducted a number of environmental studies (inclusive of technical reports) regarding the Scotian Slope and Scotian Shelf marine region, including the following which are pertinent to the EA:

- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities – Western Scotian Slope (Phase 3B) (Stantec 2014b);
- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities – Eastern Scotian Shelf – Middle and Sable Island Banks (Phase 1A)(Stantec 2012a);
- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities – Eastern Scotian Slope (Phase 1B)(Stantec 2012b);
- Strategic Environmental Assessment: Petroleum Exploration Activities on the Southwestern Scotian Slope (Hurley 2011);
- The Scotian Shelf in Context: The State of the Scotian Shelf Report (ACZISC 2011);
- An Ecological and Biodiversity Assessment of Sable Island (Freedman 2014); and
- Several Canadian Science Advisory Secretariat Science Advisory Reports pertaining to the Scotian Shelf and marine species, including the Review of Mitigation and Monitoring Measures for Seismic Survey Activities in and near the Habitat of Cetacean Species at Risk (DFO 2015a).

The studies above have been considered as part of the EA process and have informed preparation of this EIS. In particular, the recent Strategic Environmental Assessments (SEAs) undertaken by the CNSOPB for the Scotian Shelf and Slope have been used extensively to characterize the Project Area and surrounding region (refer to Section 5).

This EIS also incorporates relevant data from various databases managed by DFO and Environment and Climate Change Canada (ECCC) including marine mammal observation data and fisheries licences and landings from DFO, meteorological data and avifauna observation data (Eastern Canadian Seabirds at Sea [ECSAS], and Programme intégré de recherches sur les oiseaux pélagiques [PIROP] from ECCC's Canadian Wildlife Service), and seabird colony data from Nova Scotia Department of Natural Resources (NSDNR) (refer to Section 5).

The Shelburne Basin Venture Exploration Drilling Environmental Impact Statement (Stantec 2014a) and Environmental Assessment Report (CEA Agency 2015d) have also been drawn on in the preparation of this EIS, along with the Environmental Assessment of Exploration Drilling of the Cabot Licence EL 2403 Final Report (BP 2003) and Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014).

1.6.2 Aboriginal Policies and Guidelines

There are two key Mi'kmaq guidelines that have influenced the EA process for this Project. The *Proponents' Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia* (NSOAA 2012) was used to inform engagement activities with Aboriginal groups (refer to Section 4); the *Mi'kmaq Ecological Knowledge Study Protocol* (Assembly of Nova Scotia Mi'kmaq Chiefs 2007) was adhered to in the preparation of a TUS for the Project by MGS and UINR (refer to Appendix B).

In the absence of similar guidelines or an equivalent protocol for New Brunswick, these documents were also used to direct engagement and TUS activities involving select Mi'kmaq and Wolastoqiyik (Maliseet) Nations in that province. This approach was used to engage relevant First Nations in New Brunswick (*i.e.*, Fort Folly, St. Mary's, and Woodstock) during the Shelburne Basin Venture Exploration Drilling Project EA process and has been adopted in this case as well.

Other pertinent guidelines which influenced the EA process with respect to Aboriginal engagement include:

- *Aboriginal Consultation and Accommodation - Updated Guidelines for Federal Officials to Fulfill the Duty to Consult* (AANDC 2011); and
- *Reference Guide: Considering Aboriginal Traditional Knowledge in Environmental Assessments Conducted Under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2013c).

2.0 PROJECT DESCRIPTION

This section provides key Project information in support of this EIS, explaining the rationale and need for the Project, describing the location and nature of Project components and activities, including the management of emissions and discharges that would likely be generated by the Project. This section also provides detail on required personnel and the Project schedule, and examines alternative means for carrying out the Project.

2.1 RATIONALE AND NEED FOR THE PROJECT

On January 15, 2013, BP was awarded exploration rights to ELs 2431, 2432, 2433 and 2434 from the CNSOPB with a total work expenditure bid (*i.e.*, amount of money proposed to be spent on exploration activity in the licences) of approximately $1.05 billion. In 2014, following an EA and authorization process under the Accord Acts, BP carried out a 3D Wide Azimuth Towed Streamer (WATS) seismic survey known as the Tangier 3D Seismic Survey. The 3D seismic data acquisition was completed in September 2014 and is being analyzed to identify potential drilling targets.

Exploration drilling is required to determine the presence, nature and quantities of the potential hydrocarbon resources within the ELs further to the information gathered and analyzed as part of the WATS seismic survey. The exploration drilling program also presents an opportunity for the interest holders, including BP, to fulfill their work expenditure commitments that must be met over the term of the licence period.

As indicated in Section 1.4, the Project is expected to result in several economic, social and technological benefits realized on local, regional and national scales, including a contribution to energy diversity and supply. Oil and natural gas are likely to play a significant part in meeting energy demand for several decades. Exploration is a critical activity to enable continued oil and gas discoveries to maintain production to meet global demand for energy. The exploration licences in the Scotian Basin present potentially significant geological formations and hydrocarbon reserves.

2.2 PROJECT LOCATION

BP proposes to drill up to seven wells on ELs 2431, 2432, 2433, and 2434. These licences cover 13,982 km^2 and, at their shortest distance, are located approximately 230 km southeast of Halifax and 48 km from Sable Island National Park Reserve. Sable Island is also the nearest permanent, seasonal or temporary residence to the Project Area except for workers inhabiting offshore platforms at the Sable Offshore Energy Project and the Deep Panuke developments. Water depths in the ELs range from 100 metres (m) to more than 3,000 m. The Project will not take place on lands that have been subject to a regional study as described in sections 73-77 of CEAA, 2012, nor are there any zoning designations or management plans that apply to the Project Area.

Specific drill sites have not yet been finalized but will be located within the ELs delineated in Figure 2.2.1. Corner coordinates for this area are provided in Table 2.2.1.

Table 2.2.1 Project Area Coordinates

Project Area "Corner"	NAD 83_CSRS_UTM Zone 20 N			
	X (metres)	Y (metres)	Latitude DMS	Longitude DMS
1	702995.10700	4790378.89572	42° 10' 0.000" N	61° 45' 0.000" W
2	702995.10700	4790378.89572	43° 10' 0.000" N	61° 45' 0.000" W
3	702995.10700	4790378.89572	43° 10' 0.000" N	61° 15' 0.000" W
4	702995.10700	4790378.89572	43° 0' 0.000" N	61° 15' 0.000" W
5	702995.10700	4790378.89572	43° 0' 0.000" N	61° 0' 0.000" W
6	702995.10700	4790378.89572	43° 20' 0.000" N	61° 0' 0.000" W
7	702995.10700	4790378.89572	43° 20' 0.000" N	60° 45' 0.000" W
8	702995.10700	4790378.89572	43° 30' 0.000" N	60° 45' 0.000" W
9	702995.10700	4790378.89572	43° 30' 0.000" N	60° 0' 0.000" W
10	702995.10700	4790378.89572	42° 40' 0.000" N	60° 0' 0.000" W
11	702995.10700	4790378.89572	42° 40' 0.000" N	60° 15' 0.000" W
12	702995.10700	4790378.89572	42° 30' 0.000" N	60° 15' 0.000" W
13	702995.10700	4790378.89572	42° 30' 0.000" N	61° 0' 0.000" W
14	702995.10700	4790378.89572	42° 20' 0.000" N	61° 0' 0.000" W
15	702995.10700	4790378.89572	42° 20' 0.000" N	61° 30' 0.000" W
16	702995.10700	4790378.89572	42° 10' 0.000" N	61° 30' 0.000" W

Prospective areas will be selected to optimize the potential discovery of hydrocarbon reservoirs. A number of factors are considered with respect to wellsite location, including:

- geophysical data;
- geohazard data; and
- seabed baseline conditions, including environmental sensitivities and anthropogenic features.

Extensive geophysical data acquisition and interpretation has been undertaken within the ELs as part of the Tangier 3D WATS survey, which was executed in 2014. The presence of prospective hydrocarbon reserves is a complex interaction of many factors including time, pressures, source rock, migration pathways and impermeable traps all of which need to be accounted for in interpreting the geophysical data and deciding where to drill. Prospective well locations within the ELs are being identified based on information gathered during the seismic program. Seismic data has provided information about the subsurface formations and consequently has guided the strategy for the location of potential exploration well location.

Within the prospective areas, the selection of wellsite locations also takes in account geohazards. A geohazard is a feature or geological condition which could pose a potential hazard to drilling activity, up to the depth of the first pressure containment casing string (generally from the seabed to 1,000 to 1,200 m depth below mudline). Some examples of geohazards include: faults, erosion and truncation surfaces; shallow gas pockets, gas charged sediments and hydrates; shallow water flow zones; seabed topography and soft seabed conditions; slump or scour features and mud slides; and abnormal pressure zones. These are all factors which could affect the delivery of safe and efficient drilling operations. Geohazard analysis is being carried out using reprocessed seismic data from the 3D WATS survey, and existing regional data, such as geotechnical cores and offset wells where available. Prior to any drilling activity, BP will conduct a comprehensive regional geohazard baseline review (GBR), followed by detailed geohazard assessments for each proposed wellsite.

An assessment of existing anthropogenic features, including unexploded ordnances, shipwrecks and telecommunication cables has been carried out (refer to Section 5.32). BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.

For the purpose of environmental assessment a “Regional Assessment Area” (RAA) has been defined as the main study area boundary for describing existing baseline conditions and assessing potential direct and cumulative environmental effects of the Project (refer to Figure 2.2.1). The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e*., certain or reasonably foreseeable) physical activities. The RAA is restricted to the 200 nautical mile limit of Canada’s Exclusive Economic Zone (EEZ), including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction. The western extent of the RAA encompasses the Georges Bank Oil and Gas Moratorium Area and terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA extends into the Laurentian Channel to the Northwest Atlantic Fisheries Organization (NAFO) division 4S boundary and approaches the Nova Scotia coastline along the boundary of NAFO Unit Area 4VSb. The RAA extends along the Nova Scotia coastline from North Fourchu, Richmond County to Comeaus Hill, Yarmouth County. Section 6 of this EIS provides additional information on spatial boundaries used to evaluate potential environmental effects from the Project.

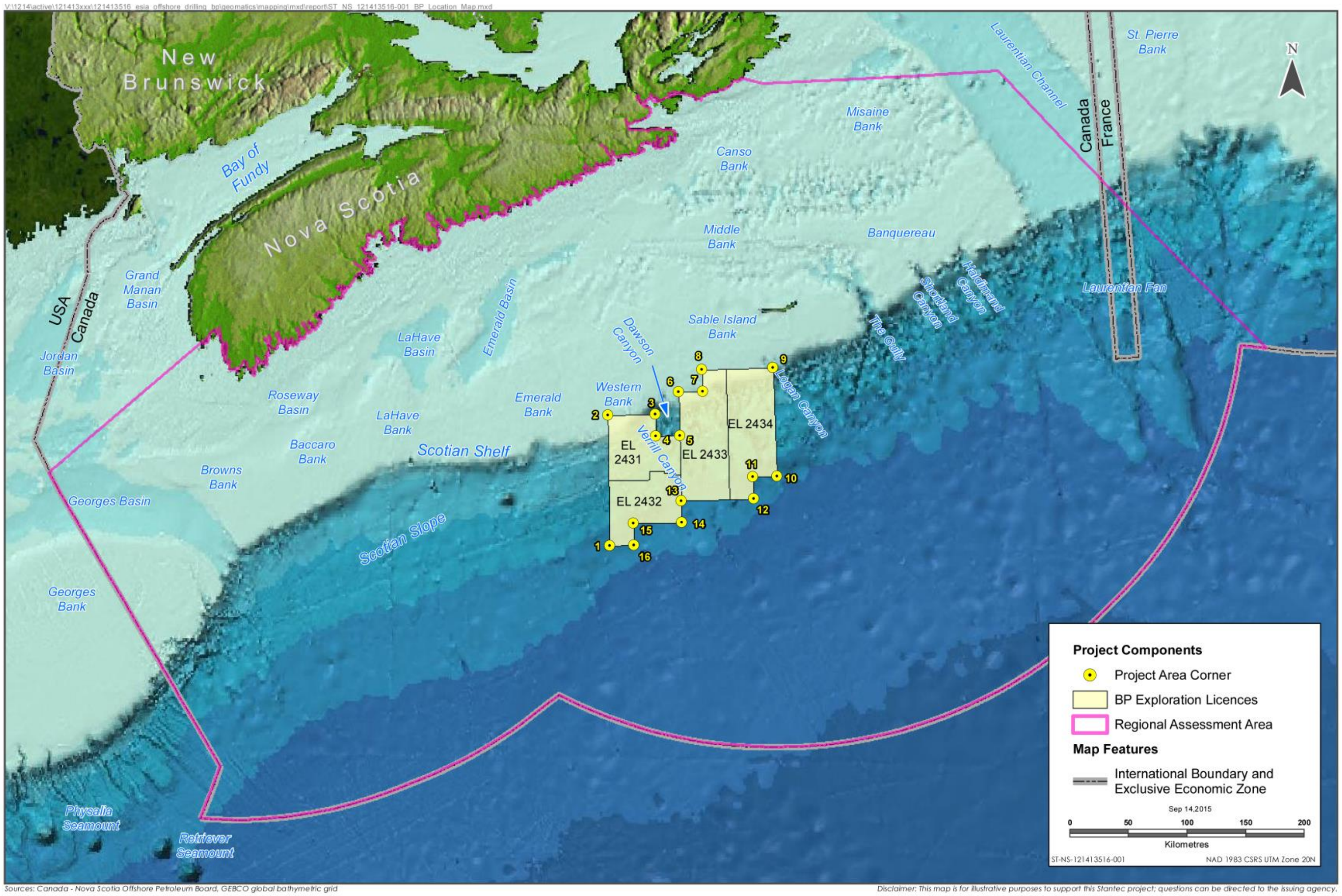


Figure 2.2.1 Project Area and Regional Assessment Area

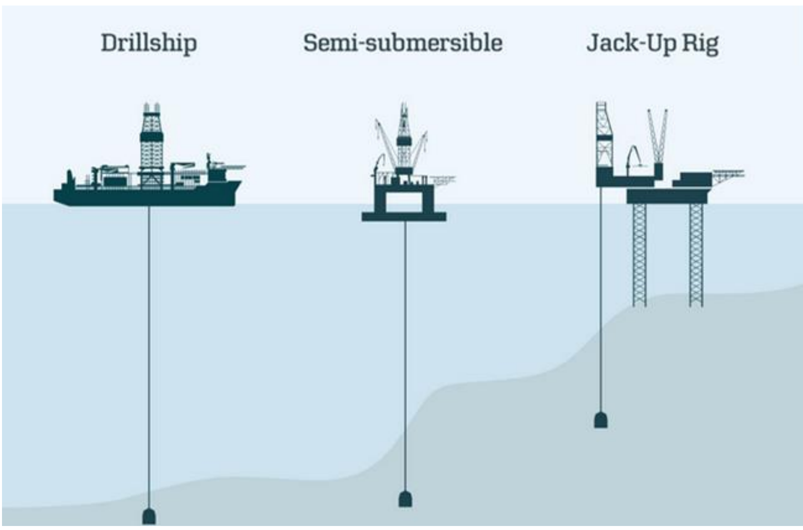
2.3 PROJECT COMPONENTS

The Project includes two main physical components: the drilling vessel and the offshore exploration wells. The Project also includes components for logistics support for servicing and supplying offshore activity. Logistics related components include supply vessels and helicopters for the transportation of personnel and equipment, and a supply base in Nova Scotia.

The offshore exploration wells are the only new pieces of infrastructure that need to be constructed as part of the Project. All other Project components, including the drilling vessel, supply vessels, helicopters and supply base are pre-existing and will be used by the Project on a temporary basis through contractual arrangements.

2.3.1 Drilling Vessel

Within Atlantic Canadian waters, three main types of exploration drilling vessels are typically used. The selection of the drilling vessel generally depends on physical characteristics of the wellsite, including water depth and oceanographic conditions, and logistical considerations (*e.g.*, rig availability). In shallow waters (less than 100 m), a jack-up rig (*e.g.*, Rowan Gorilla II used on Sable Bank) is typically used; in deeper waters a semi-submersible rig or drillship is used. These drilling vessels (*i.e.*, semi-submersible rigs, drillships and jack ups) are often referred to as mobile offshore drilling units (MODU). A schematic of the three types of MODUs described here is shown in Figure 2.3.1.



Source: Modified from Maersk Energy (n.d.)

Figure 2.3.1 Different Types of MODUs Used in Atlantic Canadian Waters

BP has not yet selected the MODU that will be used to drill the wells in the Scotian Basin. In consideration of the water depths in the ELs (up to approximately 3,000 m), it is expected that either a semi-submersible rig or a drillship will be used.

2.3.1.1 MODU Selection and Approval Process

To deliver the goal of drilling safe, compliant and reliable wells, BP will use several criteria for MODU selection, focusing on regulatory compliance, meteorological and physical oceanographic conditions, and the technical capability of the MODU. The MODU is expected to be capable of ultra-deepwater drilling to accommodate the water depths and meteorological and oceanographic (metocean) conditions within the ELs. It is also expected to be winterized to allow year-round drilling if required.

Once the MODU has been identified, it will be subject to a BP internal rig intake process. The rig intake process provides the means to identify and effectively manage risks for rig start-ups and verify that contracted rigs conform to specified BP practices and industry standards. Pursuant to the Accord Acts and the requirements of an OA, a Certificate of Fitness for the drilling vessel will be required which will be issued by a recognized Certifying Authority prior to approval for use. BP will obtain a Certificate of Fitness from an independent third party Certifying Authority for the MODU prior to the commencement of drilling operations in accordance with the Nova Scotia Offshore Certificate of Fitness Regulations.

2.3.1.2 General Operational Requirements

Although not yet identified, the MODU selected by BP shall, as a minimum, satisfy the operational requirements listed in Table 2.3.1.

Table 2.3.1 Operational Requirements for Mobile Offshore Drilling Unit (MODU)

General The MODU will be equipped with the following for the rig to operate:	
Drilling Mast	The support structure for the equipment used to lower and raise the drill string into and out of the wellbore.
Ballast Control	Maintains stability during operations.
Power System	Diesel generated power system to safely operate the MODU and all associated drilling equipment. The rig shall also be equipped with an emergency power system.
Positioning System	Dynamic positioning (DP) to maintain position under a range of meteorological and ocean conditions. Thrusters on the MODU are automatically controlled by the DP system to maintain the MODU in position. A variety of sensors, monitoring the ambient conditions and in combination with global positioning system (GPS) and acoustic referencing control the DP system.
Subsea Equipment	Inclusive of well control equipment such as blowout preventers (BOP), and a marine riser to act as a conduit from seafloor to rig floor. BOPs are devices installed on the wellhead that act as barriers to prevent the uncontrolled release of formation fluids escaping from the wellbore. These can take the form of an annular, pipe rams and blind shear rams.

Table 2.3.1 Operational Requirements for Mobile Offshore Drilling Unit (MODU)

Logistics Support The MODU shall be equipped with the following to support drilling operations:	
Helicopter Deck and Refuelling Equipment	For safe landings and departures for helicopters which are used for transfer of personnel and equipment.
Storage Space	Houses material used in drilling operations. This can include bulk storage for liquids, such as drilling fluid, fuel oil, cement *etc.*, as well as drilling equipment, such as casing, tubular equipment, *etc.*
Cranes	To transfer equipment between the supply vessels and the MODU.
Waste Management Facilities	To allow for offshore treatment or temporary storage of hazardous and non-hazardous waste streams prior to shipment to shore or disposal in line with the OWTG.
Emergency and Lifesaving Equipment	Inclusive of firefighting equipment, lifeboats and rafts for emergency evacuation.
Accommodation	Inclusive of welfare facilities, such as sleeping, washing, toilet and mess facilities, and recreational facilities and medical facilities. Accommodation facilities will provided for a maximum of 200 persons on board.

Additional detail on the two types of MODUs, which are currently under consideration for use by BP (*i.e*., semi-submersible drilling rig and drillship), is presented below.

2.3.1.3 Semi-submersible MODU

A semi-submersible is characterized by a lower hull of separate pontoons with a number of vertical columns supporting a large upper deck. The upper deck contains drilling equipment, equipment and material storage areas and accommodation. During drilling operations, to ensure stability, the lower hull is submerged to a nominated depth using a ballast system and the semi's configuration minimizes the environmental loading compared to a ship-shaped hull, providing a relatively stable platform for drilling operations. Semi-submersible MODUs can either be moored in position over the drilling site using anchors, or maintained on station by DP.

The standard mooring technique for a semi-submersible in water depths up to approximately 1,200 m is a multi-point mooring system using a combination of wire rope, chains, and anchors. The anchors are set in a pre-determined pattern using an anchor handling offshore vessel. Given the location and water depths of the Project Area, it is assumed that the MODU would employ a DP system for positioning, rather than using anchors.

In DP mode, the drilling vessel maintains position using thrusters positioned on the hulls, which are controlled by a computerized DP system using GPS and acoustic positioning data. The acoustic system transmits energy signals to transponders (receivers) positioned on the seafloor, which then send signals back to the transmitter allowing an accurate calculation of the position of the transponder relative to the vessel (Kongsberg 2015). This system is used to improve underwater positioning accuracy and redundancy to keep the drilling vessel in its intended position.

Figure 2.3.2 is a photo of the West Hercules, a semi-submersible drilling rig that has been employed by Statoil Petroleum in the Barents Sea and Newfoundland and Labrador.

Source: Offshore Energy Today 2014a

Figure 2.3.2 West Hercules Semi-Submersible

2.3.1.4 Drillship

A drillship is a self-propelled drilling vessel with very large variable deck load (VDL) capacity to allow for increased storage of equipment and materials to drill ultra-deep water wells, similar to those encountered within the ELs, and in remote locations. Drillships utilize DP to maintain position and rotate the ship over well center to head the ship into prevailing weather, following shifts in wind or wave direction to minimize the pitch and roll motion. Drillships are different from typical offshore vessels, such as cargo vessels, by the presence of a drilling package and a moon pool. The moon pool is an opening in the bottom of the hull of the vessel, which allows direct access to the water, enabling drilling equipment on the vessel to connect to equipment on the seafloor in order to drill the well.

Figure 2.3.3 is a photo of the Stena *IceMax* drillship, which has been contracted for use by Shell on the Shelburne Basin Venture Exploration Drilling Project.

Source: Chronicle-Herald 2014

Figure 2.3.3 Stena *IceMax* Drillship

2.3.2 Offshore Exploration Wells

BP will drill up to seven exploration wells within ELs 2431, 2432, 2433, and 2434 in phases over the term of the licences, from 2018 to 2022.

The well design and location for the proposed wells have not yet been finalized. Once confirmed, these details for the wells will be provided for review and approval to the CNSOPB as part of the OA and ADW for each well submitted in association with the Project.

Typically, oil and gas wells are drilled using a drill bit in a number of sections of progressively smaller-diameter intervals. Drill bits are available in many sizes to drill different diameter holes. The top interval is drilled starting at the sea floor and has the largest diameter hole. The drill bit is controlled from the MODU through a series of pipes, referred to as the drill string, which rotate the drill bit. The drill bit is lubricated by drilling fluids, also known as drilling "muds".

Drilling fluids are formulated according to the well design and the expected geological conditions. They comprise a base fluid, weighting agents and other chemicals that give the drilling fluid the properties required to drill a well safely and efficiently. Several types of drilling fluids are available including water-based mud (WBM) and synthetic-based mud (SBM). A framework for chemical selection to minimize the potential for environmental effects from the discharge of chemicals in drilling fluids used in offshore operations is provided in the OCSG (refer to Section 2.9.3 for more information on chemical management).

Drilling fluids flow from the MODU to the drill bit while it is drilling in the wellbore through the drill string. As the drill bit rotates downward through the rock layers, it grinds the rock, breaking it up, which generates rock fragments known as drill cuttings. The drill cuttings are circulated by the drilling fluid out of the wellbore through the annulus, a process illustrated in Figure 2.3.4.

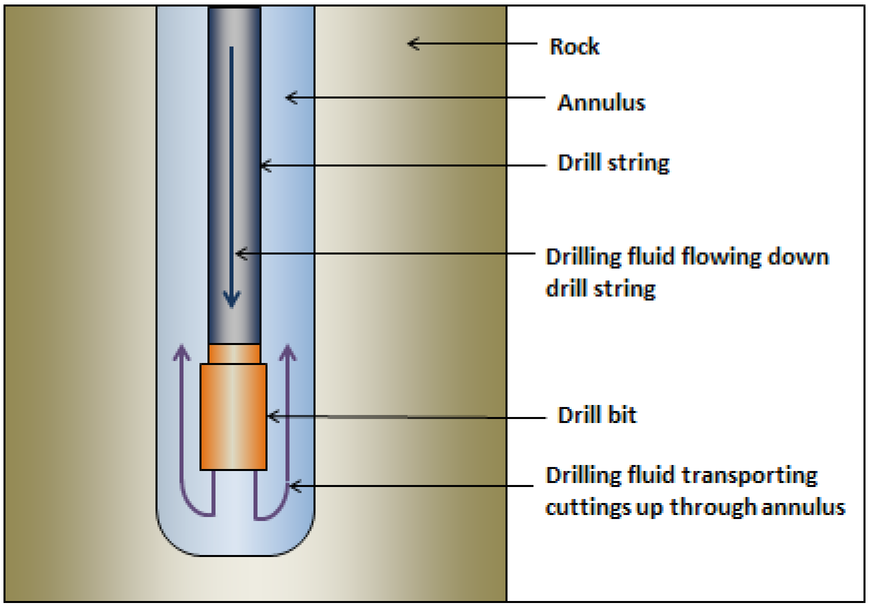
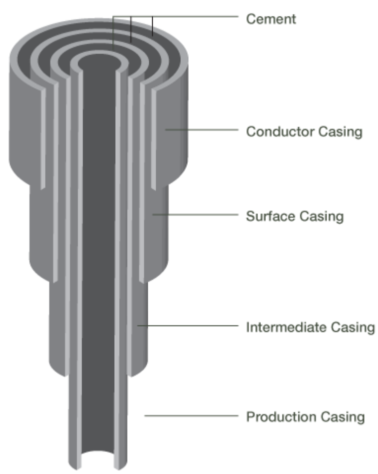


Figure 2.3.4 Drilling Fluid Circulation

The drilling of each well can be broken down into two phases: riserless drilling and riser drilling. During riserless drilling, the well is drilled using an open system with no direct drill fluid return connection to the MODU. Riserless drilling is typically only carried out in the shallow sections of the well before the equipment which allows the riser to be anchored to the seafloor is installed. During riserless drilling, WBM is typically used as the drilling fluid and cuttings are discharged directly to the water column in accordance with regulatory guidelines. Once a wellhead has been installed, a blowout preventer and a riser can be connected to the well. The riser is a conduit which allows drilling fluid and solids from the wellbore to be returned from the well to the surface. Drilling with a riser is therefore a closed loop system which allows drill fluids and cuttings to be returned to the MODU for treatment; therefore WBM or an alternative drilling fluid such as SBM can be used.

Each section will be drilled with an increasingly smaller drill bit and secured with casing. Casing is the liner installed within the wellbore. It is made up of a series of steel pipes that form a major structural component of the wellbore which serves several important functions, such as preventing the formation from caving into the wellbore, isolating the different formations to prevent flow or cross flow of formation fluids, and providing a means of maintaining control of formation fluids and pressure as the well is drilled. Once the casing has been inserted into the wellbore at the end of the drilled section, it is cemented in place to secure it. The cement is used to permanently seal the annular spaces between the casing and the wall of the borehole. It also seals the formation, preventing the loss of drilling fluid. To cement the casing in place, slurrified cement is flowed through the casing and up into the annular space between the formation and the casing, displacing any drilling fluid. The cement fills the annular space and solidifies. During the riserless phase, excess cement may be discharged to the seafloor. Once the riser has been installed, excess cement can be returned to the MODU.

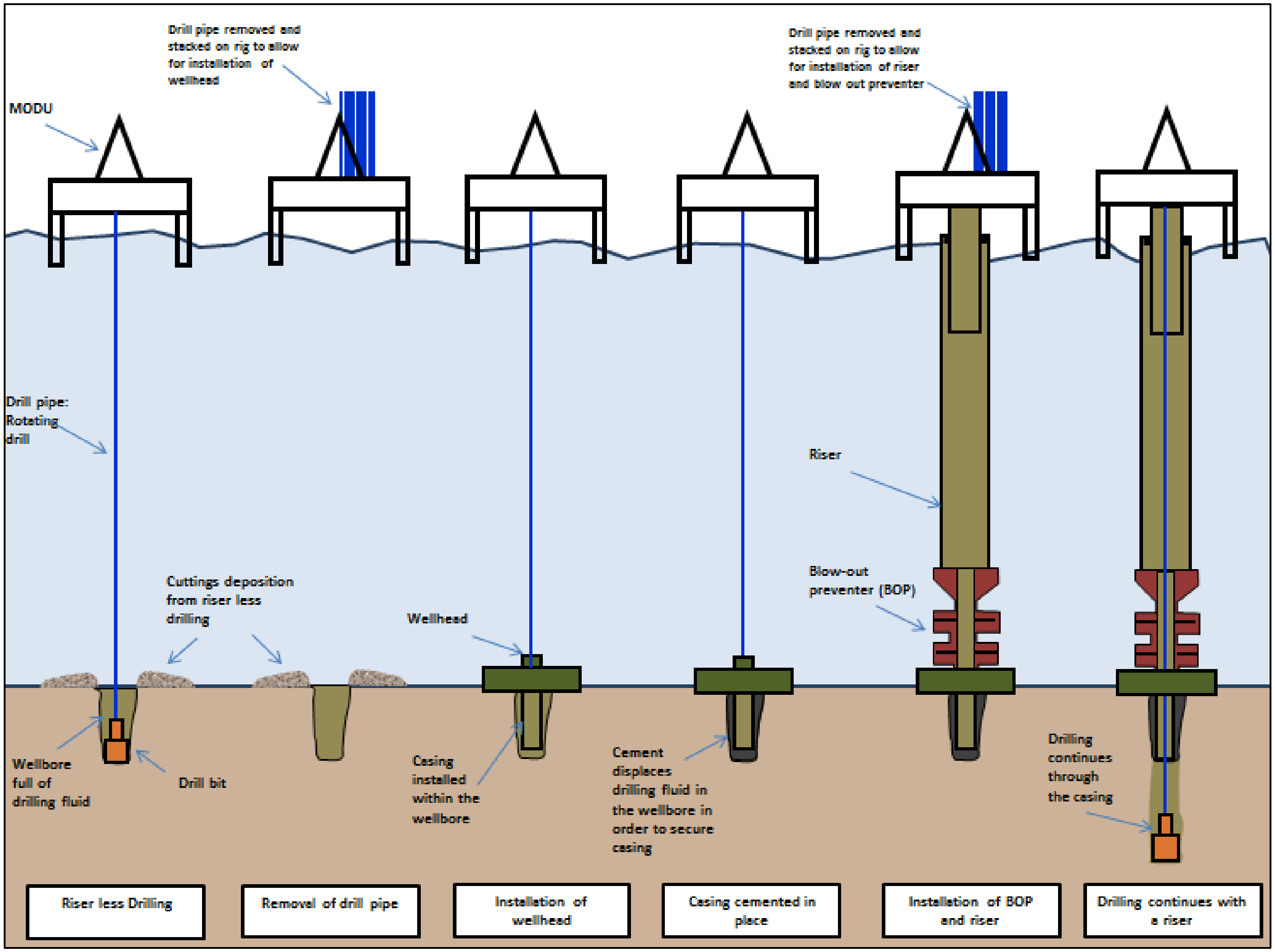
A typical casing configuration is illustrated in Figure 2.3.5 to show the increasingly smaller diameter sections of a well. This figure is indicative and does not represent the Project casing design.



Source: Encana 2015

Figure 2.3.5 Typical Casing Configuration

Figure 2.3.6 illustrates the drilling sequence described above. The wells drilled as part of the Project will be drilled in line with the principles described above. Further information about the Project wells is described in Section 2.4.2.



Source: Modified from Petroleum Club of Western Australia, Drilling for Oil and Gas

Figure 2.3.6 Drilling Sequence (NB – not to scale)

2.3.3 Supply and Servicing Components

Offshore drilling operations will be supported by logistics arrangements for supply and servicing activity. Such arrangements shall allow the transportation and movement of equipment and personnel between the MODU and land, and shall allow sufficient stocks of equipment and supplies to be maintained for reliable, ongoing drilling operations.

In accordance with the Final Guidelines for the Preparation of an Environmental Impact Statement issued to BP by the CEA Agency (CEA Agency 2015a), activity within the supply base is not considered within the scope of this EIS. The supply base is described below with the intent to clarify PSV routes between the supply base and the Project Area. Supply and servicing components and activities included in the scope of assessment comprise PSV operations (*e.g.*, loading, transit and unloading of vessels) and helicopter support (*e.g.*, crew transport and delivery of supplies and equipment).

Additional details on supply and servicing activities are provided in Section 2.4.5.

2.3.3.1 Onshore Supply Base

An onshore supply base will be used to support offshore drilling operations in Nova Scotia. The supply base serves as a location to temporarily store, stage, and load materials onto PSVs to be brought offshore. Likewise, the supply base serves as a location for materials to be returned onshore by PSVs, as needed, throughout the Project.

The Woodside Terminal has been selected as the preferred supply base location that will be used to support the Project. The Woodside Terminal is an existing multi-user industrial port facility located in Dartmouth, Nova Scotia on Halifax Harbour across from downtown Halifax (refer to Table 2.3.2 for geographic coordinates).

Table 2.3.2 Supply Base Location Geographic Coordinates

Supply Base Location	Latitude DMS	Longitude DMS
Woodside Terminal (Halifax Harbour)	44°38'49.00"N	63°32'53.00"W

The proposed facility is made up of two areas. This first area is dedicated to quayside operations and the second area serves as a temporary storage and laydown area (refer to Figure 2.3.7).

Blue Water Group, which has been selected as the third party logistics service provider for BP, operates the Woodside Terminal, providing supply base operations for the Sable Offshore Energy Project (SOEP) and Deep Panuke offshore gas developments as well as the Shelburne Basin Venture Exploration Drilling Project.

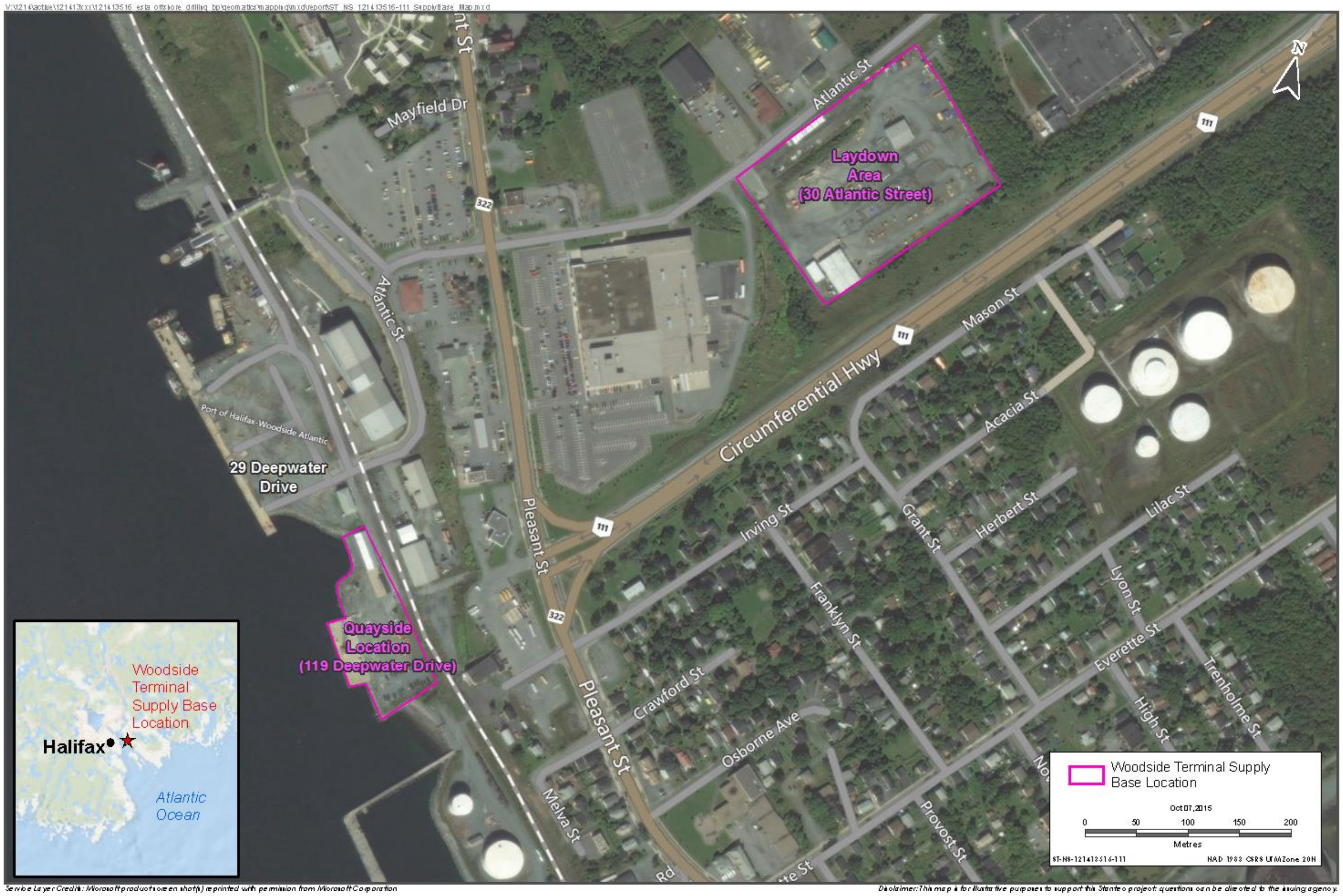


Figure 2.3.7 Woodside Supply Base Location

2.3.3.2 Support Vessels and Helicopters

The Project will require support from PSVs and helicopters for equipment and supplies and for crew changes. Both PSV and helicopter operations will be based out of the Halifax area. Like the supply base, the helicopter and PSVs will be owned and operated by third-party service providers, and will be used to support the Project on a temporary basis through contractual arrangements.

PSVs will be used to re-supply the MODU with equipment and supplies during the drilling program. The PSVs have not yet been identified; however, the fleet will be selected to fulfill the following functions for the MODU:

- supply food, fuel and bulk powders, drilling fluid and drilling materials;
- collect waste;
- assist in emergency response situations; and
- monitor the safety (exclusion) zone around the MODU and intercept vessels if required.

It is anticipated that two or three PSVs will be required in total. A PSV will remain on standby at the MODU at all times in the event that operational assistance or emergency response support is required. Figure 2.3.8 is a photo of a typical PSV that could be used on the Project. PSVs will undergo BP's internal audit process, as well as additional inspections/audits inclusive of the CNSOPB pre-authorization inspection process in preparation for the Project.

Source: Farstad 2012

Figure 2.3.8 Typical Platform Supply Vessel

Helicopters will be used to transfer personnel and light supplies to and from the MODU and land. These will also be used for emergency support services, including medical evacuation from the MODU in the event that it is required, as well as search and rescue operations if requested by the Canadian authorities. Figure 2.3.9 shows a typical offshore helicopter that could be used to support the Project.

Source: Offshore Energy Today 2014b

Figure 2.3.9 Typical Offshore Helicopter

Additional details on PSV and helicopter operations are provided in Section 2.4.5.

2.4 PROJECT ACTIVITIES

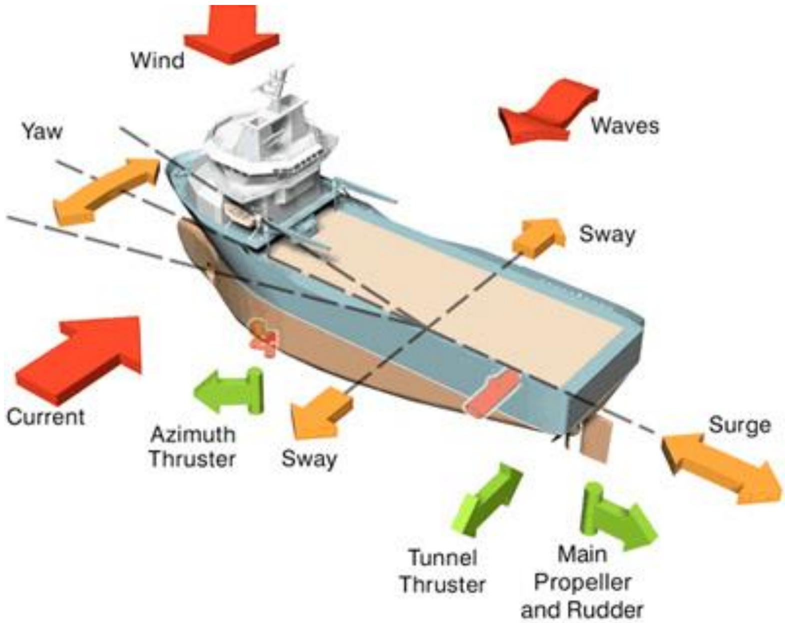
2.4.1 MODU Mobilization

As described in Section 2.2, drilling locations will be selected taking account of geohazard data, geophysical data and seabed baseline conditions. Further information about the reviews for each wellsite location is presented in Section 9.5.5.

As explained in 2.3.1.1, the MODU will be subject to the BP rig intake process as well as regulatory inspections which are required in order to deliver a Certificate of Fitness prior to approval for use. After all of the permits, regulatory approvals and authorizations have been obtained, the MODU will be mobilized to the drilling location.

The MODU will be either towed or will move self-propelled to the drilling location. Once the MODU is in place, positioning and stability operations will occur. This will include ballasting to increase the stability of the MODU and implementing the DP system to maintain position.

The DP system is made up a series of thrusters, which operate to continually adjust the vessel to counteract current, waves and wind forces to maintain the position of the MODU. Figure 2.4.1 illustrates dynamic positioning forces and does not represent the MODU or the configuration of thrusters for the Project, which have not yet been determined.



Source: Rigzone 2015

Figure 2.4.1 Dynamic Positioning Forces

In accordance with the *Nova Scotia Offshore Drilling and Production Regulations*, a safety (exclusion) zone (estimated to be a 500-m wide radius) will be established around the MODU within which non-Project related vessels are prohibited. This safety (exclusion) zone will be established around the MODU during initial mobilization activities and drilling operations, including well evaluation and abandonment processes. The safety (exclusion) zone is put in place to prevent collisions between the MODU and other vessels (*e.g.*, fishing, research or cargo vessels) operating in the area. The safety (exclusion) zone will be monitored by the standby vessel at the MODU. BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notice to Shipping and Notice to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with commercial and Aboriginal fishers.

To maintain navigational safety at all times during the Project, obstruction lights, navigation lights and foghorns will be kept in working condition on board the MODU and PSVs. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

The MODU will be equipped with local communication equipment to enable radio communication between the PSVs and the MODU's bridge. Communication channels will also be put in place for internet access, and enable communication between the MODU and shore.

2.4.2 Drilling

2.4.2.1 Well Execution Strategy and Drilling Sequence

Designs for Project wells have not yet been finalized, although an indicative well design is presented in Table 2.4.1. Well design depends on a number of factors including the geology of the formations. Wells will be drilled in line with the principles set out in Section 2.3.2. The information below sets out the general execution strategy for wells drilled as part of the Project. Detailed plans will be provided for review and approval to the CNSOPB before drilling operations commence as part of the OA and ADW processes.

Table 2.4.1 Indicative Well Casing Plan for Project Wells

Section	Section Name	Drilling Fluid	Hole size (inches)	Casing Size (inches)	Interval Depth (metres)
1	Conductor Section	Seawater / WBM	36" or 42"	36"	100 m
2	Surface Casing	Seawater / WBM	26"	22"	800 m
3	Intermediate Casing 1	SBM / WBM	17" x 20"	16"	950 m
4	Intermediate Casing 2	SBM / WBM	14 3/4" x 17 1/2"	14"	1,100 m
5	Intermediate Casing / Liner 3	SBM / WBM	10 5/8" x 12 1/4"	9 5/8"	2,250 m
6	Production Hole 1	SBM / WBM	8 1/2"		250 m

If a planned section total depth (TD) cannot be reached, contingency casing sections, also referred to as strings, will be available. A contingency string is effectively an additional string inserted into the well to enable the well to be drilled to TD. Typical contingency strings include casing or liner sizes of 18", 11.3/4" and 7". It is expected the well can be completed in six sections or less; however there could be up to three additional sections if contingencies are used.

It is possible, that in the event of well success, a planned sidetrack may be drilled to explore other areas of the reservoir that are nearby. In the event of sidetracking, a secondary wellbore will be "kicked-off" from the original wellbore using a similar methodology described in Section 2.3.2 and below. The original wellbore will be abandoned using cement prior to side track drilling commencing. The details and design of the sidetrack will be contingent on the results of the original well and therefore have not yet been finalized. Once they have been established, plans and designs for the sidetrack will be submitted to CNSOPB for approval.

It is expected that the conductor and surface casing sections of wells drilled as part of the Project will be drilled riserless. During the riserless phase, the well will be drilled with either WBM or seawater. The drilling fluid is used to provide overbalance to the formation pressure with the hydrostatic pressure in the wellbore, keep the drill bit cool and flush out cuttings from the wellbore. During the riserless phase, as there is no mechanism to return cuttings to the MODU, cuttings and any associated fluid will be discharged at the seafloor as is permitted by the OWTG (NEB *et al.* 2010).

The first section of the well will be the conductor section. The conductor section provides the initial structural foundation for the borehole and the foundation for the subsea wellhead. A large diameter hole, potentially 42" in diameter, will be drilled to approximately 100 m depth below the seafloor. Once the section has been drilled, the conductor pipe can be run and cemented to secure the wellbore. The conductor can also be "jetted" into place, which effectively means that the conductor string is directly drilled into place. No cement is required when the conductor string is jetted in place.

After the completion of the conductor section, a smaller size drill bit will be passed through the conductor, and a new hole is drilled to section TD. Once the section is drilled, a surface casing string will be run and cemented to secure the wellbore. The top of the surface string will be connected to the wellhead. The wellhead is a pressure-containing mechanism that is the anchor point for casing used in drilling the well. The wellhead will be lowered down with the surface casing string attached, and installed on the conductor section. The surface casing section will be drilled with seawater or WBM, and like the conductor section, drill cuttings and associated fluids will be discharged to the seafloor as is permitted by the OWTG (NEB *et al.* 2010).

Once the surface casing has been installed, a BOP stack is run on the end of a drilling riser and connected to the wellhead. The riser creates a conduit back to the MODU. The BOP is a critical piece of safety equipment and is put in place to protect the crew and the environment against unplanned fluid releases from the well. It allows the wellbore to be closed through a series of rams and annular preventers, thereby closing the aperture, preventing any hydrocarbons from escaping the wellbore. More information on the BOP and additional well control features is provided in Section 2.5.

Once the riser and BOP have been installed, the drilling fluids and cuttings generated from the wellbore can be circulated back to the MODU for treatment. It is unknown at this stage which drilling fluids will be used to drill the remaining well sections. It is currently proposed that either a WBM or SBM will be used. The choice of which drilling fluids and other components of well design, such as section depths will be determined by the specific geology and predicted pore pressure of each individual well. The process of drilling, casing and cementing is continued for the remaining drill sections. This sequence of events is repeated until the TD of the well is reached. For more information on drilling fluids and drilling waste management, refer to Section 2.8.2.

2.4.3 Well Evaluation

If the exploration drilling results indicate that hydrocarbons are present in the target formations, the wells will be evaluated and possibly tested to provide further information about the stratigraphic column with special emphasis on reservoir characteristics. Well evaluation is an important component of exploration drilling as it helps to determine the viability of a prospect and commercial potential of the reservoirs.

There are a number of processes involved in well evaluation. While drilling, the well will be monitored and evaluated using Measurement while Drilling and Logging While Drilling (MWD/LWD) techniques, mud logging, drilling parameters evaluation and subsurface pressure evaluation activities. Wireline logging, vertical seismic profiling and formation testing may be performed after drilling activity has been completed based on the results of the primary evaluation tools.

2.4.3.1 Wireline Logging

A formation evaluation contractor will be employed to deploy specialized equipment and tools in the well to gather petrophysical data. The logging tools are used to take and record detailed measurements of the geological formations encountered in and around the well and the rock and fluid properties of the targeted reservoirs.

2.4.3.2 Vertical Seismic Profiling

VSP may be carried out which facilitates the correlation of surface seismic data (recorded in time, milliseconds) to well data (recorded in depth, metres). This effectively allows an accurate correlation of seismic reflectivity events to geological formations encountered in the wellbore through time to depth calibration and matching of wavelet character between the surface seismic data and the VSP result.

VSP operations can be carried out in a number of ways; for the BP exploration wells it is likely that a stationary acoustic sound source will be deployed from the MODU while a number of receivers, positioned at different levels within the drilled hole, will measure the travel time of the sound generated at the source as it arrives at those receivers. This form of VSP operation is referred to as zero-offset VSP. An offset VSP could also be used in the exploration wells. This is where the acoustic source is used from a marine vessel, and deployed at a distance of up to 8 km from the well.

Up to 12 sound sources may be used, each with a volume of up to 250 cubic inches. These multiple sources are tuned to one another to effectively simulate one larger sound source. These sound sources are generally positioned at 5 to 10 m below the water surface. VSP operations are typically short duration, normally taking no more than a day to complete the profiling. Longer duration VSP operations for additional characterization may be run, which could extend the duration of the VSP by a few additional days. VSPs are quieter and shorter in duration than exploration seismic surveys (refer to Section 2.8.5 for more information on underwater sound generated by VSP).

VSP activity will be planned and conducted in consideration of the Statement of *Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP, DFO 2007b). Specific details of the VSP program will depend on the geological target and the objectives of the VSP.

2.4.3.3 Well Flow Testing

Well testing may be required for the Project. Well testing can be used to gather information about subsurface characteristics such as potential productivity, connected volumes, fluid properties, composition, flow, pressure, and temperature. This dynamic data set in turn enables the confirmation of data in logs and cores assimilated during drilling activity, which in turn can build a comprehensive picture of reservoir potential. Flow testing is required under the Accords Act to convert an EL to a Significant Discovery Licence (SDL), to demonstrate the potential for sustained production.

It is not currently anticipated that well testing will be carried out on the wells drilled in the initial phase of the Project (*i.e.*, one to two wells). In the event of well success in the initial wells, and if the need for well testing is identified, a well test program will be developed and executed on subsequent wells drilled as part of the primary term of the licence.

In the event that a well test is required, it will be subject to BP's process for well test planning which is designed to promote safe and efficient well test operations. A key requirement of these processes is the use of process safety design methods to ensure effective barriers are in place for the well test activity, and an internal approval process for any well test activity and any associated flaring.

Where well testing is considered necessary, specialized equipment and services will be contracted to carry out the activity. Equipment that will be used in the well test will be designed to be able to safely control the maximum potential pressure that the reservoirs may be able to generate. It is likely that the well test operation will be run using conventional drill stem test (DST) tooling, subsea safety systems and temporary surface flow equipment to manage and measure the well fluids, collect fluid samples and necessary data sets. A DST is envisioned as historically the only acceptable type of flow test to support a SDL application. However alternative testing technologies may be proposed to satisfy the legislated requirements, with benefits that include potentially improved safety and environmental performance and protection.

The primary purposes of the DST tools and tubing are: (i) to provide a controlled flow path for the reservoir fluids to surface; (ii) provide downhole shut in; (iii) facilitate well killing operations; and (iv) convey the data measurement instrumentation and specialized sampling equipment as close to the formation being tested as practically possible. At the seabed level, subsea tools will be placed inside the drilling BOP. These tools are primary safety tools that provide fast acting (emergency) isolation of the well fluids at subsea level and permit disconnection of the test string from the well if required. The subsea tools will also be designed to ensure the emergency BOP functions such as shearing and emergency disconnect are available for use during the well test. The well will subsequently be suspended or abandoned in accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*.

Any formation hydrocarbons, such as gas, oil or formation water that are brought to surface as part of the well test activity will be flared to enable their safe disposal. All flaring will be via one of two horizontal burner booms, to either a high efficiency burner head for liquids, or simple open-ended gas flare tips for gases. High efficiency combustion equipment will be used which will maximize complete combustion, thereby reducing the likelihood of black smoke in flaring activity and drop-out of un-combusted hydrocarbons liquids on to the sea surface.

Where it is carried out, it is likely that the full well testing operational process would occur over a one month window after drilling is complete; however it is possible that it could extend up to three months. This would include all testing through to well abandonment. Within this operational window, the well test process will vary in terms of activity and it is likely that there will be a number of periods of short duration where flaring is required. Flaring may be for operational purposes, such as flushing, or bleeding where it will be carried out for between one and six hours each with low flow rates. Flaring may also be required during a series of separate periods of well test flow that could last up to two or three days for any one period. More information on flaring as part of well testing is provided in Section 2.8.1.

2.4.4 Well Abandonment

Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. Plugs will be placed above and between any hydrocarbon bearing intervals at appropriate depths in the well, as well as at the surface.

It is possible that the subsea infrastructure could be removed. If this is the case, casing will be cut below the seabed and the wellhead removed. The wellhead will be lifted to the surface and brought to shore using a PSV. No infrastructure will be left on the seafloor after the wellhead has been removed. A seabed survey will be conducted at the end of the drilling program using an ROV to survey the seabed for debris. Alternatively, approval may be sought to leave the wellhead in place.

The final well abandonment program has not yet been finalized; however, these details will be confirmed to the CNSOPB as planning for the Project continues.

2.4.5 Supply and Servicing

The existing facility at the Woodside Terminal will be used to support logistical requirements for offshore operations. Supply base activities will be conducted by a third-party contractor and are considered outside the scope of this EIS.

2.4.5.1 Platform Supply Vessel Operations

The rig will be supported by a fleet of PSVs to re-supply the drilling vessel with fuel, equipment, drilling mud, and other supplies during the drilling program, as well as removing waste. It is likely that two to three PSVs will be required, with one vessel on stand-by at the drilling vessel at all times. It is estimated that the PSVs will make two to three round trips per week between the MODU and the supply base.

Typical PSVs travel at approximately 12 knots at service speed. It is therefore expected that a PSV could take approximately 16 hours to reach the furthest point of the Project Area from Halifax. Existing shipping lanes will be used as practicable to minimize incremental effects.

Supplies will be loaded and unloaded onto PSVs using personnel and cranes for drilling materials and closed piping systems (*e.g.*, pumps, hoses) for bulk powders, liquid supplies and waste (*e.g.*, drilling fluids).

PSVs will undergo BP's internal audit process as well as additional external inspections/audits inclusive of the CNSOPB pre-authorization inspection process in preparation for the Project. Procedures will be put in place to ensure that hoses are inspected and operated correctly to minimize the risk of an unintended release. The PSVs, MODU and supply base will be equipped with primary spill contingency equipment to deal with spills in the unlikely event that they occur.

The PSVs will transfer diesel fuel, also referred to as marine gas oil (MGO) to the MODU from shore. Fuel is required offshore to power the MODU, including drilling equipment and thrusters. Fuel will not be loaded from the Woodside Terminal. Instead, an existing field distribution facility will be used within Halifax Harbor. A number of potential locations have been identified within Halifax Harbor; however, the exact location for fuel loading operations has not yet been confirmed. Fuelling operations, according to standard vessel fuelling procedures, are expected to take place up to two to three times per week by a third party contractor.

2.4.5.2 Helicopter Traffic and Operations

Helicopters will be used for crew changes on a routine basis and to support medical evacuation from the MODU and search and rescue activities in the area, if required.

It is anticipated that approximately one helicopter trip per day would be required to transfer crew and any supplies not carried by the PSV to the MODU. The MODU will be equipped with a helideck for safe landings. Helicopter operations will be run out of Halifax Stanfield International Airport (YHZ).

Routes to the well locations from shore have not yet been finalized, as the well locations have not yet been confirmed. The maximum distance that a journey from Halifax International Stanfield Airport to a well location is 198 nautical miles (nm), based on the boundaries of the ELs. The maximum flight time is therefore expected to be 90 minutes, including taxi time. Military exclusion areas and areas of high environmental sensitivity have been identified and will be avoided as the helicopter flight paths are determined by the helicopter operators.

The helicopters that will make up the helicopter fleet have not yet been contracted; however, it is expected that the helicopters used by the Project will have a capacity of approximately 19 passengers and a maximum range of approximately 540 nm without refuelling. Refuelling operations are expected to take place at Halifax Stanfield International Airport; however, the MODU will be equipped with refuelling equipment.

2.5 WELL CONTROL AND BLOWOUT PREVENTION

A number of barriers are used in drilling operations to manage formation pressure, including the drilling fluid and casing, and dedicated pressure control equipment. Formation pressures are managed in order to prevent a blowout, which is an uncontrolled flow of formation fluids. A blowout can occur when the specific well control barriers have failed.

Blowouts are prevented in the first instance using primary well control measures and procedures. This includes monitoring the formation pressure and controlling the density of the drilling fluid accordingly. The density, or weight, of the drilling fluid is increased to maintain an overbalance of pressure against the formation, which keeps the wellbore stable. In the event that a primary barrier fails, the next line of defense is a BOP system, which is a secondary well control barrier.

A BOP is a mechanical device, which is designed to seal off a well at the wellhead when required. The system is made up of a series of different types of closing mechanisms. These include rams, which are pistons that move horizontally across the top of the well creating a seal around the drill string. Blind shear rams are also used to sever the pipe in the drill string and create a seal. Additionally, blind shear rams are used to seal the well when no pipe is present in the wellbore. Annular preventers can also be used to physically close off the well aperture around various sizes of pipe.

The BOPs that will be used as part of the Project will comply with American Petroleum Institute (API) standards, specifically Standard 53 (Blowout Prevention Equipment Systems for Drilling Wells). For each well drilled as part of the Project, a BOP rated to 15,000 psi working pressure (which will be able to accommodate the anticipated formation pressures) will be installed and pressure tested. These BOPs will consist of a series of control measures, including hydraulically-operated valves and sealing mechanisms that are open to allow the mud to circulate during drilling, but can be quickly closed if reservoir fluids, referred to as a "kick", enter the well. If a kick occurs and additional controls are required, an annular preventer will be closed to prevent any further influx from the reservoir into the well if there is pipe in the hole. If no pipe is in the hole, blind shear rams will be closed. The next line of defense, provided there is pipe in the hole, are the pipe rams, of which there are multiple for redundancy. The last line of defense is the blind shear rams, which, if necessary, cut right through the drill pipe and seal the well completely. There will also be a ram that is capable of cutting planned casing sizes, which is called a casing shear ram.

Prior to installation on the well, the BOP stack will be pressure tested on the MODU deck, and then again following installation on the well to test the wellhead connection with the BOP. It is expected that the BOP will be function tested every 7 days in accordance with API Standard 53 (Blowout Prevention Equipment Systems for Drilling Wells), and pressure tested every 21 days while connected to the wellhead. Additionally, when the BOP is initially installed, the ROV intervention capability for operating the BOP, if necessary, will be tested. This is done by physically engaging the ROV control panel to function the controls. The BOP will only be removed once the well has been plugged and abandoned and the casing pressure tested above the abandonment plugs to confirm plug integrity.

A discussion of emergency response measures and strategies is presented in Section 8.

2.6 PROJECT PERSONNEL

The overall Project will be managed by BP through a multidisciplinary Project Team. The Project Team will include members of BP's global wells organization who are responsible for delivering a consistent and standardized approach to the delivery of wells-related activity across the company. This team will be responsible for planning and delivering the Project as a whole; however a number of contractors will be engaged to carry out specific components of the work. Key contractors include: the drilling contractor, who will provide and operate the MODU; well services providers who provide equipment and services to support drilling operations; and logistics contractors who provide and operate the shore base, supply vessels and helicopters.

As the Project progresses, the number of BP and contractor personnel involved in the Project will change. The contractor providing the most number of personnel is the drilling contractor. During drilling operations, a maximum of 200 people from the drilling contractor will work on board the MODU. A small number of BP personnel, such as drilling supervisors and drilling engineers will also work offshore on the MODU. BP and contractor personnel will be trained and capable of carrying out their functions.

During the drilling program, the offshore BP team led by the drilling supervisor, also known as the wellsite leader (WSL), is responsible for coordinating the overall execution of the drilling program and providing oversight of well-related operations. The WSL interfaces with the drilling contractor offshore leadership team to ensure that drilling is carried out safely and efficiently and complies with all relevant regulations. The WSL reports to the BP well superintendent, who is based onshore and is responsible for supervising the execution of the approved drilling program.

Offshore drilling contractor roles will include management positions, such as the offshore installation manager (OIM) and tool pusher, who work with the BP drilling management team to deliver safe, reliable drilling operations. The drilling contractor team will also include a number of roustabouts, technicians and health, safety and environmental (HSE) personnel. BP and drilling contractor personnel will also support drilling operations from offices onshore.

2.7 PROJECT SCHEDULE

BP plans to commence exploration drilling in 2018 pending regulatory approval to proceed. At this time, it is anticipated that exploration drilling will be carried out in multiple phases so that initial well results can be analyzed to inform the strategy for subsequent wells. Up to seven exploration wells may be drilled in phases over the term of the ELs contingent on the drilling results of the initial wells.

It is anticipated that each well will take approximately 120 days to drill. Figure 2.7.1 shows key elements of the proposed Project schedule.

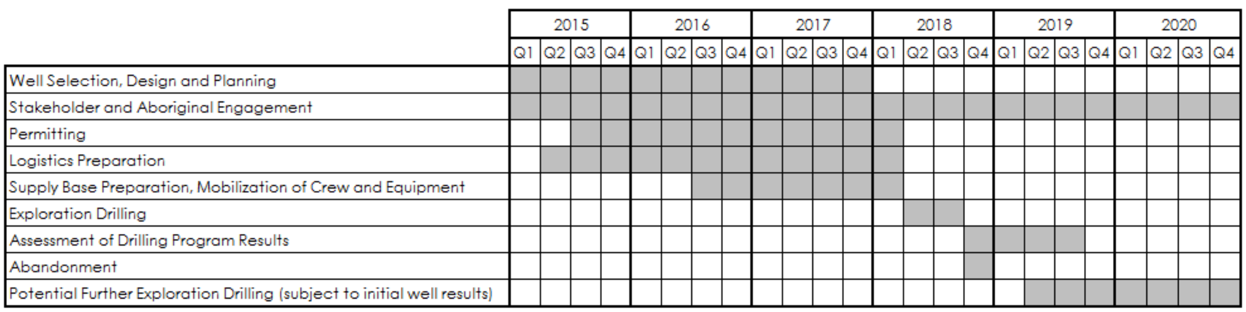


Figure 2.7.1 Proposed Project Schedule

2.8 EMISSIONS, DISCHARGES AND WASTE MANAGEMENT

This section provides an overview of the key emissions, discharges and waste streams, which are likely to originate from the proposed Project activities under routine and accidental conditions.

The key waste streams from the Project have been classified into the following groups:

- atmospheric emissions;
- drilling waste;
- liquid discharges;
- hazardous and non-hazardous waste; and
- heat, light and sound.

Some wastes will be managed and disposed of directly offshore from the MODU and the PSVs, whereas some wastes will be brought to shore for disposal. Offshore waste discharges and emissions associated with the Project (*i.e.*, operational discharges and emissions from the MODU and PSVs) will be managed in accordance with relevant regulations and municipal bylaws as applicable, including the Offshore Waste Treatment Guidelines (OWTG) (NEB *et al.* 2010) and the International Convention for the Prevention of Pollution from Ships (MARPOL), of which Canada has incorporated provisions under various sections of the *Canada Shipping Act*. Waste discharges not meeting legal requirements will not be discharged to the ocean and will be brought to shore for disposal.

Waste management plans and procedures will be developed and implemented to define waste storage, transfer and transportation measures.

Information on the releases, wastes and discharges will be reported as part of a regular environmental reporting program in accordance with regulatory requirements as described in the OWTG.

2.8.1 Atmospheric Emissions

Key Project activities resulting in atmospheric emissions are:

- combustion from the MODU and PSV diesel engines, and fixed and mobile deck equipment, and helicopters; and
- flaring during well test activity, in the event that well testing is required.

Emissions from diesel combustion activity are likely to include carbon dioxide (CO_2), carbon monoxide (CO), sulphur dioxides (SOx), nitrogen oxides (NOx), and particulate matter (PM). Air emissions from the Project will adhere to applicable regulations and standards including the Nova Scotia *Air Quality Regulations* under the Nova Scotia *Environment Act,* the National Ambient Air Quality Objectives (SO_2, NO_2, total suspended PM, and CO) and the Canadian Ambient Air Quality Standards (fine PM).

Marine engines are also subject to NO_X limits set by the International Maritime Organization (IMO) of the United Nations, with Tier II limits applicable in 2011 and Tier III limits to become applicable in 2016 in Emission Control Areas (ECA), which include the offshore waters of Nova Scotia to the 200 nautical mile (370 km) limit. On January 1, 2015, the sulphur limit in fuel in the ECAs in large marine diesel engines dropped from 1.0% to 0.1% in accordance with the Vessel Pollution and Dangerous Chemicals Regulations under the *Canada Shipping Act*. The IMO is also responsible for development of efficiency measures that will involve mandatory measures to increase energy efficiency on ships, a process that will reduce the greenhouse gas emissions (GHG) in the offshore.

Ultra-low sulphur diesel (ULSD) fuel will be used for the Project wherever practicable and available. Using ULSD instead of regular diesel will reduce the potential for adverse local air quality effects.

Atmospheric emissions from individual components are contingent on fuel consumption. Activity and therefore fuel consumption will be variable throughout the Project; however, expected emissions from individual components are presented below (Table 2.8.1 and Table 2.8.2). Emission factors from US EPA AP-42 (Fifth Edition, Volume 1, Chapter 3.4) have been used to estimate the amount of carbon dioxide and other atmospheric emissions from expected routine emission sources. It has been assumed that evaporation in diesel engines has been negligible, and therefore only exhaust emissions have been considered.

Table 2.8.1 Gaseous Emissions Factors for Large Stationary Diesel Internal Combustion Sources

Air Contaminant	Emission Factor from US EPA AP-42 (lb/MMBtu)
CO_2	165
CO	0.85
NO_x	3.2
SO_x *	1.01S[1]
PM	0.1
* Note: Assumes that all sulphur in the fuel is converted to SO_2. S[1] is the sulphur in fuel oil and it has been assumed that the sulphur content will be 0.05% The emission factor is therefore 0.0505.	

- **MODU**

  As described previously, the MODU for the drilling program has not yet been identified and therefore exact fuel consumption data is not available. It is expected that on average, based on fuel consumption information from a comparable semi-sub DP powered MODU (as an example) that approximately 56 tonnes of fuel will be used by the MODU per day while on station (under extreme metocean conditions).

- **PSV**

  It is possible that up to three PSVs will be required to support MODU operations. PSVs will make approximately two to three trips per week at a service speed of 12 knots and a PSV shall remain on standby at the wellsite at all times. PSV emissions will be dependent on the speed of the vessel; however, it has been assumed that on average, each PSV will consume approximately 12 tonnes of fuel per day.

- **Helicopter**

  A helicopter will be used to transport personnel to and from the MODU. It is expected that one trip will be required per day. The furthest distance that the helicopter will travel from Halifax to the drilling location, based on the boundaries of the ELs is 198 nm. It is likely that approximately 1.2 tonnes of fuel could be used per round trip from Halifax to the wellsite and back again.

Table 2.8.2 Daily Criteria Air Contaminant Emissions for the MODU and Support Vessels and Helicopter

	Daily Fuel consumption (tonnes)	Daily Energy consumption (MMBtu)	CO_2 (tonnes per day)	CO (tonnes per day)	NO_x (tonnes per day)	SO_x (tonnes per day)	PM (tonnes per day)
MODU	56	2,380	178	0.9	3.5	0.006	0.1
PSV 1	12	510	38	0.2	0.7	0.001	0.02
PSV 2	12	510	38	0.2	0.7	0.001	0.02
PSV 3	12	510	38	0.2	0.7	0.001	0.02
Helicopter	1.2	51	3.8	0.02	0.07	0.	0.002
TOTAL	**93.2**	**3,961**	**295.8**	**1.52**	**5.75**	**0.009**	**0.18**

In terms of GHG emissions from routine activity, the Project is predicted to emit approximately 295.8 tonnes of CO_2 equivalent per day from fuel combustion for the MODU, helicopters and PSVs. ECCC reports an annual GHG emission value for the province of Nova Scotia of 17,000 kilotonnes of CO_2 equivalent per year (46,575 tonnes of CO_2 equivalent per day) (Environment Canada 2016). BP's predicted daily CO_2 emissions for the Project therefore represent approximately 0.64% of Nova Scotia's average daily emission.

It is not currently anticipated that well flow testing will be carried out on the wells drilled in the initial phase of the Project (*i.e.*, one to two wells). In the event of well success in the initial wells, and if the need for well flow testing is identified, a well test program will be developed and executed on subsequent wells drilled as part of the primary term of the licence. If well flow testing is carried out, atmospheric emissions will be generated as a result of flaring activity.

Well flow testing is a non-routine activity that occurs over a short period of time at the end of the drilling program. The well flow test window is likely to last no more than a month, although it could extend up to three months. Within this operational window, the well flow test process will vary in terms of activity and it is likely that there will be periods where flaring is required. Flaring may be for operational purposes, such as flushing or bleeding, and it would be carried out over one to six hours per flaring event, with low flow rates. Flaring may also be required during a series of separate well flow test periods that could last two or three days per period. It is also possible that there could be multiple targets containing hydrocarbons within each well, each of which could be subject to a well flow test.

In the event that a well flow test is desired, it will be subject to BP's process for well flow test planning, which is designed to promote safe and efficient well test operations. A key requirement of these processes is the use of process safety design methods and an internal approval process for any well test activity and associated flaring. Once the well design has been defined, a detailed well evaluation plan will be prepared and will be submitted for regulatory approval as part of the OA process.

For the purposes of quantifying GHG emissions from a non-routine flaring event for this assessment, it has been assumed that there could be two targets in each well that could potentially be tested as part of the evaluation program, and that no more than 10,000 bbls of oil would be flared per target in each well. Using a mass balance approach, the tonnes of CO_2 equivalents emitted as a result of flaring 10,000 bbls of oil from one target during a well flow test are 4,362 tonnes. In the assumption that two targets could be tested in each well, it is therefore possible that up to 8,724 tonnes of CO_2 equivalents could be emitted.

In line with the Project schedule, it is possible that two wells could be drilled in any year, and consequently, it is assumed that up to 17,448 tonnes of CO_2 equivalents could be released as a result of non-routine flaring during well flow testing, per year. This represents approximately 0.10 % of Nova Scotia's annual GHG emissions (17,000 kilotonnes CO_{2eq}/yr), as reported for 2014.

2.8.2 Drilling Waste Discharges

A number of drilling related waste streams will be generated as part of the Project; including:

- drill cuttings;
- drill fluids; and
- cement.

All drilling related waste streams will be disposed of in accordance with the OWTG.

The shallow sections of the wells will be drilled with WBM or seawater, and then deeper sections with either WBM or SBM.

WBM is primarily made up of water (approximately 75%), which can be freshwater, seawater or brine. Barium sulphate (barite) is added to the water in WBM to control mud density and thus help balance formation pressures within the well. Bentonite clay is also added which is used as a viscosifier, which thickens the mud to suspend and carry drill cuttings to the surface. Other substances can be added to the WBM to obtain the required drilling properties of the fluid, such as thinners, filtration control agents and lubrication agents. The vast majority of WBMs discharged are classified under the OCNS as substances which pose little or no risk to the environment (PLONOR.)

SBM is a water-in-oil emulsion which contains non-aqueous (water insoluble) fluids manufactured through chemical processes. SBMs can be made up of internal olefins, alpha olefins, polyalphaolefins, paraffins, esters or blends of these materials. The same weighting materials, such as barite, used in WBMs to control density are typically added to SBMs, as well as additives to manage viscosity, fluid loss, alkalinity, emulsion stability and wettability, where required. SBMs may be selected over WBM as they can offer improved lubricity, thermal stability, wellbore integrity and protection against gas hydrates in the well.

It is proposed that cuttings will be disposed to the seabed along with associated WBM or seawater drilling fluids used in the initial riserless sections. Cuttings from subsequent sections drilled with the riser will be returned to the MODU for treatment.

The MODU will be equipped with specialized solids control equipment for cuttings management. Shale shakers will be used to recover drilling fluids from the cuttings. Shale shakers are made up of a system of coarse and fine mesh screens that collect cuttings and allow drilling fluids to pass through and be collected. The purpose of solids control is to quickly and simply remove as much of the drilling fluids as possible from the cuttings for re-use in the drilling process. Additional solids control equipment, such as centrifuges may be required depending on the drilling fluid basis of design, and geological characteristics for reconditioning of the drilling fluid for re-use. Following treatment with solids control, WBM cuttings can be discharged to sea from the MODU through a caisson. Any excess or spent WBM may be discharged to the marine environment without treatment in line with the OWTG.

Additional treatment of cuttings will be required when SBM is used as the drilling fluid to enable disposal in accordance with the OWTG. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained “synthetic on cuttings” on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG. It is expected that this SBM treatment will be done using a cuttings dryer, equipment that uses high-speed centrifuge technology to separate drilling fluid from the liquids. In accordance with the OWTG, no excess or spent SBM will be discharged to the sea. Spent or excess SBM that cannot be re-used during drilling operations will be brought back to shore for disposal.

Cement is used in drilling operations to secure casing in the well, and to prevent the escape of hydrocarbons around the outside of the well casing. Cement is pumped into the well and up and around the casing, and typically sets in approximately 5 to 6 hours.

Excess cement slurry may be discharged to the seabed during the initial phases of the well, which will be drilled without a riser. Once the riser has been installed, all cement waste will be returned to the MODU. Cement waste will then be transported to shore for disposal in an approved facility.

Based on the typical well design presented in Section 2.4.2, estimated quantities of cuttings that could be generated by drilling are presented below in Table 2.8.3. Predictive dispersion modelling for cuttings discharges is presented in Appendix C with a summary provided in Section 7.1.

Table 2.8.3 Estimated Drill Cuttings Discharges Based on Typical Well Profile

	Hole Size	Section Depth (m)	Quantity of Cuttings (tons)	Type of Drilling Fluid Used	Treatment	Discharge Location
1	36”x 42”	100	224	Seawater / WBM	None	Seabed
2	26”	800	766	Seawater / WBM	None	Seabed
3	17” x 20"	950	490	SBM / WBM	Shale shakers and cuttings dryers for SBM where used	Water column
4	14.3/4” x 17.1/2”	1,100	439	SBM / WBM	Shale shakers and cuttings dryers for SBM where used	Water column
5	10.5/8” x 12.1/4”	2,250	462	SBM / WBM	Shale shakers and cuttings dryers for SBM where used	Water column
6	8.1/2”	250	26	SBM / WBM	Shale shakers and cuttings dryers for SBM where used	Water column
TOTAL		**5,450**	**2,406**			

Table 2.8.4 Estimated Drill Fluids Discharges Based on Typical Well Profile (assumed that SBM will be Used for Sections 3-6)

		Discharges While Drilling			Batch Discharge of WBM [3]	
	Hole Size	Mud Discharged (tonnes)	Chemicals Discharged [1] (tonnes)	Oil Discharged [2] (tonnes)	Whole Mud Displacement (tonnes)	Chemicals Discharged (tonnes)
1	36”x 42”	146	2	0	703	193
2	26”	1,168	19	0	2,184	772
3	17” x 20"	91	77	40	0	0
4	14.3/4” x 17.1/2 “	101	89	37	0	0
5	10.5/8” x 12.1/4”	128	116	40	0	0
6	8.1/2”	8	8	2	0	0
TOTAL		**1,499**	**183**	**70**	**2,887**	**965**

Note:
[1] Chemicals include commercial solids (barite, bentonite *etc.*) added to the mud system.
[2] Assumes that SBM will be used to drill sections 3, 4, 5 and 6 and that SBM cuttings will be treated with cuttings dryers prior to discharge. Oil discharged is synthetic base oil only.
[3] WBM will be discharged in bulk at the end of sections drilled with WBM in line with OWTG.

2.8.3 Liquid Discharges

A number of liquid wastes could be generated from the MODU and associated drilling equipment, and on the PSVs. Some of these liquid wastes can be discharged directly from the MODU or PSVs, following treatment where necessary, in accordance with the OWTG. Where discharges occur offshore, the points of discharge will be below the water surface.

A short description of the major liquid discharge streams and the way in which they will be managed and disposed is shown below in Table 2.8.5.

Table 2.8.5 Potential Project-Related Liquid Discharges

Discharge	Source and Characterization	Waste Management
Produced water	Produced water includes formation water encountered in a hydrocarbon bearing reservoir. Produced water would only be produced during well evaluation and testing processes when formation fluids are brought to surface.	Small amounts of produced water may be flared. If volumes of produced water are large, some produced water may be brought onto the MODU for treatment so that it can be discharged in line with the OWTG.
Bilge and deck drainage water	Deck drainage is water on deck surfaces of the MODU from - precipitation, sea spray or MODU activities such as rig wash-down, or from fire control system or equipment testing. Bilge water is seawater that may seep or flow into parts of the MODU. Water may pass through pieces of equipment into other spaces of the MODU. As it may come into contact with equipment and machinery, deck drainage and bilge water may be contaminated with oil and other chemicals.	Deck drainage and bilge water will be discharged according to the OWTG which state that deck drainage and bilge water can only be discharged if the residual oil concentration of the water does not exceed 15 mg/L.
Ballast water	Ballast water is used in MODU and PSVs for stability and balance. It is taken up or discharged when the cargo is loaded or unloaded, or when extra stability is needed to manage weather conditions. The water typically does not contain hydrocarbons or chemicals as it is stored in dedicated tanks on the vessel.	Ballast water will be discharged according to IMO *Ballast Water Management Regulations* and Transport Canada's *Ballast Water Control and Management Regulations.* The MODU will carry out ballast tank flushing prior to arriving in Canadian waters.
Grey and black water	Black and grey water will be generated from ablution, laundry and galley facilities onboard the MODU and PSVs. Grey water will be generated from washing and laundry facilities, and black water includes sewage water generated from the accommodation areas.	Sewage will be macerated prior to discharge. In line with the OWTG and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements, sewage will be macerated so that particles are less than 6 mm in size prior to discharge.

Table 2.8.5 Potential Project-Related Liquid Discharges

Discharge	Source and Characterization	Waste Management
Cooling water	Cooling water is seawater that is pumped onto the MODU and passed over or through equipment such as machinery engines using heat exchangers. Cooling water may be required on the MODU; however in the event that it is required, any volumes of seawater used for cooling water are likely to be minimal. Water may be treated through biocides or electrolysis prior to use.	Cooling water will be discharged in line with the OWTG which states that any biocides used in cooling water are selected in line with a chemical management system developed in line with the OCSG. Cooling water is likely to be warmer than the ambient water temperature upon discharge but will be rapidly dispersed, reaching ambient temperatures.
BOP testing fluids	The BOP is regularly pressure and function tested. BOP fluids are released directly to the ocean during testing activity (approximately 5 bbls per test) and whenever the riser unlatches (approximately 50 bbls). BOP fluids are typically freshwater based, seawater soluble chemicals.	BOP fluids and any other discharges from the subsea control equipment will be discharged according to OWTG and OCSG.
Well treatment and testing fluids	Well testing may be required as part of the Project to gather information about the subsurface characteristics, and to convert an EL to a SDL. Depending on well success, formation fluids, including hydrocarbons and associated water are likely to be brought to surface during a well test.	Any hydrocarbons, such as gas, oil or formation water that are brought to surface as part of well test activity will be flared to enable their safe disposal. All flaring will be via one of two horizontal burner booms, to either a high efficiency burner head for liquids, or simple open ended gas flare tips for gases to minimize fall out of un-combusted hydrocarbons. Flaring will be optimized to the amount necessary to characterize the well potential and as necessary for the safety of the operation.

Liquid wastes, not approved for discharge in OWTG such as waste chemicals, cooking oils or lubricating oils, will be transported onshore for transfer to an approved disposal facility. This is described in further detail in Section 2.8.4.

2.8.4 Hazardous and Non-Hazardous Wastes

All waste generated offshore on the MODU and PSVs will be handled and disposed of in accordance with relevant regulations and municipal bylaws. Waste management plans and procedures will be developed and implemented to prevent unauthorized waste discharges and transfers. Putrescible solid waste, specifically food waste generated offshore on the MODU and PSVs, will be disposed of according to OWTG and MARPOL requirements. In particular, food waste will be macerated so that particles are less than 6 mm in diameter and then discharged. There will be no discharge of macerated food waste within 3 nm from land.

Non-hazardous wastes, such as other domestic wastes, packaging material, scrap metal and other recyclables such as waste plastic for example, will be stored in designated areas on board the MODU. At scheduled intervals, waste will be transferred to the PSVs so that it can be transported to shore where it will be transferred to a third party waste management contractor at an approved facility.

Some solid and liquid hazardous wastes are likely to be produced as part of the Project, including oily wastes (*e.g.*, filters, rags and waste oil), waste chemicals and containers, batteries, biomedical waste and spent drilling fluids. Biomedical waste will be collected onboard by the doctor and stored in special containers before being sent to land for incineration. Hazardous wastes will be stored in designated areas on the MODU and will be transferred to shore on a PSV for disposal by a third party contractor at an approved facility. Transfer of hazardous wastes will be conducted according to the *Transportation of Dangerous Goods Act*. Any applicable approvals for the transportation, handling and temporary storage, of these hazardous wastes will be obtained as required.

2.8.5 Sound and Light Emissions

2.8.5.1 Sound Emissions

Underwater sound will be generated by the MODU and PSVs, as well as during VSP operations. The level of underwater sound generated by a MODU can be influenced by the type of MODU and by the method of positioning on station (*i.e.*, DP or mooring system). The extent to which sound travels is determined by environmental conditions, including water depths, water salinity and temperature.

The sound generated by the MODU will be continuous throughout the drilling program, whereas underwater sound generated during the VSP operations are typically impulsive in nature, occurring over a short duration (*e.g.*, typically no more than a day as described in Section 2.4.3.2).

Acoustic modelling of underwater sound generated by the Project is presented in Appendix D. A general overview of underwater sound and how it affects the marine environment is presented in Section 7.1.

Atmospheric sound (*e.g*., sound above the sea surface) is not of particular concern given the relative low level of atmospheric sound sources (above sea level) and limited transmission of underwater sound through the air-sea interface. The nearest communities to the Project Area are coastal Nova Scotia communities more than 200 km away. Potential receptors on Sable Island (*e.g*., temporary residents or visitors) would also be geographically separated from the Project Area (approximately 48 km away) such that they would not perceive atmospheric sound generated by Project activities.

Helicopter traffic associated with the Project will generate atmospheric sound emissions although the use of an existing operational airport (Halifax Stanfield International Airport) will reduce effects on human receptors. Effects of helicopter traffic (including atmospheric sound) on wildlife will be mitigated through avoidance of Sable Island and bird colonies (refer to Section 7.4).

2.8.5.2 Light

Artificial lighting will be generated by the Project from several sources.

- MODU and PSV navigation and deck lighting will be operating 24 hours a day throughout drilling and PSV operations for maritime safety and crew safety (refer to Section 2.4.1 for further information).
- Flaring activity during well flow testing, in the event that it is carried out, will generate light and thermal emissions on the MODU. Well flow testing, where it occurs, will be carried out on a temporary basis at the end of drilling operations. It is possible that there could be several, intermittent, short periods of flaring (lasting up to two or three days) during a one to three month window at the end of drilling operations. It is not expected that well flow testing will take place on the first two wells drilled as part of the Project (refer to Section 2.4.3.3 for further information).

2.9 ALTERNATIVE MEANS OF CARRYING OUT THE PROJECT

2.9.1 Options Analysis Framework

As required under section 19(1)(g) of CEAA, 2012, every environmental assessment of a designated project must take into account alternative means of carrying out the project that are considered technically and economically feasible, and considers the environmental effects of any such alternative means.

Consistent with the *Operational Policy Statement: Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2013b), the process for consideration of alternative means of carrying out the Project includes the following steps:

- consideration of legal compliance, technical feasibility, and economic feasibility of alternative means of carrying out the Project;
- description of each identified alternative to the extent needed to identify and compare potential environmental effects;
- consideration of the environmental (including socio-economic) effects of the identified technically and economically feasible alternatives of carrying out the Project; this includes

potential adverse effects on potential or established Aboriginal and Treaty rights and related interests (where this information has been provided); and

- selection of the preferred alternative means of carrying out the Project, based on the relative consideration of effects.

There are several components of the Project that remain to be finalized. Some options under review will be confirmed to CNSOPB as part of the OA and ADW process (*e.g.*, wellsite location).

2.9.2 Identification and Evaluation of Alternatives

As per the EIS Guidelines, the analysis of alternative means considers the following alternative means of carrying out the Project:

- drilling fluid selection (*e.g.*, WBM or SBM);
- drilling waste management; and
- platform lighting and flaring options.

A consideration of legal compliance, technical feasibility and economic feasibility, as well as the environmental effects (where applicable) of each alternative means is described for each option.

Technical feasibility considers criteria, which could influence safe, reliable and efficient operations. Technology must be available and proven for use in a similar environment and activity set (*i.e.*, offshore drilling in deep water), and cannot compromise personnel and process safety for it to be considered. Economic feasibility considers capital and operational project expenditure. Project expenditure can be impacted directly (*e.g.*, equipment and personnel requirements) and indirectly (*e.g.*, schedule delays).

Each option for the alternative means identified above is summarized in a tabular format. Options are colour-coded red to demonstrate where an option is unfeasible, orange to demonstrate if there are potential issues and green to demonstrate if there are no issues. The preferred alternative means form the basis for the Project to be assessed (*i.e.*, assumed to be the base case that is assessed for environmental effects in Section 7 of this EIS).

2.9.2.1 Drilling Fluids Selection

Both WBM and SBM could be used to drill wells associated with the Project. Drilling fluids are formulated according to the well design and the expected geological conditions. Both WBM and SBM are acceptable according to local regulations, provided that the components of the drilling fluids are selected according to criteria of the OCSG and their disposal is carried out according to the OWTG.

Both drilling fluids are available within Nova Scotia; however, there are several factors, which determine the technical feasibility of one drilling fluid relative to another. In general, SBM can enable more efficient drilling operations than WBM when drilling through challenging geological conditions, including areas containing hydrate shales.

A summary of the comparison between WBM and SBM is presented in Table 2.9.1. As a preferred option has not been selected, the EIS considers the use of WBM and SBM in the effects assessment (refer to Section 7).

Table 2.9.1 Summary of Drilling Fluid Alternative Analysis

Option	Legally acceptable?	Technically feasible?	Economically feasible?	Environmental Issues	Preferred Option
WBM only	Yes	Yes – potential challenges with borehole stability	Yes – potential increased cost from non-productive time and losses	No substantial difference between either options. Both are considered acceptable provided that appropriate controls are in place and chemicals are selected in line with OCSG.	A preferred option has not yet been identified as well planning is still underway. It is likely both drilling fluid types will be used and both are assessed in the EIS.
WBM / SBM hybrid for different sections	Yes	Yes	Yes		

2.9.2.2 Drilling Waste Management

Drilling waste management options vary depending on the type of drilling fluid used. In the event that different drilling fluids are used to drill different sections of the well, it is likely that a combination of drilling waste management options will be used.

Figure 2.9.1 describes the options available for treatment and disposal of WBM and SBM wastes, excluding the direct discharge of WBM associated with the riserless section. The options can be broadly categorized into onshore and offshore disposal.

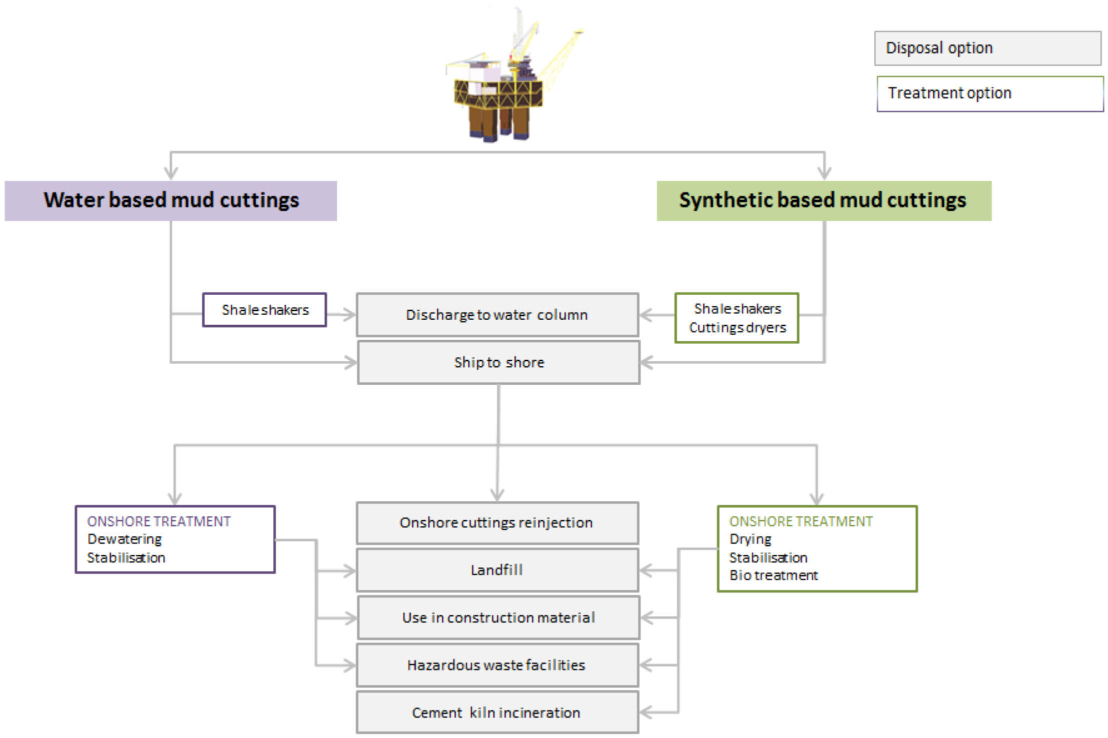


Figure 2.9.1 Drilling Waste Management Options

Offshore disposal treatment on board the MODU is described in Section 2.8.2. An alternative method of offshore disposal is cuttings reinjection. Reinjection involves slurrifying cuttings (*i.e.*, mixing them with a liquid) and then pumping them into a dedicated well, designed for reinjection. Under pressurized conditions, cuttings pass into targeted formations down the well. Offshore injection of cuttings from fixed wellhead platforms is well proven, but subsea injection from mobile drilling units is limited. The subsea injection equipment involved is very specialized (*i.e.*, it requires a flexible injection riser and a specially designed wellhead) and has only been developed for water depths of 1,000 feet (305 m). It is likely that some Project wells will be drilled at water depths much greater than 305 m, so implementing subsea injection at these water depths would require the use of unproven technology. Additionally, equipment weight increases considerably with the length of the pipe, so the use of a flexible pipe at deep water depths would be costly and require a large storage capacity on the rig. There would ultimately be a length limitation for deep water applications. Special installation procedures may also be required. Therefore, subsea cuttings reinjection has never been developed for deep water either by operators or the service sector, because the risked costs are too high especially for exploration drilling.

For onshore disposal, cuttings are shipped to shore where both WBM and SBM waste can be treated prior to onshore disposal. Cuttings would be shipped from the MODU to shore using a PSV. Some typical onshore treatment and disposal options for WBM and SBM waste are presented in Figure 2.9.1. Ship-to-shore treatment of waste reduces offshore effects associated with drilling waste discharge; however, additional effects due to increased marine transportation (*e.g.*, atmospheric emissions) and onshore treatment and disposal (*e.g.*, habitat alteration) will be introduced instead. Ship-to-shore options are expected to be more expensive than the offshore options due to additional transportation costs. In general, ship-to-shore and associated onshore disposal presents a potentially higher operational risk option as it is dependent on a number of external factors, specifically onshore waste management facility availability and PSV availability. PSV transit may be affected by poor weather conditions, which could impact their ability to collect cuttings on a regular basis from the MODU. If cuttings cannot be removed from the MODU, drilling operations may have to stop.

Discharge to the water column following treatment to OWTG standards is the preferred option for cuttings generated as part of the Project and has been assessed as part of the Project (refer to Section 7). This analysis of alternative means for drilling waste management is summarized in Table 2.9.2.

Table 2.9.2 Summary of Drilling Waste Management Alternative Analysis

Disposal Option	Legally acceptable?	Technically feasible?	Economically feasible?	Environmental Issues	Preferred Option
Discharge to water column (following treatment)	Yes	Yes	Yes	Some localized effects are expected on the seafloor from discharge of cuttings.	✓
Offshore Reinjection	Yes	No	Not considered as option has been identified as unfeasible		✗
Ship-to-shore	Yes	Yes	Yes – but increased costs from increased transportation and operational delays	Some limited offshore effects are expected from increased transportation, and some onshore effects from transportation and onshore disposal of waste	✗

2.9.2.3 Offshore Vessel Lighting

Lighting will be used on the MODU and the PSVs for navigation and deck lighting 24 hours a day throughout drilling and PSV operations for maritime safety and crew safety. Lighting is required under Canadian and international law to minimize the risk of collisions between offshore vessels.

Alternative MODU lighting techniques have been tested elsewhere in the industry. In the North Sea, spectral modified lighting, which uses red light (570 nm to 650 nm) has been tested on offshore platforms and has demonstrated a reduced effect on marine birds. The technology is not considered yet commercially viable. The lighting has satisfied regulatory requirements in a number of regions, including in the Netherlands, Germany and in the United States, however implementation in the offshore oil and gas industry has been restricted by commercial availability, limited capability in extreme weather, safety concerns around helicopter approach and landing and lower energy efficiency (Marquenie *et al.* 2014).

Options to reduce lighting on the MODU and PSVs as far as practicable will be investigated; however, it will be maintained at a level that will not impede the safety of the workforce or drilling operations (see Table 2.9.3). The EIS considers the environmental effects associated with standard MODU lighting (refer to Section 7).

Table 2.9.3 Summary of Lighting Alternative Analysis

Disposal Option	Legally acceptable?	Technically feasible?	Economically feasible?	Environmental Issues	Preferred Option
No lighting	No – lighting is required by local and international law	Not considered as option has been identified as legally unacceptable			✗
Standard MODU lighting	Yes	Yes	Yes	Some localized visual effect is expected which could affect migratory birds	✓
Spectral modified lighting	Yes	No – not considered ready for commercial use yet	No - not considered as commercially viable yet	Not considered as option has been identified as unfeasible	✗

2.9.2.4 Well Test Flaring

In the event that well flow testing is conducted, flaring will be required. Well flow testing, where it occurs, will be carried out on a temporary basis at the end of drilling operations as described in Section 2.4.4.3.

Well testing is required by the CNSOPB to declare a significant discovery and to convert an EL to an SDL. When well flow testing is carried out, flaring is required to safely dispose of hydrocarbons that may come to surface. No flaring is therefore not an option.

Another alternative option could be to manage the timing of flaring activity. Flaring could be restricted during periods of poor visibility including at night and during inclement weather to reduce light generated during flaring. However, data gathered during the well test could be compromised if the well flow was restricted during test period (*i.e.*, restricted to certain weather conditions). This could mean prolonged well test activity (*i.e.*, greater than one month as currently predicted) which could also increase operational costs (*i.e.*, increased rig costs).

Flaring is expected to be brief and intermittent in nature (lasting two to three days at a time) which could occur several times in the well flow test period, which in total is expected to last between one to three months. Flaring alternatives are provided in Table 2.9.4. The analysis of Project effects (refer to Section 7) assumes there will be routine flaring. However, it is not currently anticipated that well testing will be carried out on the wells drilled in the initial phase of the Project (*i.e.*, one to two wells).

Table 2.9.4 Summary of Flaring Alternative Analysis

Disposal Option	Legally acceptable?	Technically feasible?	Economically feasible?	Environmental Issues	Preferred Option
No flaring	No	Not considered as option; current regulatory practice requires DST/Flaring to secure Significant Discovery Licence. Industry continues to advocate for alternative methods.			✗
Reduced flaring (*i.e.* no flaring during night time or inclement weather)	Yes	Yes – although activity could give result to compromised data	Yes – but increased MODU costs and risk of delays	Reduced flaring would still result in some measure of light and atmospheric emissions.	✗
Flaring as required	Yes	Yes	Yes	Some limited offshore effects are expected from the light and atmospheric emissions generated during flaring. These are expected to be intermittent and brief in duration over a temporary period at the end of drilling.	✓

2.9.3 Chemical Management

The details of chemicals to be used in the Project have not yet been confirmed and potential alternatives have not yet been identified. A drilling fluid contractor for the Project has not yet been selected, and the drilling fluid basis of design for the wells is under development. Nonetheless, as planning for the Project continues, BP will follow chemical management and selection processes to define the ways in which chemicals will be chosen and used.

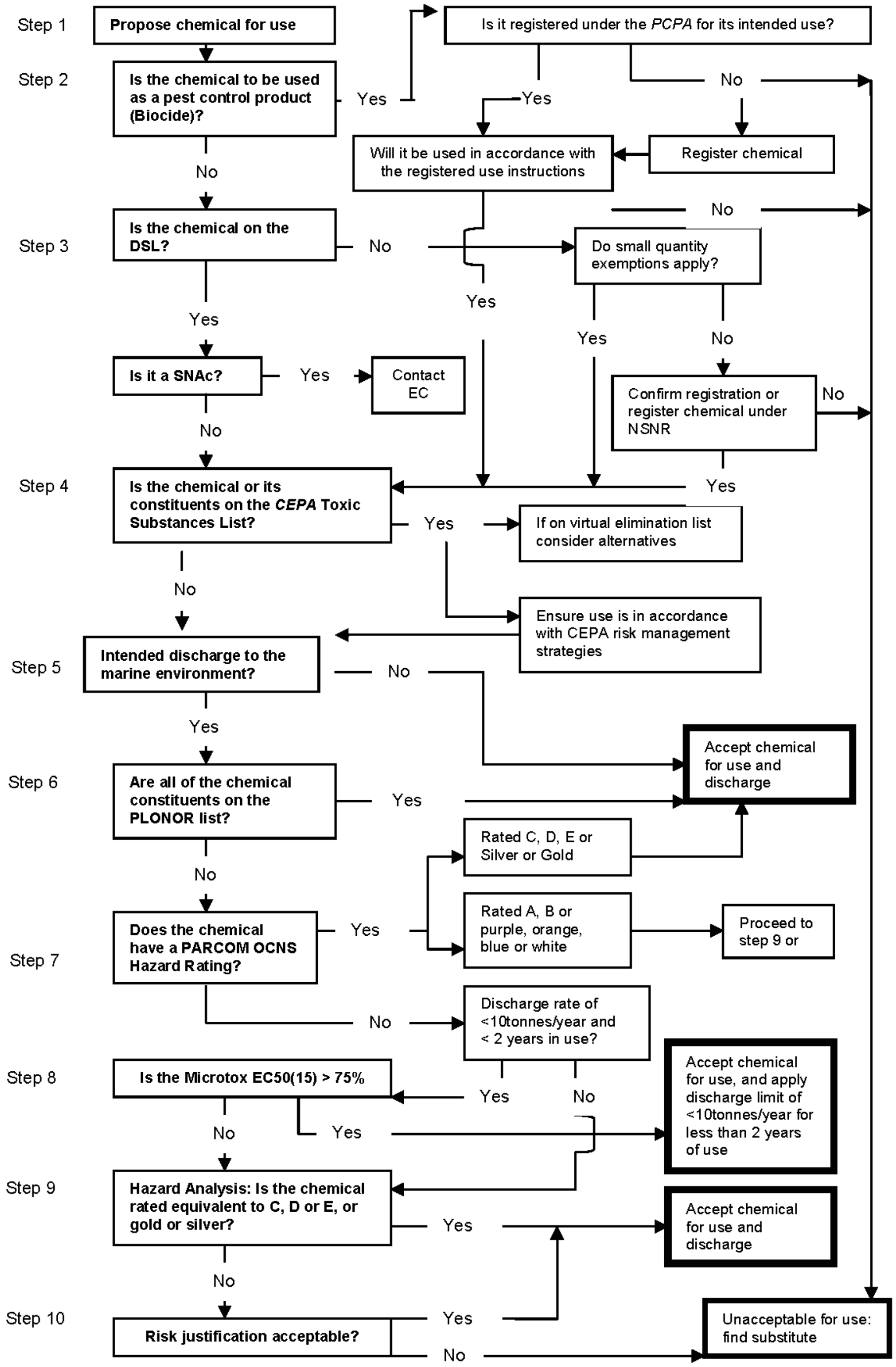
Chemical management processes will be defined prior to the start of any drilling activity and will be conducted in accordance with applicable legislation as summarized in Table 2.9.5.

Table 2.9.5 Applicable Offshore Chemical Management Legislation and Guidelines

Legislation	Regulatory Authority	Relevance
Canadian Environmental Protection Act (CEPA)	ECCC	Provides for the notification and control of certain manufactured and imported substances. The DSL is a list of substances approved for use in Canada. Schedule 1 includes a list of substances that are considered toxic and subsequent restrictions or phase out requirements
Fisheries Act	DFO; ECCC	Prohibits the deposition of toxic or harmful substances into waters containing fish
Hazardous Product Act	Health Canada	Standards for chemical classification and hazard communication
Migratory Birds Convention Act, 1994	ECCC	Prohibits the deposition of harmful substances in waters or areas frequented by migratory birds
Pest Control Products Act	Health Canada	Regulates the importation, sale and use of pest control products, including products used as biocides offshore
Offshore Chemical Selection Guidelines (OCSG)	CNSOPB	Framework for the selection of drilling and production chemicals for use and possible discharge in offshore areas

At a minimum, selection of drilling chemicals will be in accordance with the OCSG. The OCSG establishes a procedure and criteria for offshore chemical selection. The objective of the guidelines is to promote the selection of lower toxicity chemicals to minimize the potential environmental impact of a discharge where technically feasible.

Figure 2.9.2 shows the chemical selection process outlined in the OCSG which will be employed by BP. Furthermore, BP will document the process used to evaluate prospective chemicals.



Source: CNSOPB 2009

Figure 2.9.2 Chemical Selection Flowchart

Proposal for Use: Initial Screening and Regulatory Controls Identification

As shown in Figure 2.9.2, a screening of the proposed chemical will be carried out to determine whether it is restricted through any of the other elements of legislation as described in Table 2.9.5. This includes specific aspects of the use of the chemical, including likely volume demand and discharge assumptions.

In line with the regulations, certain restrictions, controls and prohibitions agreed with applicable regulatory agencies will be placed on:

- chemicals which will be used as a biocide;
- chemicals which have not been approved for use in Canada previously (*i.e*. are not registered on the domestic substances list (DSL)) or have not been used previously for the purpose which is proposed;
- chemicals which have been identified as toxic under Schedule 1 of CEPA. In the event that a chemical is proposed for use that is listed under Schedule 1 of CEPA, BP will consider alternative means of operation, and / or will evaluate less toxic alternatives.

Chemicals Intended for Marine Discharge: Toxicity Assessment

Following the initial screening activity to identify any restrictions, controls and prohibitions on proposed chemicals, BP will conduct a further assessment for chemicals that will be discharged to the marine environment. This assessment will be carried out to evaluate the potential toxicity of proposed chemicals (and any constituents of the chemical as applicable), and to establish if additional restrictions, controls or prohibitions are required.

In line with the OCSG chemical selection framework shown in Figure 2.9.2, any chemicals intended for discharge to the marine environment shall be reviewed against a number of criteria. Chemicals that are intended for discharge to the marine environment must:

- be included on the OSPAR PLONOR list; or
- meet certain requirements for hazard classification under the OCNS; or
- pass a Microtox test (*i.e.,* toxicity bioassay); or
- undergo a chemical-specific hazard assessment in accordance with the OCNS model; or
- have the risk of its use justified through demonstration to the Board that discharge of the chemical will meet OCSG objectives.

BP will review each criteria in turn.

- OSPAR PLONOR List: If a proposed chemical is included on the OSPAR PLONOR list, it will be considered acceptable for use and discharge in line with OCSG.

- OCNS Hazard Classification: If BP proposes the use of a chemical which will be discharged to the marine environment that is not included on the OSPAR PLONOR list, BP will review the hazard classification in line with the Offshore Chemical Notification Scheme (OCNS). This scheme ranks chemical products according to a hazard quotient (HQ) based on a range of physical, chemical and ecotoxological properties of products, including toxicity, biodegradation and bioaccumulation information.

The Chemical Hazard and Risk Management (CHARM) model is used to determine the HQ which is subsequently used to rank chemicals into groups, linked to their expected hazard rating. If the chemical that is proposed for use is ranked as being least hazardous under the OCNS scheme (*i.e.*, C, D or E, gold or silver), BP will consider the chemical acceptable for use and discharge in line with the OCSG.

- Risk Justification: Where a chemical is identified for potential use which is not ranked as C, D or E, or gold or silver under the OCNS scheme, BP will consider alternative means of operation, and / or will evaluate less toxic alternatives. If it is not possible to identify alternatives, BP will conduct a hazard assessment to determine its suitability of use in line with the OCSG. The hazard assessment process will be documented and will be provided to the CNSOPB to allow them to evaluate whether that the objectives of OCSG have been met.
- Microtox Test and Chemical-Specific Hazard Assessment: In the event that a chemical is proposed for use which does not have an OCNS rating, BP will work with the chemical contractors to carry out a Microtox test to determine the potential toxicity of the chemical. If the chemical passes the test and is considered non-toxic, restrictions will be placed on discharge volumes and time limits in line with the OCSG. If the chemical does not pass the test, it will be subject to a hazard assessment as per OCSG to determine suitability for use.

It is expected that the following categories of chemicals will be used as part of the Project:

- drilling fluids, including sweeps and displacement fluids;
- well conditioning fluids;
- blowout preventer fluids;
- cement slurry;
- fuel, including diesel;
- hydraulic oil and greases;
- fire suppressant systems;
- cleaning fluids; and
- biocides.

A Material Safety Data Sheet (MSDS) will be available for chemicals present on the PSVs and MODU. The inventory of chemicals on board the MODU will be monitored regularly and an annual report will be submitted to the CNSOPB to outline each chemical used including the hazard rating, quantity used, and its ultimate fate.

3.0 STAKEHOLDER CONSULTATION AND ENGAGEMENT

This section of the EIS describes the ongoing and proposed engagement activities with public stakeholders that may have an interest in the Project. This section also provides a summary of questions, comments, and key issues raised in relation to the Project. For information on Aboriginal engagement, including ongoing and proposed engagement activities, and questions and comments raised, refer to Section 4.

3.1 ENGAGEMENT PROCESS

BP recognizes the importance of early and ongoing stakeholder engagement that continues over the life of the Project. BP believes that it is important to build positive relationships with Aboriginal groups and key stakeholders, and their primary objective around engagement is to provide transparent and timely communications to help build understanding and trust. BP views Aboriginal and stakeholder engagement as a continuous process which consists of a number of iterative steps (shown in Figure 3.1.1):

- **INFORM:** Provide accurate, relevant, timely and culturally appropriate information about the Project, its potential effects, and the EIS process;
- **ENGAGE:** Provide opportunities for Aboriginal groups and stakeholders to express their opinions and concerns about the Project, and to seek support for the Project and effects mitigation;
- **UNDERSTAND:** Enable the Project team to understand the concerns and priorities of Aboriginal groups and stakeholders;
- **REVIEW:** Incorporate as appropriate these concerns and priorities into the design, construction and operation of the Project; and
- **INFORM:** Provide feedback to Aboriginal groups and stakeholders as the Project develops so that engagement continues.

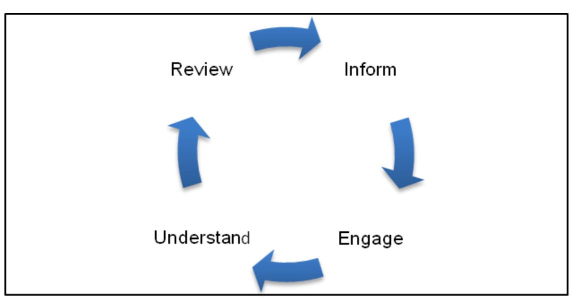


Figure 3.1.1 Consultation and Engagement Process

BP's key objectives for stakeholder engagement are to:

- provide appropriate information in a timely manner to relevant, interested and affected parties based on the nature, location and duration of the Project;
- create an understanding of BP's proposed drilling operations and address questions and concerns that arise; and
- provide feedback to stakeholders so that they are satisfied, or if not satisfied, that they understand how BP has represented and responded to their input.

BP's stakeholder and community outreach objectives include providing transparent and factual information about its plans and activities and encouraging input from stakeholders. As an active member of the broader Nova Scotia community, investing in local energy education and research initiatives and participating in association memberships, BP also has opportunities to develop and maintain positive working relationships with stakeholders.

This section of the EIS discusses ongoing and proposed engagement with public stakeholders along with questions and comments raised during engagement.

3.2 IDENTIFICATION OF STAKEHOLDERS AND MEANS OF ENGAGEMENT

BP employs a broad definition of stakeholders to include fisheries organizations, environmental non-governmental organizations (ENGOs), industry associations, government, and the interested public. BP has developed a preliminary list of stakeholders that potentially have an interest in the Project. The list will be reviewed regularly and updated appropriately throughout the Project planning and execution stages to make sure that the appropriate parties are kept informed and updated about key Project information on a timely basis.

The preliminary list of stakeholders was developed through an evaluation of the economic, social and environmental aspects of the Project, and a review of groups with a potential vested interest in the Project. BP has consulted with regulatory agencies and government departments to further refine the list of potential stakeholders. BP also used the list of stakeholders from the Tangier 3D WATS seismic survey program in developing the preliminary list of stakeholders.

Stakeholders that have been identified to date include the following:

- federal, provincial and municipal governments;
- fish producers and fisheries associations;
- non-governmental stakeholders; and
- the general public.

Each of these stakeholder groups is described below.

3.2.1 Federal, Provincial and Municipal Governments

Federal, provincial and municipal government departments and agencies identified thus far during the Project planning and EIS preparation stages include those that:

- have a regulatory mandate concerning the authorization of Project activities;
- have technical knowledge concerning the assessment or mitigation of environmental effects; and/or
- are involved in Crown consultation.

Specific departments and agencies are listed in Table 3.2.1.

Table 3.2.1 Government Departments and Agencies Identified for Consultation

Level of Government	Specific Department or Agency
Federal	• Canadian Environmental Assessment Agency • Department of Fisheries and Oceans (including Canadian Coast Guard) • Environment and Climate Change Canada • Department of National Defence • Parks Canada • Transport Canada – Navigable Waters • Natural Resources Canada
Provincial	• Nova Scotia Department of Environment • Nova Scotia Department of Energy • Nova Scotia Department of Fisheries and Aquaculture • Nova Scotia Office of Aboriginal Affairs • Emergency Management Office of Nova Scotia
Federal-Provincial	• Canada-Nova Scotia Offshore Petroleum Board
Municipal	• Halifax Regional Municipality • Coastal Nova Scotia municipalities

BP will engage with these stakeholders through face to face meetings, written correspondence, and project presentation meetings. BP has started to engage with a number of the stakeholder groups and will continue to do so over the lifetime of the Project. BP will provide continuous information and opportunities for dialogue to stakeholders as project planning or activity milestones are nearing or achieved. Engagement will continue throughout the CEAA, 2012 and drilling program authorization processes, through to Project completion.

3.2.2 Fish Producers and Fisheries Associations (including the CNSOPB Fisheries Advisory Committee)

Fish producers and fisheries associations have primarily been engaged through the CNSOPB Fisheries Advisory Committee (FAC) meetings. The Board's FAC includes representatives from various fishing groups, DFO, the Nova Scotia Department of Fisheries and Aquaculture, Natural Resources Canada, and the Nova Scotia Department of Energy. FAC members provide advice and suggestions to the CNSOPB for consideration in work authorization applications, regulations and guidelines. Meetings are held quarterly and briefings are distributed to inform and engage members in discussion of upcoming projects and other petroleum related activities. Committee members are provided with notice of all environmental assessments and are invited to submit comments to the CNSOPB for consideration during the review processes.

Through the FAC, BP has participated in a number of meetings to present an overview of proposed plans and activities, and to gather feedback from interested parties. This will continue throughout the duration of the Project.

3.2.3 Non-Governmental Stakeholders

Non-governmental stakeholders include: environmental non-government organizations (ENGOs) particularly those with an interest in environmental and social issues within the area; industry and business associations; chambers of commerce; the media; and academic institutions. These stakeholders can make important contributions to the EA process due to their knowledge and perspectives on relevant issues and/or their strong links with communities. BP has long-standing relationships with scientific and academic communities, which often have valuable technical perspectives on aspects of Project design and development.

Key groups that have been identified to date include the following:

- ENGOs: Ecology Action Centre (EAC); World Wildlife Fund (WWF); Ducks Unlimited; Pembina Institute; Sierra Club; Canadian Parks and Wilderness (ENGOs may be engaged through the EAC);
- petroleum industry associations (*e.g.*, Maritime Energy Association, Canadian Association of Petroleum Producers) and peer companies;
- economic development agencies and chambers of commerce;
- post-secondary institutions and research organizations (*e.g.*, Offshore Energy Research Association (OERA)); and
- cultural organizations (*e.g.*, Black Business Initiative).

BP will engage with the organizations listed above throughout the duration of the Project and will provide them with information about upcoming activity.

3.2.4 General Public

The general public has been and will continue to be primarily consulted through the public participation opportunities as required under CEAA, 2012. In addition to the Project Description and EIS Guidelines, the EIS and other documents related to public participation opportunities will be posted on the CEA Agency's Registry website for the Project (http://www.ceaa-acee.gc.ca/050/details-eng.cfm?evaluation=80109).

BP also maintains a website with updates on their activity in Nova Scotia (http://www.bp.com/en/global/corporate/about-bp/bp-worldwide/bp-in-canada/bp-in-nova-scotia.html).

3.3 SUMMARY OF CONSULTATION AND ENGAGEMENT ACTIVITIES

A summary of BP's stakeholder engagement efforts on the Project from December 2014 to October 2016 is provided in Table 3.3.1. For a summary of BP's Aboriginal engagement efforts on the Project, refer to Section 4.4.

Table 3.3.1 Summary of Stakeholder Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Topics Discussed
Government Agencies/Departments			
Canadian Environmental Assessment Agency	April 15 & 20 2015	Meeting (face-to-face) - Attended by BP EIS Lead and Regional Manager	Project introduction and discussion of regulatory framework for an EIA.
	September 16, 2015	Meeting (face-to-face) - Attended by BP Senior Advisor Global Deepwater Response and BP EIS Lead	Discussion of lessons learned from Deepwater Horizon (DWH), source control and oil spill response. Discussions about EIS.
	March 1, 2016	Email	Discussion about seabed survey.
	March 2, 2016	Phone Call	Discussion about seabed survey.
	March 22, 2016	Phone Call	Discuss engagement and clarify the level of involvement of Wolastoqiyik (Maliseet) First Nations of NB.
	March 23, 2016	Meeting (face to face) - Attended by BP Regional President and BP Wells Manager	Discussion of seabed survey requirements for the Project (with DFO and CNSOPB).
	September 1, 2016	Meeting (face to face) - Attended by BP Regional Manager and BP EIS Lead	Discussion about EIS
	September 15, 2016	Meeting (face to face) - Attended by BP Regional Manager	Discussion about EIS
	October 14, 2016	Meeting (face to face) attended by BP Regional Manager and BP Community Relations Advisor	Discussion about EIS

Table 3.3.1 Summary of Stakeholder Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Topics Discussed
Canada-Nova Scotia Offshore Petroleum Board	September 17, 2015	Meeting (face to face) - Attended by BP Senior Advisor Global Deepwater Response and BP EIS Lead	Lessons learned from DWH, source control and oil spill response.
	November 11, 2015	Meeting (telecom)	Workshop concerning oil spill modelling approach (with DFO and ECCC).
	November 19, 2015	Meeting (telecom)	Overview of metocean data to be used in modelling work (with DFO and ECCC).
	December 7, 2015	Meeting (telecom)	Discussion about spill modelling thresholds.
	April 13, 2016	Meeting (face-to-face) - Attended by BP Regional Manager and Country President	Project update
	June 28, 2016	Meeting (face-to-face) attended by Attended by BP Regional Manager, BP Wells Manager and BP Exploration Manager	Project technical update
	June 28, 2016	Meeting (face-to-face) – Attended by BP Exploration Manager	Project technical update
	June 29, 2016	Meeting (face-to-face) - Attended by BP Exploration Manager	Project technical update
	July 22, 2016 & August 2, 2016	Meeting (face-to-face) - Attended by BP Regional Manager	Discussion about Project Communication
	August 23, 2016	Meeting (face-to-face) -Attended by BP Regional Manager and BP Business Manager	Discussion about exploration licenses
	September 23, 2016	Meeting (face to face) – Attended by BP Regional Manager	Project update
Fisheries and Oceans Canada (DFO)	March 16, 2015	Meeting (face to face)	Discussion about Aboriginal commercial fishing program.
	April 13, 2015	Meeting (face to face)	Discussion on insights into areas of interest in EIS.

Table 3.3.1 Summary of Stakeholder Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Topics Discussed
	September 15, 2015	Meeting (face to face) – Attended by BP Senior Advisor Global Deepwater Response	Project introduction and EIS update; Discussion of lessons learned from DWH.
	June 27, 2016	Meeting (face-to-face)	Introductions and BP Project overview
	September 20, 2016	Meeting (face to face) Anita Perry, Mike Wamboldt	Discussion about Project approach for baseline data
Environment and Climate Change Canada	April 20, 2015	Meeting (face to face)	Discussed insights into areas of interest in EIS.
Nova Scotia Department of Energy	April 1, 2016	Meeting (face to face)	Update on Scotian Basin Exploration Project.
	June 29, 2016	Meeting (face to face)	Project technical update
	September 21, 2016	Meeting (face to face)	Project update
	September 27, 2016	Meeting (face to face)	Project update
Nova Scotia Office of Aboriginal Affairs	December 4, 2014	Meeting (face to face)	Regulatory requirements around consultation.
	September 17, 2015	Meeting (face to face)	Introductory meeting with environment team to discuss consultation.
Nova Scotia Emergency Management Office	June 29, 2016	Meeting (face to face)	Introductory meeting to discuss project and to provide awareness on where NSEMO can assist with co-ordination to support an offshore incident.
	October 4, 2016	Email	BP provided update on Project schedule.
Joint Rescue Coordination Centre	October 4, 2016	Email	BP provided update on Project schedule.
Fisheries			
Fisheries Advisory Committee (FAC) (CNSOPB)	January 21, 2015	Notes for Meeting	BP provided a written update on the exploration drilling Project for communication at the FAC meeting.
	May 12, 2015	Meeting (face to face)	BP provided a timeline update and discussed the key areas requiring further discussion as BP progresses to an exploration program.
	September 16, 2015	Meeting (face to face) – Attended by BP Senior Advisor Global Deepwater Response	BP presented an overview and update on EIS process, lessons learned from DWH, and an overview of BP's source control methods and Oil Spill Response Plan.

Table 3.3.1 Summary of Stakeholder Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Topics Discussed
	February 17, 2016	Meeting (face-to-face)	BP provided an update on project planning to the FAC, focusing on pending EIS submission to CEA Agency later than anticipated due to taking the time up-front to address matters raised in engagement meetings related to spill modelling. Also discussed FAC members' consultation style preferences (response was face-to-face as much as possible) and what topics they wished to cover. Topics discussed included: BP as an operator, use of dispersants, worst case discharge impact, emergency preparedness, the role of BOPs, cap and containment.
	June 22, 2016	Meeting (face-to-face)	BP provided presentation on EIS and spill modelling approach and results
	September 21, 2016	Meeting (face-to-face)	BP provided update on the Project.
Guysborough County Inshore Fishermen's Association	March 24, 2015	Meeting (face to face)	Identified the key areas requiring further discussion as BP progresses to an exploration program.
Seafood Producers of Nova Scotia (SPANS)	March 25, 2015	Meeting (face to face)	Identified the key areas requiring further discussion as BP progresses to an exploration program.
Other Interest Groups			
Maritime Energy Association	May 12, 2015	Information Session (face-to-face) – Attended by BP's Logistics & Infrastructure Manager and Regional Manager, Procurement Supply Chain Management	BP presented information on logistics including: Project scope; procurement process – approach to local business, local content strategy, expectations from vendors, and procurement process; and proposed timeline on exploration project plan.
Maritime Energy Association	September 29, 2015	CORE Conference Presentation (face-to-face) - Attended by BP Canada Exploration Manager	Updated participants on exploration project area, proposed timeline, expanded exploration joint venture EL2431-2434, project planning and early look at 3D seismic.

Stakeholder engagement will continue beyond the EIS, throughout the full project life-cycle. BP is committed to listening and responding to stakeholder concerns if and as they arise.

3.4 QUESTIONS AND COMMENTS RAISED DURING ENGAGEMENT

Questions and comments raised during engagement, including comments raised during the public comment periods held thus far under CEAA, 2012, have been taken into consideration during the preparation of this EIS. In general, questions and comments include those related to: potential environmental, health and safety implications of an accidental spill; the current regulatory framework and industry response to an accidental spill; potential environmental effects on marine life and fisheries; and economic development opportunities.

A summary of key issues that have been raised during the public comment period under CEAA, 2012 and how they have been addressed is presented in Table 3.4.1.

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
What has BP learned since the Deepwater Horizon (DWH) incident in the Gulf of Mexico?	BP's internal investigation of the DWH incident, which culminated in the Bly Report (BP 2010), involved a team of over 50 internal and external specialists from a variety of fields, including safety, operations, subsea, drilling, well control, cementing, well flow dynamic modelling, BOP systems, and process hazard analysis. Eight key findings relating to the causal chain of events were made, with 26 associated recommendations to enable the prevention of a similar accident and aimed at further reducing risk across BP's global drilling activities. The Bly Report recommended a number of measures to strengthen BPs operational practices, and these are being addressed through the implementation of enhanced drilling requirements. Key requirements have been captured in guidance documents and engineering technical practices. Key areas that have been addressed include: cementing and zonal isolation practices; process safety management through the life cycle of a well; well casing design; and rig audit and verification. In addition to these technical requirements, BP has focused on enhancement of capability and competency; verification, assurance and audit; and process safety performance management. An account of lessons learned from the DWH incident and information about progress against recommendations in the Bly Report are presented in the EIS (refer to Section 8.3.4).	• *Section 8.3.4:* Information about lessons from the DWH incident
Request for more information on BP's environmental management, spill prevention and incident management plans	BP works in line with its operating management system (OMS), a framework which sets out requirements on a range of criteria, such as health and safety, security, environmental management, social responsibility and operational reliability. Contractors, such as drilling and well services contractors, will be accountable for the development and delivery of their safety and environmental management systems. Contractors will be responsible for carrying out self-verification activity to assess conformance with their contractual requirements. Contractor safety performance is typically assessed and reviewed by BP throughout the duration of the contract. Further information will be presented in the Environment Protection Plan which will be submitted to CNSOPB as part of the OA process.	• *Section 1.3.1*: Information about how BP operates, including information about management systems and working with contractors • *Section 8.3.1*: Information about the incident management plan and spill response plan • *Section 12*: Information about environmental management plans for the Project

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
	The Project will operate under an incident management plan (IMP) which will be a comprehensive document including practices and procedures for responding to an emergency event. The IMP will include, or reference, a number of specific contingency plans for responding to specific emergency events, including potential spill or well control events. The IMP and supporting specific contingency plans, such as the spill response plan (SRP) will be aligned with applicable regulations, industry practice and BP standards and will include response strategies, arrangements and procedures. These plans will be submitted to CNSOPB prior to the start of any drilling activity as part of the OA process.	
Concern raised about length of time for a capping stack response to a well blowout	If a blowout incident were to occur, BP would immediately commence the mobilization of the primary capping stack from Stavanger. Analysis indicates that the cap mobilization to the wellsite will take 12 to 19 days with the well capped between 13 and 25 days after an incident. BP has included information in the EIS about spill response and well intervention strategies that would be deployed in the event of a spill.	• *Section 2.5*: Well control measures • *Section 8.3.3.2*: Well intervention response
Concern raised about environmental effects of dispersant use	Dispersants will not be used by BP without prior approval. BP will prepare a net environmental benefit analysis (NEBA) for dispersant use which will be used to support any application for dispersant use. Dispersed oil may cause harm to some marine organisms, particularly coral and plankton. Dispersants are generally non -toxic at the concentrations used for response. In the event that they are used, exposure to any dispersants and dispersed oil is likely to be brief as they are quickly diluted into the marine environment. The NEBA will analyze the trade-off between the potential toxic effects of the dispersed oil relative to the advantages of removing oil from the surface and preventing shoreline effects.	• *Section 8.3.3.3:* Overview of dispersants
Concern raised about possible effects on species at risk and critical habitat	Several species at risk (SAR) and species of conservation concern (SOCC) are known to occur in the vicinity of the Project Area. Potential Project-related effects on SAR, SOCC and critical habitat are assessed in Section 7 of this EIS. In recognition of best management practices and mitigation measures proposed by BP, significant residual adverse effects on SAR and critical habitat are predicted to be not likely.	• *Section 5.2.9*: Summary of marine SAR and SOCC that could be affected by the Project • *Section 7.2:* Assessment of Project-related environmental effects on fish (SAR and SOCC)

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
		• *Section 7.3:* Assessment of Project-related environmental effects on marine mammal (SAR and SOCC) • *Section 7.3:* Assessment of Project-related environmental effects on sea turtle (SAR and SOCC) • *Section 7.4: Assessment of* Project-related environmental effects on marine bird (SAR and SOCC) • *Section 8.5:* Environmental effects of potential accidental events • *Section 10:* Cumulative environmental effects
Concern raised about possible effects on the fishing industry	Routine Project activities and components have potential to interact with fisheries resources by direct or indirect effects on commercially fished species and/or effects on fishing activity from displacement from fishing areas, gear loss or damage that could potentially result in a demonstrated financial loss to commercial fishing interests. For the most part, effects on the fishery will be limited to a 500-m safety (exclusion) zone from the MODU that is standard for the offshore industry. BP has committed to employing mitigation measures and standard practices to reduce Project-related effects on fish and fish habitat, as well as fisheries activities. BP will continue to engage commercial and Aboriginal fishers to share Project details as applicable and facilitate coordination of information sharing. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers. A Fisheries Communication Plan will facilitate communication of Project updates, issues and concerns as the Project moves past the EA process and into the implementation stage.	• *Section 5.3.5:* Existing conditions regarding commercial fisheries • *Section 7.6*: Project-related environmental effects on commercial fisheries • *Section 8.5*: Environmental effects of potential accidental events • *Section 10:* Cumulative environmental effects

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
Concern raised about possible effects on the tourism industry	The Project is not predicted to interact with the provincial tourism industry. Most tourism and recreational activities occur in coastal or nearshore areas and would not interact with routine Project activities (the Project Area is located more than 200 km offshore and 48 km from Sable Island National Park Reserve). In the event of a large spill (*e.g.*, blowout), there could potentially be an interaction with coastal resources which could be related to local tourism and recreation. As discussed in Section 8, the likelihood of such a spill event is extremely low, and BP would implement spill response measures to reduce interactions with coastal resources.	• *Section 5.3.4.4:* Existing conditions regarding tourism and recreational activities • *Section 7.2:* Project-related environmental effects on fish and fish habitat • *Section 8.5:* Environmental effects of potential accidental events
Concern raised about effect of underwater sound and preventative measures to mitigate effects on marine life	Underwater sound will be generated by the MODU and PSVs, as well as during VSP operations. The extent to which sound travels is determined by environmental conditions, including water depths, water salinity and temperature. The sound generated by the MODU will be continuous throughout the drilling program, whereas underwater sound generated during the VSP operations are typically impulsive in nature, occurring over a short duration (*e.g.*, up to one day per well). BP has commissioned an acoustic modelling study to inform the assessment of underwater sound effects on marine life. BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the drilling program to collect field measurements of underwater sound in order to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and the CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.	• *Section 2.8.5:* Information about potential underwater sound sources • *Section 7.2:* Project-related environmental effects on fish and fish habitat • *Section 7.3:* Assessment of project-related environmental effects on marine mammals and sea turtles • *Section 7.6:* Project-related environmental effects on commercial fisheries • *Section 10:* Cumulative environmental effects • *Section 11:* A summary of effects • *Appendix D:* Acoustic Modelling Study
Concern raised about effects of drilling discharges and emissions	Drilling activities give rise to a range of wastes, discharges and emissions. All emissions, wastes and discharges will be disposed of in accordance with applicable legislation and guidelines including MARPOL and the OWTG. In accordance with regulatory requirements, some wastes will be managed and disposed of directly offshore from the MODU and the PSVs, whereas some	• *Section 2.8*: Overview of emissions, discharges and waste management • *Section 7.2:* Assessment of Project-related environmental

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
	wastes will be brought to shore for disposal. The effect of drilling waste, discharges and emissions is considered as part of the EIS. Drilling waste discharges have been quantified and modelled as part of the EIS.	effects on fish and fish habitat • *Section 7.3*: Assessment of Project-related environmental effects on marine mammals and sea turtles • *Section 7.4:* Assessment of Project-related environmental effects on migratory birds • *Section 7.5:* Assessment of Project-related environmental effects on Special Areas • *Section 7.6:* Assessment of Project-related environmental effects on commercial fisheries • *Section 7.7*: Assessment of Project-related environmental effects on Aboriginal use of lands and resources for traditional purposes • *Section 10:* Cumulative environmental effects
Concern raised about proximity to Sable Island, the Gully, and northern bottlenose whale critical habitat	The EIS assesses potential Project-related (and cumulative) effects on Special Areas which include, among other areas, Sable Island, the Gully and SARA-designated critical habitat. Routine Project activities and components could potentially interact with Special Areas, which could affect the ability of the Special Area to continue to provide important biological and ecological functions on which marine species and/or fisheries depend. These potential interactions most closely relate to concerns with the changes to the existing quality and use of natural habitats within these Special Areas. To reduce potential adverse effects on Special Areas, BP has committed to implementing best management practices and mitigation measures including	• *Section 5.2.10:* Existing conditions regarding Special Areas • *Section 7.5:* Project-related environmental effects on Special Areas • *Section 8.5:* Environmental effects of potential accidental events • *Section 10:* Cumulative environmental effects

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
	avoidance of Sable Island, the Gully and northern bottlenose whale critical habitat. Mitigation measures identified for Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Migratory Birds will be implemented to reduce the potential environmental effects of the Project on Special Areas. BP will also implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences (refer to Section 8.3 for details on plans and specific response strategies).	
Concern raised about geohazards including slope failure	Prior to any drilling activity, BP will conduct a comprehensive regional geohazard baseline review (GBR), followed by detailed geohazard assessments for each proposed wellsite to identify potential geohazards that may affect drilling operations. The GBR and detailed wellsite assessments will be based primarily on reprocessed 3D Wide Azimuth Towed Streamer (WATS) seismic data acquired by BP in 2014. Existing regional data, such as geotechnical cores and offset wells, will be incorporated where available. The geohazard assessments will focus on identifying potential drilling hazards at the seabed and subsurface. This work will be conducted by a BP geohazards specialist following internal guidelines that either meet or exceed local regulatory requirements.	• *Section 2.2:* Information about well location selection criteria, including geohazards • *Section 9.1.6*: Information about geohazards • *Section 9.2*: Information about mitigation measures for geohazard management
General concern regarding use of fossil fuels and implications for climate change	Energy demand is forecast to increase globally over the next 20 years. Population growth and increases in per capita income are the key drivers behind the growth in energy demand. Energy production and consumption patterns vary and emphasize the need for secure, sustainable energy supplies. Nova Scotia's 2009 Energy Strategy – *Toward a Greener Future* (NSDOE 2009b), highlights the importance of a sustainable energy mix, and the role that offshore hydrocarbon exploration and development plays within the province's ongoing energy strategy. In the strategy, Nova Scotia commits to "encourage renewed offshore exploration and development, with its enormous potential for building future prosperity". In order to achieve their stated goal, the province has stated that it will invest revenues from offshore hydrocarbon activity into expenditures that offer enduring benefits.	• *Section 1.4:* Benefits of the Project, including information about energy diversification and sustainability
Request for information on management of drilling waste, including waste	It is likely that the initial, shallow sections of the well will be drilled without a riser and that deeper sections will be drilled with a drilling riser attached. During riserless drilling, WBM will be used as the drilling fluid and cuttings are	• *Section 2.3.2*: Information about cuttings • *Section 2.8.2*: Information about

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
minimization	discharged directly to the water column in accordance with regulatory guidelines. Once a riser is attached, cuttings can be returned to the MODU for treatment; therefore, WBM or an alternative drilling fluid such as SBM can be used. The MODU will be equipped with specialized solids control equipment for cuttings management. Treatment technology will include shale shakers which recover drilling fluids from the cuttings to minimize the amount of waste fluids. Additional treatment of cuttings will be required when SBM is used to enable disposal in accordance with the OWTG. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained "synthetic on cuttings" on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU to achieve compliance with the OWTG. BP has modelled the dispersion of predicted drilling waste (refer to Appendix C); this modelling study has been used to inform the assessment of effects of drilling waste on marine life. Overall, the dispersion of sediments associated with drill waste discharges is predicted to be limited to approximately 1,367 m (for a minimum deposition thickness of 0.1 mm). Using a threshold of 9.6 mm to assume burial of benthic species, it is predicted that this sediment thickness could extend approximately 116 m from the discharge point, or cover an area of approximately 0.54 ha per well.	drilling waste discharges • *Section 7.1.2.1:* Summary of drill waste discharges and modelling results • *Section 7.2:* Assessment of Project-related environmental effects on fish and fish habitat • *Section 7.3:* Assessment of Project-related environmental effects on marine mammals and sea turtles • *Section 7.4:* Assessment of Project-related environmental effects on migratory birds • *Section 7.5:* Assessment of Project-related environmental effects on Special Areas • *Section 7.6* Assessment of Project-related environmental effects on commercial fisheries • *Section 7.7* Assessment of Project-related environmental effects on Aboriginal use of lands and resources for traditional purposes • *Section 10:* Cumulative environmental effects • *Appendix C:* Drilling Waste Dispersion Modelling Study
Request for information on anticipated greenhouse gas emissions related to Project activities	Key Project activities resulting in atmospheric emissions are: • Combustion from the MODU and PSV diesel engines, and fixed and mobile deck equipment and helicopter engines; and	• *Section 2.8.1:* Information about atmospheric emissions from Project activities

Table 3.4.1 Summary of Key Issues Raised During Public Stakeholder Engagement

Question or Comment	Response	EIS Reference
	• Flaring during well test activity, in the event that well testing is required. It is currently anticipated that well testing (and associated flaring) will not be carried out on the first two wells drilled as part of the Project. When well testing is required, these emissions will be short-term and intermittent (*e.g.*, flaring from a few hours up to three days). In terms of GHG emissions, the Project is predicted to emit approximately 295.8 tonnes of CO_2 per day. ECCC reports an annual GHG emissions value for the province of Nova Scotia of 17,000 kilotonnes of CO_2 equivalent per year (Environment Canada 2016). BP's predicted daily CO_2 emissions for the Project therefore represent approximately 0.59 % of Nova Scotia's average daily emission. Atmospheric emissions, including GHGs, will be variable over the lifetime of the Project as activity varies.	
Request that the EIS considers how local conditions and natural hazards can affect the Project and result in environmental effects	Aspects of the environment that could potentially affect the Project include: fog; sea ice and superstructure icing; seismic events and tsunamis; extreme weather conditions; and sediment and seafloor stability. The EIS includes information about local conditions and natural hazards which could potentially affect the Project and mitigation measures to manage these.	• *Section 9.1:* Environmental conditions which could affect the Project • *Section 9.2*: Mitigation measures which will be put in place to manage environmental conditions
Request for information on well abandonment including monitoring or inspection	Once wells have been drilled to total depth and well evaluation programs completed, the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. Plugs will be placed above and between any hydrocarbon bearing intervals at appropriate depths in the well, as well as at the surface. The final well abandonment program has not yet been finalized; however, these details will be confirmed as planning for the Project continues. A seabed survey will be conducted at the end of the drilling program using an ROV to survey the seabed for debris. Inspection and monitoring of abandoned wellheads will be conducted according to CNSOPB requirements.	• *Section 2.4.4:* Overview of plan for well abandonment

4.0 ABORIGINAL ENGAGEMENT

This section of the EIS discusses ongoing and proposed engagement with Aboriginal organizations that may have an interest in the Project. For information on public stakeholder engagement including ongoing and proposed engagement activities, and questions and comments raised, refer to Section 3.

4.1 ABORIGINAL ENGAGEMENT OBJECTIVES

BP recognizes the potential for the Project to affect Aboriginal interests including potential or established Aboriginal or Treaty rights, and acknowledges the importance of engaging Aboriginal organizations to provide Project information and obtain feedback on potential issues and concerns. BP also recognizes the importance of supporting Project-related Crown consultation efforts that may arise as part of the EIS process and related government decision-making.

4.2 ABORIGINAL ORGANIZATIONS

4.2.1 First Nations in Nova Scotia

According to the 2011 National Household Survey (Statistics Canada 2013a), 33,850 individuals of Aboriginal identity live in Nova Scotia, of which 12,910 have "registered or Treaty Indian" status. The majority of Aboriginal people in Nova Scotia are from the Mi'kmaw nation (NSOAA 2011).

There are 13 First Nations in Nova Scotia (refer to Table 4.2.1 and Figure 4.2.1). The General Assembly of Nova Scotia Mi'kmaq Chiefs represents the governance for the Mi'kmaq of Nova Scotia. The Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO) represents the Assembly with respect to consultation on Mi'kmaq Aboriginal or treaty rights. Sipekne'katik First Nation and Millbrook First Nation are members of the Assembly of Nova Scotia Mi'kmaq Chiefs but in 2013 and 2016 respectively chose to independently represent themselves in consultation, as opposed to representation by the KMKNO. Sipekne'katik First Nation and Millbrook First Nation assert the same rights as other Mi'kmaq communities. Mi'kmaq and other Aboriginal peoples residing off-reserve in Nova Scotia are discussed in Section 4.2.4.

Table 4.2.1 First Nations in Nova Scotia

Band	Census Subdivision/Designated Place[1]	Location	Chief	Registered Population (2015)[2]		
				Total	On Reserve[3]	Off Reserve
Acadia	Gold River 21 (IRI), Medway River 11 (IRI), Ponhook Lake 10 (IRI), Wildcat 12 (IRI), Yarmouth 33 (IRI)	Yarmouth, Nova Scotia	Deborah Robinson	1,511	229	1,282
Annapolis Valley	Cambridge 32 (IRI), St. Croix 34 (IRI)	Kings County, Nova Scotia	Gerald Toney	286	119	167
Bear River	Bear River 6 (IRI), Bear River 6A (IRI), Bear River 6B (IRI)	Bear River, Nova Scotia	Carol Thompson	331	106	225
Eskasoni	Eskasoni 3 (IRI), Eskasoni 3A (IRI), Malagawatch 4 (IRI)	Eskasoni, Nova Scotia	Leroy Denny	4,371	3733	608
Glooscap	Glooscap 35 (IRI)	Hantsport, Nova Scotia	Sidney Peters	367	90	276
Membertou	Caribou Marsh 29 (IRI), Malagawatch 4 (IRI), Membertou 28B (IRI), Sydney 28A (IRI)	Sydney, Nova Scotia	Terry Paul	1,369	880	532
Millbrook	Beaver Lake 17 (IRI), Cole Harbour 30 (IRI), Millbrook 27 (IRI), Sheet Harbour 36 (IRI), Truro 27A (IRI), Truro 27B (IRI), Truro 27C (IRI)	Truro, Nova Scotia	Robert Gloade	1,787	856	893
Paq'tnkek (Afton)	Franklin Manor 22 (IRI), Paqtnkek-Niktuek 23 (IRI), Welnek 38 (IRI)	Afton, Nova Scotia	Paul Prosper	570	405	137
Pictou Landing	Boat Harbour West 37 (IRI), Fisher's Grant 24 (IRI), Fisher's Grant 24G, Franklin Manor 22 (IRI), Merigomish Harbour 31 (IRI)	Trenton, Nova Scotia	Andrea Paul	649	473	154
Potlokek (Chapel Island)	Chapel Island 5 (IRI), Malagawatch 4 (IRI)	Chapel Island, Nova Scotia	Wilbert Marshall	716	547	134
Sipekne'katik	Indian Brook 14 (IRI), New Ross 20 (IRI), Pennal 19 (IRI), Shubenacadie 13 (IRI), Wallace Hills 14A (IRI)	Indian Brook, Nova Scotia	Rufus Copage	2,495	1283	1,212
Wagmatcook	Malagawatch 4 (IRI), Margaree 25 (IRI), Wagmatcook 1 (IRI)	Wagmatcook, Nova Scotia	Norman Bernard	826	604	179

Table 4.2.1 First Nations in Nova Scotia

Band	Census Subdivision/Designated Place[1]	Location	Chief	Registered Population (2015)[2]		
				Total	On Reserve[3]	Off Reserve
We'koqma'q (Whycocomagh)	Malagawatch 4 (IRI), Whycocomagh 2 (IRI)	Whycocomagh, Nova Scotia	Rod Googoo	981	864	83

[1]Aboriginal Affairs and Northern Development Canada: First Nation Profiles (2015).
[2]Population estimates based on Aboriginal Affairs and Northern Development Canada Registered Population (2015).
[3] On reserve population estimates only include registered males and females on own reserve.

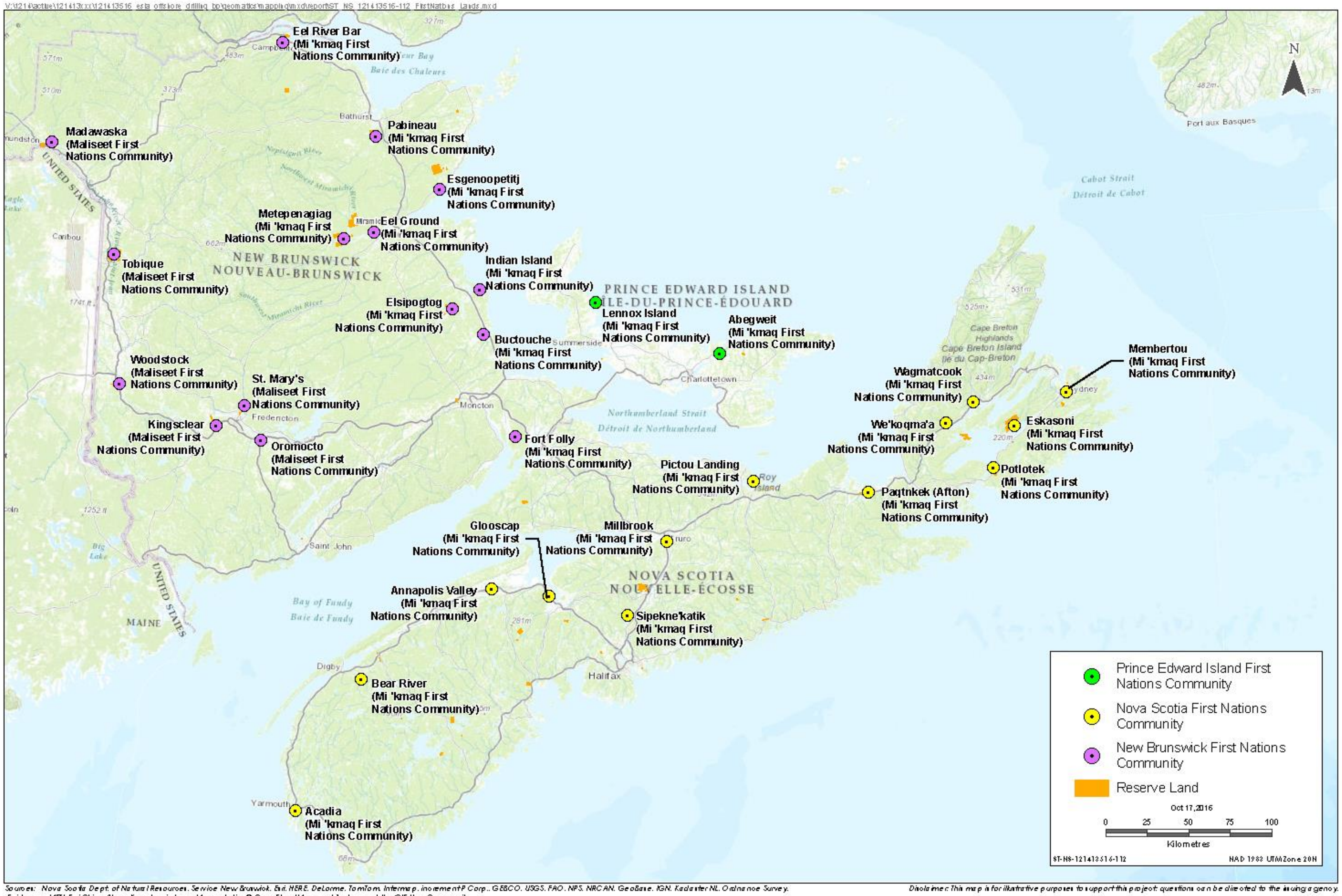


Figure 4.2.1 Location of First Nations Communities in Nova Scotia, New Brunswick and PEI

4.2.2 First Nations in New Brunswick

The 2011 National Household Survey (Statistics Canada 2013b) indicates that there are 22,620 individuals of Aboriginal identity living in New Brunswick, of which 10,275 are "registered or Treaty Indian". In New Brunswick, there are 15 First Nations communities, six are from the Wolastoqiyik (Maliseet) nation and nine are from the Mi'kmaw nation (NBDAA 2015). Wolastoqiyik (Maliseet) First Nations communities reside along the Saint John River, predominately in the west and northwest areas of the province. Mi'kmaq First Nations communities reside along the eastern and northern coasts of the province. Table 4.2.2 provides a summary of demographic information on each First Nation. Locations of band councils for each community are shown on Figure 4.2.1.

The Assembly of First Nations' Chiefs in New Brunswick (AFNCNB), the highest level of decision-making in the negotiation and consultation processes in New Brunswick, was established in 2007. The AFNCNB was a political organization, mandated to promote a unified voice for the 15 First Nations in New Brunswick. In 2015, the six Wolastoqiyik (Maliseet) communities split from the AFNCNB and announced they will be forming their own organization to conduct their administrative affairs. The AFNCNB is now defunct; Mi'gmawe' Tplu'taqn Incorporated (MTI) was created by the Mi'gmag First Nations of New Brunswick.

Table 4.2.2 First Nations in New Brunswick

Band	Census Subdivision/Designated Place[1]	Contact Information	Chief	Registered Population (2015)[2]		
				Total	On Reserve[3]	Off Reserve
Buctouche	Buctoche 16 (IRI)	Buctouche Reserve, New Brunswick	Ann Mary Steele (Simon)	119	75	43
Eel Ground	Big Hole Tract 8 (IRI), Eel Ground 2 (IRI), Renous 12 (IRI)	Eel Ground, New Brunswick	George Ginnish	1,026	559	452
Eel River Bar First Nation	Eel River 3 (IRI), Indian Ranch (IRI), Moose Meadows 4 (IRI)	Eel River Bar, New Brunswick	Thomas Everett Martin	726	346	367
Elsipogtog First Nation	Richibucto 15 (IRI), Soegao 35 (IRI)	Elsipogtog First Nation, New Brunswick	Arren Sock	3,285	2,519	721
Esgenoopetitj First Nation	Esgenoopetitj Indian Reserve 14 (IRI), Pokemouche 13 (IRI), Tabusintac 9 (IRI)	Burnt Church, New Brunswick	Alvery Paul	1,865	1,310	515
Fort Folly	Fort Folly 1, (IRI)	Dorchester, New Brunswick	Rebecca Knockwood	132	35	96
Indian Island	Indian Island 28 (IRI)	Indian Island, New Brunswick	Ken Barlow	183	103	79
Kingsclear	Kingsclear 6 (IRI), The Brothers 18 (IRI)	Kingsclear First Nation, New Brunswick	Gabriel Atwin	1,007	706	200
Madawaska Wolastoqiyik (Maliseet) First Nation	St Basile 10 (IRI), The Brothers 18 (IRI)	Madawaska Maliseet First Nation	Patricia Bernard	367	150	217
Metepenagiag Mi'kmaq Nation	Big Hole Tract 8 (North Half) (IRI), Indian Point 1 (IRI), Red Bank 4 (IRI), Red Bank 7 (IRI)	Metepenagiag Mi'kmaq Nation, New Brunswick	Alan Blowers	668	211	211
Oromocto	Oromocto 26 (IRI)	Oromocto, New Brunswick	Shelly Sabattis	664	311	351
Pabineau	Pabineau 11 (IRI)	Pabineau First Nation, New Brunswick	David Peter-Paul	301	199	100

Table 4.2.2 First Nations in New Brunswick

Band	Census Subdivision/Designated Place[1]	Contact Information	Chief	Registered Population (2015)[2]		
				Total	On Reserve[3]	Off Reserve
Saint Mary's	Devon 30 (IRI), St. Mary's 24 (IRI)	Fredericton, New Brunswick	Candice Paul	1,849	839	966
Tobique	The Brothers 18 (IRI), Tobique 20 (IRI)	Tobique First Nation, New Brunswick	Ross Perley	2,281	1,507	767
Woodstock	The Brothers 18 (IRI), Woodstock 23 (IRI)	Woodstock First Nation, New Brunswick	Timothy Paul	1,004	287	713

[1] Aboriginal Affairs and Northern Development Canada: First Nation Profiles (2015).
[2] Population estimates based on Aboriginal Affairs and Northern Development Canada Registered Population (2015).
[3] On reserve population estimates only include registered males and females on own reserve.

4.2.3 First Nations in Prince Edward Island

In 2011, based on the National Household Survey, Prince Edward Island (PEI) was home to 1,520 First Nations people, of which 770 are "registered or Treaty Indian" (Statistics Canada 2013c). The majority of Aboriginal people are from the Mi'kmaw Nation (Statistics Canada 2013c). There are two First Nation communities in PEI: Lennox Island Mi'kmaq First Nation and Abegweit Mi'kmaq First Nation. Abegweit First Nation was formed in 1972 to improve communication and governance issues that had resulted in part due to geographic separations between the Lennox Island Band Council and member reserves that were geographically separated from Lennox Island. Through a majority vote it was agreed that Morell Reserve #2, Rocky Point Reserve #3, and Scotchfort Reserve #4 would form the new Abegweit Band (Abegweit First Nation 2015).

The Mi'kmaq Confederacy of PEI is a tribal council and provincial territorial organization which provides a common forum for the two First Nations of PEI, offering a unified voice for the advancement of Treaty and Aboriginal rights.

Table 4.2.3 provides a summary of the demographic information on each of two PEI First Nations. Locations of band councils for each community are shown on Figure 4.2.1.

Table 4.2.3 First Nations in Prince Edward Island

Band	Census Subdivision/Designated Place[1]	Contact Information	Chief	Registered Population (2016)[2]		
				Total	On Reserve[3]	Off Reserve
Lennox Island	Lennox Island 1, Lennox Island No. 6, Lennox Island Reserve No. 5	Lennox Island, Prince Edward Island	Matilda Ramjattan	952	389	553
Abeqweit	Morell 2, Rocky Point 3, Scotchfort 4	Scotfort, Prince Edward Island	Brian Francis	374	213	147

[1]Aboriginal Affairs and Northern Development Canada: First Nation Profiles (2015).
[2]Population estimates based on Aboriginal Affairs and Northern Development Canada Registered Population (2016)
[3]On reserve population estimates only include registered males and females on own reserve.

4.2.4 Off-Reserve Aboriginal Peoples

The Maritime Aboriginal Peoples Council (MAPC) is a regional Aboriginal Peoples Leaders Institution established by the Native Council of Nova Scotia (NCNS), the Native Council of Prince Edward Island (NCPEI), and the New Brunswick Aboriginal Peoples Council (NBAPC). MAPC represents the Traditional Ancestral Homeland of the Mi'kmaq, Wolastoqiyik (Maliseet), and Passamaquoddy Aboriginal Peoples of Canada who live off-reserve.

In Nova Scotia, the NCNS advocates for all off-reserve Mi'kmaq and other Aboriginal people throughout traditional Mi'kmaw territory (NCNS 2015) and has established 13 geographic zones encompassing the province of Nova Scotia to administer their affairs (refer to Figure 4.2.2). The NCNS's 13 community zones have an Aboriginal ancestry population of 32,465, which represents 80% of the total Aboriginal ancestry (*i.e.*, having at least one Aboriginal ancestor) population of 40,415 in Nova Scotia (MAPC 2014). The NCNS community identity population of 16,190 represents approximately 67% of the total Aboriginal identity population in Nova Scotia (MAPC 2014).

The NBAPC constitutes a community of off-reserve Aboriginal people residing in New Brunswick, and provides programs and services, including advocacy services. Similar to the NCNS, the NBAPC has organized off-reserve Aboriginal communities into seven zones (refer to Figure 4.2.2). The NBAPC community zones have an Aboriginal ancestry population of 24,550, which represents 78% of the total Aboriginal ancestry population of 31,540 in New Brunswick (MAPC 2014). The NBAPC community identity population of 10,645 represents 60% of the total Aboriginal identity population of 17,655 in New Brunswick (MAPC 2014).

The NCPEI is the self-governing authority for all off-reserve Aboriginal people living on PEI. The NCPEI has organized off-reserve Aboriginal communities into three zones (refer to Figure 4.2.2). The NCPEI's three community zones have an Aboriginal ancestry population of 2,960, representing approximately 88% of the total Aboriginal ancestry population in PEI (MAPC 2014).

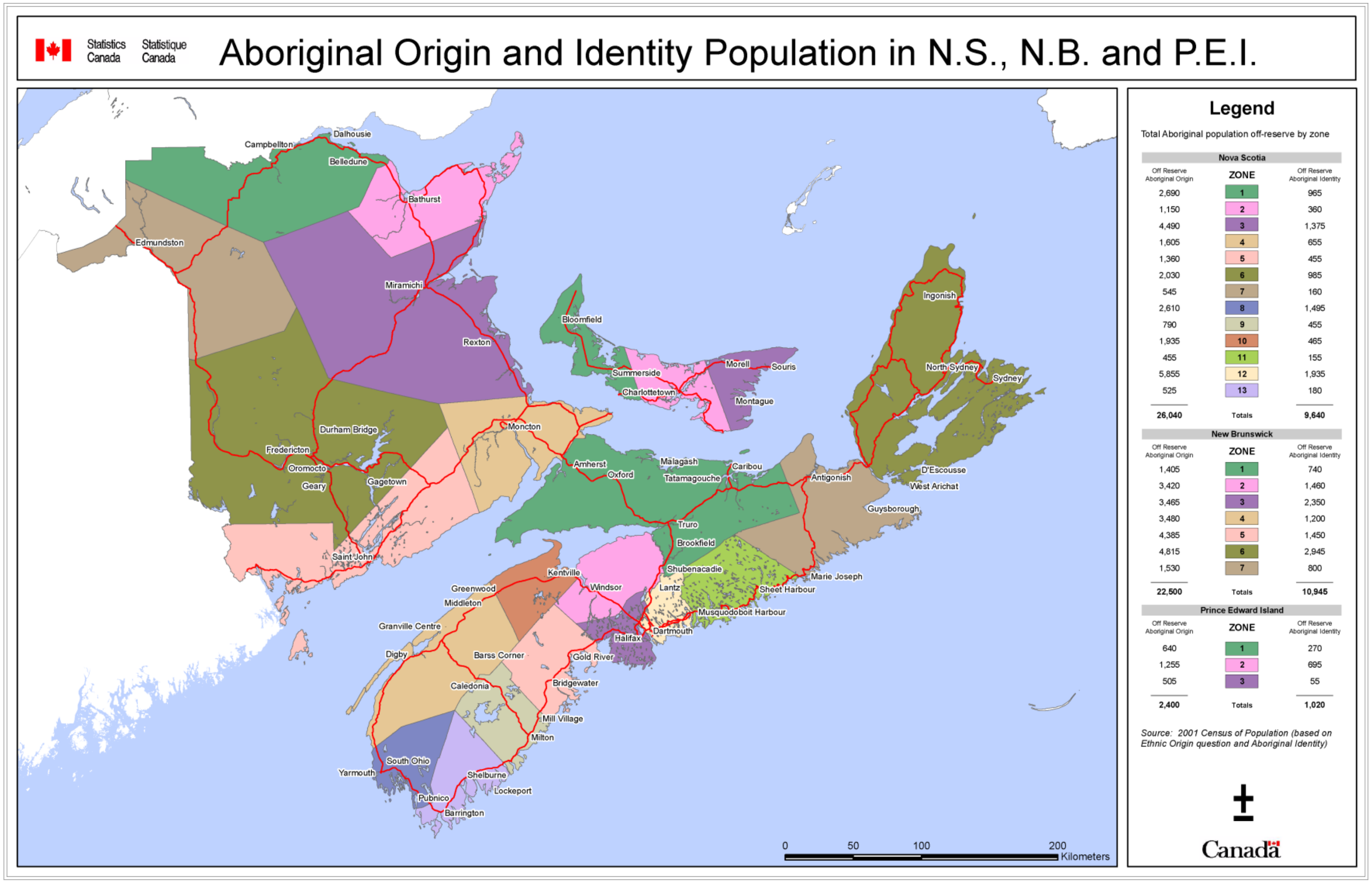


Figure 4.2.2 Off Reserve Aboriginal Origin and Identity by Community Zones (MAPC 2014)

4.3 POTENTIAL OR ESTABLISHED RIGHTS AND RELATED INTERESTS

Under the federal *Constitution Act*, *1982*, existing Aboriginal and Treaty rights are recognized as constitutionally protected rights. Various Peace and Friendship Treaties were established between the Mi'kmaq, the Wolastoqiyik (Maliseet), and British settlers between 1725 and 1779, the terms of which were intended to assist in establishing peace and commercial relations (AANDC 2013). As affirmed by various recent Supreme Court decisions, these treaties guarantee Aboriginal rights to hunt and fish throughout the region and to maintain a moderate livelihood. These rights are protected by section 35(1) of the *Constitution Act*, *1982*.

In the 1990 Sparrow Decision, the Supreme Court of Canada found that the Musqueam First Nation had an Aboriginal right to fish for food, social and ceremonial (FSC) purposes. This landmark decision highlighted the importance of consulting with Aboriginal groups when their fishing right may be affected (DFO 2008c). The Governments of Canada and Nova Scotia continue to work with First Nations to negotiate outstanding treaty, title and Aboriginal rights questions in Nova Scotia. A description of Mi'kmaq access to FSC and commercial fisheries is provided in Section 5.3.6 and the Traditional Use Study (TUS) (Appendix B).

A "Made-in-Nova Scotia Process" has been established as a process for the Mi'kmaq, the Province of Nova Scotia and the Government of Canada to ensure that the interests of Aboriginal groups in land, resource management and environmental protection are realized and that claimants share in the benefits of development. On February 23, 2007, a Framework Agreement was signed between the Mi'kmaq of Nova Scotia, the Province of Nova Scotia and the Government of Canada to set out the process to promote efficient, effective, orderly and timely negotiations towards a resolution of issues respecting Mi'kmaq rights and title.

In New Brunswick, the Mi'kmaq and Wolastoqiyik (Maliseet), the Province of New Brunswick and the Government of Canada are involved in tripartite exploratory discussions. These discussions are focused on establishing a tripartite process to address issues of mutual concern, including Aboriginal and treaty rights and self-government.

In addition to the engagement efforts by BP, the federal government is consulting with Aboriginal organizations in Nova Scotia and New Brunswick to understand potential Project effects on Aboriginal and Treaty rights and to take any adverse effects into consideration before reaching a regulatory decision on the Project.

To facilitate the engagement process for this Project and provide input to the EIS, a TUS has been conducted (refer to Appendix B) to characterize Aboriginal use of marine waters near the Project. Additional information about the TUS is provided in Section 4.4.

4.4 ABORIGINAL ENGAGEMENT ACTIVITIES

BP's engagement with the Mi'kmaq of Nova Scotia began in October 2013 when BP was planning the Tangier 3D Seismic Survey Project. Since then, their engagement program has expanded in recognition of a potentially larger regional area of influence associated with the exploration drilling program and has included engagement of Mi'kmaq and Wolastoqiyik (Maliseet) in New Brunswick in addition to the Mi'kmaq of Nova Scotia. BP has also commenced engagement with the First Nations in PEI.

Engagement methods used by BP to provide Project information and obtain feedback have included:

- face to face meetings;
- provision of information packages; and
- phone calls and emails.

Table 4.4.1 summarizes the Aboriginal engagement conducted by BP for this Project as of October 2016. BP will continue its Aboriginal engagement over the lifetime of the Project.

Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Key Issues
Kwilmu'kq Maw-Klusuaqn Negotiation Office (KMKNO)	December 3, 2014	Meeting with Benefits Committee	Emphasis on meaningful engagement and benefits
	December 4, 2014	Meeting with KMK consultant	KMKNO's training and capacity strategic plan discussion
	January 28, 2015	Meeting with KMK consultant	KMKNO's training and capacity strategic plan discussion update
	February 23, 2015	Meeting	Project update and discussion around BP/KMKNO relationship development including engagement principles and commitments
	February 24, 2015	Meeting	Update on timing of EIS related to exploration project
	March 12, 2015	Meeting	Progress made on engagement protocol discussion
	April 15, 2015	Meeting	Detailed discussion on engagement principles
	April 15, 2015	Meeting	Regulatory process and inclusion of KMKNO discussed

Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Key Issues
	May 27, 2015	Meeting	Detailed discussion on engagement expectations as well as follow up on regulatory process and inclusion of KMKNO
	June 15, 2015	Meeting	Relationship discussion
	July 9, 2015	Meeting	Relationship protocol discussion
	July 17, 2015	Provided information package meeting	BP provided information package for the KMKNO to share with the General Assembly of NS Mi'kmaq Chiefs (meeting agenda could not accommodate a BP presentation)
	August 20, 2015	Email	BP requested guidance for introductory meeting with Chief Paul Prosper, Lead on the Energy file for the Assembly of NS Mi'kmaq Chiefs
	August 26, 2015	Phone Call	Relationship discussion, touching base on sponsorship opportunities and BP's request to be included on the agenda for Assembly of NS Mi'kmaq Chiefs meeting
	September 15, 2015	Meeting/ Presentation	BP presented project overview, provided an update on the EIS, and shared lessons learned from Deepwater Horizon, source control and OSRP; KMKNO recommended an EIS findings workshop be held in February 2016
	October 16, 2015	Meeting	Met to discuss sponsorship opportunities for Annual Youth Trades Fair
	November 27, 2015	Email	Seeking guidance from KMKNO regarding First Nations requesting BP participation; Request came through TUS interview activity
	March 3, 2016	Email	Update on timing of EIS related to exploration project
	March 22, 2016	Email	Relationship update discussion to address any outcomes from upcoming meetings
	March 30, 2016	Phone call	Discussion about Project timeline, EIS submission and planned technical session

Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Key Issues
	April 4, 2016	Email	Discussion on topics to include in meeting with fisheries managers
	April 5, 2016	Email	Planning for technical session with fisher managers from KMKNO in May
	April 19, 2016	Email	Finalization of topics for meeting with fisheries managers
	May 2, 11, 17, 2016	Emails	Emails to invite and confirm attendance at technical session hosted by BP
	May 24, 2016	Meeting	Technical presentation delivered by BP to provide project update and overview of exploration drilling and emergency response and TUS
	June 7, 13, 14, 24	Emails	Emails from BP to inform the KMKNO of the EIS submission to CEA Agency for review and provision of TUS report to the KMKNO
	July 12, 2016	Email	Provided clarification on engaging KMKNO membership in all phases of the Project
	August 24, 2016	Meeting	Relationship update discussion to address best methods to engage all members within KMK
	September 27, 2016	Email	Notification of upcoming BP technical presentations
	September 29, 2016	Email	Email to confirm upcoming meeting
	October 5, 2016	Email	Invitation to the Technical Session Meeting at the KMKNO office
	October 12, 2016	Meeting	Meeting with the Benefits Committee to better establish working relationship between leadership of KMK and BP
Whycocomagh Wagmatcook Membertou Eskasoni Chapel Island (Potlotek) Pictou Landing Millbrook Acadia	May 24, 2016	Meeting	Technical presentation delivered by BP to provide project update and overview of exploration drilling and emergency response and TUS

Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Key Issues
Paq'tnkek Bear River Annapolis Valley Glooscap			
Sipekne'katik	February 24, 2015	Meeting	Update on timing of EIS related to exploration project
	May 20, 2015	Meeting	Meeting to engage the community of Sipekne'katik on the Scotian Basin Project
	March 1, 2016	Email	Confirmation of upcoming meeting
	March 24, 2016	Meeting	Meeting to discuss Project, including timeline, location and EIS submission
	May 16, 2016	Email	Email to provide update on Project status including delay in operations schedule
	August 25, 2016	Email	Email to provide an update on Project status
Native Council of Nova Scotia (NCNS)/Netukulimkewe'l Commission	December 3, 2014	Meeting	General discussion around BP's future plans in Nova Scotia
	February 24, 2015	Meeting	Update on timing of EIS related to exploration project
	February 25, 2015	Meeting	Employment and capacity training and contract opportunity discussion
	March 19, 2015	Meeting	Discussion around BP's plans and NCNS's interest in offshore fishery; Identified the key areas requiring further discussion as BP progresses to an exploration program
	March 25, 2015	Teleconference meeting	General discussion around BP's exploration program
	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
	July 11, 2016	Email	Consideration of an initiative that NCNS is promoting in the fall in Nova Scotia
Maritime Aboriginal Peoples Council	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
Kingsclear First Nation -	October 20, 2015	Meeting	Meeting to introduce the Project

Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Key Issues
Wolastoqiyik (Maliseet) Nation	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
	June 13, 2016	Email	Email to provide update on Project status and submission of EIS to CEA Agency for review
Woodstock First Nation - Wolastoqiyik (Maliseet) Nation	October 20, 2015	Meeting	Meeting to introduce the Project
	March 3, 2016	Email	Reaching out to arrange a time to discuss the Project
	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
	June 13, 2016	Email	Email to provide update on Project status and submission of EIS to CEA Agency for review
	August 4, 2016	Email	Brief Project update
St. Mary's First Nation - Wolastoqiyik (Maliseet) Nation	June 13, 2016	Email	Email to provide update on Project status and submission of EIS to CEA Agency for review
	August 4, 2016	Email	Brief Project update
	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
Tobique First Nation - Wolastoqiyik (Maliseet) Nation	October 20, 2015	Meeting	Meeting to introduce the Project
	March 3, 2016	Email	Update on timing of EIS related to exploration project
	March 18, 2016	Email	Planning for upcoming meeting
	March 21, 2016	Meeting	Meeting to discuss Project, including timeline, location and EIS submission
	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
Oromocto First Nation - Wolastoqiyik (Maliseet) Nation	October 20, 2015	Meeting	Meeting to introduce the Project
	March 3, 2016	Email	Update on timing of EIS related to exploration project
	March 21, 2016	Meeting	Meeting to discuss Project, including timeline, location and EIS submission

Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Key Issues
	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
	June 2, 2016	Meeting	Meeting to discuss project update; Oromocto indicated Maliseet are looking into having an organization represent interests of all Maliseet in New Brunswick and expressed interest in a technical presentation; Oromocto indicated they are in regular contact with CEA Agency on several projects
	June 13, 2016	Email	Email to provide update on Project status and submission of EIS to CEA Agency for review
Madawaska First Nation - Wolastoqiyik (Maliseet) Nation	March 3, 2016	Email	Update on timing of EIS related to exploration project
	March 21, 2016	Meeting	Meeting to discuss Project, including timeline, location and EIS submission
	May 13, 2016	Email	Email to provide update on Project status including delay in operations schedule
	June 2, 2016	Meeting	Meeting to discuss Project status and ongoing engagement with BP and CEA Agency; Madawaska First Nation expressed interest in broad presentation on offshore oil and gas exploration
	June 13, 2016	Email	Email to provide update on Project status and submission of EIS to CEA Agency for review
St. Mary's First Nation Woodstock First Nation Kingsclear First Nation Madawaska First Nation Oromocto First Nation Tobique First Nation	June 27, 2016	Meeting	Meeting to provide general presentation (technical session) on offshore drilling and incident response as well as the TUS
	October 5, 2016	Email	Confirming meeting at St. Mary's First Nation to discuss the Project
Woodstock First Nation Madawaska First Nation Oromocto First Nation	August 23, 2016	Meeting	BP provided info and update on submission of EIS and shared communal commercial fisheries information from DFO

Table 4.4.1 Summary of Aboriginal Engagement Conducted for the Project (as of October 2016)

Organization	Date	Means of Engagement	Key Issues
Mi'gmawe'l Tplu'taqnn Incorporated (MTI) (formerly Assembly of First Nation Chiefs of New Brunswick)	October 20, 2015	Meeting	Meeting to introduce the Project
	March 3, 2016	Email	Update on timing of EIS related to exploration project
	March 8, 2016	Email	Confirmation of upcoming meeting
	March 16, 2016	Meeting	Meeting to discuss the Project: BP EIS submission date, TUS, MTI involvement, budget
	April 11, 2016	Email	Email to confirm communications with New Brunswick Mi'kmaq is transitioning from AFNCNB to MTI
	May 18, 2016		Email to provide update on Project status including delay in operations schedule
	June 1, 2016	Meeting	Meeting to discuss continued engagement with BP and CEA Agency with preference for MTI First Nations to be engaged as unified group; expressed interest in American eel as important species, and interest in broad presentation informing MTI First Nations in offshore oil and gas exploration
	June 7, 2016	Email	MTI provided BP copy of Indigenous Study Guide
	June 13-14, 2016	Emails	BP provided update of Project status, discussed option for follow up meeting with Wells Manager, and copy of TUS report
	September 23, 2016	Email	Received email informing BP that as of April 1, 2016 Mi'gmawe'l Tplu'taqnn has been designated to hold the mandate of consultation and accommodation, and rights implementation for its member communities in New Brunswick.
Abegweit First Nation	October 12, 2016	Email	Email to introduce the Project
Lennox First Nation	October 12, 2016	Email	Email to introduce the Project

As noted in Table 4.4.1, BP held technical sessions with several First Nations groups in Nova Scotia (through the KMKNO) and New Brunswick in May and June 2016 to provide an overview of offshore exploration drilling activities and emergency planning and response. A further technical session is planned in November 2016.

In addition to activities listed in Table 4.4.1, BP sought to engage the Aboriginal Peoples Training and Employment Commission to meet and discuss the Project.

BP also attended the Business Together Symposium on March 11, 2015 where BP had conversations with several leaders of the Assembly of Nova Scotia Mi'kmaq Chiefs about economic opportunities.

BP will continue to reach out to Aboriginal organizations in Nova Scotia and New Brunswick to share Project information and obtain feedback on issues and concerns. BP will also continue to engage with Aboriginal fishery groups through the FAC.

Information sessions focussed on topics or concerns expressed about the proposed Project will be conducted. BP subject matter experts will participate in the presentations to address concerns highlighted for the discussions.

In an effort to better understand traditional use of marine areas and resources by Aboriginal peoples and potential effects on Aboriginal and Treaty rights, Membertou Geomatics Solutions (MGS) and Unama'ki Institute of Natural Resources (UINR) were commissioned to undertake a Traditional Use Study (TUS). Based on knowledge of fishing interests obtained from DFO and/or through consultation with the CEA Agency, the TUS targeted interviews with the NCNS and all 13 First Nation Bands in Nova Scotia, and Fort Folly, St. Mary's, and Woodstock First Nations in New Brunswick. Interviews with fisheries managers, captains and fishers, along with a literature review and review of DFO licensing information were used to help characterize communal commercial and/or FSC fisheries that could be occurring in the RAA. Organizations that were interested and available to participate are included in the study results. The TUS is not intended to represent an exhaustive inventory of Aboriginal resource use occurring in the RAA but provides a reasonable characterization of potential interactions with the Project. BP has presented information about commercial and FSC fisheries that could interact with the RAA in Section 5. As part of ongoing engagement activity, BP will continue to gather information about commercial and FSC fishing by Aboriginal groups and monitor the suitability of any mitigation measures to manage any potential effects from the Project. Refer to the TUS in Appendix B for more information on study participants, methods, and results.

4.5 QUESTIONS AND COMMENTS RAISED DURING ABORIGINAL ENGAGEMENT

Questions and comments raised during Aboriginal engagement, including comments submitted to the CEA Agency during the public comment periods held thus far under CEAA, 2012, have been taken into consideration during the preparation of this EIS.

Key concerns raised by various Aboriginal organizations were a perceived lack of funding, limited duty to consult, and limited engagement scope. On December 8, 2015, the CEA Agency announced the allocation of federal funding through the Participant Funding Program to assist public and Aboriginal groups in their participation in the EA process. Federal funding was allocated to 10 applicants; all are Aboriginal organizations in Nova Scotia or New Brunswick.

In addition to concerns raised about the engagement process, Aboriginal organizations raised questions and concerns about the collection and integration of traditional knowledge for the EIS, and potential effects of the Project on potential or established Aboriginal and Treaty rights, through effects on marine resources and/or through potential obstruction to these resources.

A summary of key issues and how they have been addressed is provided in Table 4.5.1.

Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement

Question or Comment	Summary of Response	EIS Reference
Recommendation to complete a TUS and Mi'kmaq Fisheries Communication Plan	A TUS has been commissioned by BP to assess the extent and timing of traditional use of the RAA by the Mi'kmaq and Wolastoqiyik (Maliseet). This activity primarily includes fisheries use. The TUS has been completed by MGS and UINR. The results of the TUS have been used to inform the EIS. BP has commenced engagement with community fishery directors, fishers and fisheries organizations. BP will continue to engage commercial and Aboriginal fishers to share Project details as applicable and facilitate coordination of information sharing. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers.	• *Section 5.3.6:* Description of Aboriginal fishing activities • *Section 7.7*: Assessment of Project-related environmental effects on aboriginal use of lands and resources • *Appendix B*: Traditional Use Study
Concern about scope of TUS, particularly as it pertains to involvement of First Nations in New Brunswick	The TUS includes First Nations from the Mi'kmaq and Wolastoqiyik (Maliseet) communities in Nova Scotia and New Brunswick. Prior to the commencement of the TUS, the First Nation communities as well as the NCNS, were solicited for their participation because of known existing fishing activity. The communities who were invited to participate in the TUS include: Acadia First Nation, Glooscap First Nation, Membertou First Nation, Millbrook First Nation, Sipekne'katik (Indian Brook) First Nation, Woodstock First Nation, St. Mary's First Nation, Fort Folly First Nation, Eskasoni First Nation, Potlotek First Nation, Wagmatcook First Nation, We'koqma'q (Whycocomagh) First Nation, Paq'tnkek (Afton) First Nation, Pictou Landing First Nation, Annapolis Valley First Nation and Bear River First Nation. Sipekne'katik (Indian Brook) First Nation declined to participate in the TUS. As of April 2016, Annapolis Valley First Nation and Bear River First Nation had not been included in the TUS for EIS submission. The area considered by the TUS is consistent with the RAA defined in the EIS.	• *Section 5.3.6:* Description of Aboriginal fishing activities • *Section 7.7*: Assessment of project-related environmental effects on aboriginal use of lands and resources • *Appendix B*: Traditional Use Study
Request to include off-reserve Status and Non Status Indian/Mi'kmaq/Aboriginal Peoples in the TUS	BP has engaged with the NCNS, which represents off-reserve Aboriginal peoples in Nova Scotia, and the NCNS participated in the TUS.	• *Section 5.3.6:* Description of Aboriginal fishing activities • *Section 7.7*: Assessment of project-related environmental effects on aboriginal use of lands and resources • *Appendix B*: Traditional Use Study

Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement

Question or Comment	Summary of Response	EIS Reference
Concern that an oil spill could reach the Bay of Fundy and affect species at risk, migratory waterfowl, and tidal salt marshes	Safe operations are BP's priority. BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences (refer to Section 8.3 for details on plans and specific response strategies). BP has conducted spill trajectory modelling to determine the likely fate and behavior of a blowout in the extremely unlikely event one should occur over the life of the Project. The results of this modelling indicate that, if left unmitigated (*i.e.*, with no oil spill response measures to manage or contain spilled oil), oil from a blowout could potentially reach the Bay of Fundy under certain oceanographic conditions. However, the probability of oil reaching the Bay of Fundy at levels where environmental effects could be detected is 0 to 5% (if left unmitigated). Furthermore, the length of time it would take to reach the Bay of Fundy at these concentrations is in excess of 50 days, which would be considerable time to implement spill response measures to further reduce the probability of interaction of oil and sensitive receptors.	• *Section 8.3:* Emergency response and spill management • *Section 8.5:* Environmental effects of potential accidental events • Appendix H: Oil Spill Modelling Study
Concern that a spill could affect migration, spawning and/or feeding grounds of species of significance to Mi'kmaq culture including American eel, Atlantic sturgeon, Bluefin tuna, herring and gaspereau, whales, and migratory birds	Safe operations are BP's priority. BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. BP's oil spill response plan will contain specific details of response methods which could be used in the event of an oil spill (refer to Section 8.3 for details on plans and specific response strategies). The EIS has used oil spill modelling (refer to Appendix H) to inform the assessment of effects on valued components of the marine environment (refer to Section 8.5).	• *Section 8.3:* Emergency response and spill management • *Section 8.5:* Environmental effects of potential accidental events • *Appendix H*: Oil Spill Modelling Study
Concern of potential cumulative effects with proposed TransCanada marine terminal and shipping in the Bay of Fundy	Routine Project activities will not interact with the Bay of Fundy, therefore the proposed TransCanada marine terminal and associated shipping was not considered as a foreseeable activity with effects that would likely interact spatially and temporally with effects of the Project. Shipping in general within the RAA is considered in the cumulative effects assessment.	• *Section 10:* Cumulative Effects Assessment

Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement

Question or Comment	Summary of Response	EIS Reference
Concern that the Project will result in obstruction of Mi'kmaq fishing areas	Similar to commercial fisheries, the Project could have an effect on fisheries resources by direct or indirect effects on fished species and/or effects on fishing activity from displacement from fishing areas, gear loss or damage. Routine Project activities are not expected to interact with nearshore fishing activities. A 500-m safety (exclusion) zone will be established around the MODU, in accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, within which Aboriginal (and commercial) fishing activities will be excluded while the MODU is in operation. This will result in localized Aboriginal fisheries exclusion within an area of approximately 0.8 km^2 (80 ha) for an expected maximum of 120 days for each well to be drilled. Although fishing efforts may be disrupted within this safety (exclusion) zone, it is anticipated to be a temporary and localized fishing exclusion and is not likely to have a substantial effect on Aboriginal fishing activities and fisheries resources. The Project Area does not include any unique fishing grounds or concentrated fishing effort; similar alternative sites are readily available within the immediate area.	• *Section 7.7:* Assessment of project-related effects on aboriginal use of lands and resources • *Appendix B:* Traditional Use Study
Recommendation for compensation and/or accommodation for impacts to fish and fish habitat	The Canada Nova Scotia Offshore Petroleum Board provides guidelines respecting damages relating to offshore petroleum activity. BP adheres to and complies with the principles outlined within the guidelines. Specified concerns regarding BP activity resulting in gear loss or damage will be investigated.	• *Section 7.6:* Assessment of project-related effects on commercial fisheries • *Section 7.7:* Assessment of project-related effects on aboriginal use of lands and resources
Question about PSV fuelling and fuel transfer to the MODU	Fuel will be transferred to the PSV for PSV fuelling and for transfers to the MODU using closed piping systems (*e.g.*, pumps and hoses). Procedures will be implemented for the safe management and use of fuelling systems to minimize the risk of an unintended release. The vessels, MODU and fuelling base will be equipped with primary spill contingency equipment to deal with spills in the unlikely event that they occur. The PSVs will transfer diesel fuel, also referred to as marine gas oil to the MODU from shore. Fuel is required offshore to power the MODU,	• *Section 2.4.5.1*: Information about platform supply vessels and fuelling operations

Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement

Question or Comment	Summary of Response	EIS Reference
	including drilling equipment and thrusters. Fuel will be loaded from an existing field distribution facility within Halifax Harbour according to standard vessel fuelling procedures up to two to three times per week by a third party contractor.	
Request for more information on drill waste dispersion modelling exercise and effects on marine life	It is likely that the initial, shallow sections of the well will be drilled without a riser and that deeper sections will be drilled with a drilling riser attached. During riserless drilling, WBM will be used as the drilling fluid and cuttings are discharged directly to the water column in accordance with regulatory guidelines. Once a riser is attached, cuttings can be returned to the MODU for treatment. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained "synthetic on cuttings" on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU to achieve compliance with the OWTG. BP has modelled the dispersion of predicted drilling waste (refer to Appendix C); this modelling study has been used to inform the assessment of effects of drilling waste on marine life. Overall, the dispersion of sediments associated with drill waste discharges is predicted to be limited to approximately 1,367 m (for a deposition thickness of 0.1 mm). Using a threshold of 9.6 mm to assume burial of benthic species, it is predicted that this sediment thickness could extend approximately 116 m from the discharge point, or cover an area of approximately 0.54 ha per well.	• *Section 2.3.2*: Information about cuttings • *Section 2.8.2*: Information about drilling waste discharges • *Section 7.1.2.1*: Summary of drill waste discharges and modelling results • *Section 7.2:* Assessment of Project-related effects on fish and fish habitat • Section 7.3: Assessment of Project-related effects on marine mammals and sea turtles • Section 7.4: Assessment of Project-related effects on migratory birds • Section 7.5: Assessment of Project-related effects on Special Areas • Section 7.6 Assessment of Project-related effects on commercial fisheries • *Section 7.6:* Assessment of Project-related effects on Aboriginal use of lands and resources for traditional purposes commercial fisheries • *Section 10:* Cumulative effects • *Appendix C:* Drilling Waste

Table 4.5.1 Summary of Key Issues Raised During Aboriginal Engagement

Question or Comment	Summary of Response	EIS Reference
		Dispersion Modelling Study
Question about whether drill wastes will contain naturally occurring radioactive material (NORM) and if so, how it will be managed	NORM is not expected to occur in the drilling waste. NORM typically is created in the production process, when the produced water may create sulfate scale on the wall of production tubing and surface equipment.	None
Request for more information on predictive spill modelling exercise and spill effects on nearshore and inshore resources	BP has conducted stochastic and deterministic modelling to predict the fate and behavior of an oil spill in the unlikely event that one occurs (refer to Appendix H). The results of the modelling have been used to inform the assessment of effects of accidental spills on the marine environment (refer to Section 8.5). As part of stakeholder and Aboriginal engagement efforts, BP intends to present an overview of spill modelling results, as well as spill prevention and response measures that will be implemented to reduce adverse environmental effects from a spill.	• *Section 8.3:* Emergency response and spill management • *Section 8.5:* Environmental effects of potential accidental events • *Appendix H*: Oil Spill Modelling Study
Request for more information on Project effects on sensitive and protected areas (Special Areas)	The EIS assesses potential Project-related (and cumulative) effects on Special Areas which includes sensitive and protected areas including, but not limited to, Sable Island, the Gully and SARA-designated critical habitat. Routine Project activities and components could potentially interact with Special Areas (*e.g.*, drilling and VSP), which could affect habitats in Special Areas. Special Areas could also be affected in the unlikely event of large spills. To reduce potential adverse effects on Special Areas, BP has committed to implementing best management practices and mitigation measures including avoidance of Sable Island, the Gully and northern bottlenose whale critical habitat. Mitigation measures identified for Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Migratory Birds will be implemented to reduce the potential environmental effects of the Project on Special Areas. BP will also implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences (refer to Section 8.3 for details on plans and specific response strategies).	• *Section 5.2.8:* Existing conditions regarding Special Areas • *Section 7.5:* Project-related effects on Special Areas • *Section 8.3:* Emergency response and spill management • *Section 8.5:* Environmental effects of potential accidental events • *Section 10:* Cumulative effects

5.0 EXISTING ENVIRONMENT

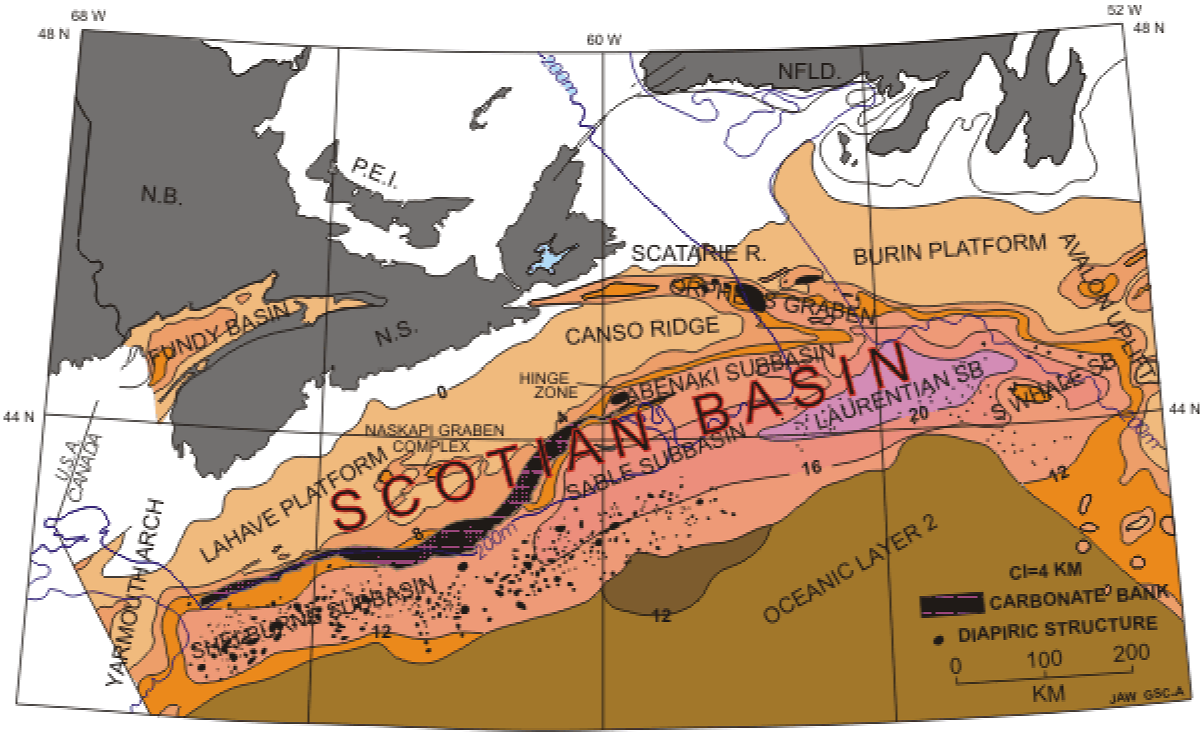
This section provides an overview of the physical, biological and socio-economic environments in which the Project is located and is intended to provide a regional perspective of the existing environment and to help identify key factors that may interact with the Project and require further assessment as Valued Components in Section 7. These environments are described below at different scales and specificity, depending on the information available and/or relevance to the EA. Where site-specific information may be lacking in the deep waters of the Project Area, general information from the Scotian Shelf and Slope is included. Recent Strategic Environmental Assessments (SEAs) undertaken by the CNSOPB for the Scotian Shelf and Slope as well as the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) and Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) have been used to characterize the Project Area and surrounding region.

5.1 MARINE PHYSICAL ENVIRONMENT

5.1.1 Marine Geophysical Environment

The Project Area is located within the Scotian Basin geological formation located on the Scotian Slope offshore of Nova Scotia. As described by the CNSOPB (2013) the basin extends approximately 1,200 km from the Yarmouth Arch on the United States (US) and Canadian Border in the southwest to the Avalon Uplift located on the Grand Banks of Newfoundland in the North East (refer to Figure 5.1.1). The basin has an average width of 250 km, with a total area of approximately 300,000 km^2. Half of the Scotian Basin is situated on the continental slope in waters ranging in depth from 200 m to over 4,000 m, while the other half is situated over the shallow Scotian Shelf in waters less than 200 m (CNSOPB 2013).

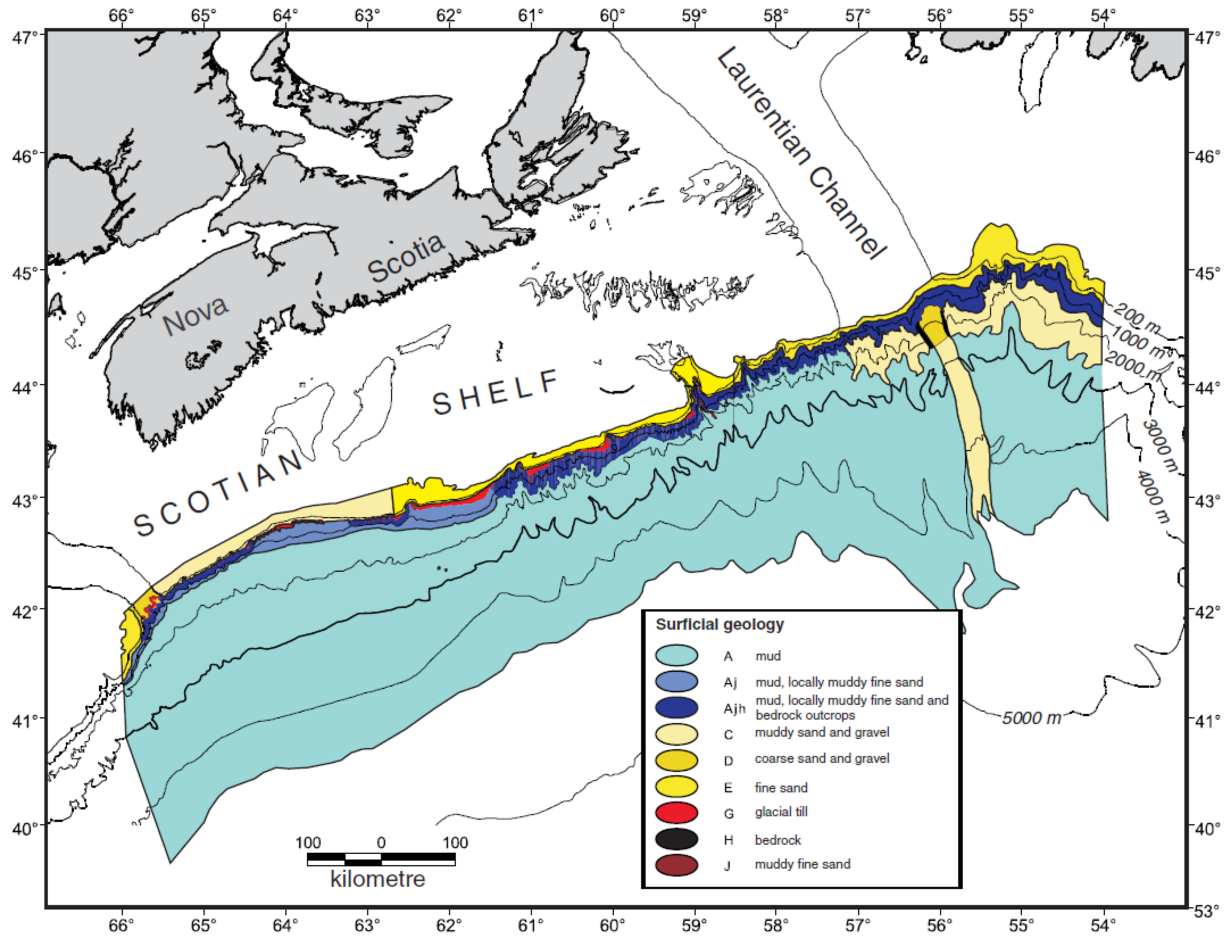
The Scotian Basin is a rifted continental margin located on the northeastern flank of the Appalachian Orogen with a maximum sediment thickness of 24 km. The continental-sized drainage system of the paleo-St. Lawrence River provided a continuous supply of sediments which accumulated into a variety of complex and interconnected sub-basins.



Source: NRCan 2010

Figure 5.1.1 Major Tectonic Features of the Scotian Basin

The Project Area is located on the Scotian Slope which is characterized by a gentle gradient with low gentle hills and valleys, sloping towards the deep Scotian Rise and Abyssal Plain (WWF 2009). As the shelf edge hits the slope west of latitude 62.50 °W, the surficial sediment on the shelf edge and upper slope are comprised mostly of a high concentration of muddy sand and gravel. At the shelf edge off of the Emerald and Western Banks, the seafloor is made up of a mostly fine sand substrate (Piper and Campbell 2002). From the 200 to 1,000 m isobaths the seafloor sediments consist mostly of mud with local patches of muddy fine sand. There are also sections of mud with local muddy fine sand and bedrock outcrops, patches of glacial till, and muddy fine sand (Figure 5.1.2). From the 1,200 m isobath to 3,000 m, the seafloor consists of a smooth mud surface that contains less than 5% sand. On the Continental Rise below the 3,000-m water depth profile, the seafloor sediments are primarily composed of muddy foraminifera (single-celled protozoans that produce a shell made of calcium carbonate, mineral grains or other particles glued together)(Piper and Campbell 2002).



Source: Piper and Campbell 2002

Figure 5.1.2 Seafloor Sediment Types on the Scotian Slope

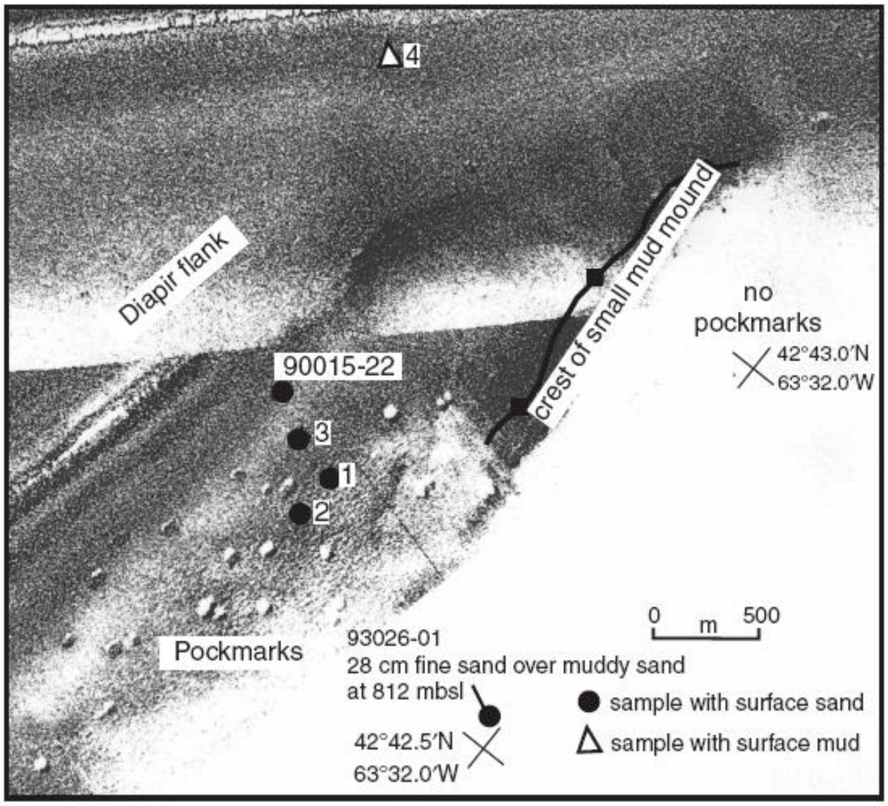
The seafloor gradient increases at the shelf break at the 80 to160 m water depth to gradients of 1.1° to 3.3° on the upper slope (Piper and Campbell 2002). Most areas of the shelf break have a smooth seabed up to a water depth of approximately 250 m. From the 250 to 500 m water depth contours, there are widespread relic formations of iceberg pits and scours. In shallower water depths, these pits and scours become less obvious as they have been filled in by modern sedimentation, consisting mostly of sand. There are also local areas of sand waves in the 200 to 250 m water depth range, confirming the abundance of modern sedimentation (Piper and Campbell 2002).

Sable Island Bank, approximately 48 km northeast from the Project Area, is a large defining bank of the Scotian Shelf. The seafloor of Sable Island Bank is characterized by complex fields of sand ridges that have an average height of 12 m and a width of 6.4 m (Stantec 2014b). Sand ridges occur on the lower section of the shore face, extending offshore on either side of Sable Island. The larger and more expansive ridges can be found on the south side of the island and in the deeper waters to the west of the island. At the edge of eastern Scotian Shelf, sand and gravel slump over the edge and onto the upper slope. Dramatic, exposed bedrock cliffs can also be found along the transition from the eastern Scotian Shelf to the Slope (*i.e.*, the shelf break or shelf edge) (WWF 2009). Along the Scotian Rise, the transition zone from the slope to the Abyssal Plain, glacial erosion, sea level rise and fall, and modern sedimentation have deposited sediments in a wide area seaward of the Scotian Slope.

The Laurentian Channel, which divides the Scotian Shelf and Slope from the Grand Banks at the eastern end of the RAA, is a deep trough created from an ancient river valley that was eroded by past glaciation. The substrate at the mouth of the channel is mostly a sand and mud mixture and the flanks of the channel are covered by old iceberg furrows lined with gravel. The Laurentian Fan is a large delta-shaped sediment deposit at the edge of the Laurentian Channel. Two major valleys originate from an area of gullies on the upper slope and terminate at water depths between 4,500 and 5,200 m where they open onto a sandy area of the Abyssal Plain (WWF 2009). To the west of the Laurentian Fan, the debris flow can be found. This is an area occupied by a large mass of muddy debris that has shifted and settled into sheets of sediments. Here, the debris mix with sediment flows down the canyons and slope from the area above, creating a smooth muddy complex material 200 km wide and extending 200 m downslope.

The mobility of bottom sediments (*e.g.*, susceptibility of sediment transport, slope failure) is an important consideration in assessing natural geological hazards (geohazards) which can affect the selection of wellsites. Other geohazards include pore pressure phenomena and pockmarks. Geohazards are discussed in Section 9 in the context of Effects of the Environment on the Project.

Pore pressure phenomena is described as former or present day activities of fluid flow related to conduits such as faults or sedimentary discontinuities. It is the fluid flow within sediments, exploiting pathways of permeable sediments or faults and resulting in upward migration of gas and water expelled from sediments at depth. The end-result of these extrusions is pockmarks and mud volcanoes and diapirisms, which form where entrained sediment erupt at the seafloor. These processes are related to excess pore pressure at depth, which decreases sediment strength and increases slope failure potential. Pore pressure phenomena could include shallow gas accumulations, gas hydrates, shallow water flows, mud diapirism, mud volcanism, fluid vents and pockmarks (Stantec 2014a). Figure 5.1.3 illustrates pockmarks and diapir observed on the Western Scotian Slope by Piper and Campbell (2002).



Source: Piper and Campbell 2002

Figure 5.1.3 SAR High-resolution Sidescan Image of Mud Diapir on the Western Scotian Slope Showing Distribution of Surface Samples. Numbers Refer to Identification of Core Sample.

The morphologic evidence suggests that all these features should be considered as common rather than exceptional on the seafloor (Cochonat *et al.* 2007). Prior to drilling, BP will conduct a comprehensive regional geohazard baseline review (GBR) followed by detailed geohazard assessments for each wellsite to identify potential geohazards that could impact drilling operations. Section 5.2.2 has additional information on BP's GBR process and how it is being used to help characterize the benthic environment and identify geohazards. Section 9.5.5 has additional information on how geohazards will be identified and managed for the Project.

5.1.2 Atmospheric Environment

5.1.2.1 General Climate

The climate of the Scotian Shelf and Slope varies between Atlantic, boreal, and sub-arctic climates, influenced by the warm Gulf Stream and the cold Labrador Current. Air temperatures in the region, as measured on Sable Island, have shown an increase of 1°C over the last century (Worcester and Parker 2010). Daily average temperatures on Sable Island range from below freezing in February, with mean daily minimum being about -5°C, to 18°C in August, with mean daily maximum of 21°C (Freedman 2014). Although precipitation is somewhat less in the summer, the total monthly precipitation does not vary much over the year, ranging from an average of 100.8 mm in July to 150.7 mm in November (Freedman 2014; Environment Canada 2015b). Table 5.1.1 presents the average temperature and precipitation profile from 1981 to 2010 on Sable Island.

Table 5.1.1 Temperature and Precipitation Climate Data, 1981–2010, Sable Island, Nova Scotia

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)												
Daily Average	-0.1	-1.2	0.7	4.0	7.5	11.4	15.8	17.9	15.8	11.7	7.3	2.5
Daily Maximum	3.0	1.8	3.3	6.5	10.2	14.2	18.5	20.7	18.6	14.3	9.9	5.5
Daily Minimum	-3.1	-4.2	-2.0	1.5	4.8	8.6	13.0	15.1	13.0	9.1	4.6	-0.5
Extreme Maximum	14.5	12.8	13.7	13.9	17.8	21.7	26.7	27.8	27.0	22.8	18.9	15.6
Extreme Minimum	-19.4	-18.3	-13.6	-8.9	-8.3	0.6	3.0	4.4	0.6	-1.2	-7.8	-16.7
Winds (km/hour)												
Average Wind Speed	31	30	29	26	21	19	17	17	21	25	28	31
Prevailing Wind Direction	W	W	W	W	SW	SW	SW	SW	W	W	W	W
Extreme Hourly Wind Speed	103	117	100	89	77	77	74	98	100	100	130	116
Direction of Extreme Hourly Wind Speed	NNW	N	WSW	ESE	WSW	SSE	ESE	ESE	SW	SSW	W	SW
Extreme Daily Max Gust Speed	141	170	140	122	113	119	100	143	132	158	174	137
Direction of Extreme Daily Max Gust	SSW	NNW	SW	NNE	ENE	W	ESE	SE	NNW	SSW	W	WNW
Precipitation (mm)												
Rainfall	110.42	92.41	107.66	105.86	101.22	115.87	100.8	121.62	129.54	144.83	145.06	123.7
Snowfall (cm)	33.31	19.79	22.14	9.14	0.11	0	0	0	0	0.01	5.18	18.64
Precipitation	144.66	112.51	130.35	114.76	101.33	115.87	100.8	121.62	129.54	144.85	150.73	144.54
Extreme Daily Rainfall	99.3	52.2	87.6	66	99.6	140.7	85.3	155.7	99.2	166.1	84.8	77.5
Extreme Daily Snowfall (cm)	61.0	45.7	45.7	27.4	15.2	0	0	0	0	0.2	25.4	66.0
Days with Precipitation												
≥ 0.2 mm	20.4	16.8	16.7	16.0	14.5	13.9	13.5	12.0	12.4	16.2	19.3	19.8
≥ 5 mm	8.0	5.8	7.3	7.2	5.4	6.4	5.0	5.3	5.6	6.4	8.1	8.5
≥ 10 mm	5.2	3.7	4.4	3.9	3.4	4.1	3.2	3.8	3.6	4.2	4.7	5.2
≥ 25 mm	1.2	0.84	0.74	0.76	0.78	0.88	1.0	1.1	1.2	1.7	1.3	1.1

Source: Environment Canada 2015b

The North Atlantic Oscillation (NAO) is the dominant atmospheric pattern in the North Atlantic Ocean, which is the significant large-scale abiotic driver of the Scotian Shelf ecozone (Drinkwater *et al.* 1998; Petrie 2007; Worcester and Parker 2010) and likely to impinge on the adjacent Scotian Slope. The NAO index quantifies the dominant winter atmospheric function of the North Atlantic Ocean. It affects winds, air temperature, precipitation, and hydrological properties on the eastern Canadian seaboard (DFO 2015b). The NAO is a back and forth pattern between a high-pressure cell over the Azores in the southeast Atlantic and a low pressure cell over Iceland. The NAO index is a measure in the difference in sea-level pressure between the two locations in winter. A high positive index brings increased northwesterly winds, cold air and sea temperatures, and heavy ice in the Labrador Sea (DFO 2015b). During a high positive index the Scotian Shelf experiences increased precipitation, westerly winds and warmer waters. The opposite forcing occurs with a low NAO index, bringing drier conditions, a decrease in storm conditions, and cooler water temperatures as a result of an increase in influence from the Labrador Current. In 2014, the winter NAO was above normal bringing colder winter air temperatures and the highest volume of sea ice seen since 1994 on the Newfoundland and Labrador shelf (outside the RAA)(DFO 2015b).

5.1.2.2 Air Quality

Environment Canada and Nova Scotia Environment (NSE) operated an ambient air quality monitoring station on Sable Island. NSE closed the station in October 2014. Ambient concentrations of particulate matter with aerodynamic diameters less than or equal to 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ozone (O_3) were measured at this station. The most recently available ambient air quality data (2012 and 2013) were obtained from the National Air Pollutant Survey (NAPS) website (Environment Canada 2012a and 2013a). Although areas near Sable Island have been used for the exploration and extraction of fossil fuels since 1992, with these industrial activities releasing emissions to the atmosphere, the results from the Sable Island monitoring station do not appear to indicate adverse effects on air quality.

Table 5.1.2 summarizes the most recent (2012-2013) ambient air quality data from the Sable Island station.

Table 5.1.2 Summary of Measured Air Contaminant Concentrations on Sable Island, Nova Scotia

Parameter	$PM_{2.5}$ Concentrations (µg/m³)*		SO_2 Concentrations (µg/m³)		NO_2 Concentrations (µg/m³)*		O_3 Concentrations (µg/m³)
	1-hour	24-hour	1-hour	24-hour	1-hour	24-hour	1-hour
NSE Max Permissible GLC/ CCME CWS	-	30*	900		400	-	160
Maximum	163	38	7.9	2.6	43.3	7.5	122
99th Percentile	30	22	2.6	0	5.6	3.8	100
98th Percentile	24	20	0	0	3.8	3.8	96

Table 5.1.2 Summary of Measured Air Contaminant Concentrations on Sable Island, Nova Scotia

Parameter	$PM_{2.5}$ Concentrations (µg/m³)*		SO_2 Concentrations (µg/m³)		NO_2 Concentrations (µg/m³)*		O_3 Concentrations (µg/m³)
	1-hour	24-hour	1-hour	24-hour	1-hour	24-hour	1-hour
90th Percentile	16	15	0	0	1.9	1.9	86
Average	-	-	-	-	0	0	68
Minimum	0	1	0	0	0	0	10
Exceedances	0	0	0	0	0	0	0
Rate of Compliance	100%	100%	100%	100%	100%	100%	100%
Hours Available	8497	8410	6307	6307	7884	7971	8672
Percent Available	97%	96%	72%	72%	90%	91%	99%

Note:
CCME Canada-wide standard is based on the 98th percentile of annual 24-hour average concentrations averaged over three consecutive years.
* All data are from 2013 except for $PM_{2.5}$ concentrations, which are from 2014, and NO_{2}, which are from 2012.

Sources: Environment Canada 2012a, 2013a, 2015f

NO_2 data from 2013 is unavailable; as a result, data from 2012 was used. In 2012, the measured concentrations of NO_2 were well below the applicable NSE maximum permissible ground-level concentrations for both 1-hour and 24-hour averaging periods. In 2013, all the measured concentrations of $PM_{2.5}$, SO_2, and O_3 were also below the NSE maximum permissible ground-level concentrations for both 1-hour and 24-hour averaging periods. O_3 had the highest concentrations of all the parameters with 122 µg/m³ for a 1-hour average period.

Based on the review of the 2012 and 2013 ambient air quality data from the Sable Island monitoring station, the ambient air quality in the area is good most of the time, with no regulatory exceedances. Ozone, a secondary pollutant formed from the action of sunlight on nitrogen oxides and hydrocarbons, is often associated with regional scale emissions, for example from the northeastern seaboard of the US and the Canadian mainland. On Sable Island the median O_3 value for 2013 was 33 ppb, which is essentially unchanged from 2003 to 2006 data that ranged from 27 to 34 ppb (Environment Canada 2010a in Freedman 2014), and well below the Canada-Wide Standards (CWS) of 65 ppb (for 8 hours).

5.1.2.3 Wind Climate

Data Sources

The Meteorological Service of Canada 50-year hindcast (MSC50) wind and wave hindcast data were used to characterize the wind and wave climate conditions for the Project Area in addition to other data sources described below. These data sources generally include both wind and wave data, and therefore these sources are identified in this section along with the wind climate results, with the results for the wave climate presented in Section 5.1.3.3. The MSC50 wave hindcast is a comprehensive regional wave modelling study undertaken by Oceanweather Inc. for the Meteorological Service of Canada (MSC). Full details on the MSC50 hindcast are presented in Swail *et al.* (2006). This hindcast has been widely used in wave climate and engineering studies for the North Atlantic, particularly for the areas offshore the east coast of Canada. This wave hindcast includes the effects of shallow water physics, sea ice information, large-scale weather patterns, as well as storm track information, and predicts hourly wind and wave conditions at 0.1 degree grid points for the entire northwest Atlantic. For the present investigation, 60 years of hourly wind and wave data from 1954 to 2013 were obtained for the MSC50 Grid Point 3551 (42.9°N, 60.6°W). The water depth at this MSC50 Grid Point is 2,326 m. In addition to the hourly wind data, extreme wave conditions data at the Grid Point 3551 were also obtained. The Grid Point 3551 for the MSC50 data is located within the Project Area and is illustrated on Figure 5.1.4.

Metocean data collected at buoys located in the vicinity of Project Area were also obtained and used to compare to the MSC50 data. The details of buoy data are presented in Table 5.1.3 and the buoy locations are shown in Figure 5.1.4. LaHave Bank, East Scotia Slope, Banquereau Bank, and Laurentian Fan buoy data were collected by DFO and Environment Canada. The remainder of the data sets in Table 5.1.3 were collected by drilling rigs and exploration wells, which contain short-term data, and where their locations are also illustrated in Figure 5.1.4.

Table 5.1.3 Buoy Data Used in the Metocean Analysis

Name	Station ID	Depth (m)	Location		Period of Record	
			Lat	Long	From	To
LaHave Bank	C 44142	1500	42.49 °N	64.2 °W	9/5/1990	3/21/1995
		1500	42.44 °N	64.10 °W	6/30/1995	1/7/1998
		1300	42.50 °N	64.02 °W	6/25/1998	6/1/2006
	C44150	1300	42.51 °N	64.02 °W	3/1/2006	9/24/2015
East Scotia Slope	C44137	4500	41.32 °N	61.35 °W	11/30/1988	12/8/1988
			41.19 °N	61.13 °W	9/8/1989	6/22/1993
			41.23 °N	61.42 °W	7/3/1993	6/28/1995
			41.60 °N	60.03 °W	6/30/1995	11/2/1995
			41.65 °N	59.95 °W	9/22/1996	3/17/1997
			41.80 °N	59.92 °W	7/22/1997	7/7/1998
			41.83 °N	60.94 °W	7/8/1998	6/8/2003
		4000	42.28 °N	62.00 °W	6/9/2003	9/1/2015
Banguereau Bank	C44139	1500	44.20 °N	57.50 °W	9/5/1997	6/24/1999
			44.26 °N	57.36 °W	6/25/1999	6/8/2003
			44.27 °N	57.08 °W	6/9/2003	9/24/2015

Table 5.1.3 Buoy Data Used in the Metocean Analysis

Name	Station ID	Depth (m)	Location		Period of Record	
			Lat	Long	From	To
Laurentian Fan	C44141	4500	42.12 °N	56.13 °W	9/5/1990	7/2/1999
			42.09 °N	56.31 °W	7/3/1999	6/8/2003
		3000	43.00 °N	58.00 °W	6/10/2003	9/24/2015
Sedco 709 Drilling Rig	MEDS 133	1114	42.89 °N	61.51 °W	11/19/1982	12/23/1982
Ben Ocean Lancer	MEDS 138	955	42.86 °N	61.92 °W	5/3/1978	8/3/1978
Sedco 710 Drilling Rig	MEDS 185	1310	42.71 °N	63.07 °W	1/5/1985	3/25/1985
Balvenie B-79	WEL 441	1804	43.13 °N	60.18 °W	7/8/2003	9/2/2003
Weymouth A-45	WEL 444	1690	43.07 °N	60.6 °N	10/28/2003	5/8/2004

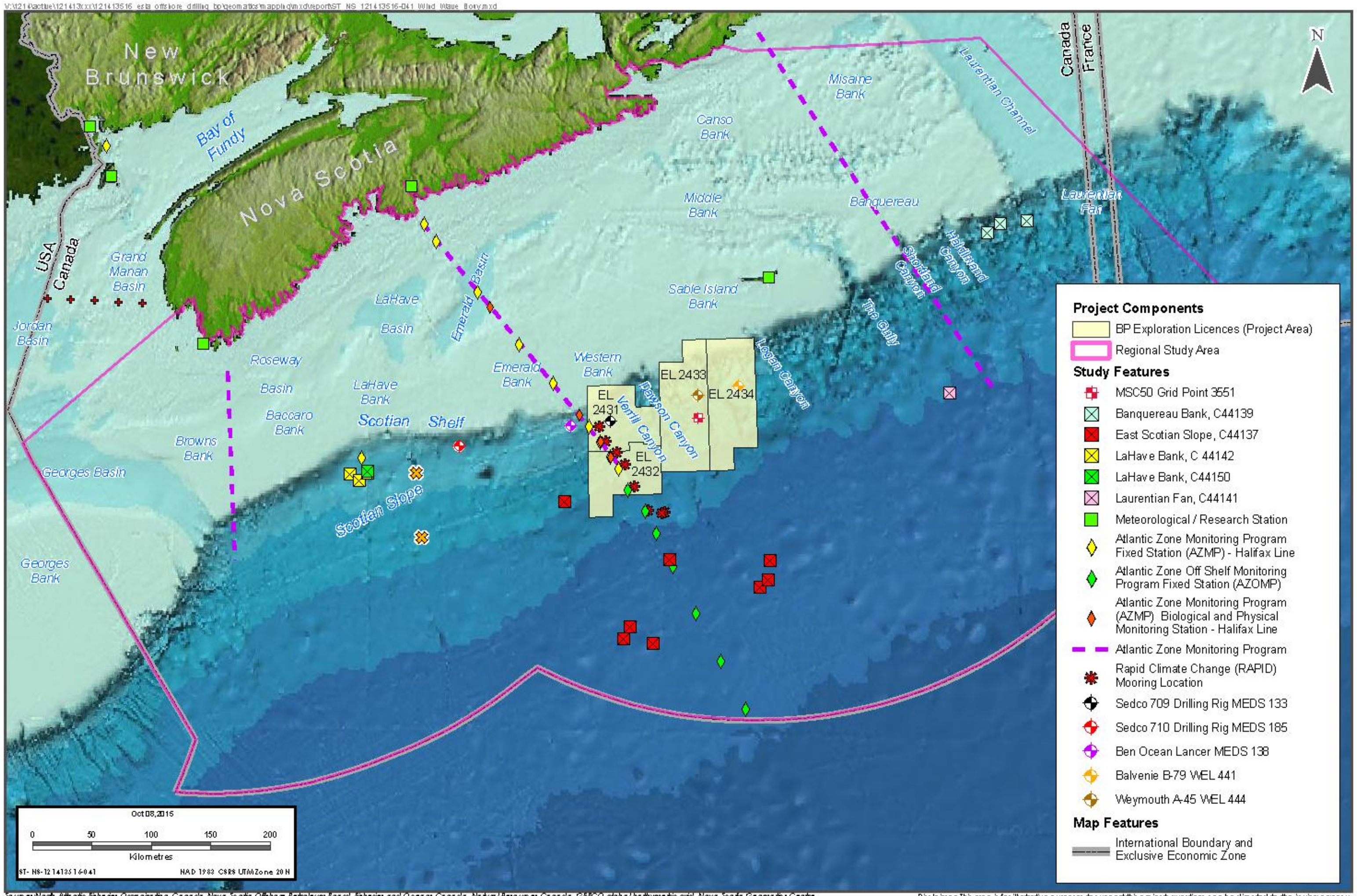


Figure 5.1.4 **Locations of MSC50 Grid Point 3551, Buoys and Other Metocean Data Sources in Relation to the Project Area**

Wind Conditions

The MSC50 hourly wind data for the Grid Point 3551 from 1954 to 2013 are the longest records of available data to characterize the wind conditions for the Project Area. Wind speeds from the MSC50 data are 1-hour averages. Figure 5.1.5(a) presents percentage of wind speed occurrence by the wind direction. An annual wind rose for the Grid Point 3551 is provided in Figure 5.1.5(b) and based on six years of MSC50 data from 2008 to 2013. Most of the winds are from the northwest, west and southwest directions and 92% of the wind speeds are less than 15 m/s. Figure 5.1.5(c) presents the wind speed duration curve for Grid Point 3551. The wind speed duration curve indicates the percentage of time a given wind speed was equaled or exceeded over a 60-year period from 1954 to 2013.

Figure 5.1.6 illustrates the monthly wind roses for Grid Point 3551. Monthly wind roses indicate that winds are predominantly from the northwest during winter and are predominantly from the southwest during spring and summer. Table 5.1.4 presents the monthly and annual wind conditions. Maximum wind speed ranges from 20.4 m/s in May to 29.8 m/s in December. Mean and maximum monthly wind speeds for the LaHave Bank buoy, East Scotia Slope buoy, Banquereau Bank buoy, Laurentian Fan buoy and MSC50 data are presented in Tables 5.1.5 and 5.1.6. Anemometer height is 5 m for La Have Bank buoy, East Scotia Slope buoy, Banquereau Bank buoy, and Laurentian Fan buoy. Winds speed from the MSC50 data set are 1-hour averages while buoy data sets are 10-minute average winds. Buoy wind speeds were adjusted to a reference level of 10 m using the log profile method (Thomas *et al.* 2005).

Extremal wind analysis was carried out using 60 years of hourly wind data from 1954 to 2013 using Gumbel, Weibull, Generalized Extreme Value and Generalized Pareto probability distributions. The Generalized Extreme Value distribution was selected based on visual best fit with simulated wind speeds. Table 5.1.7 presents the extreme wind conditions at the MSC50 Grid Point 3551 for return periods ranging from 2 to 100 years. The predicted range of extreme wind conditions are presented in Table 5.1.8 for various distributions. Tables 5.1.9 to 5.1.13 provide extreme wind speeds for various shorter wind averaging times.

Table 5.1.4 Monthly and Annual Wind Statistics[1] (I-hour Average)

Month	Mean Wind Speed (m/s)	Most Frequent Direction[2]	Maximum Hourly Wind Speed (m/s)
January	11.0	NW	28.4
February	10.8	NW	27.2
March	10.1	NW	28.1
April	8.5	NW to SW	24.2
May	6.8	SW	20.4
June	6.1	SW	24.1
July	5.6	SW	23.5
August	6.1	SW	29.4
September	7.3	NW to SW	28.7

Table 5.1.4 Monthly and Annual Wind Statistics[1] (I-hour Average)

Month	Mean Wind Speed (m/s)	Most Frequent Direction[2]	Maximum Hourly Wind Speed (m/s)
October	8.9	NW and SW	28.3
November	9.9	NW	26.7
December	10.9	NW	29.8
Annual	**8.5**	**NW to SW**	**29.8**

Note:
1 Based on 60 years of MSC50 hourly wind data from 1954 to 2013.
2 Direction winds are blowing from.

Table 5.1.5 Comparison of Mean Monthly MSC50 and Buoy Wind Speeds (10-Minute Average)

Month	Mean Monthly Wind Speed (m/s)				
	MSC50	LaHave Bank (C44142 & C44150)	East Scotian Slope (C44137)	Banquereau Bank (C44139)	Laurentian Fan (C44141)
January	11.3	9.1	9.6	7.8	9.1
February	11.1	8.9	9.9	7.6	9.0
March	10.4	8.3	9.8	7.0	8.2
April	8.7	7.4	7.9	5.9	6.3
May	7.1	5.8	7.0	5.4	5.7
June	6.3	5.4	6.2	5.6	6.0
July	5.8	4.9	5.7	5.3	5.5
August	6.2	5.3	5.9	5.7	6.0
September	7.5	6.4	6.8	6.9	6.9
October	9.1	8.2	8.4	8.3	8.2
November	10.2	8.5	9.3	8.5	8.6
December	11.2	9.6	10.2	8.2	9.2
Annual	**8.8**	**7.3**	**8.1**	**6.9**	**7.4**

Table 5.1.6 Comparison of Maximum Monthly MSC50 and Buoy Wind Speeds (10-Minute Average)

Month	Maximum Monthly Wind Speed (m/s)				
	MSC50	LaHave Bank (C44142 & C44150)	East Scotian Slope (C44137)	Banquereau Bank (C44139)	Laurentian Fan (C44141)
January	29.3	27.9	28.0	31.7	32.6
February	28.0	25.3	27.6	34.4	28.1
March	28.9	26.6	25.4	30.3	26.6
April	24.9	21.4	26.0	23.5	21.4
May	21.0	19.7	21.5	20.7	18.0
June	24.8	20.0	25.7	26.8	21.2
July	24.2	20.4	21.9	21.5	17.2
August	30.3	32.4	25.5	22.0	23.2
September	29.6	30.5	26.0	29.3	30.6
October	29.1	26.4	25.5	28.9	25.3
November	27.5	22.6	30.6	25.8	24.0
December	30.7	27.6	31.9	28.9	30.1
Annual	**30.7**	**32.4**	**31.9**	**34.4**	**32.6**

Table 5.1.7 Extreme Wind Conditions at Grid Point 3551 (1-Hour Average)

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	24.9	21.3	20.4	21.2	20.8	20.7	22.0	22.7	22.6
5	26.9	23.9	22.9	23.4	23.1	22.6	24.6	24.7	24.2
10	28.1	25.3	24.4	24.4	24.5	23.9	26.1	25.8	25.1
25	29.4	26.7	26.1	25.3	26.2	25.4	27.8	26.9	25.9
50	30.2	27.6	27.1	25.8	27.4	26.6	29.0	27.7	26.3
100	31.0	28.2	28.1	26.2	28.6	27.6	30.0	28.4	26.7

Note:
1 Direction winds are blowing from.

Table 5.1.8 Comparison of Extreme Wind Conditions at Grid Point 3551 for Various Probability Distributions – All Directions

Return Period (Year)	Wind Speed (m/s) -1-Hour Average				
	Generalized Extreme Value	Gumbel	Weibull	Generalized Pareto	Predicted Range
2	24.9	25.4	25.3	25.8	24.9-25.8
5	26.9	26.9	26.8	27.0	26.8-27.0
10	28.1	27.9	27.7	27.7	27.7-28.1
25	29.4	29.2	28.9	28.5	28.5-29.4
50	30.2	30.2	29.7	29.0	29.0-30.2
100	31.0	31.1	30.5	29.4	29.4-31.1

Table 5.1.9 Extreme Wind Conditions at Grid Point 3551 – 10-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	25.6	21.9	21.0	21.8	21.4	21.3	22.7	23.4	23.3
5	27.7	24.6	23.6	24.1	23.8	23.3	25.3	25.4	24.9
10	28.9	26.1	25.1	25.1	25.2	24.6	26.9	26.6	25.9
25	30.3	27.5	26.1	26.1	27.0	26.2	28.6	27.7	26.7
50	31.1	28.4	26.6	26.6	28.2	27.4	29.9	28.5	27.1
100	31.9	29.0	27.0	27.0	29.5	28.4	30.9	29.3	27.5

Note:
[1] Direction winds are blowing from.

Table 5.1.10 Extreme Wind Conditions at Grid Point 3551 – 3-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	26.4	22.6	21.6	22.5	22.0	21.9	23.3	24.1	24.0
5	28.5	25.3	24.3	24.8	24.5	24.0	26.1	26.2	25.7
10	29.8	26.8	25.9	25.9	26.0	25.3	27.7	27.3	26.6
25	31.2	28.3	26.8	26.8	27.8	26.9	29.5	28.5	27.5
50	32.0	29.3	27.3	27.3	29.0	28.2	30.7	29.4	27.9
100	32.9	29.9	27.8	27.8	30.3	29.3	31.8	30.1	28.3

Note:
[1] Direction winds are blowing from.

Table 5.1.11 Extreme Wind Conditions at Grid Point 3551 – 2-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	26.6	22.8	21.8	22.7	22.3	22.1	23.5	24.3	24.2
5	28.8	25.6	24.5	25.0	24.7	24.2	26.3	26.4	25.9
10	30.1	27.1	26.1	26.1	26.2	25.6	27.9	27.6	26.9
25	31.5	28.6	27.1	27.1	28.0	27.2	29.7	28.8	27.7
50	32.3	29.5	27.6	27.6	29.3	28.5	31.0	29.6	28.1
100	33.2	30.2	28.0	28.0	30.6	29.5	32.1	30.4	28.6

Note:
[1] Direction winds are blowing from.

Table 5.1.12 Extreme Wind Conditions at Grid Point 3551 – 1-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	27.6	23.6	22.6	23.5	23.1	23.0	24.4	25.2	25.1
5	29.9	26.5	25.4	26.0	25.6	25.1	27.3	27.4	26.9
10	31.2	28.1	27.1	27.1	27.2	26.5	29.0	28.6	27.9
25	32.6	29.6	28.1	28.1	29.1	28.2	30.9	29.9	28.7
50	33.5	30.6	28.6	28.6	30.4	29.5	32.2	30.7	29.2
100	34.4	31.3	29.1	29.1	31.7	30.6	33.3	31.5	29.6

Note:
[1] Direction winds are blowing from.

Table 5.1.13 Extreme Wind Conditions at Grid Point 3551 – 3-Second Average

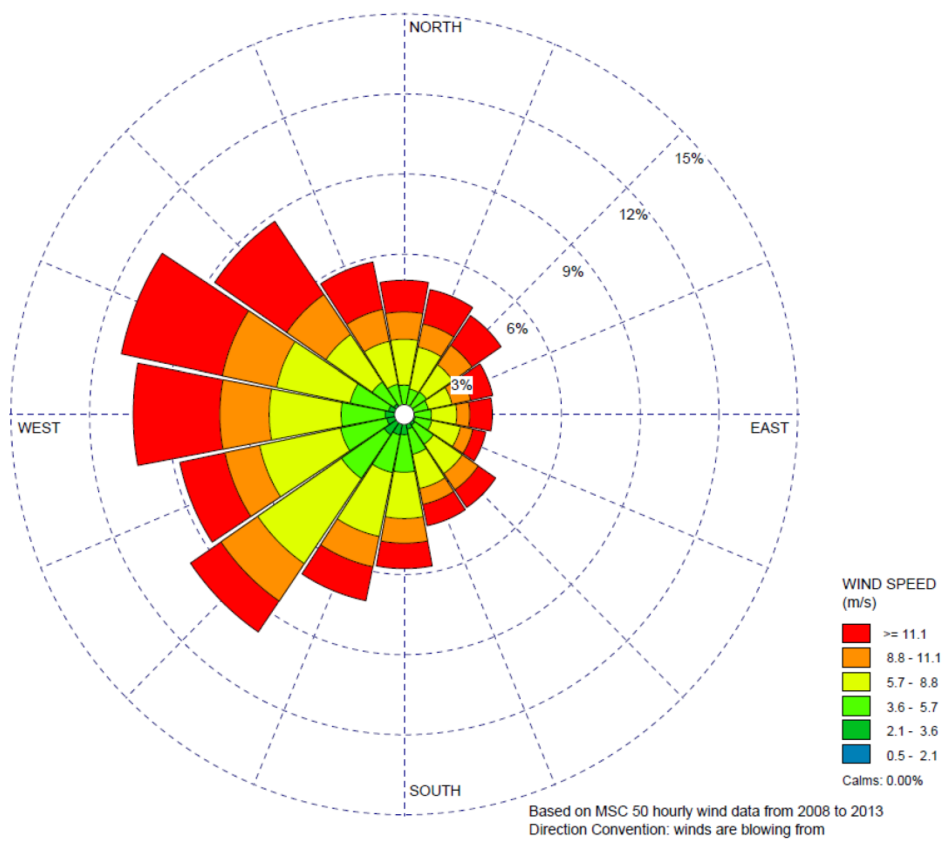
Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	32.4	27.7	26.5	27.6	27.0	26.9	28.6	29.5	29.4
5	35.0	31.1	29.8	30.4	30.0	29.4	32.0	32.1	31.5
10	36.5	32.9	31.7	31.7	31.9	31.1	33.9	33.5	32.6
25	38.2	34.7	32.9	32.9	34.1	33.0	36.1	35.0	33.7
50	39.3	35.9	33.5	33.5	35.6	34.6	37.7	36.0	34.2
100	40.3	36.7	34.1	34.1	37.2	35.9	39.0	36.9	34.7

Note:
[1] Direction winds are blowing from.

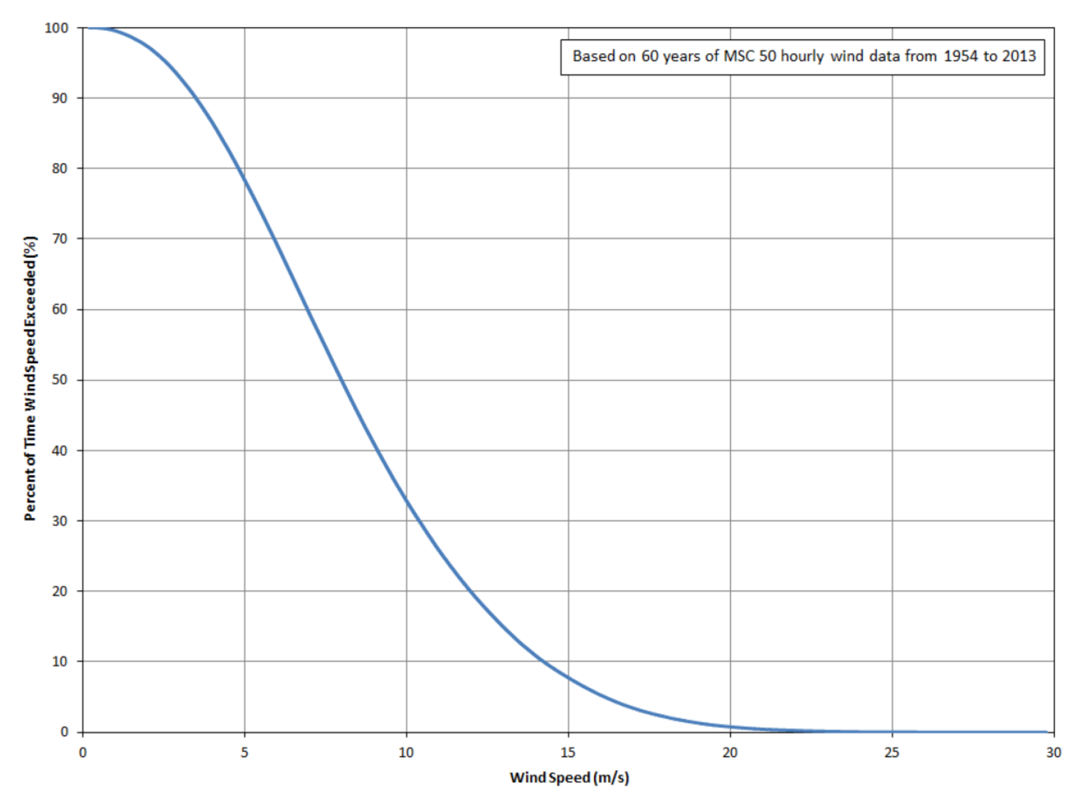
Wind Speed (m/s)	Wind Direction																Total
	N	NNE	NE	NEE	E	SEE	SE	SSE	S	SSW	SW	SWW	W	NWW	NW	NNW	
0-2.5	0.215	0.171	0.169	0.169	0.182	0.198	0.239	0.327	0.399	0.441	0.459	0.434	0.372	0.316	0.256	0.246	**4.59**
2.5-5	0.747	0.742	0.719	0.712	0.704	0.774	0.893	0.949	1.28	1.46	1.78	1.73	1.45	1.24	1.01	0.877	**17.1**
5-7.5	1.17	1.10	0.984	0.885	0.827	0.926	0.928	0.954	1.45	1.96	2.66	2.82	2.09	1.92	1.61	1.39	**23.7**
7.5-10	1.18	1.02	0.873	0.818	0.650	0.705	0.695	0.705	1.10	1.52	2.36	2.51	2.06	2.28	1.87	1.49	**21.8**
10-12.5	0.844	0.678	0.597	0.492	0.425	0.431	0.472	0.450	0.638	0.805	1.19	1.49	1.61	2.25	1.89	1.28	**15.6**
12.5-15	0.495	0.395	0.365	0.310	0.278	0.237	0.259	0.264	0.384	0.393	0.489	0.658	1.10	1.83	1.32	0.774	**9.55**
15-17.5	0.218	0.187	0.168	0.176	0.139	0.151	0.143	0.148	0.172	0.195	0.190	0.313	0.669	1.17	0.649	0.311	**5.00**
17.5-20	0.097	0.088	0.070	0.078	0.056	0.059	0.062	0.060	0.070	0.058	0.060	0.141	0.325	0.422	0.225	0.102	**1.97**
20-22.5	0.025	0.032	0.029	0.031	0.018	0.018	0.016	0.013	0.015	0.012	0.020	0.046	0.090	0.125	0.063	0.037	**0.590**
22.5-25	0.009	0.011	0.005	0.010	0.011	0.005	0.002	0.001	0.002	0.003	0.005	0.015	0.021	0.016	0.015	0.019	**0.150**
25-27.5	0.006	0.002	0.003	0.0004	0.0002	0.0004	0.001	0.001	0.0002	0.0002	0.003	0.004	0.002	0.0004	0.004	0.003	**0.029**
27.5-30	0.001	0.0002	0.002	0.001				0.0002	0.0002	0.0002	0.0002	0.001	0.0002			0.0004	**0.005**
Total	**5.01**	**4.42**	**3.98**	**3.68**	**3.29**	**3.51**	**3.71**	**3.87**	**5.50**	**6.84**	**9.21**	**10.2**	**9.80**	**11.6**	**8.91**	**6.54**	**100**

Based on 60 years of MSC 50 wind data from 1954 to 2013

(a) Percent of Wind Speed by Wind Direction

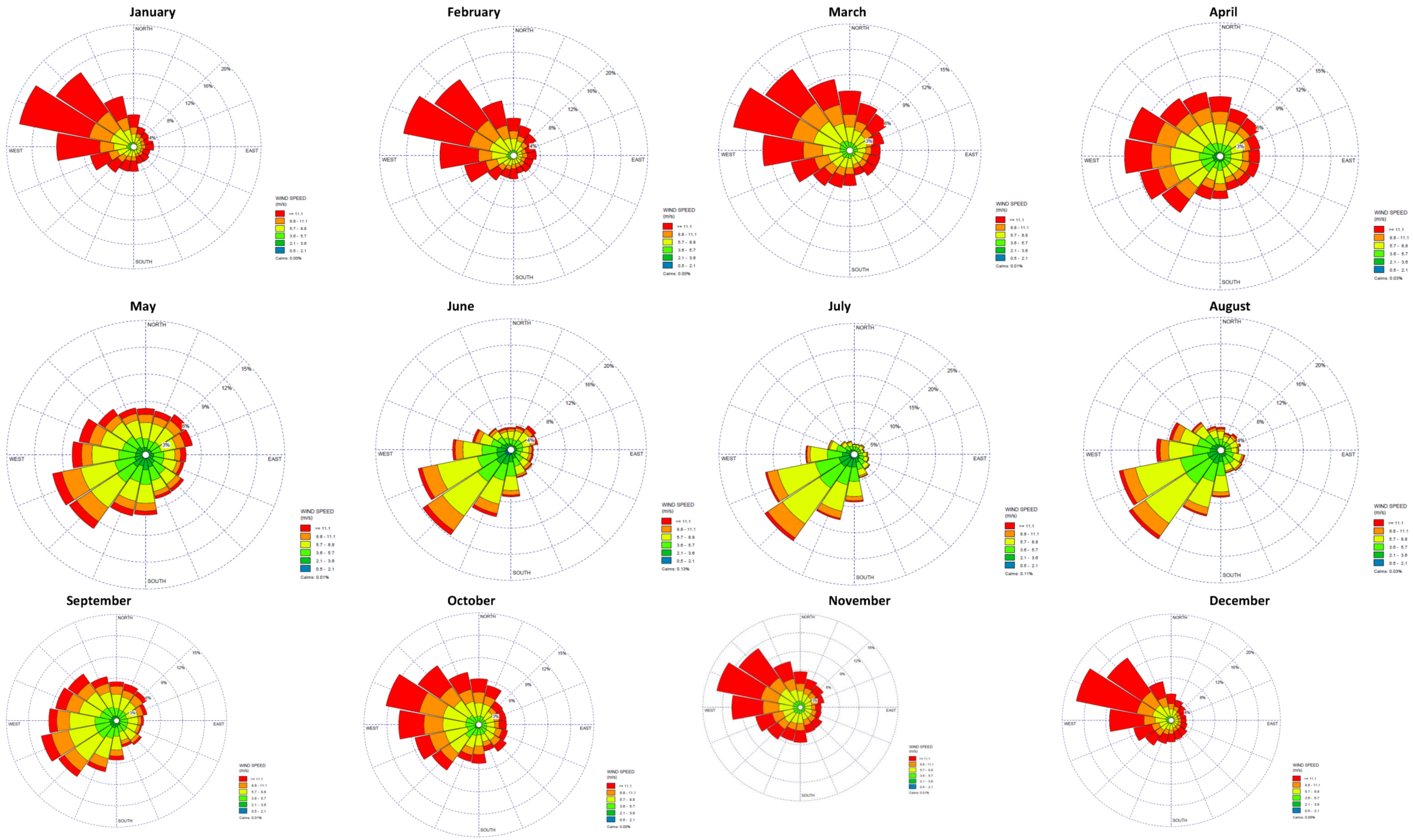


(b) Annual Wind Rose Diagram



(c) Wind Speed Exceedance

Figure 5.1.5 Wind Conditions at Grid Point 3551



Based on MSC50 hourly wind data from 1954 to 2013

Direction Convention: winds are blowing from

Figure 5.1.6 Monthly Wind Rose at Grid Point 3551

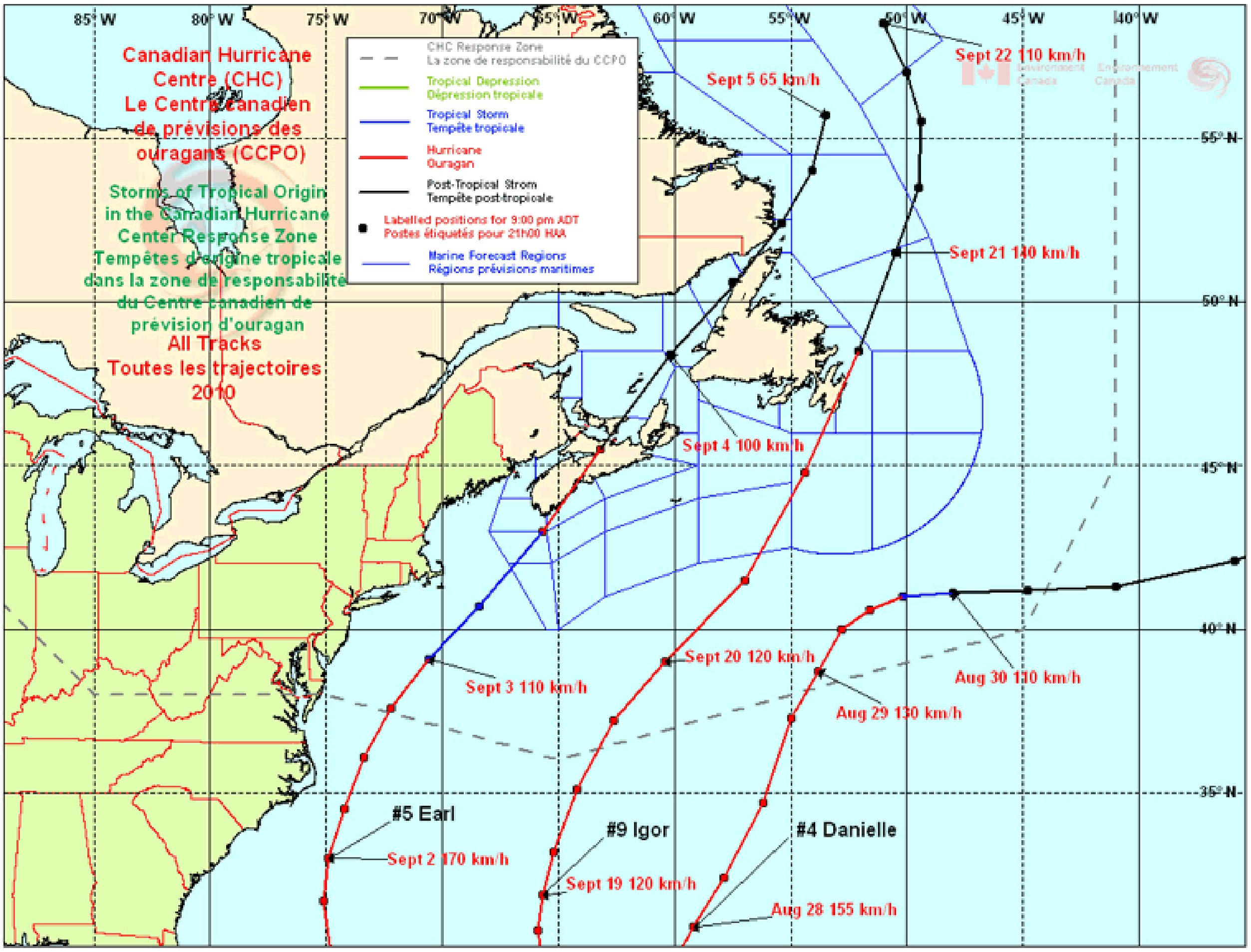
5.1.2.4 Extreme Weather

Extreme weather that could potentially occur in the Project Area and require consideration for Project planning include tropical and extra-tropical cyclones, and lightning.

Tropical and Extra-Tropical Cyclones

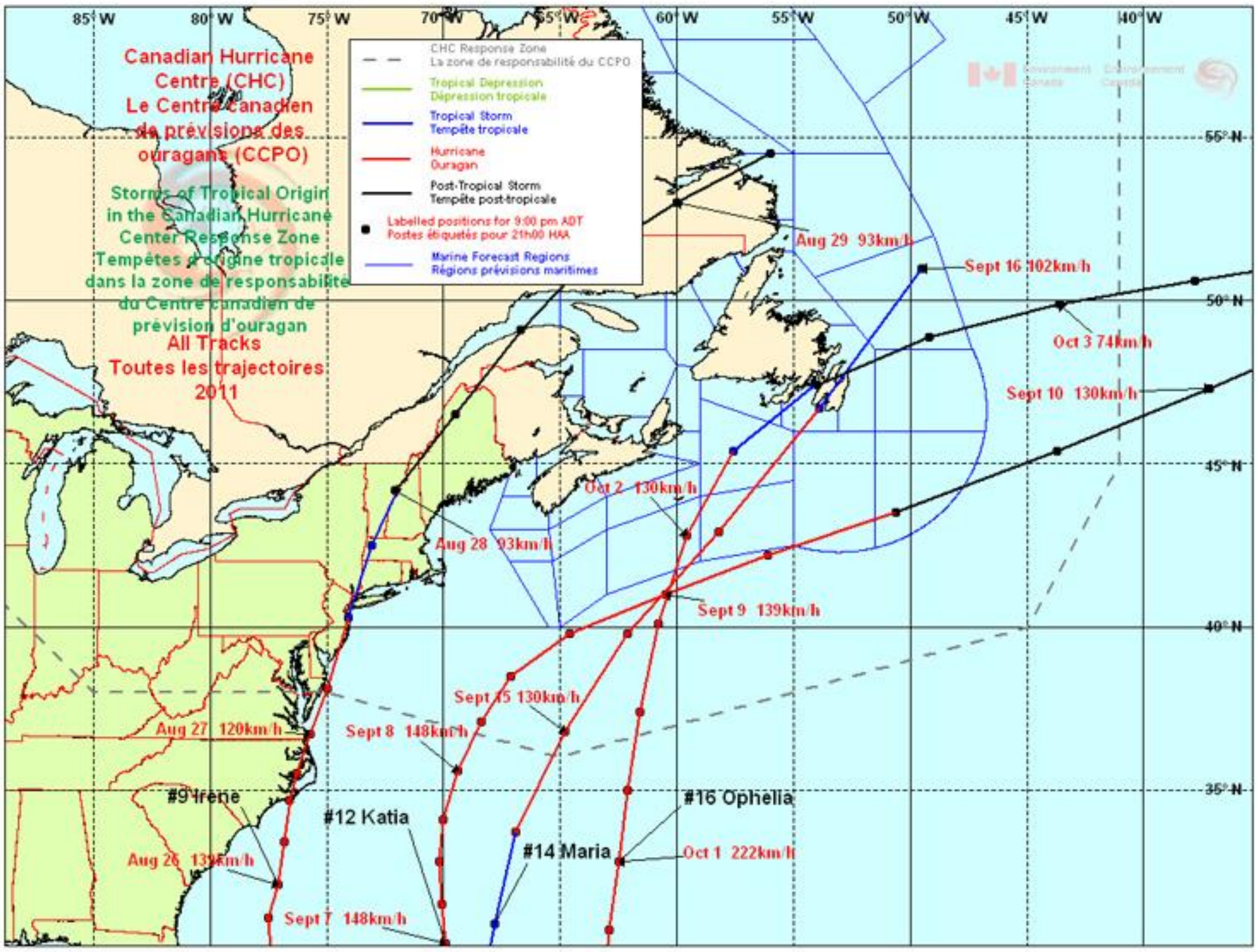
Tropical cyclones (*e.g.*, a hurricane originating over tropic or subtropical waters) typically form during June to November, bringing intense and damaging winds, rain and storm surges. They can range from Category 1 to Category 5 with wind speeds ranging from >118 km/hour to >251 km/hour. Extra-tropical cyclones are cyclones that have lost their "tropical" characteristics as they move north from very warm ocean areas to land or cold water of the North Atlantic. Tropical cyclones can transition to extra-tropical cyclones as they move north and can occur year-round, bringing the high winds and precipitation as well as freezing spray in the winter season.

Figures 5.1.7 to 5.1.11 illustrate the tracks for storms (cyclones) originating in the tropics which have tracked through Atlantic Canada between 2010 and 2014. Figure 5.1.12 depicts all of the tropical and extra-tropical cyclone tracks on the Scotian Shelf and Slope from 1980 to 2012.



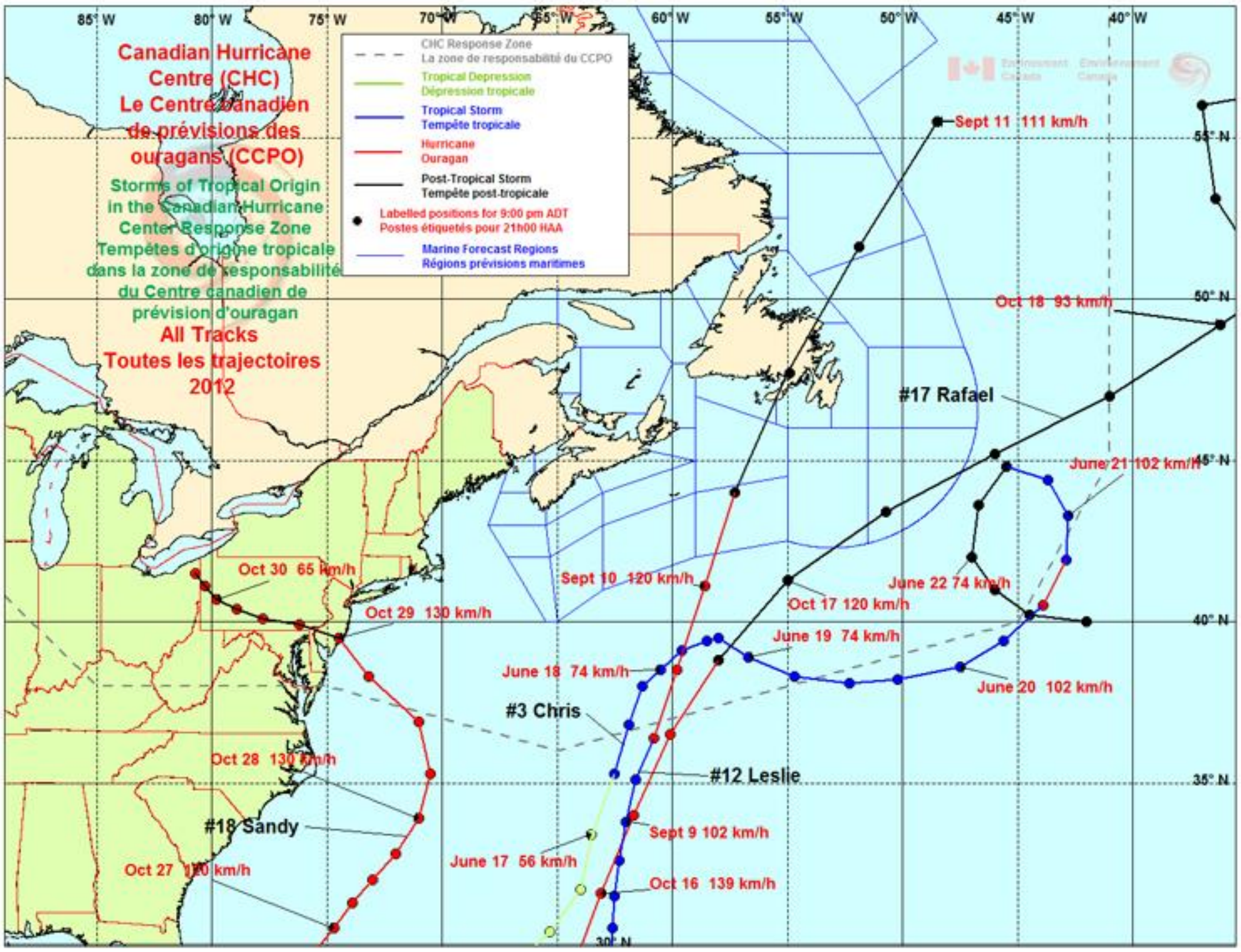
Source: Environment Canada 2015d

Figure 5.1.7 2010 Atlantic Canada Tropical and Extratropical Storm Tracks



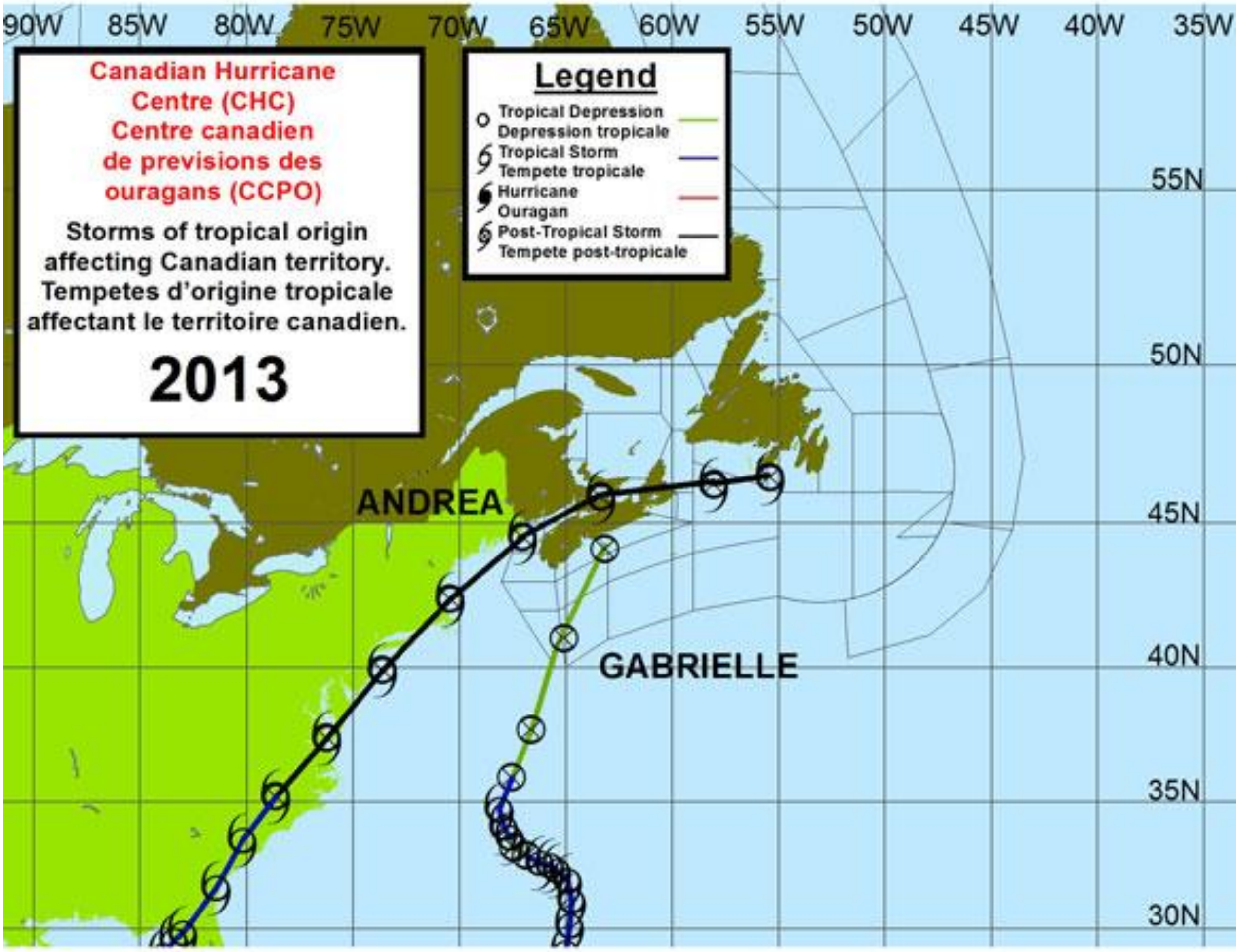
Source: Environment Canada 2015d

Figure 5.1.8 2011 Atlantic Canada Tropical and Extratropical Storm Tracks



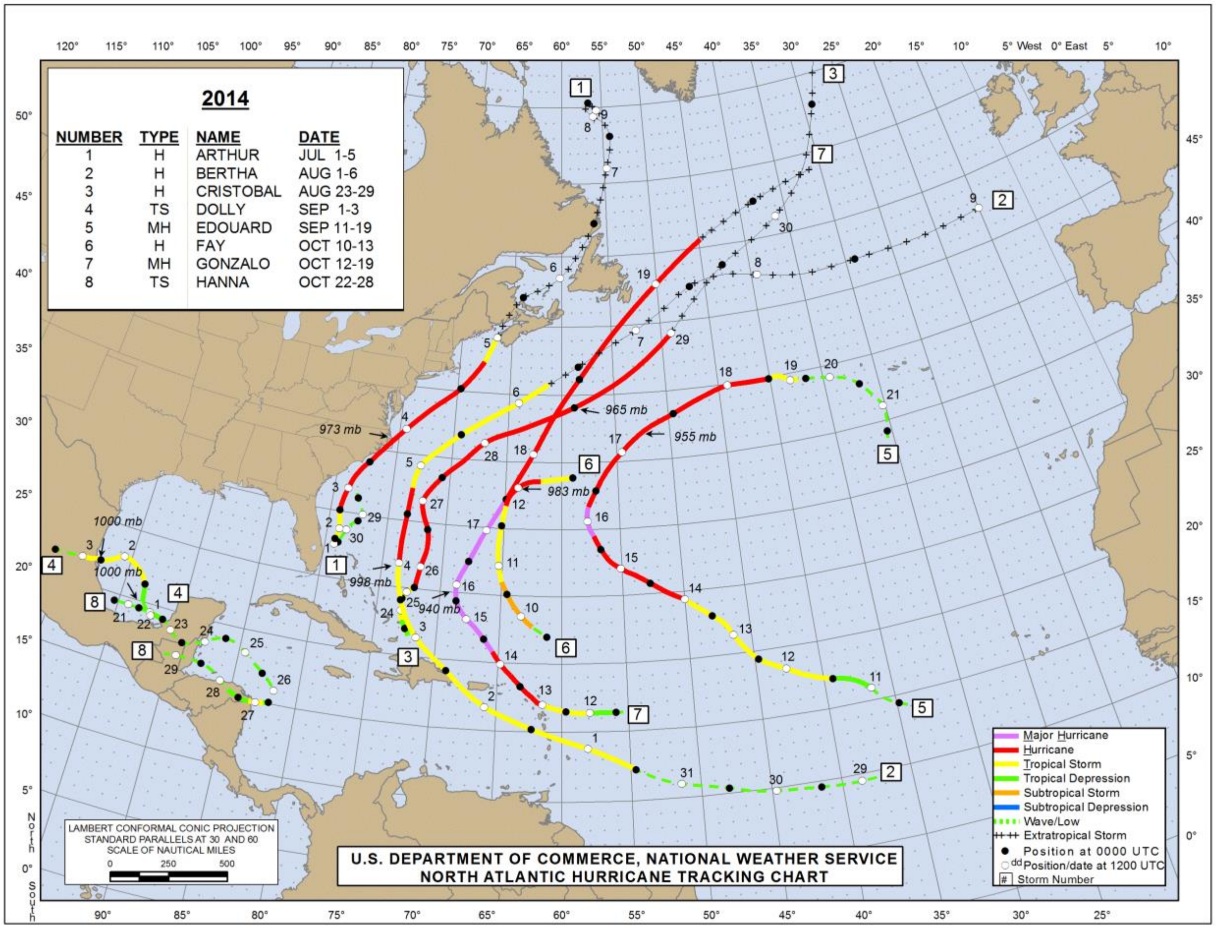
Source: Environment Canada 2015d

Figure 5.1.9 2012 Atlantic Canada Tropical and Extratropical Storm Tracks



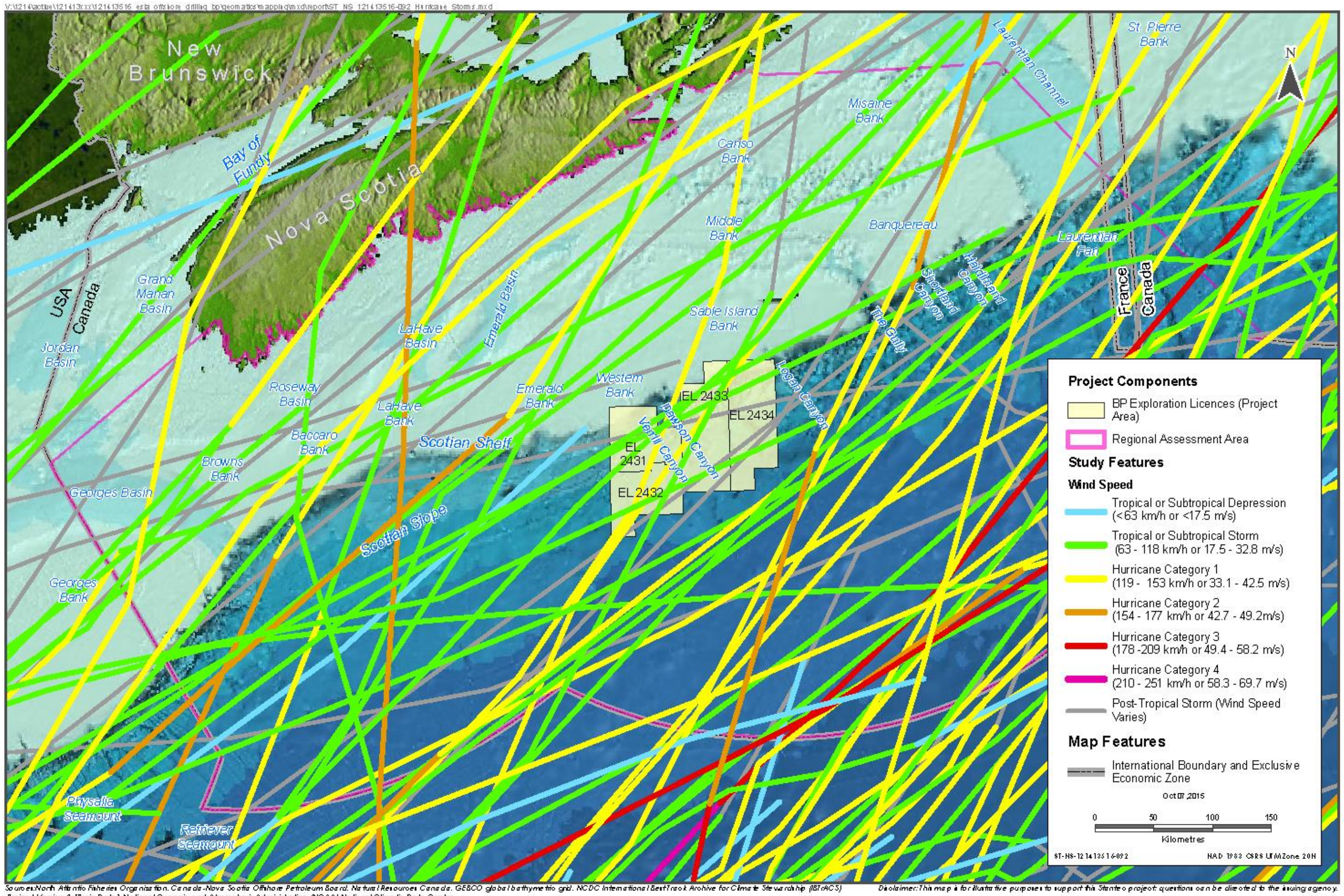
Source: Environment Canada 2015d

Figure 5.1.10 2013 Atlantic Canada Tropical and Extratropical Storm Tracks



Source: NOAA 2015

Figure 5.1.11 2014 Tropical and Extratropical Storm Tracks



Sources: Environment Canada (2013c), NOAA (2012a, 2014)

Figure 5.1.12 Cyclones in the North Atlantic (1980–2012)

Table 5.1.14 below depicts the tropical cyclones that have passed through the Scotian Shelf and Slope and the Project Area in the last ten years. A total of 22 tropical cyclones have passed through the Scotian Shelf and Slope from 2003 to 2014, with 12 (indicated in table below) passing through or within close proximity to the Project Area. Wind speeds from the storms which impacted the Project Area ranged from 45 to 295 km/hour (the upper range of 295 km/hour was reported prior to reaching the Project Area and may be different than this value). Tropical cyclones that traveled through the Scotian Shelf and Slope have been most prevalent in September, followed by July, October, August, June and November, in decreasing monthly frequency respectively. As tropical cyclones pass through the North Atlantic they typically lose strength as they travel over areas of cold water. As a result, wind speeds shown below in Table 5.1.14 may be significantly lower as storms pass through the Scotian Slope and Shelf.

Table 5.1.14 Tropical Cyclones on the Scotian Shelf and Slope from 2003–2014

Year	Name	Category	Time Frame	Wind Speed (km/hour)
2014	Arthur	Hurricane	July 1–5	37–157**
	Bertha*	Hurricane	August 1–6	46–130**
	Cristobal	Hurricane	August 23–29	56–139**
	Gonzalo	Hurricane	October 12–19	46–232**
2013	Gabrielle*	Tropical Storm	September 10–14	65–85
	Andrea	Tropical Storm	June 6–9	65–74
2012	Leslie*	Hurricane	September 4–11	100–120
2011	Maria*	Hurricane	September 15–16	100–120
	Ophelia*	Hurricane	October 1–3	140–205
2010	Earl	Tropical Storm	September 2–5	60–70
2009	Bill*	Hurricane	August 23–24	120–150
2008	Cristobal*	Hurricane	July 20–23	80–110
	Kyle	Hurricane	September 28–30	120–130
2007	Chantal*	Tropical Storm	July 31–August 1	85**
	Noel	Hurricane	October 28–November 2	130**
2006	N/A	Tropical Storm	July 17–18	75**
	Alberto*	Tropical Storm	June 10–14	115**
2005	Franklin	Tropical Storm	July 21–29	115**
	Ophelia	Hurricane	September 6–7	140**
	Wilma*	Major Hurricane	October 15–25	295**
2004	Gaston*	Hurricane	August 27–September 1	120**
2003	Juan*	Hurricane	September 24–29	170**

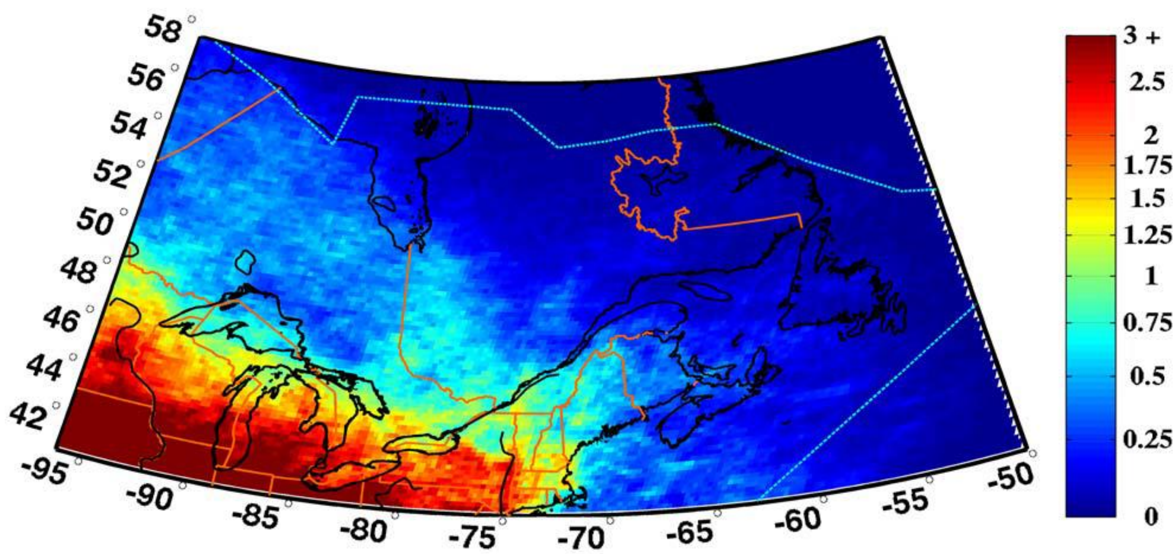
Note:
*These storms passed through the Project Area or within close proximity.
**These wind speeds may have occurred outside the Scotian Shelf and Slope region.

Sources: Environment Canada 2013c; NOAA 2014a; Berg 2015; Blake 2015; Brown 2015a, 2015b; Pasch 2015

Lightning

Lightning occurs virtually year-round over southern Nova Scotia and offshore (Burrows and Kochtubajda 2010). Winter lightning is common in this area as Arctic air masses pass over much warmer water (Lewis 2000, cited in Burrows and Kochtubajda 2010).

As shown in Figure 5.1.13, (Figure 3.b from Burrows and Kochtubajda (2010), both the Nova Scotia landmass and its offshore environs experience low average flash density although there is a subtle increase in flash density in some parts of the offshore.



Note: light blue irregular lines around the periphery are the approximate 70% detection efficiency as of 1 November 2008

Source: Burrows and Kochtubajda 2010

Figure 5.1.13 1999–2008 Average Flash Density (flash km-2 yr-1) for Eastern Canada

There are no specific statistics provided for the Project Area but it is assumed there could be increased lightning activity than that reported for land-based monitoring locations in the province as reported by the Canadian Lightning Detection Network and shown in Table 5.1.15.

Table 5.1.15 Lightning Activity in Nova Scotia as Reported by the Canadian Lightning Detection Network (1999-2013)

City	Area (km²)	Total Lighting Strikes (1999 to 2013)	Average Number of Days with Lightning (within 25 km²)
Yarmouth	4.32	11,015	14.3
New Glasgow	4.94	7,850	11.8
Truro	5.62	8,085	12.6
Sydney	102.72	4,610	8.9
Halifax	43.89	7,340	12.1

Source: Environment Canada 2015c

Overall, Nova Scotia and its offshore environs represent an area of very low average flash density (flashes per square kilometre per year) (Environment Canada 2015c).

5.1.2.5 Visibility and Fog

Fog occurs when moist air passes over a cool surface, usually by advection, cooling the air mass and causing condensation and reducing visibility to less than 1 km (Frost 2004). It is most common at sea when moist warm air encounters cold water and areas of cold-water upwelling. Localized fog can also occur when cold air passes over warm water. Fog is often present on the Scotian Shelf and Slope, especially in the summer months, as warm tropical air moves north and creates large fog banks and stratiform clouds in the area (Hurley 2011).

Historical data for visibility recorded at the Sable Island Weather Station are presented in Table 5.1.16. Fog is most prominent from May through July and during this period, fog occurs about one-third of the time and may persist for a week without clearing (Freedman 2014).

Table 5.1.16 Hours of Visibility per Month Recorded at the Sable Island Weather Station, 1971–2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
< 1 km	45.8	52.1	77	107.7	166.6	205.2	215.6	127.3	35.3	28.5	32.5	28.6
1 to 9 km	179.9	147.8	140.3	158.1	158.8	153.2	183.7	175.7	122.1	106.9	132.4	144.1
> 9 km	518.3	477.8	526.7	454.2	418.6	361.6	344.8	441.1	562.6	608.6	555	571.4

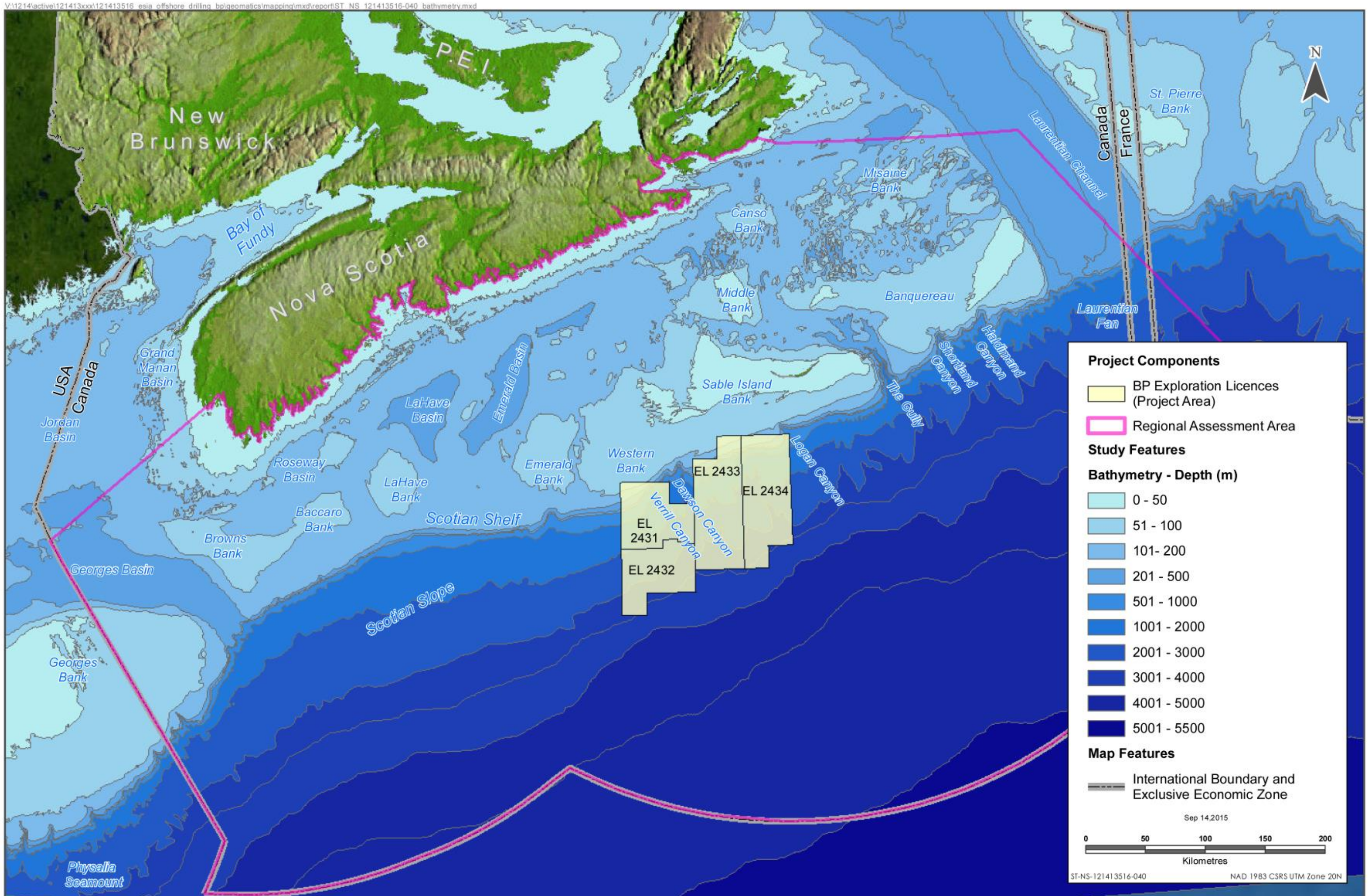
Source: Environment Canada 2013b

During the period from 1971 to 2000, the number of hours of visibility less than 1 km ranged from 28.5 hours in October to 215.6 hours in July (Environment Canada 2013b). The number of hours with visibility less than 1 km was greatest during the summer months, particularly in June and July with 65% of the days seeing fog (Hurley 2011). The fall season generally has the least amount of hours of fog due to both warmer air and sea temperatures.

5.1.3 Physical Oceanography

5.1.3.1 Bathymetry

The Project Area is located offshore of Nova Scotia on the Scotian Slope, approximately 230 to 370 km southeast of Halifax and 48 km from Sable Island. Water depths in the Project Area range from approximately 100 m to over 3,000 m. Generally speaking, the Scotian Slope begins at the edge of the Scotian Shelf at a water depth of approximately 200 m, where it then steeply descends to a water depth of 2,000 m (Stantec 2014b). From water depths of 2,000 to 5,000 m, the slope is more gradual in an area known as the Continental Rise. Figure 5.1.14 provides a bathymetric overview of the Project Area and the Scotian Slope. The western Scotian Shelf (west of the Project Area) has a less dynamic bathymetry and seabed with fewer canyons. Verrill Canyon extends into the Project Area whereas Dawson and Logan Canyons are immediately adjacent to the Project Area (Figure 5.1.14). The eastern Scotian Shelf (east of the Project Area) hosts a series of deepwater canyons, including the Gully and Shortland and Haldimand canyons, which originate on the outer edge of the Scotian Shelf and continue down the slope (Figure 5.1.14).



Sources: North Atlantic Fisheries Organization (NAFO), GEBCO global bathymetric grid

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.1.14 Bathymetric Overview of the Scotian Shelf and Slope

5.1.3.2 Ocean Currents

The description of ocean currents for the RAA has been adapted from the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) which provided a general characterization of ocean currents on the Scotian Shelf and Slope.

The physical environment on the Scotian Shelf and Slope is governed by its close proximity to the intersection of major currents of the northwest Atlantic and its complex bathymetry. The three major currents influencing the movement of water on the Scotian Shelf and Slope are the Nova Scotia Current, the Shelf Break Current (an extension of the Labrador Current), and the Gulf Stream (Zwanenburg *et al.* 2006). Figure 5.1.15 provides an overview of currents on the Scotian Shelf and Slope.

Relatively cool, fresh waters flow from the Gulf of the St. Lawrence through the Cabot Strait. A portion of this water turns at Cape Breton to flow southwest along Nova Scotia's Atlantic coast, while the rest of the flow continues through the Laurentian Channel to the shelf break. At the shelf break it turns and joins the Shelf Break Current to flow southwest along the shelf edge. The Shelf Break Current is the largest coast transport feeder on the Eastern Scotian Shelf (Han and Loder 2003).

The Gulf Stream flows northeastwards, and its warmer, more saline waters mix with the cool Labrador Current waters over the Scotian Slope, forming a mass of water known as slope water (ACZISC 2011). This slope water periodically leaks onto the Shelf through channels and canyons. The shelf bottom consists of a series of submarine banks and cross-shelf channels along the outer shelf and basins, and troughs along the central shelf which limit and guide the near-bottom flow. The predominant flow of cold, fresh water from the northeast to the southwest results in a general increase in both temperature and salinity as it flows closer to the southwest (Zwanenburg *et al.* 2006).

The eastern end of the Scotian Shelf is primarily comprised of colder, less salty water from the Gulf of St. Lawrence and the Newfoundland Shelf. The water tends to be cold because the Banquereau and Sable Island Banks prevent the mixing of warm saline water from the Gulf Stream. As a result, the water in this area tends to be cold, especially at depth. At the shelf break, the Shelf Break Current produces current speeds ranging from 0.15 to 0.55 m/s (Han and Loder 2003). Some of the strongest current speeds on the Scotian Shelf and Slope can be found as the water exiting the Laurentian Channel wraps around Banquereau Bank. Here the water makes a sharp southeasterly turn to travel along the shelf edge. Further offshore of the shelf edge, the currents are much weaker and generally travel in a northeasterly direction (Brickmand and Drozdowski 2012).

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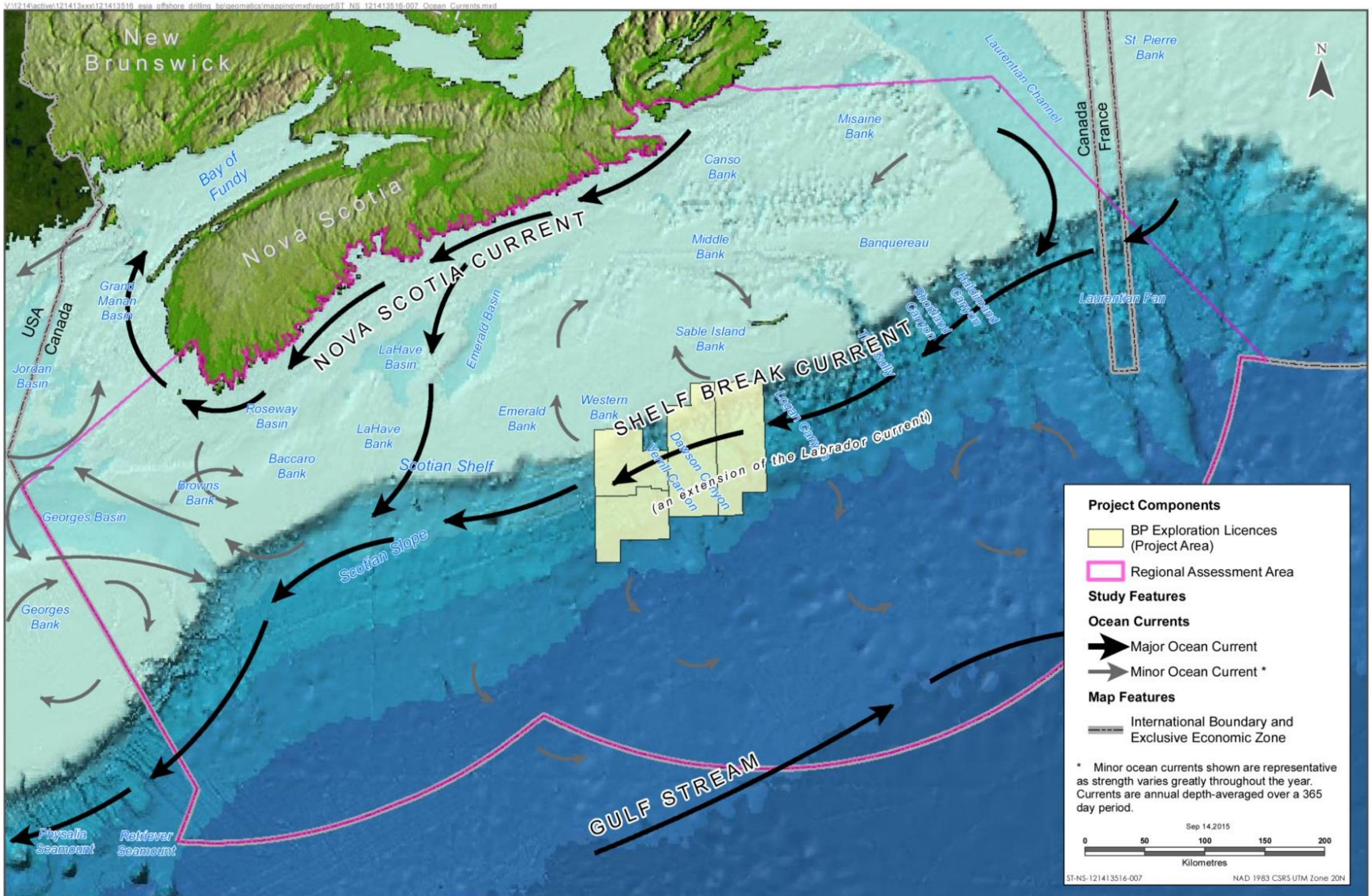


Sources: GEBCO global bathymetric grid, Department of Fisheries and Oceans, Brickman and Drozdowski 2012 Miller et al. 1998

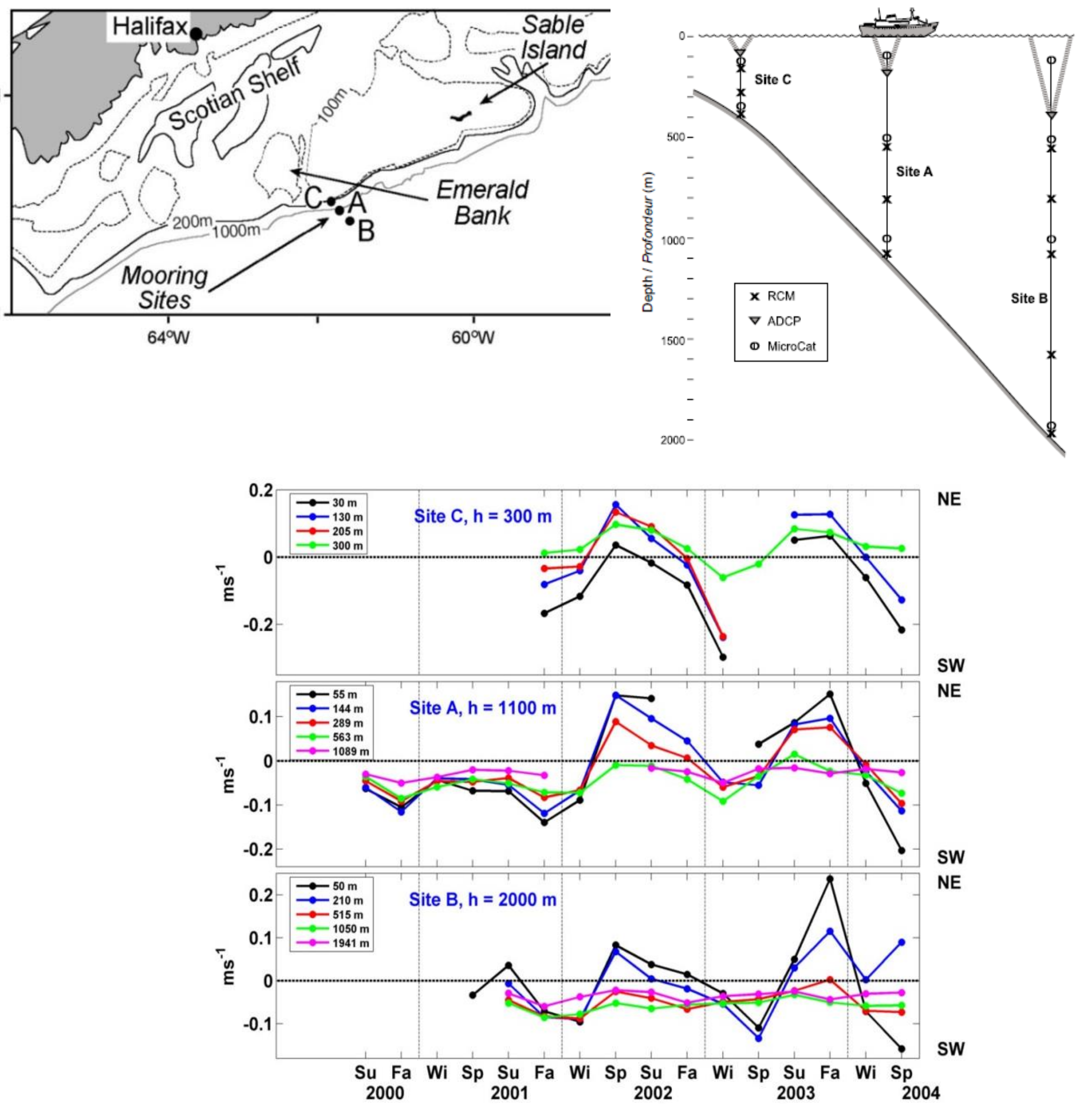
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Figure 5.1.15 Overview of Currents

On the Western Scotian Shelf, the Nova Scotia Current flows in a southwesterly direction close to the coastline (see Figure 5.1.15). As it reaches the Halifax area it branches in an offshore direction, where it joins the Shelf Break Current and continues to flow southwesterly along the shelf break (Breeze *et al.* 2002.) As the Shelf Break Current flows past the central portions of the Scotian Shelf and to the southwest, current speeds are reduced to a range of 0.05 to 0.3 m/s (Stantec 2014b). On the shelf, the influence of the warm waters from the Gulf Stream is felt primarily within the deep channels and basins. The depression between Emerald and LaHave Banks, known as the Scotian Gulf, is a well-known area of warm water infiltration. Significant differences in circulation patterns exist between the western and central Scotian Shelf, although the water masses of the central and western Scotian Shelf are more similar to one another than to those found on the eastern Scotian Shelf (Breeze *et al.* 2002).

Bedford Institute of Oceanography (BIO) has carried out a multi-year program of moored current and hydrological measurements on the outer Halifax Line of the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) (refer to Figures 5.1.4 and 5.1.16) (Loder and Geshelin 2009). Prior to 2000, there had been limited moored measurements on the section of the Shelf edge and continental slope where the Labrador Current exists.

Figure 5.1.16 illustrates the location and depth of the mooring sites, which are situated within the western section of the Project Area and on the Halifax Line of the AZMP, and current speeds (m/s) at each mooring measured between 2000 and 2004. Overall, the current speeds throughout the water column are relatively low and in the range of 0.05 to 0.2 m/s. The predominate flow measured was towards the southwest, however, in some years the surface layer to a water depth of about 200 to 300 m flowed seasonally towards the northeast. The deeper currents below 500 m at the deeper offshore mooring sites A and B (station depths greater than 1,000 m) are generally weak and less than 0.1 m/s. In contrast to the surface layer, these deeper currents consistently flowed towards the southwest when measured between 2000 and 2004.



Source: Loder and Geshelin (2009)

Figure 5.1.16 Moored Current Measurements on the Scotian Slope (2000-2004)

From the spring of 2002 to 2004, two major events lasted longer than one season (Loder and Geshelin 2009). These long-lasting events were associated with the presence of anomalous warm slope water on the Halifax Line related to mesoscale vulnerability in the Gulf Stream. In the spring of 2002 this warm water extended to depths of 1,000 m at the offshore site B and to 300 m at all three sites. In areas of this intrusion, flow was in the northeasterly direction as compared to typical southwest flow in areas not impacted by warmer waters (Figure 5.1.16; Loder and Geshelin 2009). These findings indicate that it is clear that variability in the Gulf Stream can have large influences on equatorial transport of water on the Scotian Slope. Variability from warm water intrusions from the Gulf Stream can oppose the conventional southwest directional flow of water from the subpolar regions (Labrador Current). In such cases (*e.g.*, spring of 2002 and summer/fall of 2003) there is a net northeast transport of water (Loder and Geshelin 2009).

At the southwestern limit of the Scotian Shelf and Slope (and the RAA), the movement of water on Georges Bank is driven primarily by tidal currents, wind, and variations in water density. Georges Bank is shallow in depth, and is located at the mouth of the Gulf of Maine and the Bay of Fundy, which gives rise to strong tidal currents found in the area. In the deeper water perimeter areas of the bank, current speeds can reach approximately 0.2 m/s and can reach upwards of 1.0 m/s in the shallow areas on top of the bank (Kennedy *et al.* 2011). The general circulation pattern on Georges Bank is a partial, anticyclonic gyre (water rotates in a clockwise direction). This clockwise circulation is associated primarily with interactions of the tidal currents with the bank's topography. Higher current velocities occur in the summer months, which are associated with horizontal density gradients in the frontal system. This gyre is "leaky" year-round, as storms cause an exchange of water with the nearby waters of Browns Bank, the Gulf of Maine, and the continental slope (Kennedy *et al.* 2011).

At the shelf edge, outer marginal water masses collide to form a frontal zone that shifts in location from year to year. Oceanic fronts occur when there is a sharp boundary between water masses with differing hydrographic properties (Breeze *et al.* 2002). At the boundary, there is an intensification of vertical and horizontal mixing due to differences in physical properties of the water masses. At these frontal zones, cold slope water mixes with the warm water at the edge of the outer banks, supplying nutrients and promoting phytoplankton growth (WWF 2009). Zooplankton, ichthyoplankton, jellyfish and other planktonic organism also congregate in frontal zones which attract sea turtles, whales, pelagic birds and other species that prey on planktonic organism (Breeze *et al.* 2002).

Upwelling occurs when cold, dense water from the benthic zone is forced up to the surface. Winds cause the surface water to move from one area to another, causing deep water to travel upwards and replace the surface water after it has moved. Upwelling frequently occurs in the waters offshore of Nova Scotia during the summer months due to the southwest prevailing winds (Breeze *et al.* 2002). At the shelf break moderate winds lead to regular upwelling from depths of 400 m and greater.

In areas of the shelf edge and slope currents, tidal processes and benthic topography create regular upwelling events and the enhanced mixing of water masses (Breeze *et al.* 2002). Vertical mixing from upwelling and horizontal mixing from Gulf Stream eddy intrusions are important for mixing. However, the generation of internal waves on the shelf edge may be the most important source of mixing on the Scotian Shelf and Slope. Internal waves are formed when water is stratified and tidal forces flow back and forth across the shelf break (Breeze *et al.* 2002). The dissipation of the waves causes layers within the water column to be mixed. Topography enhances the effects of internal waves. The steep slope on the shelf break traps low frequency currents and reflects, refracts, and scatters them. The steep slope on the eastern Scotian Slope is ideal for the creation of internal waves, although the tidal currents on the southwest Slope are much stronger. The internal waves created on the southwest Slope propagate across the shelf and cause widespread mixing. This widespread mixing brings nutrients up into the euphotic zone, propagating high levels of primary production.

Submarine canyons (located along the eastern Scotian Shelf Break) produce various effects on the circulation of water in and surrounding the canyon (Moors-Murphy 2014). Upwelling and downwelling zones are known to occur in submarine canyons. There is generally a downwelling zone at the rim of the canyon on the upstream side of the canyon where water near the floor of the continental shelf flows over the canyon rim and down into the canyon. The water flowing into the canyon typically turns towards the head of the canyon until it reaches the downstream rim and is forced back up onto the shelf, creating a zone of upwelling, and sometimes an eddy (Moors-Murphy 2014). In addition to these upwelling and downwelling zones, the steep topography of the canyons has the potential to enhance internal tides or generate or amplify internal waves. These internal waves and tides can break within the canyon and create turbulence and increasing the vertical mixing of the water column (Moors-Murphy 2014).

5.1.3.3 Wave Climate

The wave climate in the Project Area is necessary to assess the environmental effects for the Project and predict the wave-induced loads on the offshore structures used for drilling. The primary parameters characterizing the wave climate are significant wave height (H_s), the peak spectral period (T_p), and the significant wave period (T_s). The significant wave height is defined as the average height of the highest one-third of all waves for a particular sea state and found to be close to the wave height reported on the basis of observation. The spectral peak period is the period of the waves with the largest energy levels, and the significant wave period is the average period of the highest one-third of all waves for a particular sea state.

Sixty (60) years of hourly MSC50 wave hindcast data from 1954 to 2013 for Grid Point 3551 were used to characterize the wave conditions for the Project Area (refer to Section 5.1.2.3 for a description of the MSC50 data set). The MSC50 hourly wave hindcast data include significant wave height, H_s, peak spectral period, T_p (including sea/swell partitions), and dominant wave propagation direction (including sea/swell partitions).

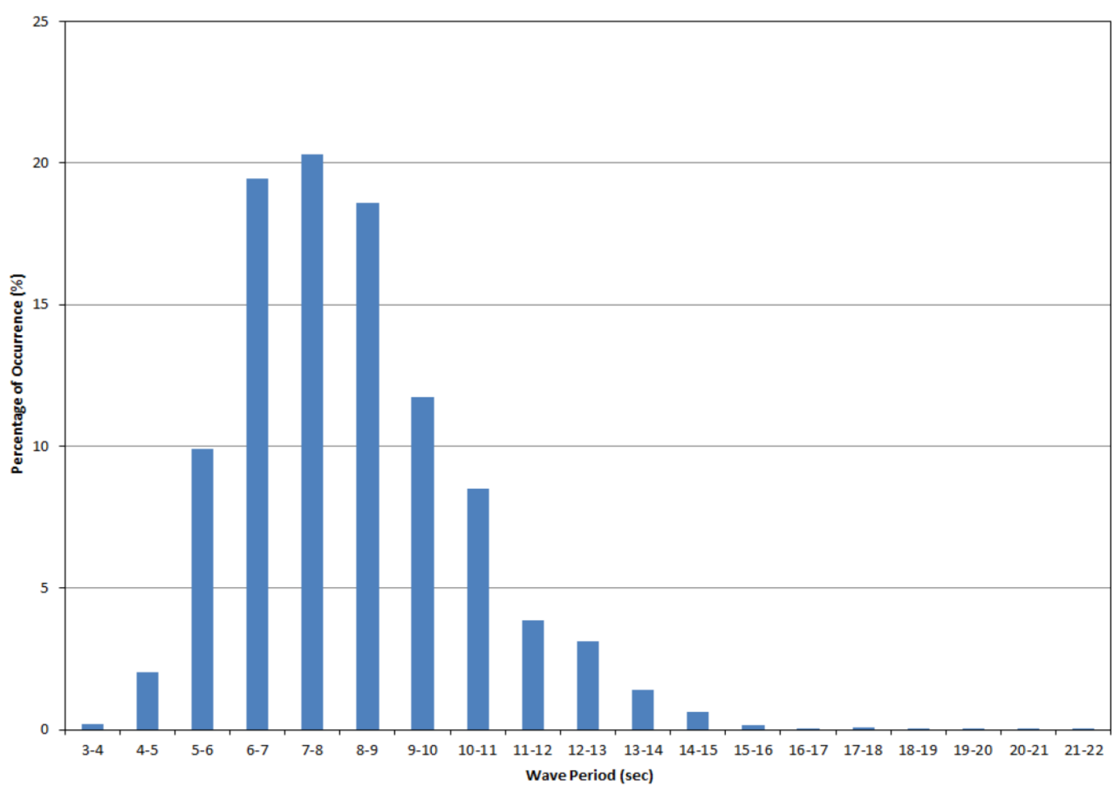
Figure 5.1.17(a) presents data on the significant wave height versus peak period. Approximately 47% of the time the significant wave heights are less than 2 m and 94% of the time the significant waves heights are less than 5.0 m. About 82% of the time wave peak periods are between 3 s and 10 s. Figure 5.1.17(b) presents the percentage of the waves falling within each range of peak wave period. Figure 5.1.17(c) illustrates the annual wave rose of the direction in which waves are prograting to for Grid Point 3551 and based on 6 years of MSC50 data from 2008 to 2013. The wave rose indicates that most of the wave energy comes from the west and southwest directions with waves propagating to the east and northeast directions. Figure 5.1.17(d) presents the wave height duration curve for Grid Point 3551. The wave height duration curve indicates the percentage of the time a given wave height was equaled or exceeded over a 60-year period from 1954 to 2013.

Monthly wave height and wave period roses are presented in Figures 5.1.18 and 5.1.19 respectively. Table 5.1.17 provides the mean monthly significant wave height, the maximum monthly significant wave height and the most frequent direction of wave propagation for each month. Significant wave heights are higher during the winter months at Grid Point 3551.

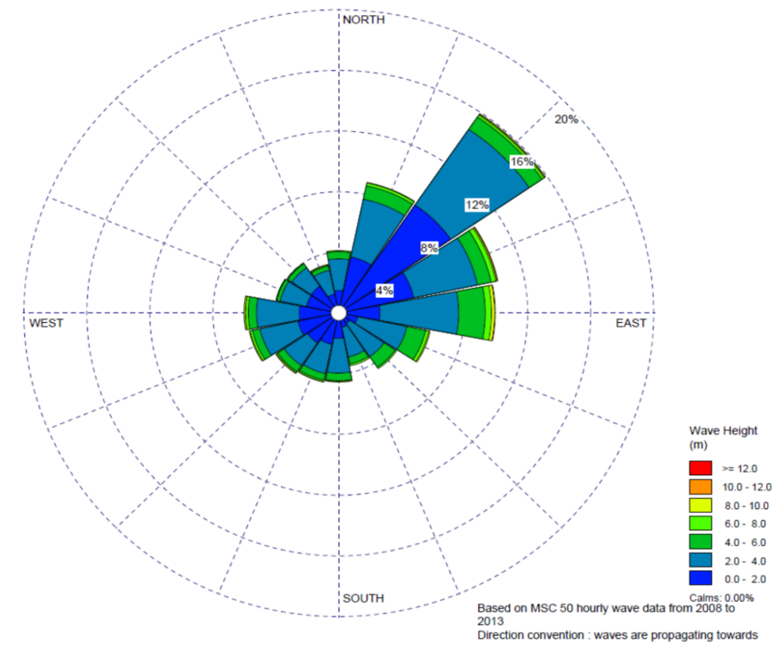
Wave Period (Sec)	Wave Height (m)																
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	Total
3-4	0.079	0.129	0.001														**0.210**
4-5	0.407	1.56	0.074														**2.04**
5-6	1.15	8.00	0.750	0.009													**9.91**
6-7	2.32	10.3	6.54	0.243	0.002												**19.4**
7-8	0.882	8.70	7.87	2.79	0.067	0.0004											**20.3**
8-9	0.426	6.26	4.44	5.60	1.78	0.064	0.002	0.0002									**18.6**
9-10	0.343	2.40	3.27	1.98	2.54	1.09	0.084	0.004	0.0002								**11.7**
10-11	0.140	0.971	1.67	1.95	1.53	1.42	0.709	0.089	0.008								**8.48**
11-12	0.113	0.679	0.703	0.611	0.490	0.372	0.448	0.303	0.128	0.024	0.001						**3.87**
12-13	0.111	0.791	0.412	0.313	0.415	0.367	0.257	0.187	0.146	0.099	0.012						**3.11**
13-14	0.054	0.421	0.275	0.141	0.095	0.123	0.110	0.057	0.040	0.056	0.035	0.007	0.001				**1.42**
14-15	0.031	0.221	0.171	0.090	0.023	0.017	0.015	0.014	0.003	0.004	0.009	0.017	0.007	0.001			**0.624**
15-16	0.015	0.086	0.026	0.011	0.004	0.006	0.004	0.001	0.001			0.001	0.004	0.001			**0.160**
16-17	0.009	0.027	0.004	0.002	0.002	0.001	0.002	0.0002	0.001			0.0002		0.0004	0.0004		**0.049**
17-18	0.016	0.045	0.016	0.0002										0.0002	0.001	0.001	**0.077**
18-19	0.001	0.005															**0.005**
19-20	0.002	0.001															**0.003**
20-21	0.002	0.001															**0.004**
21-22		0.001															**0.001**
Total	**6.10**	**40.6**	**26.2**	**13.7**	**6.96**	**3.46**	**1.63**	**0.657**	**0.328**	**0.184**	**0.056**	**0.025**	**0.012**	**0.002**	**0.001**	**0.001**	**100**

Based on 60 years of MSC 50 hourly wave data from 1954 to 2013

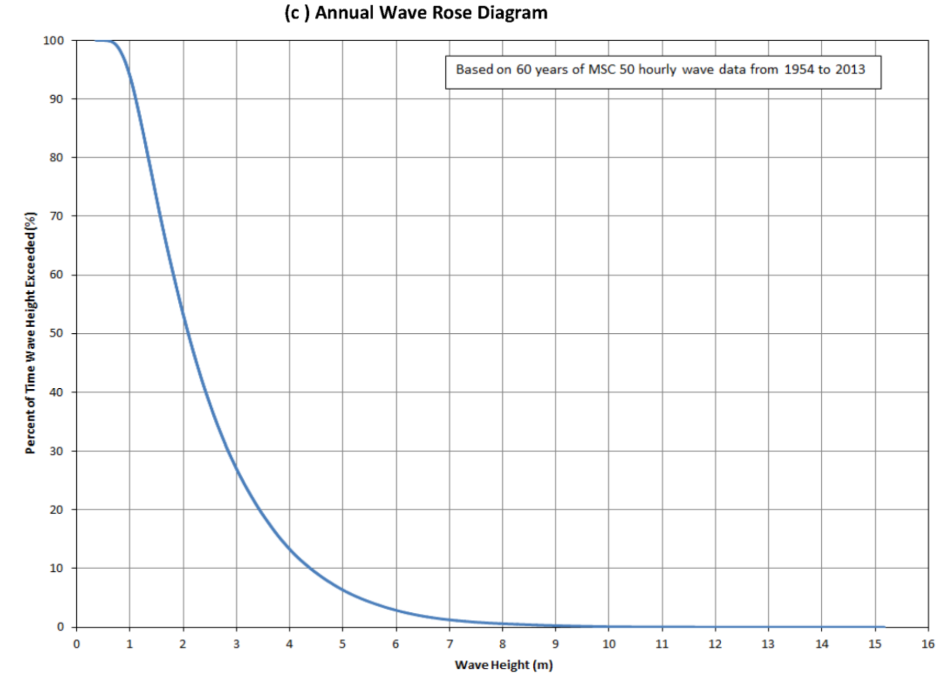
(a) Percent of Peak Spectral Period against Significant Wave Height



(b) Wave Period Histogram

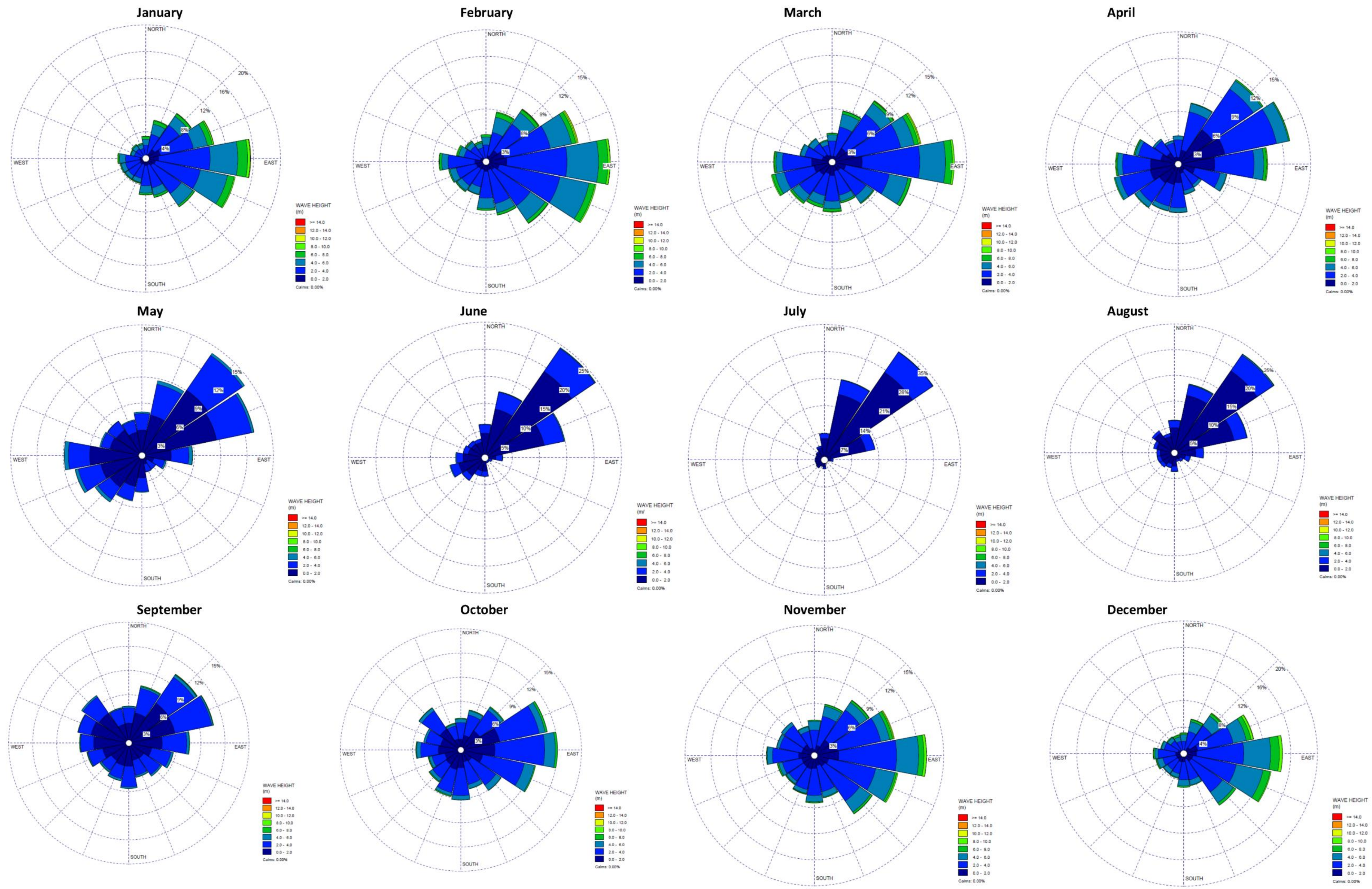


(c) Annual Wave Rose Diagram



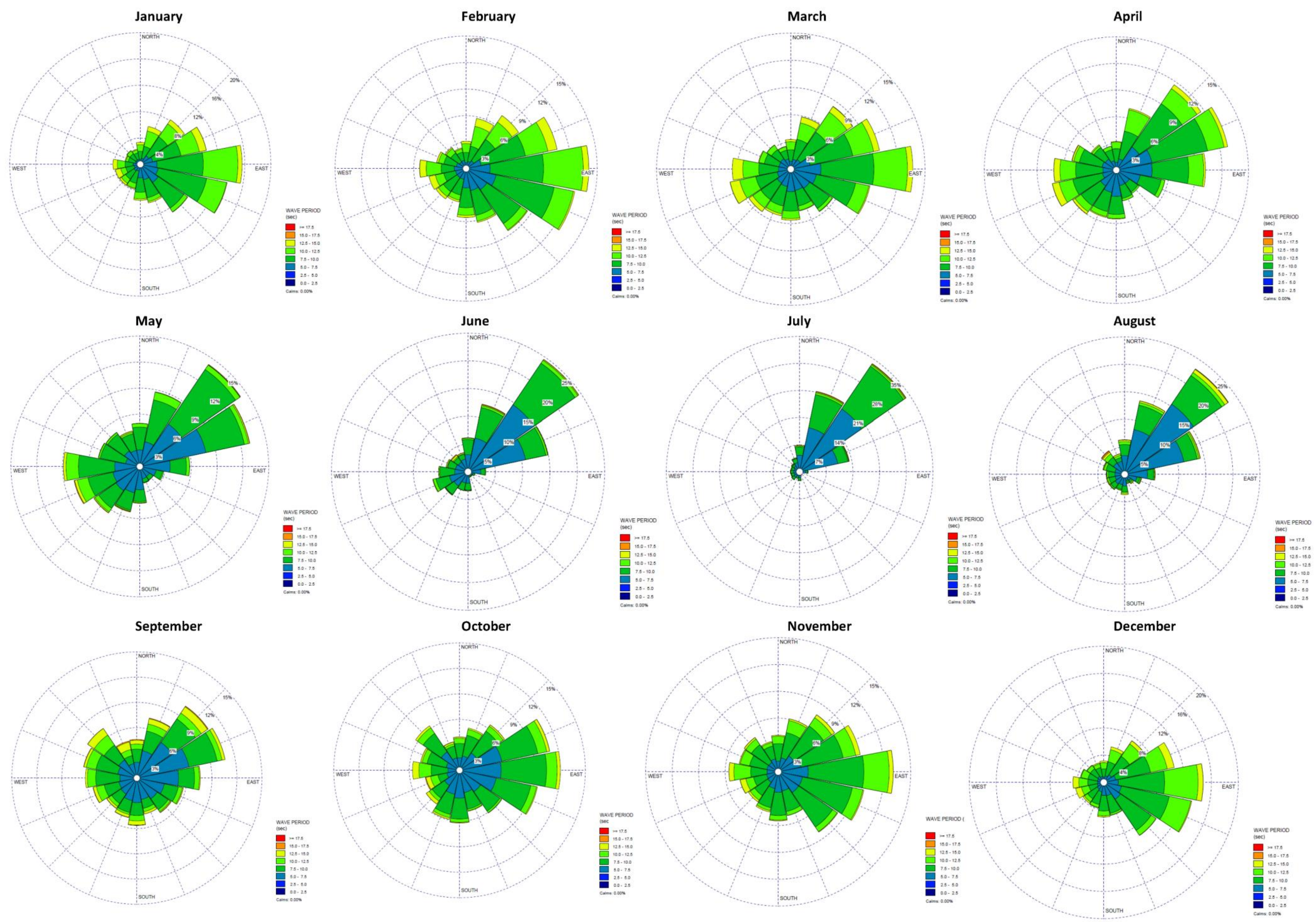
(d) Wave Height Exceedance

Figure 5.1.17 Wave Conditions at Grid Point 3551



Based on MSC50 hourly wave data from 1954 to 2013
Direction Convention: waves are propagating towards

Figure 5.1.18 Monthly Wave (Height) Rose at Grid Point 3551



Based on MSC50 hourly wave data from 1954 to 2013
Direction Convention: waves are propagating towards

Figure 5.1.19 Wave (Period) Rose Diagram at Grid Point 3551

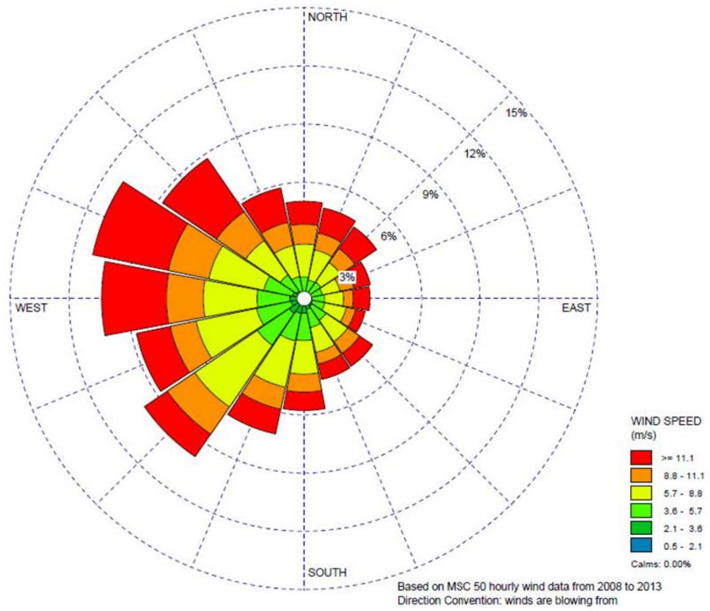
Table 5.1.17 Monthly Wave Conditions at Grid Point 3551[1]

Month	Mean Significant Wave Height (m)	Most Frequent Direction[2]	Maximum Hourly Significant Wave Height (m)
January	3.44	E	13.6
February	3.35	E	12.7
March	3.10	E	15.2
April	2.52	NE, E, SW	11.3
May	1.89	NE	6.84
June	1.64	NE	9.51
July	1.50	NE	9.0
August	1.57	NE	12.2
September	2.01	All	11.3
October	2.47	E	13.0
November	2.94	E	11.9
December	3.39	E	12.7

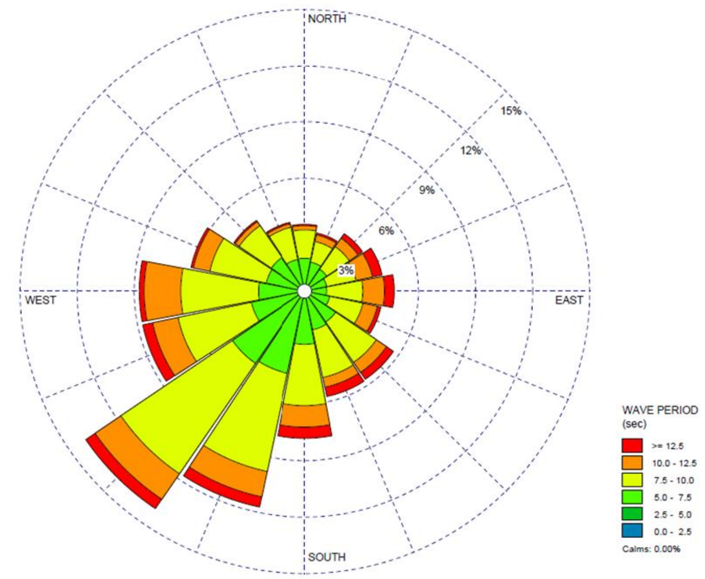
Note:
[1] Based on 60 years of MSC50 hourly wave data from 1954 to 2013. [2] Direction waves are propagating towards.

The MSC50 wave data were partitioned into sea and swell. Sea corresponds to wind waves generated by local winds. The swell waves are created by wind blowing over an area some distance away for some hours prior to travelling to the area of interest. When the characteristics of both wind and swell waves are combined, the net characteristics are termed the resultant wave. Figure 5.1.20 presents the annual wind and wave roses showing peak period and occurrences of wind, swell and resultant waves. As expected, the direction of wind waves and percentage of occurrences follows that of the wind, and wind and wind-wave period roses have a similar pattern (Figures 5.1.20(a) and 5.1.20(c)). The data in Figure 5.1.19(d) illustrate that the dominant swell directions are from the southwest, south, southeast and east. In summary, the annual wave climate for the Project Area is dominated by:

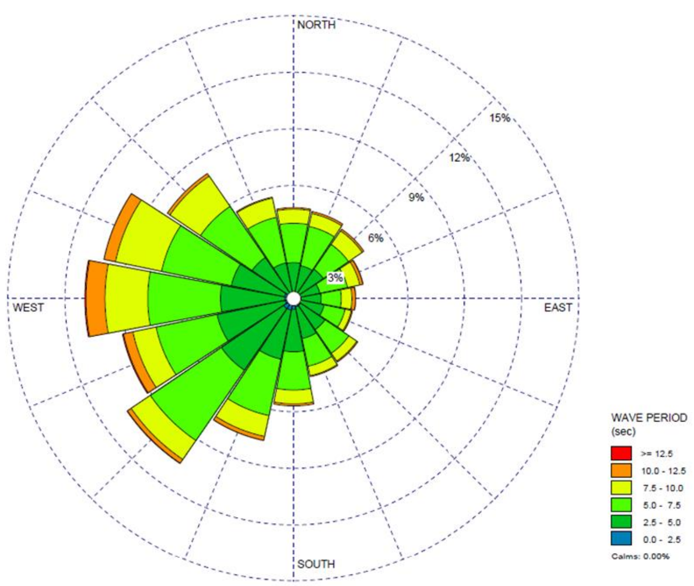
- wind waves propagating from the west, northwest and north;
- wind waves and swell waves propagating from the southwest and south; and
- swell from the southeast and east.



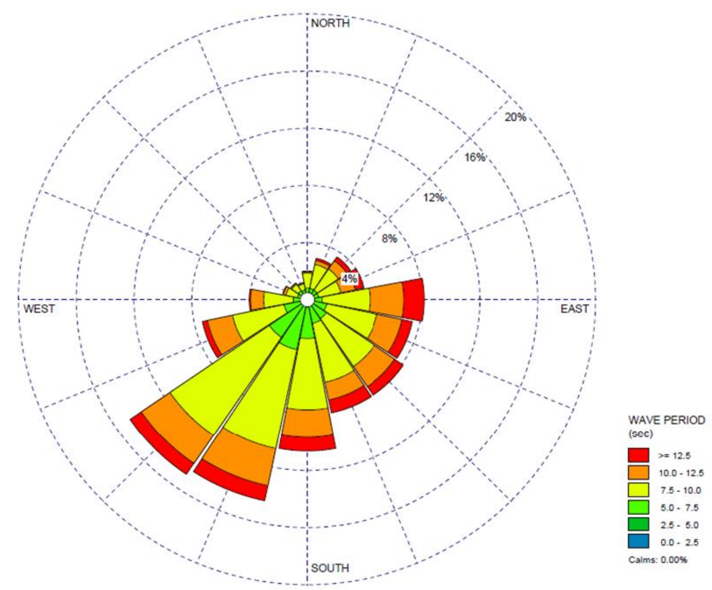
(a) Wind Rose



(b) Wave Period Rose (Resultant Wave)



(c) Wave Period Rose (Wind Waves)



(d) Wave Period Rose (Swell)

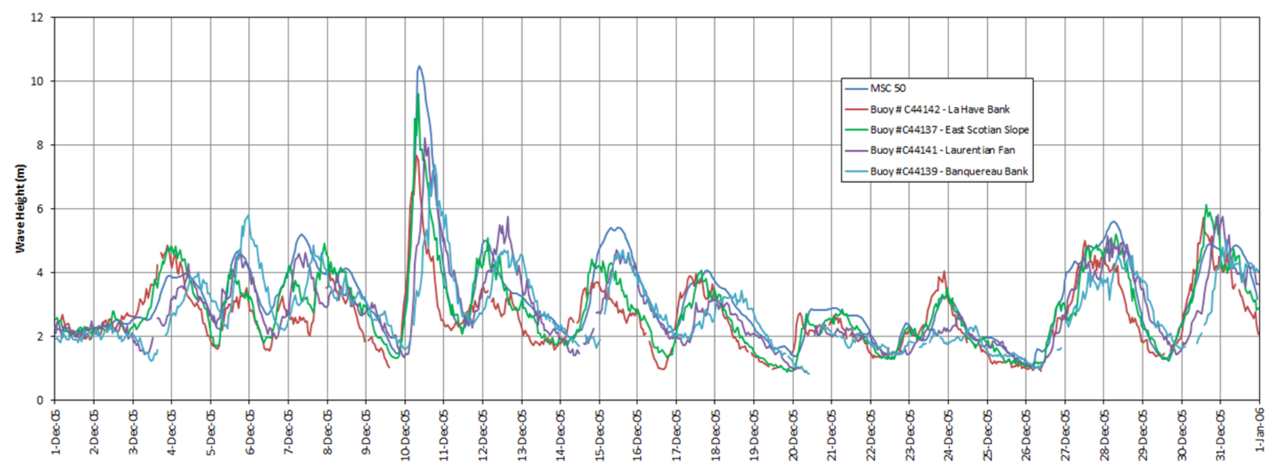
Based on MSC 50 hourly data from 2008 to 2013. Direction Convention: winds are blowing from, and waves are propagating from.

Figure 5.1.20 Comparison of Annual Wind Rose and Wave Period Roses for Wind Wave, Swell and Resultant Wave.

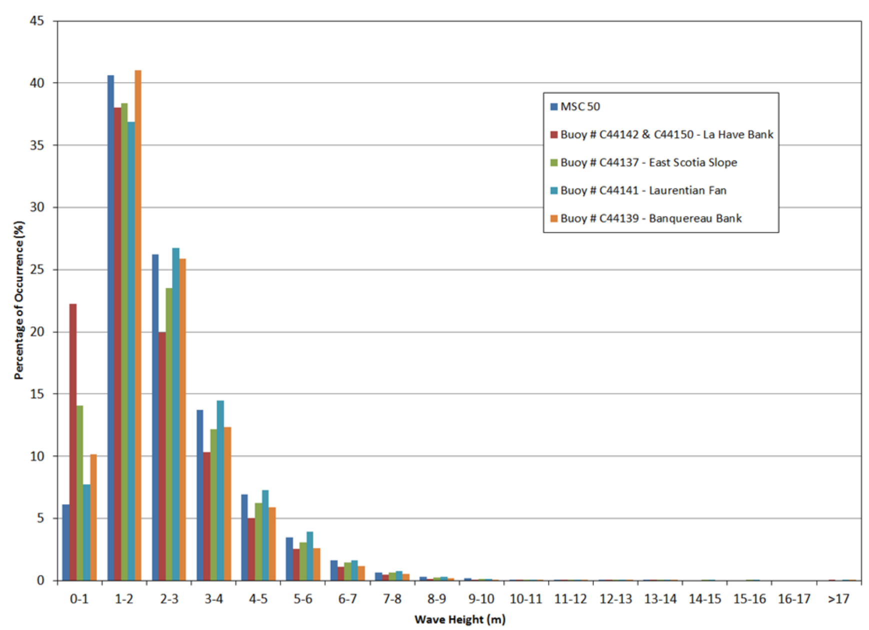
Buoy Data

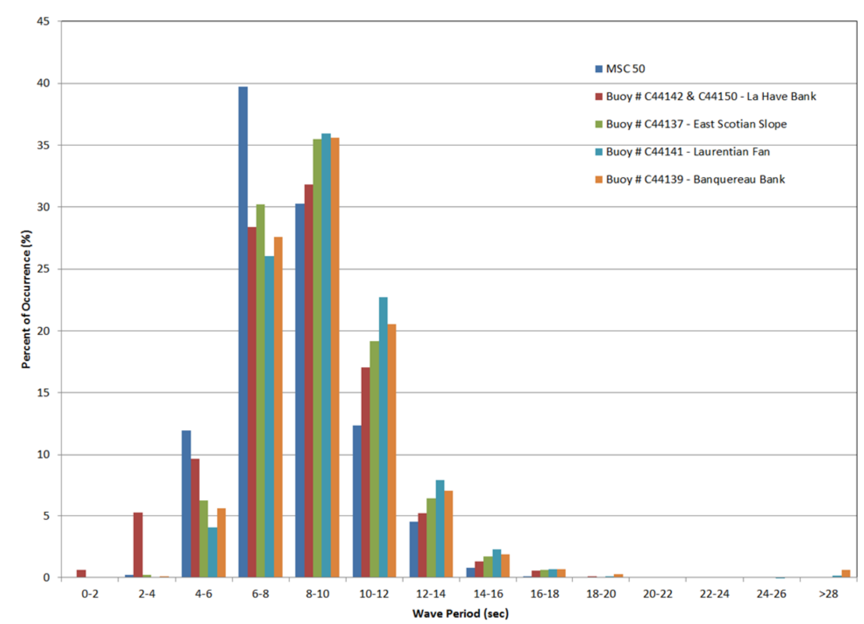
Long-term buoy data at the LaHave Bank station (ID#C44142 and ID#C44150), East Scotia Slope (ID#C44137), Banquereau Bank (ID# C44139) and Laurentian Fan (ID# C44141) were used to compare to the MSC50 data. About 22% of the hourly LaHave Bank buoy data, 17% of the hourly East Scotia Slope buoy data, 8% of the hourly Banquereau Bank buoy data, and 11% of the hourly Laurentian Fan buoy data are not used for the comparison due to the quality of the recorded data and/or malfunction of the buoy. Only data identified as good were used for comparison with the MSC50 data.

Figure 5.1.21(a) compares the hourly significant wave height for December 2005 for the LaHave Bank buoy, East Scotia Slope Buoy, Banquereau Bank buoy, Laurentian Fan buoy, and MSC50 data and indicates that overall agreement is good between the buoys and the MSC50 data. Figures 5.1.21(b) and 5.1.21(c) compare the percentage of occurrence of wave height and wave period, respectively, among the buoys data and the MSC50 data. Overall, the percentages of wave height and wave period occurrences are in good agreement between the buoys data and the MSC50 data.



(a) Hourly Significant Wave Height Vs Time (December, 2005)





(b) Percent of Wave Height Occurrence

(c) Percent of Wave Period Occurrence

Figure 5.1.21 Comparison of Buoy Data and MSC50 Data

The differences between the buoys and the MSC50 data could be attributed to unavailable buoy data and the locations of the buoy and the MSC50 grid point. Mean and maximum monthly wave heights for the LaHave Bank buoy, East Scotia Shelf buoy, Banquereau Bank buoy, Laurentian Fan buoy and MSC 50 data are presented in Tables 5.1.18 and 5.1.19, respectively.

Table 5.1.18 Comparison of Mean Monthly Significant Wave Height at Buoy Locations

Month	Mean Significant Wave Height (m)				
	MSC50	LaHave Bank (C 44142 & C44150)	East Scotian Slope (C 44137)	Banquereau Bank (C 44139)	Laurentian Fan (C44141)
January	3.44	2.89	3.20	3.18	3.48
February	3.35	2.96	3.27	3.23	3.43
March	3.10	2.63	2.95	2.80	3.07
April	2.52	2.19	2.30	2.23	2.56
May	1.89	1.57	1.89	1.77	1.95
June	1.64	1.33	1.54	1.55	1.68
July	1.50	1.19	1.46	1.40	1.55
August	1.57	1.18	1.47	1.53	1.58
September	2.01	1.50	1.78	1.83	1.94
October	2.47	2.06	2.37	2.42	2.54
November	2.94	2.35	2.76	2.64	2.95
December	3.39	2.83	3.31	3.03	3.52
Annual	**2.48**	**2.03**	**2.35**	**2.31**	**2.52**

Table 5.1.19 Comparison of Maximum Significant Wave Height at Buoy Locations

Month	Maximum Significant Wave Height (m)				
	MSC50	LaHave Bank (C 44142 & C44150)	East Scotian Slope (C 44137)	Banqureau Bank (C 44139)	Laurentian Fan (C44141)
January	13.6	12.6	10.6	10.1	12.7
February	12.7	10.4	11.8	11.0	12.7
March	15.2	10.7	16.2	14.0	15.9
April	11.3	8.6	8.7	7.56	13.9
May	6.8	7.2	7.1	6.6	8.0
June	9.5	6.9	11.1	9.8	11.0
July	9.0	9.0	6.2	4.5	6.2
August	12.2	13.4	14.1	10.4	9.4
September	11.3	13.0	11.5	9.9	13.6

Table 5.1.19 Comparison of Maximum Significant Wave Height at Buoy Locations

Month	Maximum Significant Wave Height (m)				
	MSC50	LaHave Bank (C 44142 & C44150)	East Scotian Slope (C 44137)	Banqureau Bank (C 44139)	Laurentian Fan (C44141)
October	13.0	8.8	14.1	11.8	15.0
November	11.9	9.8	13.4	9.4	11.0
December	12.7	13.6	13.4	12.8	12.8
Annual	**15.2**	**13.6**	**16.2**	**14.0**	**15.9**

Mean and maximum monthly significant wave heights for wave data obtained from the offshore platforms and wells (refer to Figure 5.1.4 for the location of platforms and wells) are presented in Tables 5.1.20 and 5.1.21. Mean monthly significant wave heights at offshore platforms and wells compare very well with mean monthly wave heights at the MSC50 grid point and buoy locations except for the values derived from partial monthly data for the offshore platforms and wells. Maximum monthly significant wave heights at offshore platforms and wells are much less than the maximum monthly significant wave heights at the MSC50 grid point and buoy locations. This is primarily due to the short-term records for the offshore platforms and wells compared to the long-term record data at the MSC50 grid point and buoy locations.

Table 5.1.20 Mean Monthly Significant Wave Heights at Offshore Platforms and Wells

Month	Mean Significant Wave Height (m)				
	Sedco 709 (MEDS 133)	Ben Ocean Lancer (MEDS 138)	Sedco 710 (MEDS 185)	Balvenie B-79 (WEL 441)	Weymouth A-45 (WEL 444)
January	-	-	4.75[P]	-	3.11
February	-	-	3.20	-	2.99
March	-	-	4.00[P]	-	2.45
April	-	-	-	-	2.17
May	-	1.62[P]	-	-	1.26[P]
June	-	1.49	-	-	-
July	-	1.25	-	1.51[P]	-
August	-	1.03[P]	-	1.30	-
September	-	-	-	1.02[P]	-
October	-	-	-	-	3.35[P]
November	3.50[P]	-	-	-	2.39
December	3.99[P]	-	-	-	3.11

Note:
[P] based on partial data.

Table 5.1.21 Maximum Monthly Significant Wave Heights at Offshore Platforms and Wells

Month	Maximum Significant Wave Height (m)				
	Sedco 709 (MEDS 133)	**Ben Ocean Lancer (MEDS 138)**	**Sedco 710 (MEDS 185)**	**Balvenie B-79 (WEL 441)**	**Weymouth A-45 (WEL 444)**
January	-	-	8.97^P	-	5.86
February	-	-	8.23	-	6.05
March	-	-	7.26^P	-	5.54
April	-	-	-	-	5.22
May	-	5.48^P	-	-	2.39^P
June	-	3.57	-	-	-
July	-	4.14	-	3.79^P	-
August	-	1.50^P	-	3.11	-
September	-	-	-	1.94^P	-
October	-	-	-	-	5.50^P
November	5.54^P	-	-	-	5.70
December	8.05^P	-	-	-	6.01

Note:
^P based on partial data.

Extreme Wave Conditions

Extremal analysis data were obtained for the Grid Point 3551 from the Oceanweather website (http://www.oceanweather.net/MSC50WaveAtlas/Extremes/MSC50_M6_Index.htm). Extremal analysis was carried out using 59 years of hourly wave data from 1954 to 2012 using various probability distributions including Gumbel, Weibull, Generalized Extreme Value and Generalized Pareto. The Generalized Extreme Value distribution was selected based on visual best fit with simulated peak wave heights. Table 5.1.22 provides extreme wave conditions for Grid Point 3551 for various return periods. Predicted range of extreme wave conditions are presented in Table 5.1.23 for various probability distributions.

The largest extreme waves are propagating towards the east and northeast directions. Significant wave heights are 9.8 m and 13.0 m for the 2- and 100-year return periods, respectively, for the east waves. Significant wave heights are 9.6 m and 14.5 m for the 2- and 100-year return periods, respectively, for the northeast waves. Wave periods ranged from 10.5 s to 15.5 s for extreme wave conditions (Table 5.1.22).

Table 5.1.22 Extreme Wave Conditions at Grid Point 3551[1]

Direction[2]	S			SW			W			NW			N			NE			E			SE		
Return Period	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}
Year	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m
2	6.8	10.5	12.6	6.8	11.3	12.7	7.1	11.3	13.2	7.3	11.8	13.2	8.4	12.9	15.1	9.6	13.3	17.4	9.8	12.9	17.8	7.6	11.2	14.0
5	8.2	11.3	15.1	8.5	12.3	16.0	8.8	12.3	16.2	8.6	12.6	15.6	9.6	13.5	17.1	11.1	14.1	20.2	10.9	13.6	19.9	8.6	11.6	15.8
10	8.9	11.7	16.5	9.6	12.9	18.0	9.7	12.9	18.0	9.5	13.0	17.2	10.3	13.4	18.5	12.1	14.5	21.9	11.6	14.0	21.1	9.2	11.8	16.8
25	9.7	12.1	18.0	10.8	13.5	20.3	10.8	13.5	20.0	10.5	13.6	19.1	11.3	14.3	20.1	13.3	15.0	23.8	12.2	14.4	22.3	9.8	11.9	17.9
50	10.2	12.4	19.0	11.7	13.9	21.8	11.5	13.9	21.3	11.3	14.0	20.6	12.0	14.5	21.3	14.0	15.3	25.1	12.6	14.6	23.0	10.2	12.1	18.6
100	10.6	12.6	19.9	12.5	14.3	23.3	12.2	14.3	22.5	12.1	14.4	22.1	12.6	14.8	22.4	14.5	15.5	26.1	13.0	14.8	23.6	10.6	12.2	19.2

Note:
[1] Based on 59 years of MSC50 hourly wave data from 1954 to 2012. [2] Direction waves are propagating towards.

Table 5.1.23 Comparison of Extreme Wave Conditions at Grid Point 3351 for Various Probability Distributions – All Directions

Probability Distribution	Generalized Extreme Value			Gumbel			Weibull			Generalized Pareto			Range of Predicted Extreme Wave Conditions		
Return Period	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}
Year	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m
2	10.5	13.5	19.0	10.8	13.6	19.6	10.7	13.5	19.6	10.9	13.7	20.2	10.5-10.9	13.5-13.7	19.0-20.2
5	11.8	14.3	21.2	11.9	14.4	21.4	11.7	14.3	21.3	11.9	14.2	21.9	11.7-11.9	14.2-14.4	21.2-21.9
10	12.6	14.8	22.6	12.5	14.9	22.6	12.4	14.8	22.4	12.5	14.4	22.9	12.4-12.6	14.4-14.9	22.4-22.9
25	13.4	15.3	24.1	13.4	15.5	24.1	13.2	15.4	23.7	13.3	14.8	24.1	13.2-13.4	14.8-15.5	23.7-24.1
50	14.0	15.7	25.1	14.0	15.9	25.2	13.8	15.8	24.7	13.7	15.0	24.8	13.7-14.0	15.0-15.9	24.7-25.2
100	14.5	16.0	26.1	14.7	16.4	26.4	14.4	16.2	25.6	14.2	15.1	25.4	14.2-14.7	15.1-16.4	25.4-26.4

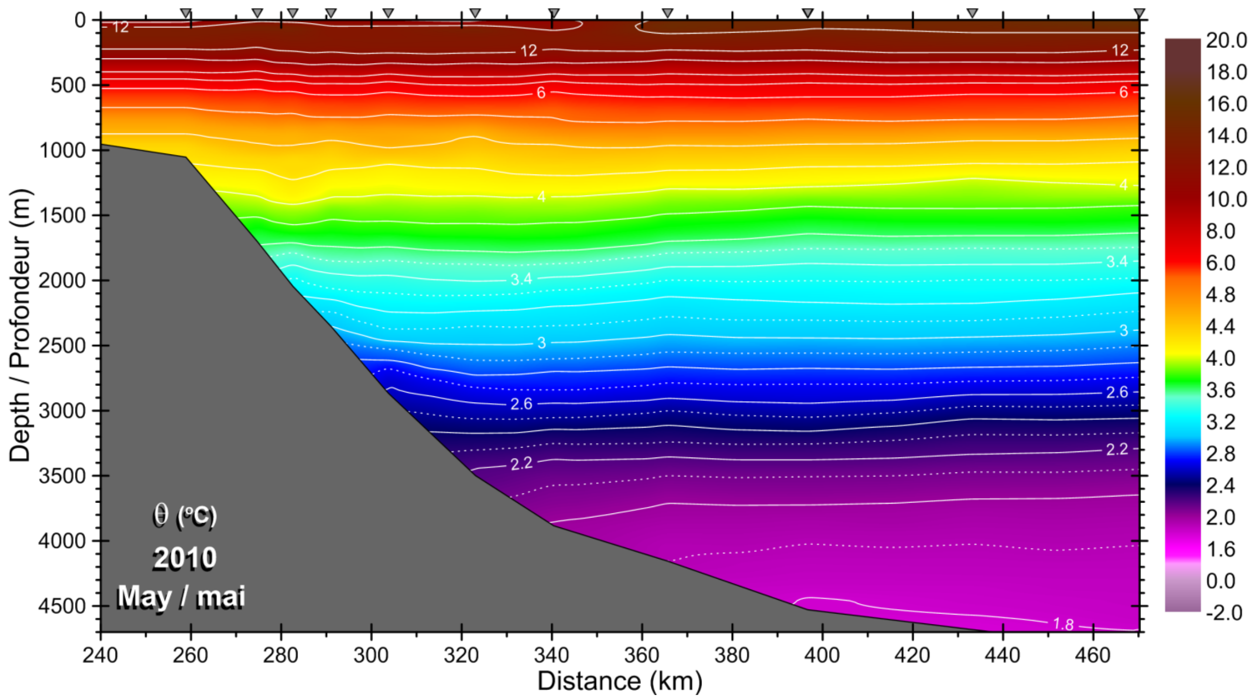
5.1.3.4 Water Mass Characteristics

Physical, chemical and biological oceanographic conditions of the continental slope and deeper waters of the Northwest Atlantic are characterized using data collected by the AZOMP (DFO 2013a). The Scotian Slope/Rise Monitoring Program collects data over the Scotian Slope and Rise at deepwater stations added to the offshore end of the Halifax Line from the AZMP which run through the Project Area (refer to Figure 5.1.4). Data on water temperature, salinity, and density profiles collected through AZOMP are provided below. Information on other water quality parameters such as pH and turbidity are drawn from the Deep Panuke Comprehensive Study Report (Encana 2002) as these parameters are not monitored through AZOMP.

Temperature

The water temperatures on the Scotian Shelf and in the Gulf of Maine are among the most variable in the North Atlantic (Worcester and Parker 2010). The temperatures on the Western Scotian Shelf and Slope are generally warmer than the Eastern Scotian Shelf and Slope. This is due to the infiltration of warm Gulf Stream water entering in between Browns and Western Banks. The normal temperature on the Western Scotian Shelf and Slope are both seasonally and spatially more dynamic than those found on the Eastern Scotian Shelf. This is also due to the impact of warm water from the Gulf Stream and increased vertical mixing (Breeze *et al.* 2002). Surface temperatures typically show a large variation over the Scotian Shelf.

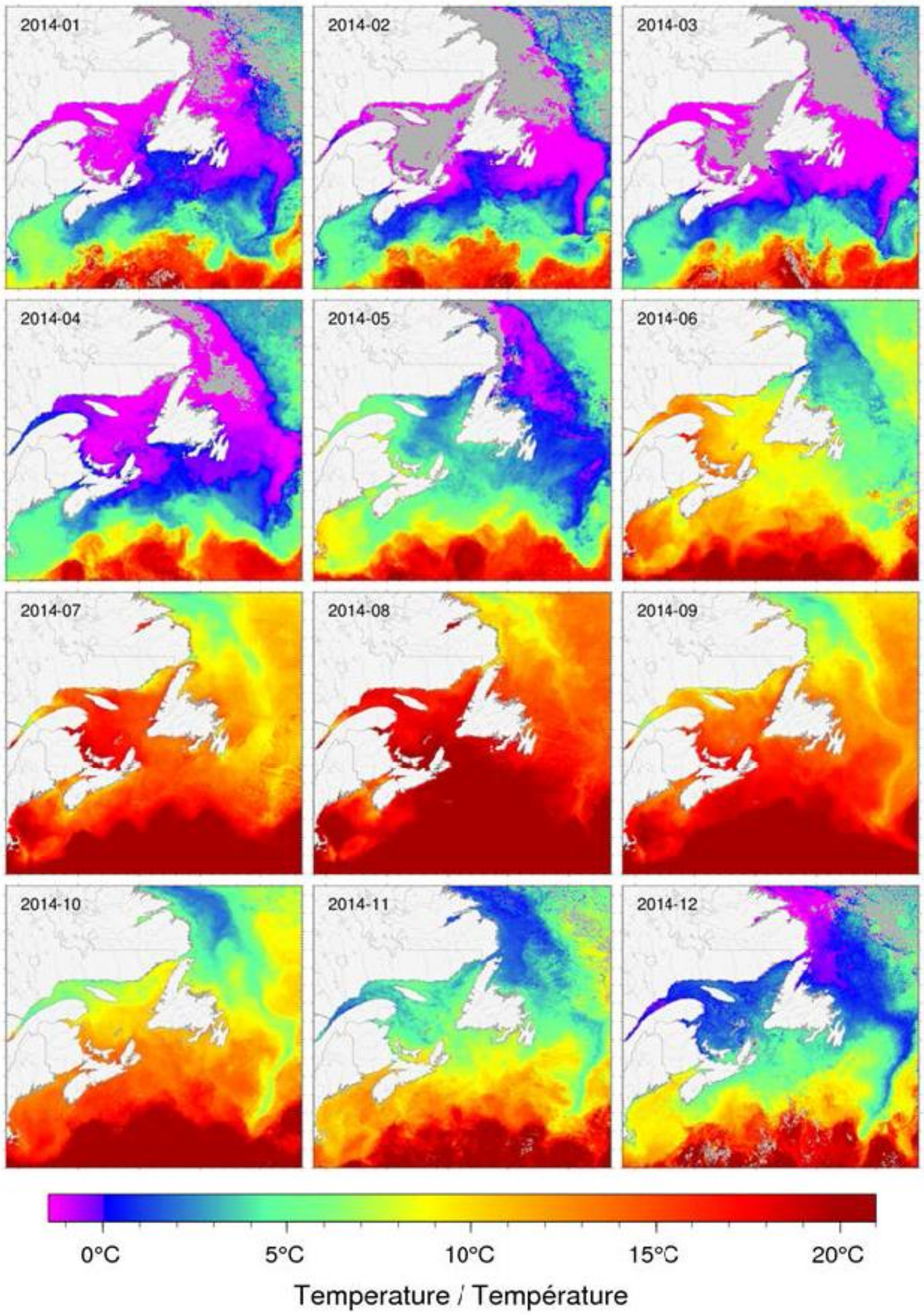
Over the Scotian Slope, water temperatures are the highest in the surface waters, with the coldest waters being found in the deep abyssal depths (DFO 2013a). This temperature profile is provided in Figure 5.1.22.



Source: DFO 2013a

Figure 5.1.22 Temperature Profile along the Extended Halifax Line (AZOMP) on the Scotian Slope (May 2010)

In 2014, the annual average temperatures for the water depths 0 to 50 m measured at the high frequency sampling sites of the AZMP were above normal. The past decade has seen a further increase in water temperatures, with record sea surface temperatures seen in 2012, and have generally remained above normal in 2014 (DFO 2015b). Refer to Figure 5.1.23 below for average monthly sea surface temperatures on the Scotian Shelf and Slope in 2014.

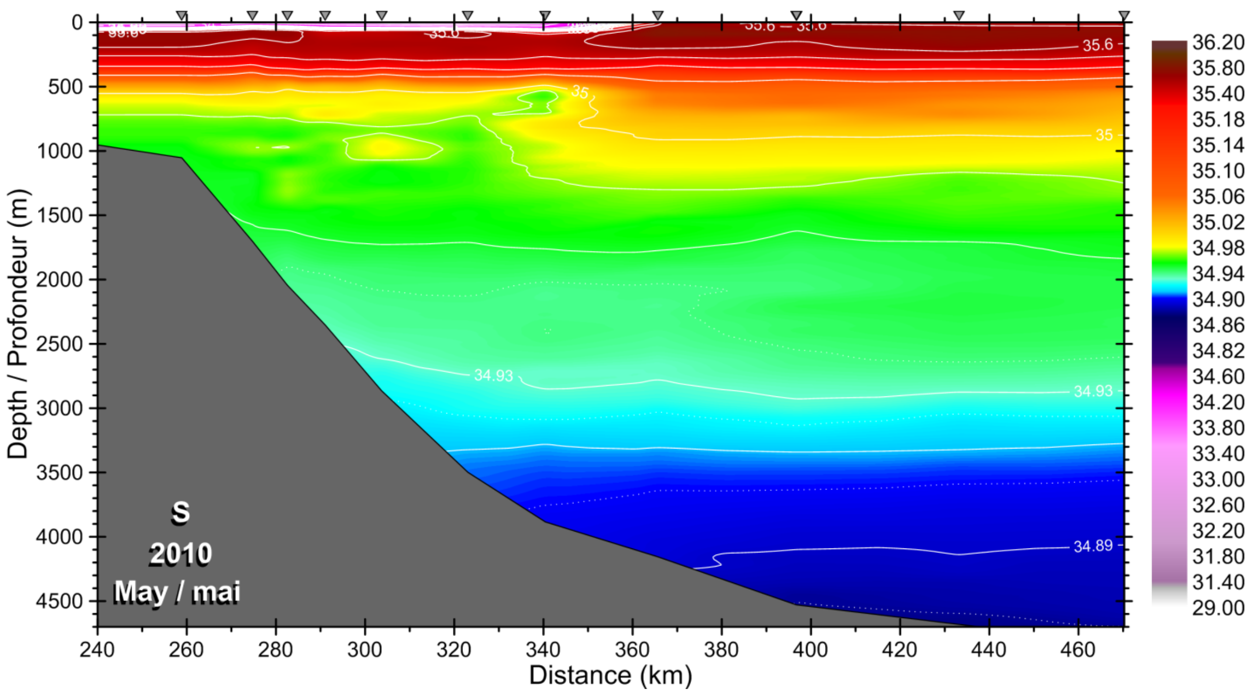


Source: DFO 2015b

Figure 5.1.23 Sea-Surface Temperature Monthly Average for 2014 in the Atlantic Zone

Salinity

Salinity influences the presence of marine life both directly through salinity preferences and needs of differing species and indirectly through its effect on density and stratification, which affects the growth of phytoplankton and thus primary production (Breeze *et al.* 2002). The Labrador Current and Gulf Stream are both more saline (34 to 36 practical salinity unit (psu)) than the Shelf Current (31 to 33 psu) (refer to Figure 5.1.15 for location of currents). The surface waters of the Scotian Slope are relatively fresh out to the area where the Gulf Stream and Labrador Current approach from offshore (DFO 2013a). Labrador Sea Water lies beneath the Slope Water at intermediate depths, with Denmark Strait Overflow water lying along the bottom beneath the 3,000 m isobath. The Denmark Strait Overflow water is the coldest, densest, and freshest water mass of what is known as North Atlantic Deep Water (NADW). Labrador Sea Water as well as Denmark Strait Overflow Water comprise components of the NADW. The salinity profile collected by DFO during May 2010 can be seen in Figure 5.1.24. The profile to the left of Figure 5.1.24 depicts the less saline surface water layer (0 to 100 m depth) from the Shelf Current closer to shore, with a more saline surface layer below it from the impacts of the Gulf Stream and the Labrador Current further offshore.

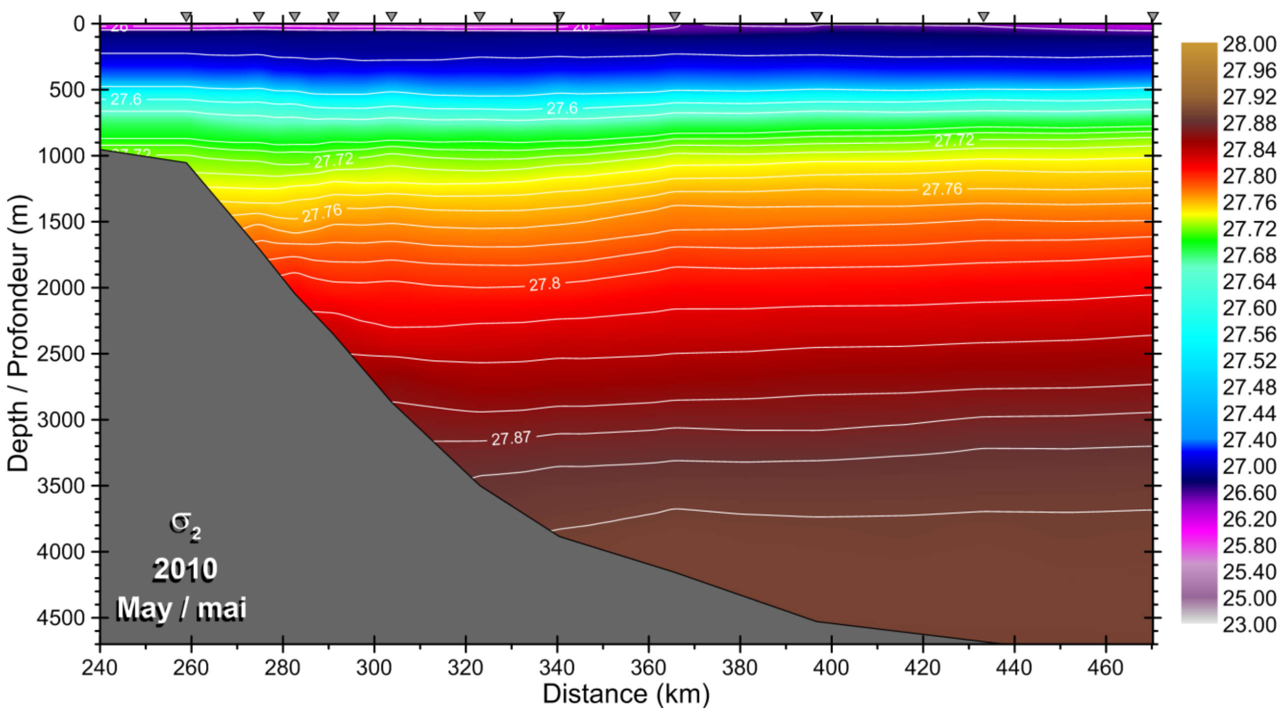


Source: DFO 2013a

Figure 5.1.24 Salinity Profile along the Extended Halifax Line (AZOMP) on the Scotian Slope (May 2010)

Density

The density of seawater depends on temperature, salinity, and pressure. Density increases with depth in the ocean (Worcester and Parker 2010). The difference in density between water at two depths is known as the density stratification. The stratification divided by the difference in depths is called the stratification index. High levels of stratification inhibit the vertical mixing of water and as a result can decrease nutrient fluxes to the surface waters, and affect the growth of phytoplankton. Increased stratification can also reduce turbulence, concentrating phytoplankton and thus lead to increased primary production in the surface waters (Worcester and Parker 2010). Under increased stratification, there is a tendency for more primary production to be recycled within the upper mixed layer, reducing the amount available for deeper layers (Hebert *et al.* 2012). On the Scotian Shelf, the 0 to 50 m stratification index increased during the 1990s and from the mid to late 1990s was at its 50-year maximum on record. Since 1948, there has been a consistent increase in the mean stratification on the Scotian Shelf. This has resulted in a change in the 0 to 50 m density difference of 0.37 kg/m^3 over 50 years (DFO 2015b). Changes in stratification have also been noted in the eastern Gulf of Maine and on Georges Bank, with stratification increasing steadily from the mid-1980s. Figure 5.1.25 depicts the density profile along the Halifax Extended Line of the Scotian Slope during May of 2010, clearly depicting increasing density with depth.

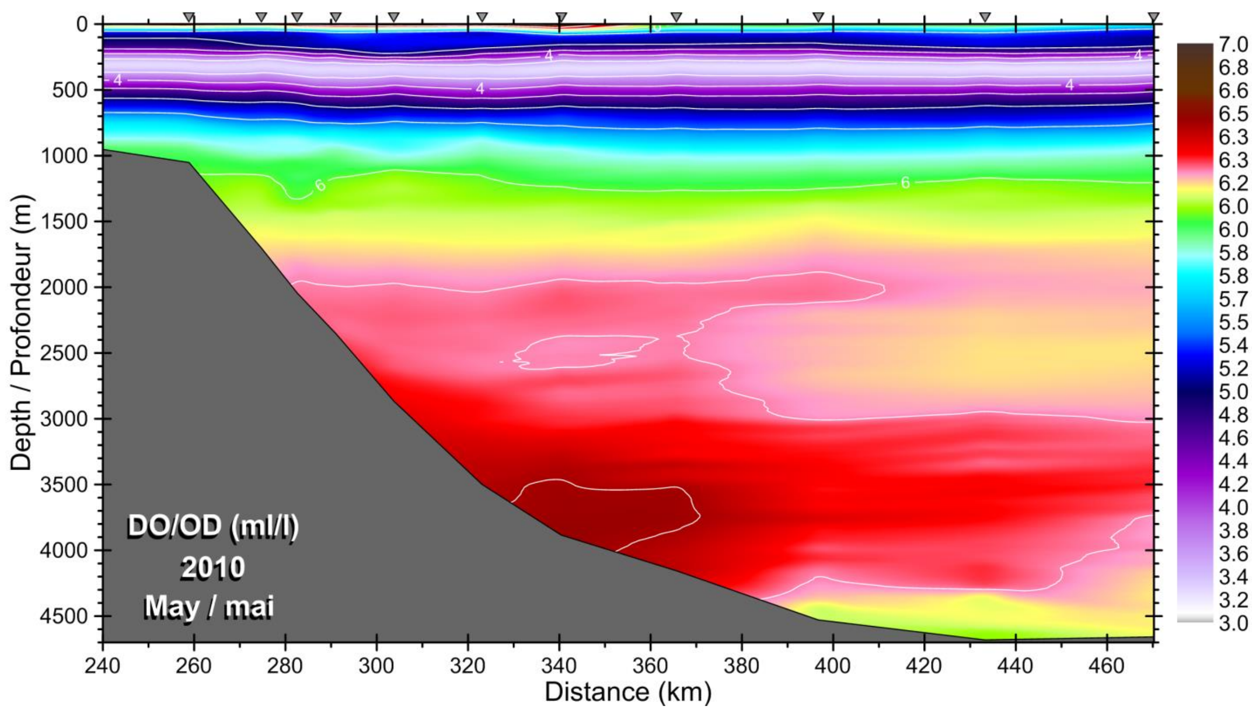


Source: DFO 2013a

Figure 5.1.25 Density Profile along the Extended Halifax Line on the Scotian Slope (May 2010)

Dissolved Oxygen

Strong stratification has the potential to inhibit the vertical mixing of water to a degree to cause dissolved oxygen levels in the deeper layers to become depressed. The waters in the Project Area do stratify, but not to a degree where low dissolved oxygen levels become an issue for the species inhabiting the area. The lowest dissolved oxygen levels can be found within the deepest basins in the area (Worcester and Parker 2010). Figure 5.1.26 depicts the dissolved oxygen profile along the Halifax Extended Line of the Scotian Slope during May of 2010. The profile depicts decreasing dissolved oxygen with water depth up to a depth of 500 m. Below this 500 m layer dissolved oxygen increases to a depth of 4,500 m and begins to decrease again after this depth is reached.



Source: DFO 2013a

Figure 5.1.26 Dissolved Oxygen along the Extended Halifax Line on the Scotian Slope (May 2010)

pH

Data on the pH of waters measured from several areas on the Scotian Shelf and over several decades since the 1930s indicate a declining trend in the pH (*i.e.*, increase in acidity) by about 0.1 to 0.2 units (DFO 2009a). This declining trend is slightly steeper than the average global ocean decrease observed for pH over the same time period (DFO 2009a; Curran and Azetsu-Scott 2013), indicating the occurrence of ocean acidification. Thomas (2015) conducted measurements using seasonal shipboard sampling and from a moored instrument on the Scotian Shelf. He noted that the regional mean surface water pH for the Scotian Shelf is roughly 7.8 in

April and increases to greater than 8.0 in September, with subsurface pH approximately 7.6 throughout the region and which indicated a seasonal decrease due to the respiration of organic matter at depth. Based on data reported in the Deep Panuke Comprehensive Study Report (CSR) (Encana 2002), measured pH values in surface waters on the Scotian Shelf ranged from 8.05 to 8.11, with intermediate and bottom waters ranging from 7.89 to 8.03. It is reasonable to assume that pH values in the Project Area would be similar.

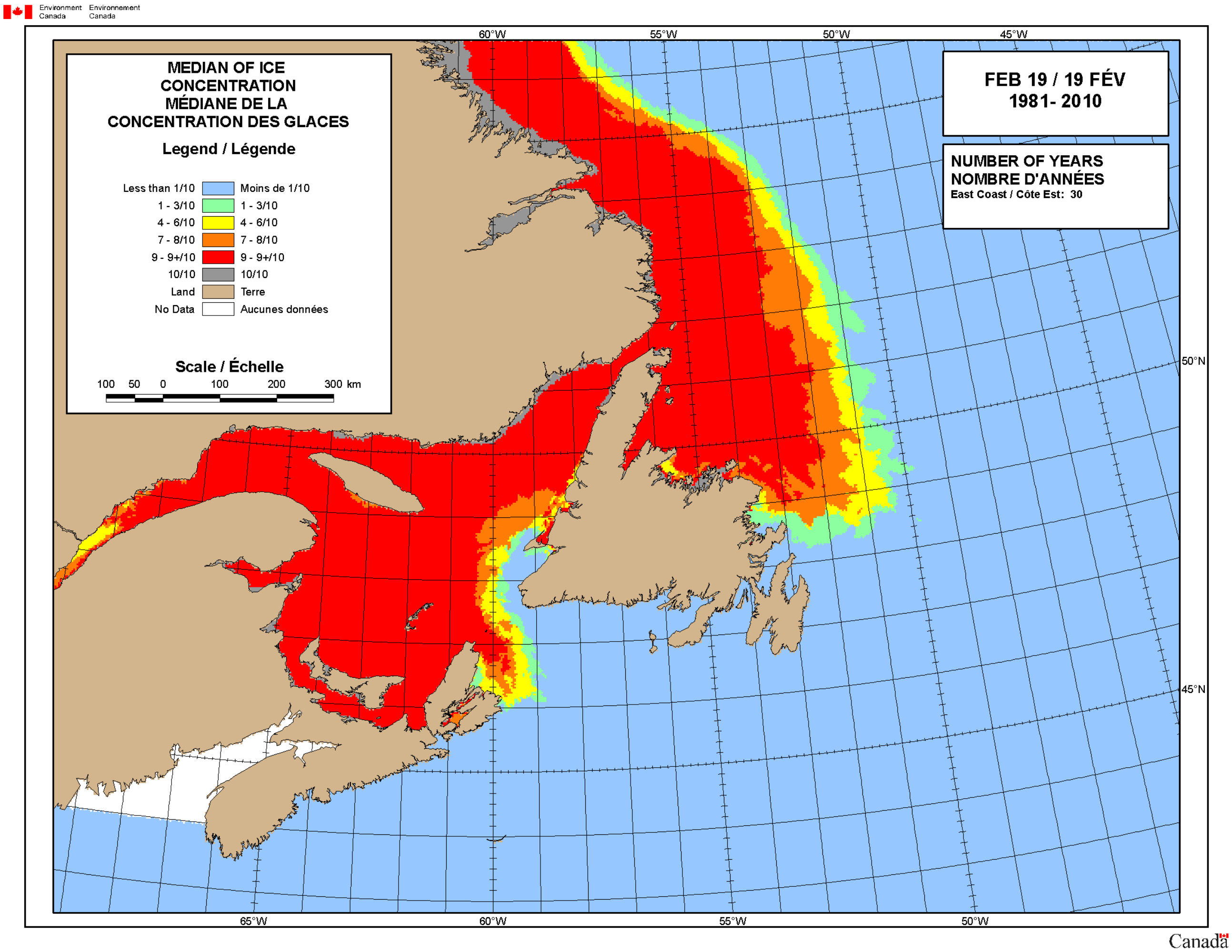
Turbidity

The Deep Panuke CSR recognized a paucity of data on suspended particulate matter (SPM) in the region, referencing data collected in 1970 on Emerald Bank. These data indicated a variation of 5.5 mgl/L at the surface, increasing to 10.1 mg/L at 20 m and then decreasing to 4.0 mg/L below this depth (Encana 2002). It is expected that SPM values in the Project Area would be comparable but lower than those measured in the shallow waters on the Bank. However, it is likely that SPM may be higher over canyons because of the higher fluxes of resuspended sediment than on adjacent shelf or slope (Walcoff and Associates 1989).

5.1.3.5 Sea Ice and Icebergs

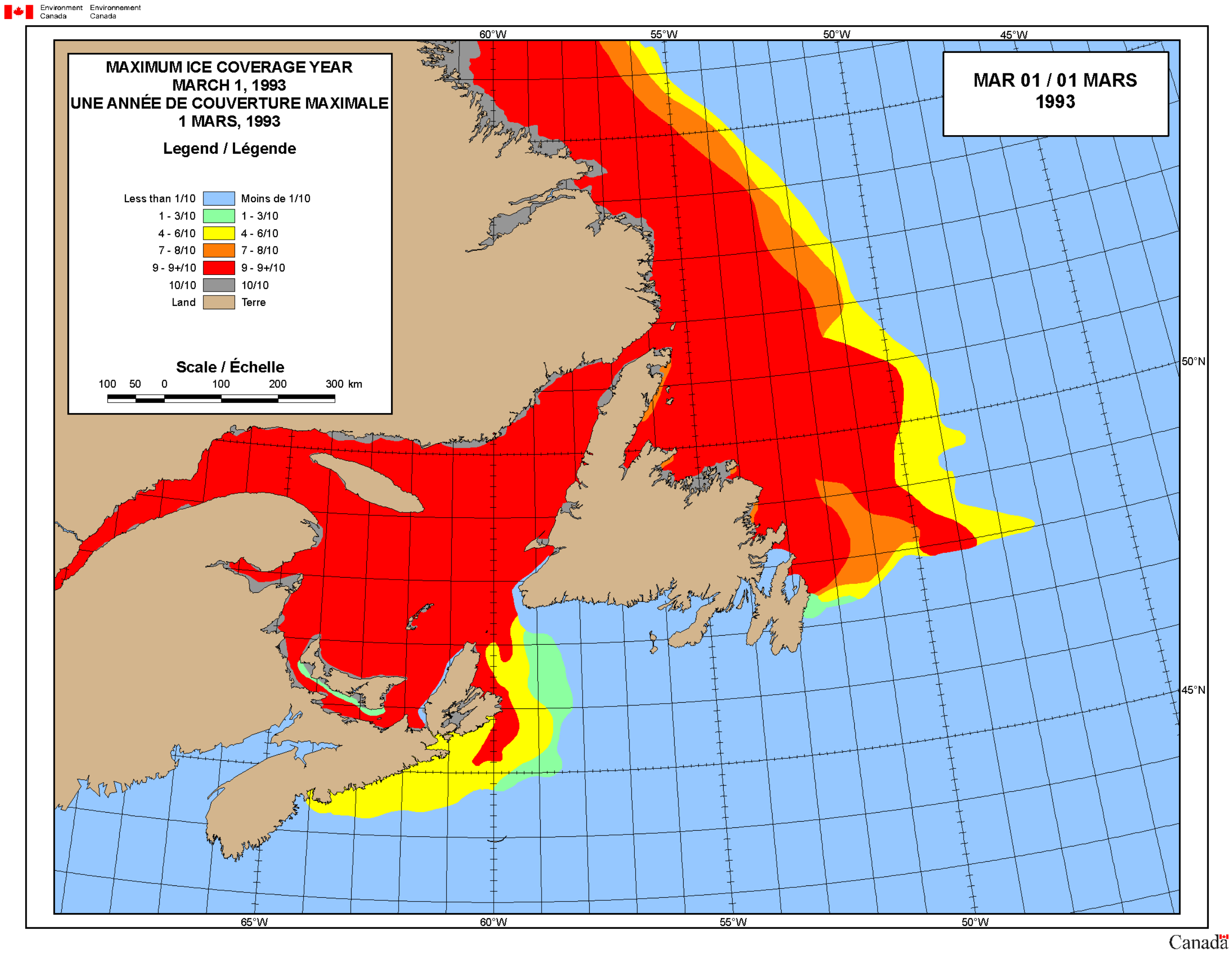
Sea ice and icebergs are very rare in the Nova Scotia offshore environment (Worcester and Parker 2010). Sea ice is generally transported out of the Gulf of St. Lawrence through the Laurentian Channel and pushed out to the Scotian Shelf by northwesterly winds and ocean currents. Generally, sea ice will only make it as far as the Eastern Scotian Shelf and melt before reaching the Central and Western sections of the Shelf. Localized sea ice may also form along the coastline of Nova Scotia, but would melt and dissipate after break-up before it has any chance of entering the Project Area. Figure 5.1.27 illustrates the maximum extent of median sea ice concentration from 1981 to 2010. The maximum extent of ice coverage that occurred on the east coast from 1981 to 2010 was observed on March 1, 1993 and which is shown in Figure 5.1.28.

For the past few decades ice volumes on the Scotian Shelf, as well as the Newfoundland and Labrador Shelf, and the Gulf of St. Lawrence, have generally been lower than normal levels. As shown in Figures 5.1.27 taken from the Sea Ice Climatic Atlas for the East Coast (1981-2010), sea ice is rarely observed on the Scotian Shelf. In the winter 2014 to 2015, sea ice was exported to the Scotian Shelf for the first time since 2009 (DFO 2015b) and which is presented in Figure 5.1.29.



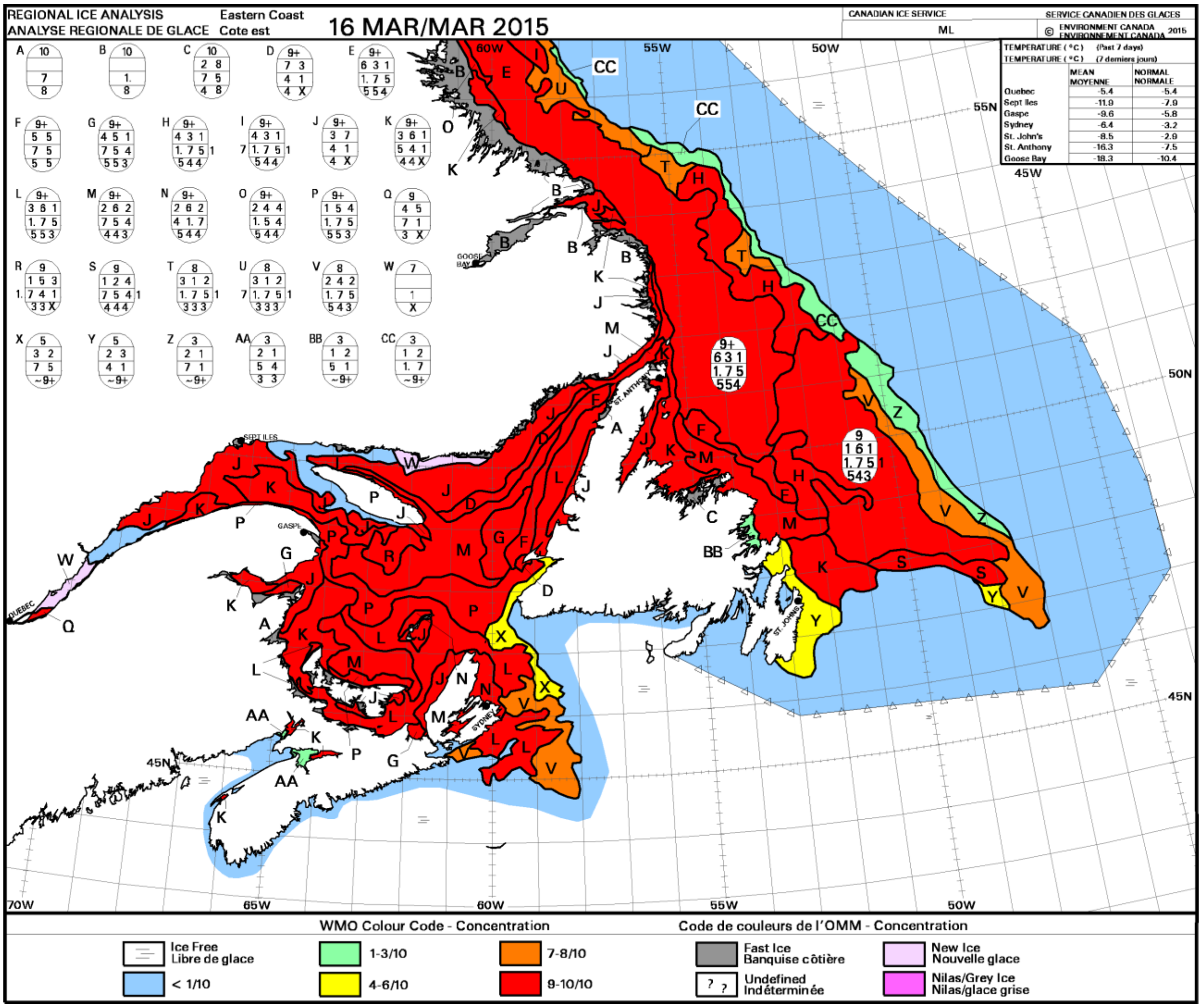
Source: Environment Canada 2012b

Figure 5.1.27 Maximum Extent of Median Sea Ice Concentration 1981–2010



Source: Environment Canada 2012b

Figure 5.1.28 Maximum Ice Coverage Observed on March 3, 1993 for the Period1981–2010.



Source: Environment Canada 2015e

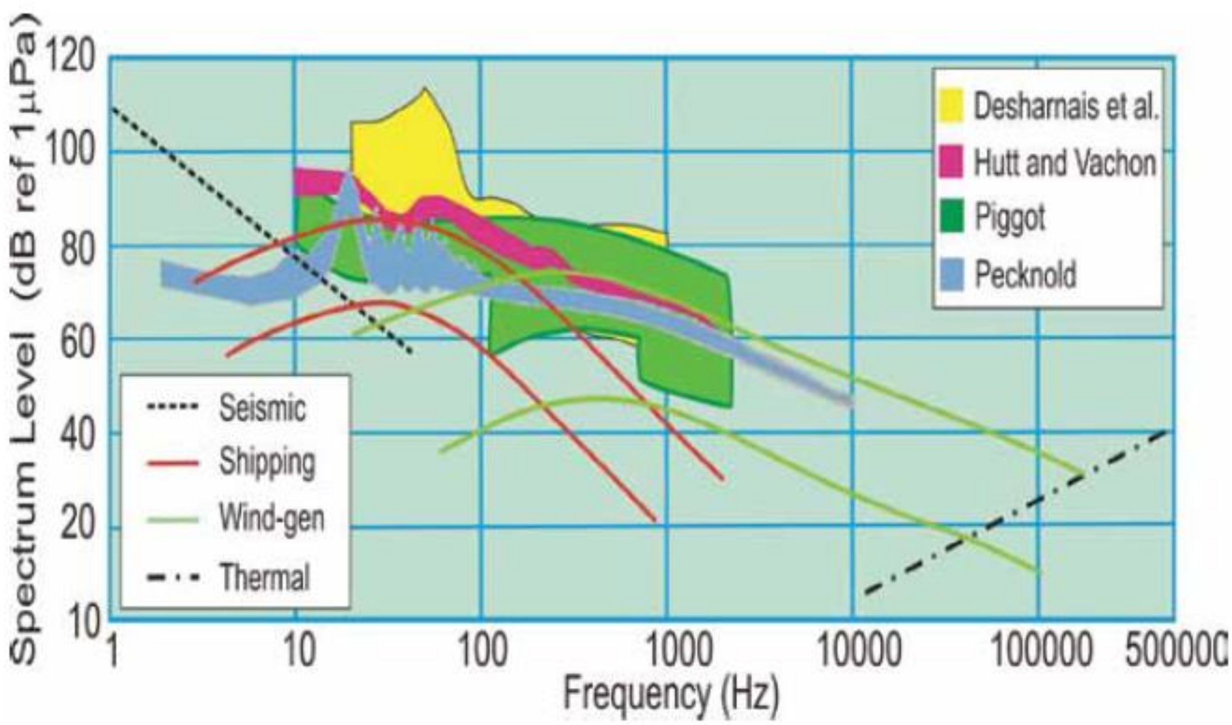
Figure 5.1.29 Sea Ice on the Eastern Scotian Shelf in March 2015

5.1.3.6 Ocean Sound

Ambient noise has been defined by the National Research Council as "the overall background noise caused by all sources such that the contribution from a single specific source is not identifiable" (NRC 2003). Ambient noise is a representation of the background noise typical of the location and depth where the measurements are taken after identifiable and occasional noise sources have been accounted for.

The Scotian Shelf is an active economic area with many influences (shipping, commercial fishing, oil and gas, defence, construction, marine research, and tourism) contributing to the ambient noise in the area on a constant and intermittent basis depending on the sound source (Walmsley and Theriault 2011). On the Scotian Shelf, shipping is the major and consistent contributor to low-frequency ambient noise. The ocean is a naturally noisy environment with ambient noise escalating as the wind and sea state rise.

Although there has not been a formal long-term monitoring program of ambient noise on the Scotian Shelf, several studies over the last 50 years have characterized the general ambient noise characteristics of the Scotian Shelf (Desharnais and Collison 2001; Hutt and Vachon 2003; Piggott 1964; Pecknold *et al*. 2010; Walmsley and Theriault 2011). These studies indicate considerable spatial and temporal variation in ambient noise levels. Wind and wave generated sound is generally higher than predicted for average sea states. The studies have also shown that at frequencies dominated by shipping sound (10 to 100 Hz), ambient noise levels are up to 40 dB re 1 µPa higher than sound levels generated by high winds (Walmsley and Theriault 2011). Figure 5.1.30 presents spectrum-frequency profiles for datasets showing ambient noise on the Scotian Shelf.



Source: Walmsley and Theriault 2011

Figure 5.1.30 Spectrum-frequency Profiles for Datasets, from Various Studies, Showing Ambient Noise on the Scotian Shelf (Studies include: Desharnais and Collison 2001; Hutt and Vachon 2003; Piggott 1964; Pecknold *et al.* 2010)

Ocean floor morphology, ocean depth, temperature, salinity, and proximity to land are important modifying factors in determining the characteristics of noise distribution in the marine environment (Walmsley and Theriault 2011). Sound levels can be expected to be higher close to fixed developments and sites where there are many forms of mechanization occurring at once (Walmsley and Theriault 2011).

5.2 MARINE BIOLOGICAL ENVIRONMENT

This section of the EIS describes the existing biological environment in the RAA, as required by the EIS Guidelines, including plankton, benthic communities, marine fish, marine mammals, sea turtles, migratory birds, and Special Areas. Species at Risk (SAR) and Species of Conservation Concern (SOCC) are discussed within each biological group, but are also summarized in a stand-alone section (Section 5.2.9).

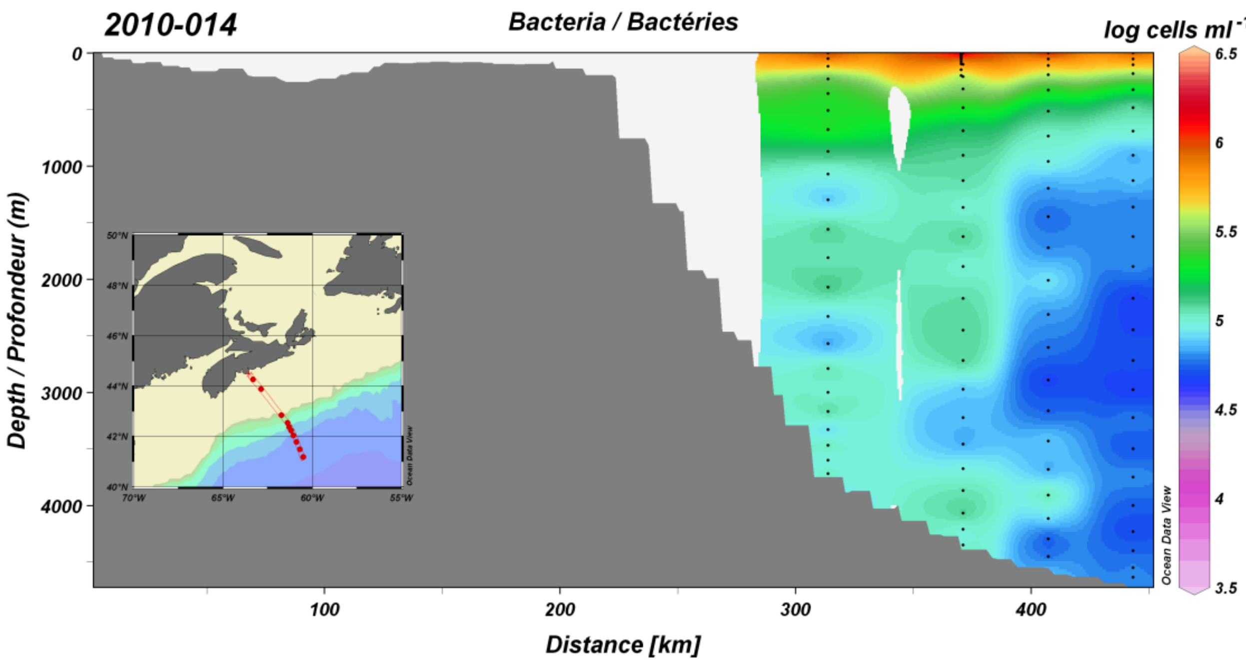
SAR include all species listed under Schedule 1 of the federal SARA as endangered, threatened, or of special concern; listed under the Nova Scotia *Endangered Species Act* (NS ESA) as endangered, threatened, or vulnerable. SOCC include those species that are listed as endangered, threatened, or of special concern by COSEWIC, but not yet listed in Schedule 1 of SARA.

This description of the biological environment relies substantially on previous research; no field work was conducted as part of this EIS. In particular, descriptions of species life histories and ranges are drawn primarily from the Shelburne Basin Venture Exploration Project EIS (Stantec 2014a), applicable SEAs conducted by the CNSOPB on the Scotian Shelf and Slope, BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA, as well as marine mammal observer (MMO) records from the recent BP Exploration (Canada) Limited's Tangier and Shell Canada's Shelburne Basin seismic surveys. Information is included in this Section (specifically in 5.2.2) about the process that BP has, and will continue to use, during project planning to increase their understanding of the surrounding environment.

5.2.1 Plankton

5.2.1.1 Bacterial Communities

Bacterial communities consist of prokaryotes (single-celled organisms including bacteria and archaea) which make up the smallest free-living cells in any pelagic ecosystem. Bacteria can have a variety of energy sources with some using light as their primary energy source (photoautotrophs), or auxiliary source (photoheterotrophs), with the majority of bacteria using organic material as an energy source (heterotrophs) (DFO 2011a). Since the majority of bacteria are secondary producers, relying on organic material for energy, their abundance can be correlated to the abundance of phytoplankton communities (see Section 5.2.1.2 for a discussion on phytoplankton). The majority of bacteria rely on material derived from phytoplankton, including waste exuded from plankton cells, cell autolysis, viral lysis, and organic material released from grazers feeding on phytoplankton (DFO 2011a). Figure 5.2.1 below depicts the concentration of bacteria in the water column along the Halifax AZOMP line over the Scotian Slope and where this line overlaps with the western part of the Project Area.



Source: DFO 2011a

Figure 5.2.1 Concentration of Bacteria in the Water Column of the Halifax AZOMP line, 2010

The highest concentration of bacteria is found in the upper surface layer of the water column (refer to Figure 5.2.1) where the highest abundance of phytoplankton is also found. It should also be noted that bacteria exist throughout the water column, below the photic zone, relying on dissolved organic matter (DOM) for energy.

Bacteria, specifically heterotrophic bacteria, are natural microbial agents which have the ability to remediate hydrocarbon contamination in the marine environment. Crude oil can be found naturally in the marine environment from natural seeps in the ocean floor (ASM 2011). Crude oil is, in essence, a natural product which has been generated by organisms millions of years ago that used photosynthesis to harness the energy of the sun as their principal energy source. The occurrence of petroleum hydrocarbons in offshore Scotian Shelf and Slope sediments is common, with background levels ranging from 1.0 to 26 mg/kg on the Scotian Shelf and Grand Banks (JWEL 2003). Certain microbes in the marine environment have evolved to use energy contained in hydrocarbons or crude oils, using enzymes to allow them to combust hydrocarbons as an energy source, much in the same manner as an engine, but at lower temperatures (ASM 2011).

5.2.1.2 Phytoplankton

Phytoplankton are microscopic plant-like organisms which, at the base of the marine food web, influence production of all higher trophic levels in an ecosystem (Worcester and Parker 2010). Phytoplankton are distinctive among ocean biota in that they derive their energy from sunlight and structural requirements from nutrients in the surrounding water (DFO 2011a).

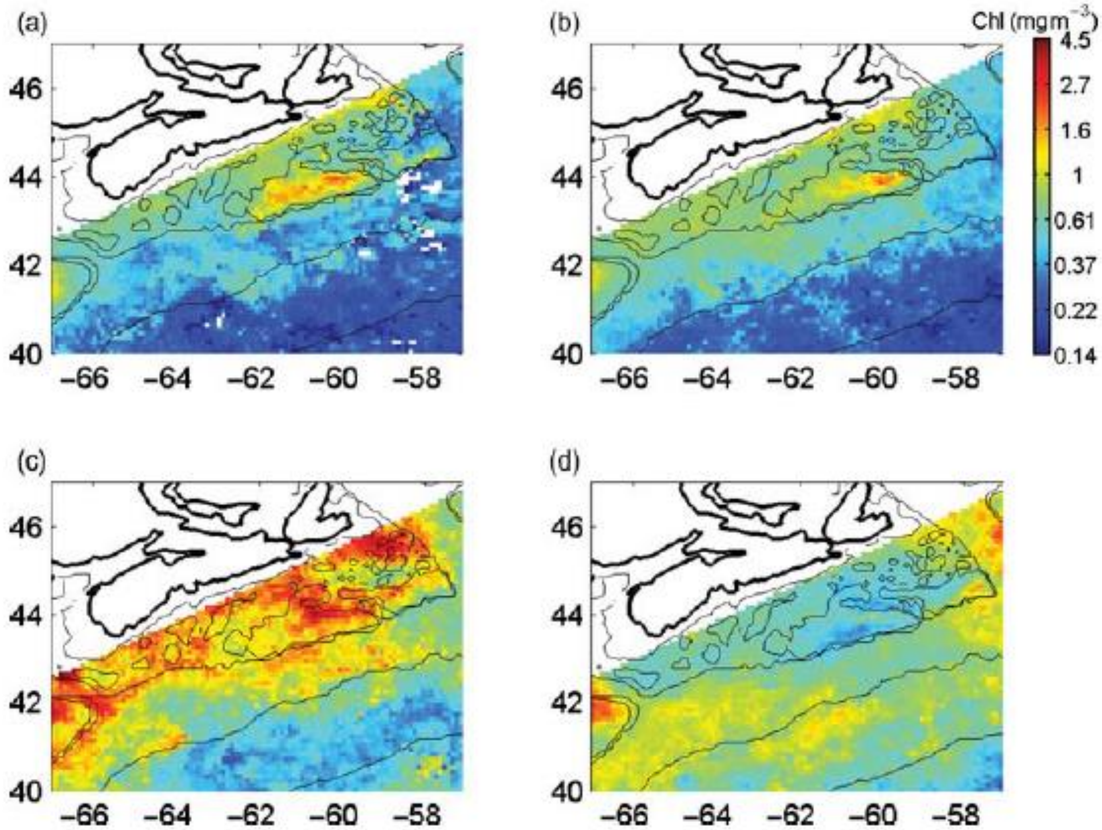
A strong increase in phytoplankton abundance, or bloom, can vary in spatial and temporal scales. Recent trends in the magnitude and duration of the spring bloom on the Scotian Shelf indicate that blooms are beginning earlier now than they did in the 1960s and 1970s and are more intense and longer in duration (Worcester and Parker 2010). The two dominant groups of phytoplankton on the shelf are the diatoms (which have silica shells) and the dinoflagellates (which can swim with flagella) (Boudreau 2013). The spring bloom is typically dominated by diatoms, with dinoflagellates contributing to blooms later in the season.

The initiation of the spring bloom on the Scotian Shelf and Slope varies by approximately two months depending on the location within the shelf and slope (Zhai *et al.* 2011). Table 5.2.1 depicts the average day of spring bloom initiation, bloom duration, peak day of the spring bloom and the amplitude of the spring bloom in various areas of the Scotian Shelf and Slope. Figures 5.2.2 and 5.2.3 depict surface chlorophyll concentrations during various times of the year and spring bloom characteristics on the Scotian Shelf and Slope.

Table 5.2.1 Values of Spring Bloom Characteristics on the Scotian Shelf and Slope

Region	Day of Bloom Initiation	Bloom Duration	Day at Peak of Bloom	Bloom Amplitude (mg/m^3)
Eastern Scotian Shelf	93	31	109	2.5
Middle Scotian Shelf	69	48	92	1.3
Western Scotian Shelf	88	29	102	1.6
Slope Water	67	99	117	0.6
Gulf Stream	84	72	120	0.5

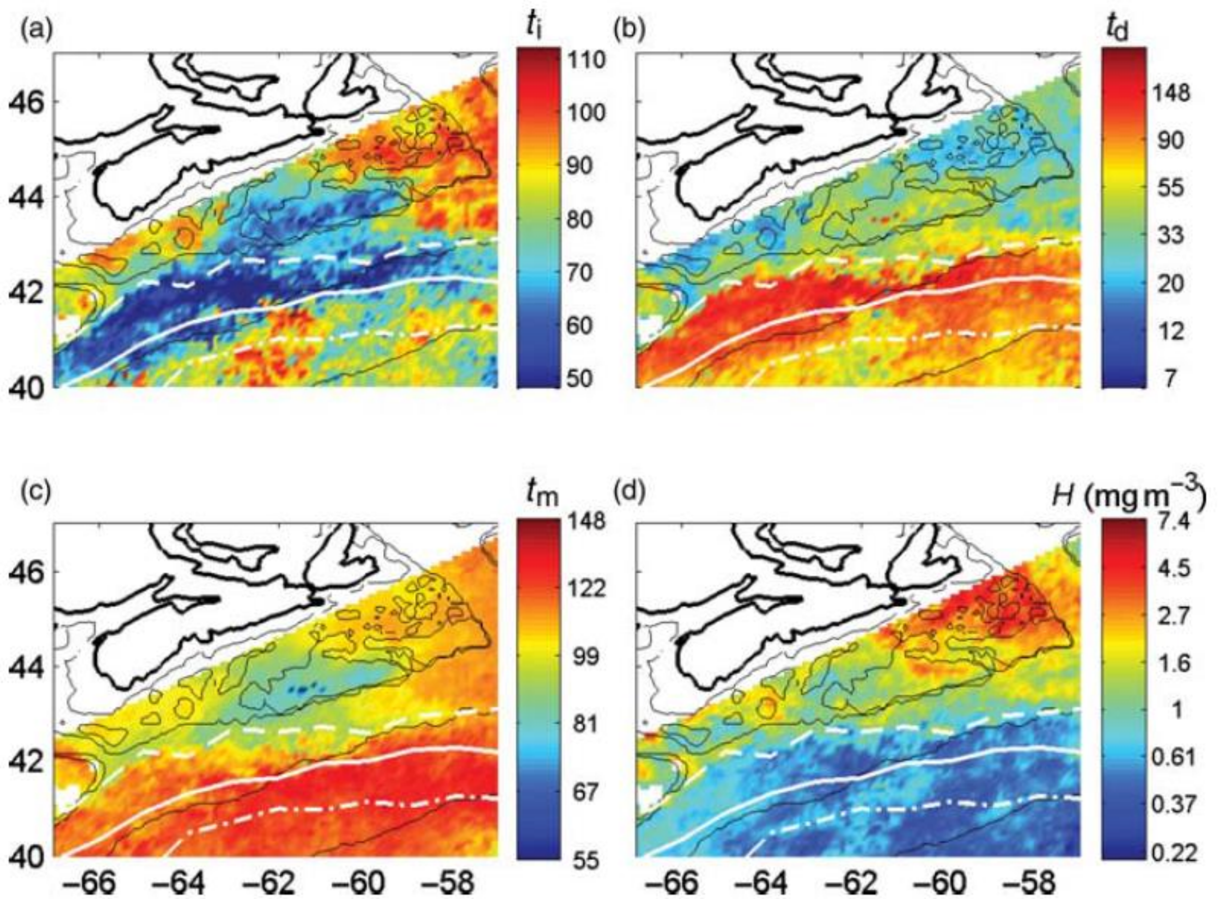
Source: Zhai *et al.* 2011



Source: Zhai *et al*. 2011

Figure 5.2.2 Ten Year Averages (1998–2007) of Eight-day Composite Surface Chlorophyll Concentrations from (a) Days 24–32 (Late January to Early February), (b) Days 56–64 (Late February to Early March), (c) Days 88–96 (Late March to Early April), and (d) Days 120–128 (Late April to Early May)

The duration of the spring bloom generally lasts longer in the slope (99 days) and Gulf Stream areas (72 days), than on the shelf (50 days) (Zhai *et al.* 2011). Even though the bloom on the slope starts before it does on the shelf, it doesn't reach a peak until after the shelf bloom has peaked. The waters of the Scotian Slope and Gulf Stream tend to peak later than those waters over the Scotian Shelf (Figure 5.2.3). Furthermore, the amplitude of the spring bloom is less on the slope and Gulf Stream when compared to shelf waters. The amplitude of the spring bloom is the highest over the Eastern Scotian Shelf with a general decline towards the southwest (Figure 5.2.3).



Source: Zhai *et al.* 2011

Figure 5.2.3 Spring Bloom Characteristics for the Scotian Shelf and Adjacent Regions: (a) time of bloom initiation (ti), (b) duration (td), (c) peak timing (tm), and (d) amplitude

5.2.1.3 Zooplankton

Zooplankton are small animals that are suspended and drift in the water column. They serve as the link between primary producers (phytoplankton) and the larger organisms in the marine environment (Breeze *et al.* 2002). Zooplankton are consumed by most marine species at some stage of their life cycle, from large baleen whales to small anemones (Breeze *et al.* 2002). Zooplankton can be divided into three main categories based on size:

- microzooplankton (20–200 µm in length), which includes ciliates, tintinnids, and the eggs and larvae of larger taxa;
- mesozooplankton (0.2–2 mm in length), which includes copepods, larvaceans, pelagic molluscs, and larvae of benthic organisms; and
- macrozooplankton (> 2mm), which includes larger and gelatinous taxa such as euphausids (krill), tunicates and salps.

The mesozooplankton community on the Scotian Shelf and Slope is dominated by copepods, with the most abundant species being: *Calanus finmarchicus* and *Pseudocalanus* sp. (winter/spring dominant); *Paracalanus parvus, Centropages typicus,* and *Centropages hamatus* (summer/fall dominant); and *Oithona similis* (abundant year-round) (Kennedy *et al.* 2011; Boudreau 2013).

In general, zooplankton abundance peaks from May to June, with the lowest concentrations from December to January.

Changes in the abundance of long-lived zooplankton species (*e.g., Calanus*) can be influenced by large-scale processes such as changes in ocean circulation. On the Scotian Shelf, zooplankton levels observed from 2000 to 2006 have been lower than those levels observed in the 1960s and 1970s, which is the reverse of the recent phytoplankton trend. However, they are beginning to recover from the lows observed in the 1990s (ASZISC 2011).

5.2.1.4 Ichthyoplankton

Ichthyoplankton include planktonic eggs and larvae of fish and shellfish. Ichthyoplankton, as well as other early planktonic life stages of marine animals, are collectively referred to as the meroplankton due to the fact that they are planktonic for only a portion of their life cycle (NOAA 2007).

The Scotian Shelf Ichthyoplankton Program (SSIP), which was conducted from 1976 to 1982, is one of the major sources of information on zooplankton for the Eastern Scotian Shelf. The outflow of the Gulf of St. Lawrence (Nova Scotia Current) is responsible for maintaining high biomass of ichthyoplankton on the northeast half relative to the southwestern half of the Scotian Shelf during June and October. High biomasses of various ichthyoplankton communities have been found on the Emerald and Western Banks during the spring and summer (Breeze *et al.* 2002).

Horseman and Shackell (2009) analyzed results from the SSIP to characterize areas on the Scotian Shelf and Slope where larvae were found. Some species of larvae were found off Browns, Baccaro, and LaHave Banks along the slope. These species include monkfish (*Lophius spp.*), haddock (*Melanogrammus aeglefinus*), red hake (*Urophycis chuss*) and redfish (*Sebastes spp.)*. The majority of fish species' larvae were found scattered along the banks of the Shelf from Emerald Bank to Sable Island including Atlantic mackerel (*Scomber scombrus*), silver hake (*Merluccius bilinearis*), cusk (*Brosme brosme*), pollock (*Pollachius virens*) and American plaice (*Hippoglossoides platessoides*). Some species larvae were found even further east towards the Laurentian Channel including witch flounder, and yellowtail founder. Herring larvae were found closer to shore, with larger numbers near southwest Nova Scotia.

Eggs and larvae have the potential to be found in areas of the Scotian Shelf and Slope year-round. Species including the Atlantic cod (*Gadus morhua*), roundnose grenadier (*Coryphaenoides rupestris*), and skate have the potential to spawn year-round. Other fish such as Atlantic mackerel, wolffish (*Anarchichas spp.*), American plaice, and flounder species spawn for short periods of time over the course of a few months. Based on variability between species, Shackell and Frank (2000) concluded from analyzing the SSIP data that the Scotian Shelf supports an array of species larvae throughout the year, with a seasonal change of species abundances with each season. In general (year-round) the most common genera found in the SSIP survey area include *Merluccius, Sebates, Urophycis, Glyptophalus,* and *Ammodytes.* Table 5.2.2 depicts the most abundant genera found within the survey area by season.

Table 5.2.2 Seasonal Abundance of Fish Larvae

Genus	Common Name(s)	Percentage of Total (%) (per Season)
Winter (December – March)		
Ammodytes	Sand lance	26.8
Clupea	Atlantic herring	19.0
Pollachius	pollock	12.8
Gadus	Atlantic cod	10.6
Lumpenus	shanny, eelblenny	5.6
Spring-Summer (April – July)		
Sebastes	redfish	18.6
Ammodytes	sand lance	16.6
Gadus	Atlantic cod	8.8
Hippoglossoides	American plaice	8.2
Melanogrammus	haddock	7.6
Summer-Fall (August – November)		
Merluccius	silver hake	21.9

Table 5.2.2 Seasonal Abundance of Fish Larvae

Genus	Common Name(s)	Percentage of Total (%) (per Season)
Urophycis	longfin, red, white hake	16.1
Glyptocephalus	witch flounder	11.3
Enchelyopus	fourbeard rockling	7
Sebastes	redfish	7

Source: Shackell and Frank 2000

Table 5.2.3 below depicts the respective spawning seasons as well as the time of year when eggs and larvae may be present in the water column on the Scotian Shelf and Slope for species at risk as well as for commercially important pelagic, groundfish, and invertebrate species.

Table 5.2.3 Summary of Spawning and Hatching Periods for Fish Species that May Occur in the Vicinity of the Project Area

Common Name	Scientific Name	Primary Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Species at Risk														
Acadian redfish	Sebastes fasciatus	Scattered over entire Scotian Shelf and Slope												
American plaice	*Hippoglossoides platessoides*	Nearshore: Halifax to Liverpool Georges to Banquereau Banks and edge, Roseway Basin												
Atlantic cod	*Gadus morhua*	Nearshore: Halifax to Yarmouth Georges Bank and scattered throughout the Western Scotian Shelf (WSS), with higher concentrations in Eastern Scotian Shelf (ESS)												
Atlantic wolffish	*Anarchichas lupus*	*Nearshore: South of Bridgewater and Southwest NS Roseway and LaHave Basins*												
Blue shark	*Priomace glauca*	*Not on Scotian Shelf or slope*												
Cusk	*Brosme brosme*	*Georges Basin, Roseway Basin, Browns to Western Sable Island Bank and edges*												
Deepwater redfish	*Sebastes mentella*	Scattered over entire Scotian Shelf and Slope												
Roughhead grenadier	*Macrourus berglax*	*Southern Grand Banks, potentially Scotian Slope*												
Roundnose grenadier	*Coryphaenoides rupestris*	*Scotian Slope*												
Smooth skate	*Malacoraja senta*	*Roseway Basin*												
Spiny dogfish	*Squalus acanthias*	*Roseway, LaHave, and Emerald Basins*												
Spotted wolffish	*Anarhichas minor*	*Outside of the RAA*												
Thorny skate	*Amblyraja radiata*	*Roseway and LaHave Basins Emerald to Banquereau Banks*												
Winter skate	*Leucoraja ocellata*	*Browns Bank, Western to Banquereau Banks*												
Pelagic Species														
Atlantic herring	*Clupea harengus*	*Nearshore: Halifax to Southwest NS Browns to Banquereau Banks, with a few along the shelf edge*												

Table 5.2.3 Summary of Spawning and Hatching Periods for Fish Species that May Occur in the Vicinity of the Project Area

Common Name	Scientific Name	Primary Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Atlantic mackerel	*Scomber scombrus*	*Emerald to Banquereau Banks and few along shelf edge*												
Black dogfish	*Centroscyllium fabricii*	*Gives birth to pups in Laurentian Channel*												
Capelin	*Mallotus villosus*	*Nearshore: Halifax* *Eastern Scotian Shelf*												
Groundfish Species														
Atlantic halibut	*Hippoglossus hippoglossus*	*Browns to Banquereau Banks and shelf edge*												
Haddock	*Melanogrammus aeglefinus*	*Nearshore: Halifax to Liverpool* *Georges Bank, Browns Bank to western Sable Island Bank and Shelf Edge, Roseway Basin*												
Monkfish	*Lophius spp.*	Georges to Banquereau Banks and shelf edge												
Pollock	*Pollachius virens*	*Nearshore: Halifax to Yarmouth* *Georges Bank, Browns to Western Bank*												
Red hake	*Urophycis chuss*	*Browns Bank to Sable Island Bank and Scotian Shelf edge*												
Sand lance	*Ammodytes dubius*	*Banquereau Bank*												
Silver hake	*Merluccius bilinearis*	Brown's Bank and Slope, Emerald to Banquereau Banks and Shelf edge												
Turbot-Greenland halibut	*Reinhardtius hippoglossoides*	*Potentially Scotian Slope*												
White hake	*Urophycis tenuis*	*Georges Bank, Roseway Basin, Baccaro Bank and Edge, Western to Sable Island Bank and edge*												
Witch flounder	*Glyptocephalus cynoglossus*	*Nearshore: Halifax to SW NS* *Georges to Banquereau Banks and the shelf edge and slope*												
Yellowtail flounder	*Limanda ferruginea*	*Nearshore: South of Halifax* *Georges Bank, Browns Bank, Emerald to Banquereau Banks*												
Invertebrate Species														
Lobster[1]	*Homarus americanus*	*Nearshore waters*												

Table 5.2.3 Summary of Spawning and Hatching Periods for Fish Species that May Occur in the Vicinity of the Project Area

Common Name	Scientific Name	Primary Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Jonah crab[2]	*Cancer borealis*	N/A												
Scallop	Potential for multiple species	Nearshore southwest NS Georges Bank, Browns Bank, Western to Banquereau Banks												
Northern shrimp	*Pandalus borealis*	Nearshore waters												
Shortfin squid	*Illex illecebrosus*	Not completely known - Possibly continental shelf south of Cape Hatteras and in the Gulf Stream												
Snow crab	*Chionoecetes opilio*	Nearshore southwest NS and Bridgewater to Halifax Eastern Scotian Shelf; Sable Island to Banquereau												

Note:
[1]Lobster eggs are extruded by the female from June to September and held until they hatch approximately 9–12 months later.
[2]Very little biological information exists for Jonah Crab on the Scotian Shelf and Slope.

	Mating period
	Potential Spawning Period
	Anticipated Peak Spawning Period
	Eggs and/or Larvae Present

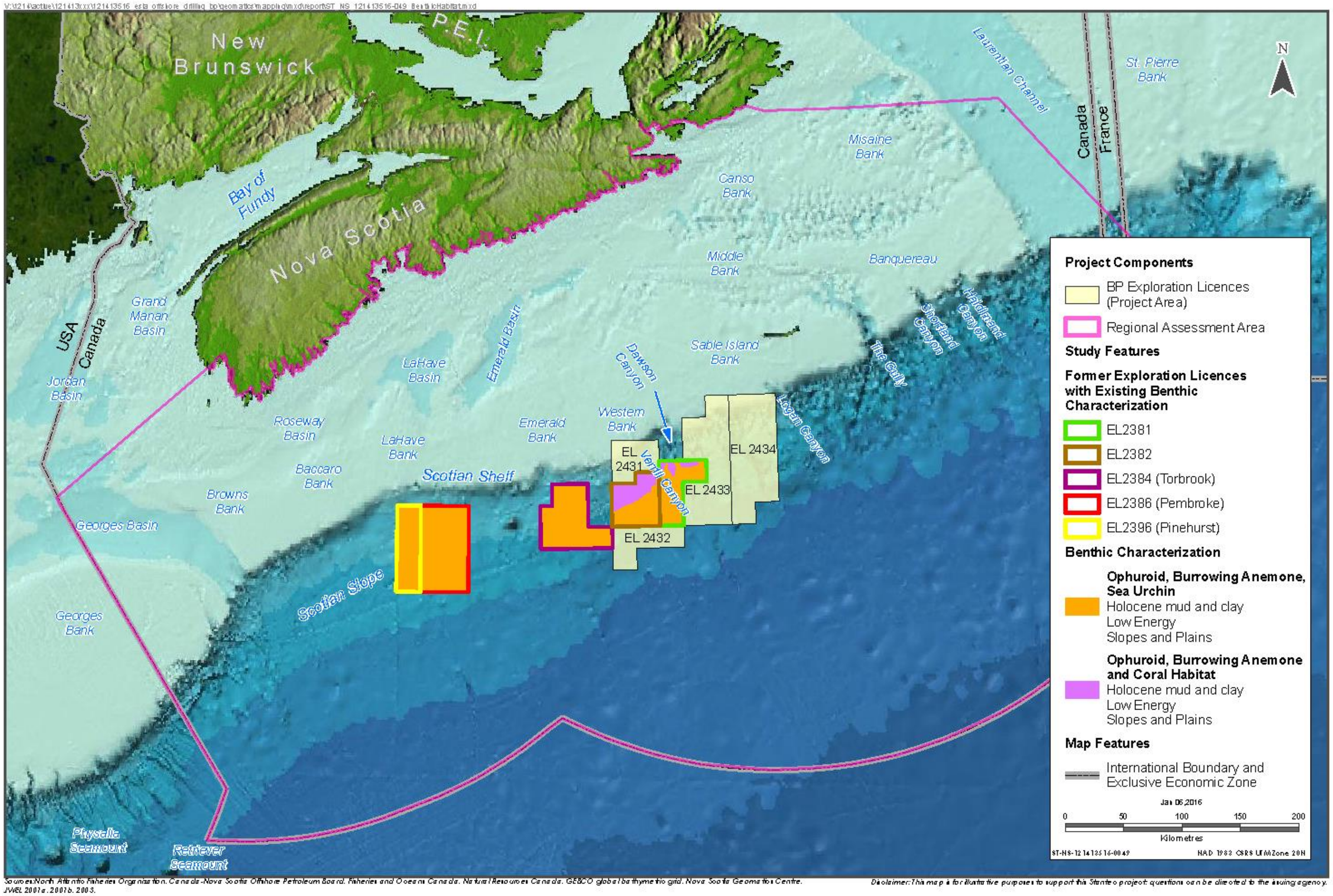
Sources: BIO 2013a; Campana *et al.* 2003, 2013; Cargnelli *et al.* 1999a,1999b; COSWEIC 2006a, 2007a, 2008a, 2010b,2012a, 2012b; DFO 2001, 2007a, 2009b, 2009c, 2010b, 2011a, 2013e2013f, 2013h, 2013i, 2013k, 2013l, 2013m, 2013n, 2013o; NOAA 2013b, 2013c; SARA 2013a, 2013b; Horseman and Shackell 2009

5.2.2 Benthic Habitat

The existing benthic habitat characterization is primarily based on deep-sea benthic surveys previously undertaken in former ELs along the Scotian Slope. Additional information has been sourced and will continue to be refined during Project planning as part of BP's regional Geohazard Baseline Review (GBR) and associated assessments including a site specific shallow hazards assessment and an ROV survey.

5.2.2.1 Previous Benthic Habitat Characterizations

Several deep-sea benthic surveys were undertaken along the Scotian Slope during 2001 and 2002 in former licence blocks near and overlapping the Scotian Basin Project Area. The former EL 2382 and EL 2381 leased by Shell Canada Ltd (JWEL 2003), Torbrook Block (EL 2384) leased by Encana Corporation (JWEL 2001b), and Pembroke and Pinehurst Blocks (ELs 2386 and 2396) leased by Kerr-McGee Offshore Limited (JWEL 2001a) were all surveyed during this time period. The areas previously surveyed fall within the depth range of the Project (Figure 5.2.4). The habitat among the adjacent blocks is consistent and provides strong evidence to suggest that similar habitat may occur within the Project Area. This section describes the benthic habitat and communities found within each of the surveyed blocks.



Sources: JWEL 2001a, 2001b, 2003.

Figure 5.2.4 Areas of Existing Benthic Characterization in Proximity to the Project Area

Former EL 2381 and 2382

ELs 2381 and 2382 were both former deepwater ELs which overlap the current Project Area and have water depths ranging from 1,500 to 3,400 m (JWEL 2003) (Figure 5.2.4). A survey was conducted in September 2002 to characterize the benthic community and surficial sediments within the licence blocks using grab samples and still camera transects.

The seabed in EL 2381 is incised by Verrill and Dawson Canyons in the centre of the block with slopes of 1.5 to 2 degrees. The seabed in EL 2382 is relatively flat with minor escarpments and an overall seabed slope of two degrees (JWEL 2003). The sediments in EL 2381 and 2382 are composed primarily of Holocene silts and clays (JWEL 2003). These silts and clays are slowly deposited in deep water and form a "blanket" over the area. The sediments consist of primarily clay, with a secondary silt component and a lesser amount of fine sand, and vary in thickness from 0.5 to 1 m. Figure 5.2.5 depicts the typical substrate found within ELs 2381 and 2382. There are isolated patches of gravel substrate, although these are rare. Sand sedimentation was observed in Dawson Canyon. Refer to Table 5.2.4 for a summary of grain size and carbon content of the surficial sediments in ELs 2381 and 2382. Petroleum hydrocarbons were found in 14 of the 16 sampling stations over the two ELs, with the majority of total petroleum hydrocarbon (TPH) levels measuring less than 3 mg/kg. The occurrence of petroleum hydrocarbons in offshore Scotian Shelf and Slope sediments is common with background levels ranging from 1 to 26 mg/kg on the Scotian Shelf and Grand Banks (JWEL 2003).

Source: JWEL 2003

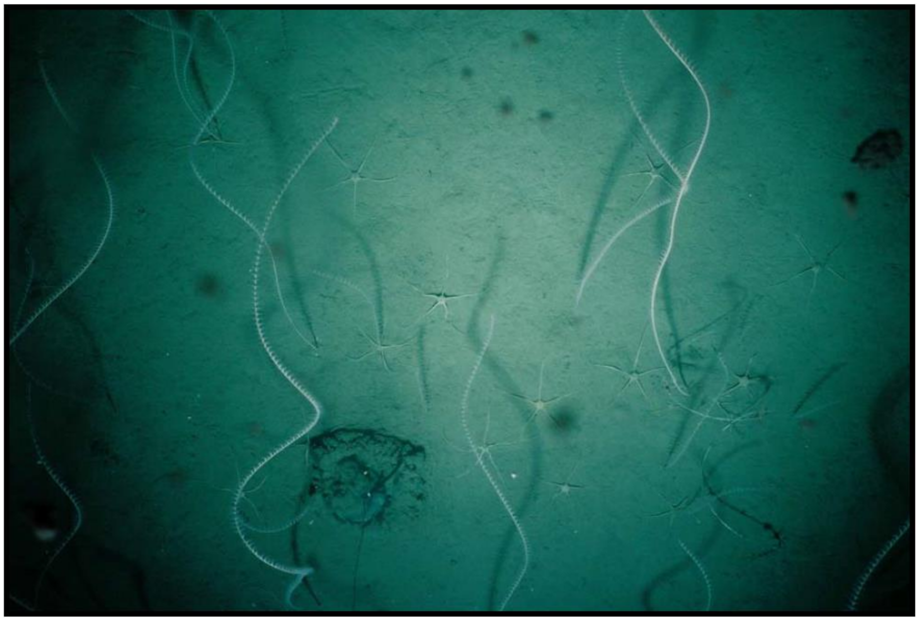
Figure 5.2.5 Typical Benthic Habitat in Former EL 2381 and EL 2382

Table 5.2.4 Summary of Grain Size and Carbon Content of Surficial Sediments from EL 2381 and EL 2382

Parameter	Unit	Range (based on 16 samples)	Mean (St. Dev.)
Gravel (>2 mm)	%	<1.0 - 0.5	0 (0.1)
Sand (0.06-2.0 mm)	%	2.7 - 60.9	10.5 (13.7)
Silt (0.015-0.06 mm)	%	20.5 - 45.4	36.8 (5.6)
Clay (<0.015 mm)	%	18.2 - 63.5	52.7 (10.7)
<12.5 mm	%	100	100 (0)
<9.5 mm	%	100	100 (0)
<4.75 mm	%	100	100 (0)
<PHI -1 (2 mm)	%	99.5 - 100.0	100 (0.1)
<PHI 0 (1 mm)	%	99.2 - 100.0	99.9 (0.2)
<PHI +1 (0.5 mm)	%	97.9 - 100.0	99.8 (0.5)
<PHI +2 (0.25 mm)	%	88.5 - 99.8	98.9 (2.6)
<PHI +3 (0.125 mm)	%	73.1 - 99.4	97.1 (6.0)
<PHI +4 (0.063 mm)	%	38.6 - 97.3	89.5 (13.9)
<PHI +5 (0.031 mm)	%	27.7 - 93.0	81.0 (15.3)
<PHI +6 (0.016 mm)	%	23.4 -86.2	72.6 (15.0)
<PHI +7 (0.008 mm)	%	19.5 - 74.1	60.6 (12.6)
<PHI +8 (0.004 mm)	%	18.2 - 63.5	52.7 (10.7)
<PHI +9 (0.002 mm)	%	10.6 - 45.9	28.3 (10.2)
Benzene	mg/kg	<0.025 - 0.2	0 (0.1)
Toluene	mg/kg	<0.025	<0.025
Ethylbenzene	mg/kg	<0.025	<0.025
Xylenes	mg/kg	<0.05	<0.05
Total C6-C10 (incl BTEX)	mg/kg	<2.5	<2.5
>C10-C21 (fuel range)	mg/kg	0.26 - 0.82	0.4(0.1)
>C21-C32 (lube range)	mg/kg	0.3 - 3.1	1.1(0.7)
Total Carbon	g/kg	12.0 - 33.0	26.5 (4.6)
Total Organic Carbon	g/kg	3.5 - 20.0	15.3 (3.6)
Total Inorganic Carbon	g/kg	8.0 - 14.0	11.1 (1.5)

Source: JWEL 2003

Brittle stars and burrowing anemones were the most common fauna observed in ELs 2381 and 2382. Polychaetes, sea cucumbers, sea urchins and large nudibranchs were also observed (JWEL 2003). A few stations contained corals which included sea whips, the soft coral *Anthomastus* spp., and the octocorals *Umbellula, a sea pen*. All of the coral species were observed at depths less than 2,000 m. Figures 5.2.6 and 5.2.7 illustrate commonly found species within the blocks. Overall, the benthic fauna across the two blocks was low in abundance and diversity and no regions containing substantial coral development were observed (JWEL 2003).



Source: JWEL 2003

Figure 5.2.6 Sea Whip Coral Observed in EL 2381

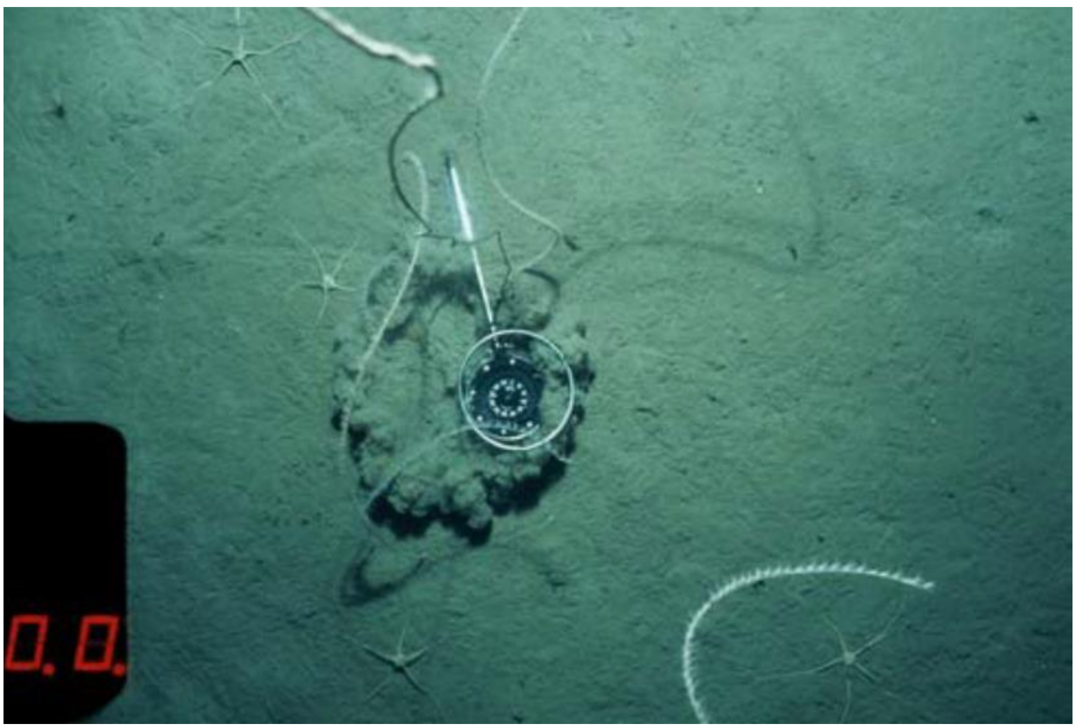
Source: JWEL 2003

Figure 5.2.7 Large Nudibranch Observed in EL 2381

Torbrook Block – EL 2384

EL 2384, known as the Torbrook Block, is a former EL located on the Scotian Slope, immediately west of the Project Area (Figure 5.2.6). The benthos shows little relief and gentle slope. The EL was located in depths ranging from 850 to 3,000 m with a seabed consisting of silts and clays of Holocene age (BEPCo 2004).

The Torbrook Block was surveyed in 2001. Isolated gravel material was observed, but rare. A diverse benthic community was found with brittle stars (0 to 20.4 per m^2) and burrowing anemones (0 to 1.6 per m^2) being the most commonly observed species, which is typical of soft sediment habitats. Sea urchins (0 to 2 per m^2) and sea whips (0 to 6.8 per m^2) were frequently observed at a few stations but not throughout the block (Figure 5.2.8). The silt and clay substrate in deep waters support sparse benthic community assemblage primarily consisting of brittlestars, borrowing anemones and sea urchins.



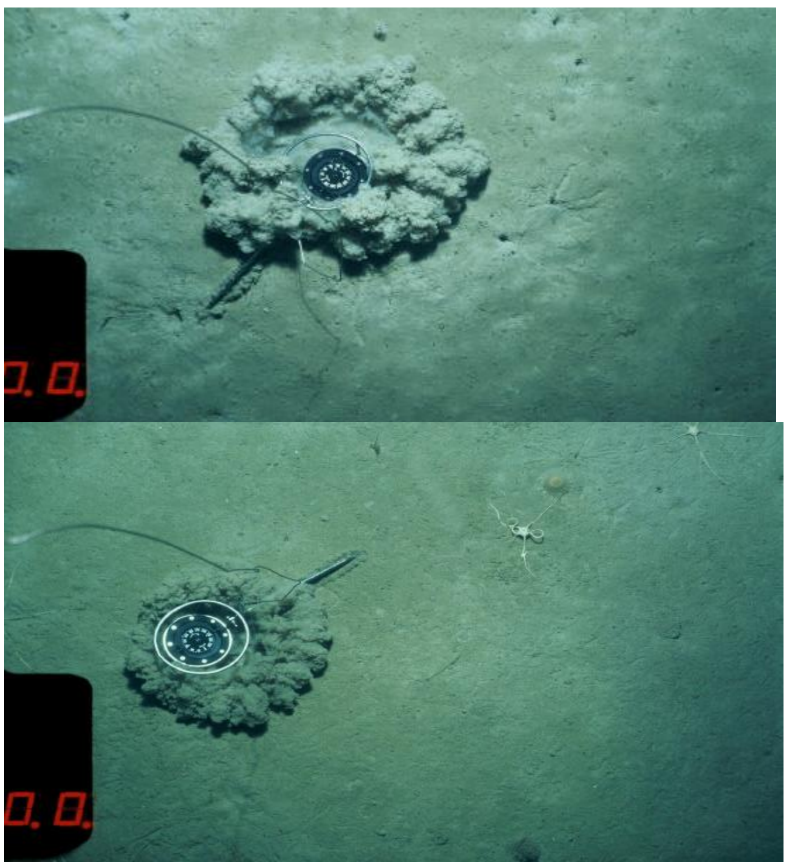
Source: BEPCo 2004

Figure 5.2.8 Sea Whips in Mud Substrate of the Torbrook Block

Pinehurst and Pembroke Blocks – ELs 2396 and 2386

The Pinehurst and Pembroke ELs were located on the Scotian Slope, west of the Project Area (BEPCo 2004) (Figure 5.2.4). Water depth ranges from 700 to 2,500 m in the Pinehurst Block, and 1,050 to 2,900 m in the Pembroke Block. The seafloor is characterized by an area of little relief and gentle slopes. From 1,159 to 2,000 m, the slope is approximately 1.5°, although there are areas of steeper slopes. The seafloor of the Pembroke Block was observed to be without large topographic feature diversity (JWEL 2002a).

A combination of underwater camera transects and grab samples in a 2001 deepwater survey (JWEL 2001a) provided information on both infaunal and epifaunal benthic community assemblages. The data obtained from both camera transects and grab samples suggested that the benthic habitat over the ELs is comprised of Holocene silt and clay. This material blankets the slope, providing habitat for epibenthic brittle stars and infaunal burrowing anemones. The uppermost image in Figure 5.2.9 shows the typical benthic habitat observed within the Pinehurst and Pembroke Blocks in 2001.



Source: JWEL 2001a

Figure 5.2.9 Typical Seafloor Habitat in the Pembroke and Pinehurst Blocks (top: image size 1.2 m²) showing Brittle Stars and Burrowing Anemones (bottom: image size 1.1 m²)

Approximately 56% of the seafloor images (41 of 74 images) within the survey areas showed barren habitat and lacked visible epifaunal organisms. Brittle stars, polychaete tubes, and burrowing anemones were the most common visible organisms (lower image in Figure 5.2.9) (JWEL 2001a). Other species which were rarely observed included sea pens (*Pennatulacea*), sea cucumbers (*Holothuroidea*), benthic shrimp, sea stars (*Asteroidea*), and sea urchins (*Echinoidea*). Small mollusks (snails, clams, and scaphopods) as well as crustaceans (amphipods, isopods, and tanaids) were other taxa observed in the sediments. Brittle stars ranged in density from 0 to 4.5 per m^2 and anemones ranged from 0 to 2.7 per m^2. Overall densities of observed species were low with an average of 0.8 to 1.2 individuals per m^2. Corals were not observed in any of the images taken and only one coral, a stony cup coral, was found in a grab sample (JWEL 2001a).

Overall the benthic habitat within the Pinehurst and Pembroke Blocks was identified as ophuroid (brittle star) and burrowing anemone habitat (JWEL 2001a). Benthic fauna across the blocks appeared to be generally low in abundance and diversity. The two blocks were not found to be an area of substantial coral development.

5.2.2.2 Geohazard Baseline Review

BP has carried out a regional GBR of the seabed and shallow geological conditions for potential shallow hazards within the ELs. The GBR was based primarily on 3D WATS exploration seismic data, and supplemented with existing regional data, such as geotechnical cores and offset wells where available. The area assessed as part of the GBR (*i.e.*, the GBR Study Area) overlaps with the sections of the ELs which were included in the WATS seismic survey, which covers approximately 8,500 km^2. Water depths included in the GBR Study Area range between 1,573 m and 3,730 m.

Geohazards are features or geological conditions which could pose a potential hazard to drilling activity. These features may include, but are not limited to, seabed and buried faults, erosion, scour and truncation surfaces, shallow gas charged sediments and hydrates, shallow water flow zones or abnormal pressure zones, variable seabed topography and seabed sediment conditions, and slope failures including slumps and debris flows. Some of these features could be indicative of cold water corals and other benthic communities.

The original 3D WATS data were acquired and processed to support exploration, not site investigation activities, but are considered to have sufficient resolution and bandwidth to define the preliminary spatial variability of marine geohazard risks on drilling and developability across the study area. The data have been processed to a 25 m x 25 m bin size with a 4ms sample rate using a Kirchhoff Prestack Depth Migration and a Sediment Flood velocity model, with a record length of approximately 14,000 m.

In order to assist with a broad, regional understanding of seabed sediments across the ELs, BP developed an extensive geodatabase from sources such as Geological Survey Canada (GSC) expeditions, CNSOPB, Nova Scotia Offshore, Project Offshore Deep Slope (PODS) and BP's own exploration data. This depository houses a significant amount of both marine and terrestrial geotechnical, geophysical, and geological data. The geodatabase was developed by C-CORE and contains specific core sampling information such as grain size distribution, radiocarbon dates, shelf and slope surficial geology and sediment type maps that in most cases cover the entire BP ELs. Moreover, the database provides insight into seabed erosion pattern, canyon formation, local slumps and debris flows, sediment zonation on the outer shelf and upper slope that all complement BP's geophysical exploration data and help to develop a better understanding of the seabed conditions at the well sites. As such, BP considers there to be sufficient existing data and information with regard to surficial seabed conditions for the purpose of drilling exploration wells.

The 3D WATS exploration seismic data was also used to gain a better understanding of potential seabed fluid expulsion features, hardgrounds and variable seabed topography across the area. The expulsion features may be derived from non-hydrocarbon and hydrocarbon based fluids. Fluid expulsion features related to shallow gas often are associated with carbonate hardgrounds and benthic communities. In addition, hardgrounds not related to fluid expulsion such as corals, may also be identified if laterally extensive. BP will take account of such features during well planning, specifically to avoid them when identifying potential wellsite locations to minimize the possibility of encountering shallow hazards and benthic communities.

The GBR has shown that the main concerns for drilling hazards within the GBR Study Area are related to variable seabed sediment properties, slope stability, possible drilling fluid losses within buried coarse-grained channel deposits and faults, regional seismicity, localized shallow gas, possible localized massive gas hydrate accumulations in coarse grained proglacial sediments, and steep angle at the top of salt. BP is currently reprocessing the 3D WATS seismic data to further increase the sampling rate and frequency requirements for detailed shallow hazard assessments for potential wellsite locations. As noted previously, the GBR may be used to assist in scoping areas for preliminary wellsites, to avoid areas of potential geohazards. The reprocessed 3D WATS seismic data will be used to refine well locations and generate site specific shallow hazards assessments to support detailed well design.

Some maps from the GBR have been presented in Figure 5.2.10 to illustrate the type of data that will be used to inform wellsite selection. The representative maps from the GBR included here show surficial geology (top image) and seafloor geomorphology and infrastructures (bottom image).

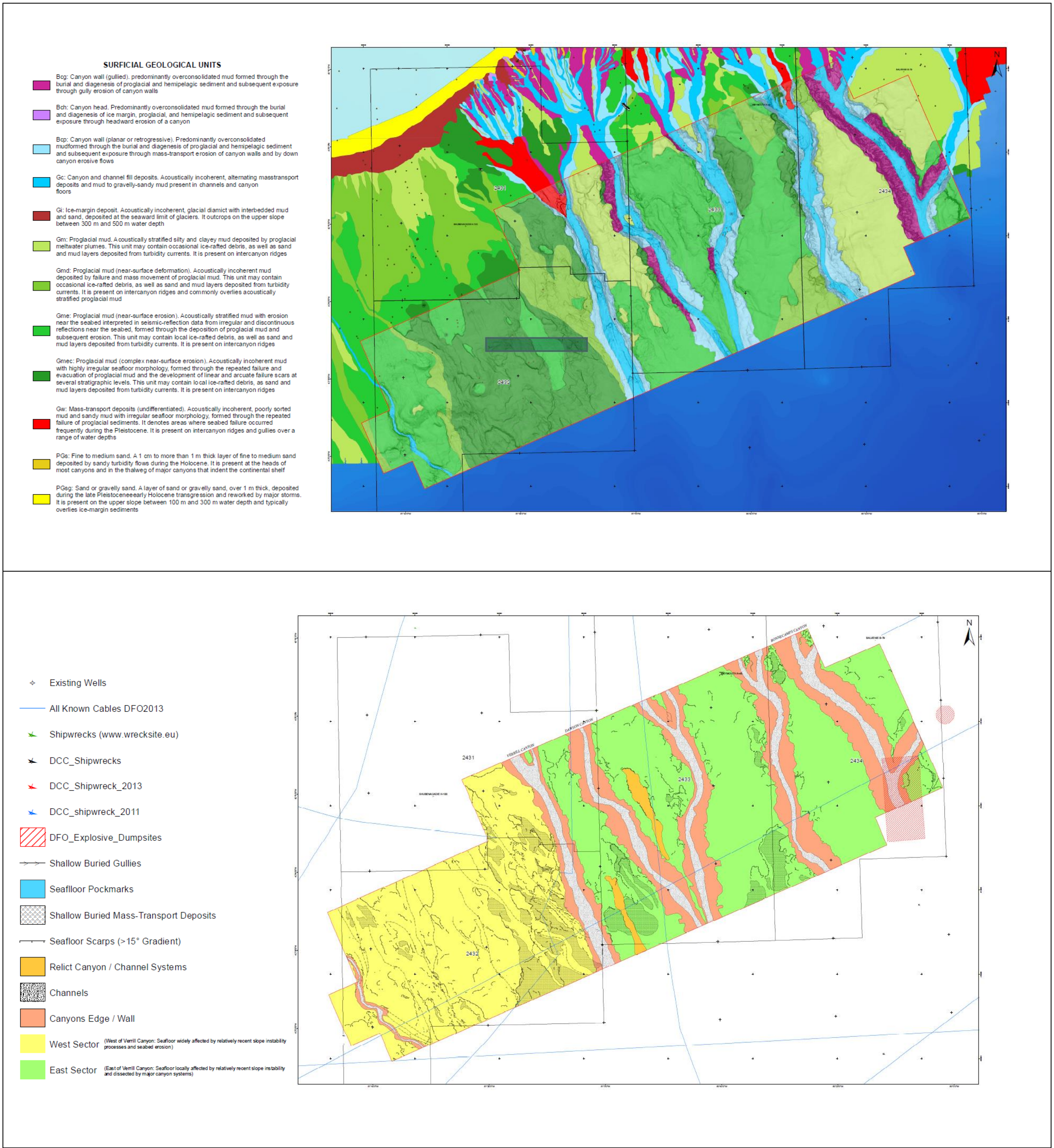


Figure 5.2.10 Extracted Maps from the Geohazard Baseline Review showing Surficial Geology and Seafloor Geomorphology and Infrastructures

Site Specific Shallow Hazards

Site specific shallow hazards assessments will be conducted once potential well locations have been identified, taking account of hazards identified in the GBR. BP will execute the shallow hazard assessment to complete a more detailed description of subsurface geological conditions which could pose a potential hazard to drilling activity and a more detailed explanation of seafloor conditions and evaluation criteria for each individual location. The site specific shallow hazards assessment will be submitted to the CNSOPB for consideration as part of the ADW process.

To provide an indication of the type of information that would be provided as part of the site specific shallow hazards assessment, a preliminary summary of seafloor site conditions at two potential well locations within the ELs has been provided. The two potential well locations that have been assessed are the same locations used as part of the spill modelling assessment (refer to Figure 8.4.1 in Section 8.4). The data that has been provided at this stage in the EIS is for illustrative purposes only and is not intended to serve as a full shallow hazards assessment.

Site 1

Site 1 is located in a generally flat area adjacent to the Bonnecamps Canyon on the Scotian continental slope in EL 2434 with a water depth of approximately 2104 m (refer to Table 8.4.1 and Figure 8.4.1 for additional information about the site location). This preliminary assessment investigates site conditions in a 2500 m radius around the proposed wellsite. Seafloor conditions are interpreted to be generally favourable in the vicinity of the proposed wellsite.

- The seabed appears smooth and stable at the proposed location and slopes approximately 1.8˚ to the southeast.
- The potential for large scale mass transport events impacting the proposed location over the course of exploration drilling activities is negligible. Small scale debris flows related to channel levee and overbank deposition associated with the Bonnecamps Canyon are possible, but unlikely and if present are not expected to negatively impact exploration drilling operations.
- The seafloor in the vicinity of the proposed wellsite is free of amplitude anomalies and topographic features indicative of hard grounds.
- Seafloor amplitude anomalies associated with the channel thalweg are likely indicative of shallow buried channel sands.
- Seafloor sediments are composed of a surficial layer of fine-grained, hemipelagic drape, underlain by proglacial muds. These muds are acoustically stratified, silty and clayey mud deposited by proglacial meltwater plumes. This unit may contain occasional ice-rafted debris, as well as sand and mud layers deposited from turbidity currents.
- There is no indication of faults that offset the seafloor. Faults are observed in the subsurface with some that come close to the seafloor, but are eroded and covered by proglacial muds and hemipelagic drape.
- Evidence of seafloor fluid expulsion mounds or pockmarks is not found within the study area.

- There are no amplitude anomalies or topographic features observed with the current dataset at Site 1 that would suggest the presence of benthic communities however this will be confirmed by an imagery based seabed survey prior to spud.
- Seafloor debris and man-made obstructions have not been identified on the 3D seismic data. There are no reported anthropogenic features such as shipwrecks or debris within the Site 1 study area however this will be confirmed by an imagery based seabed survey prior to spud.

Figure 5.2.11 displays the results of the GBR analysis for Site 1.

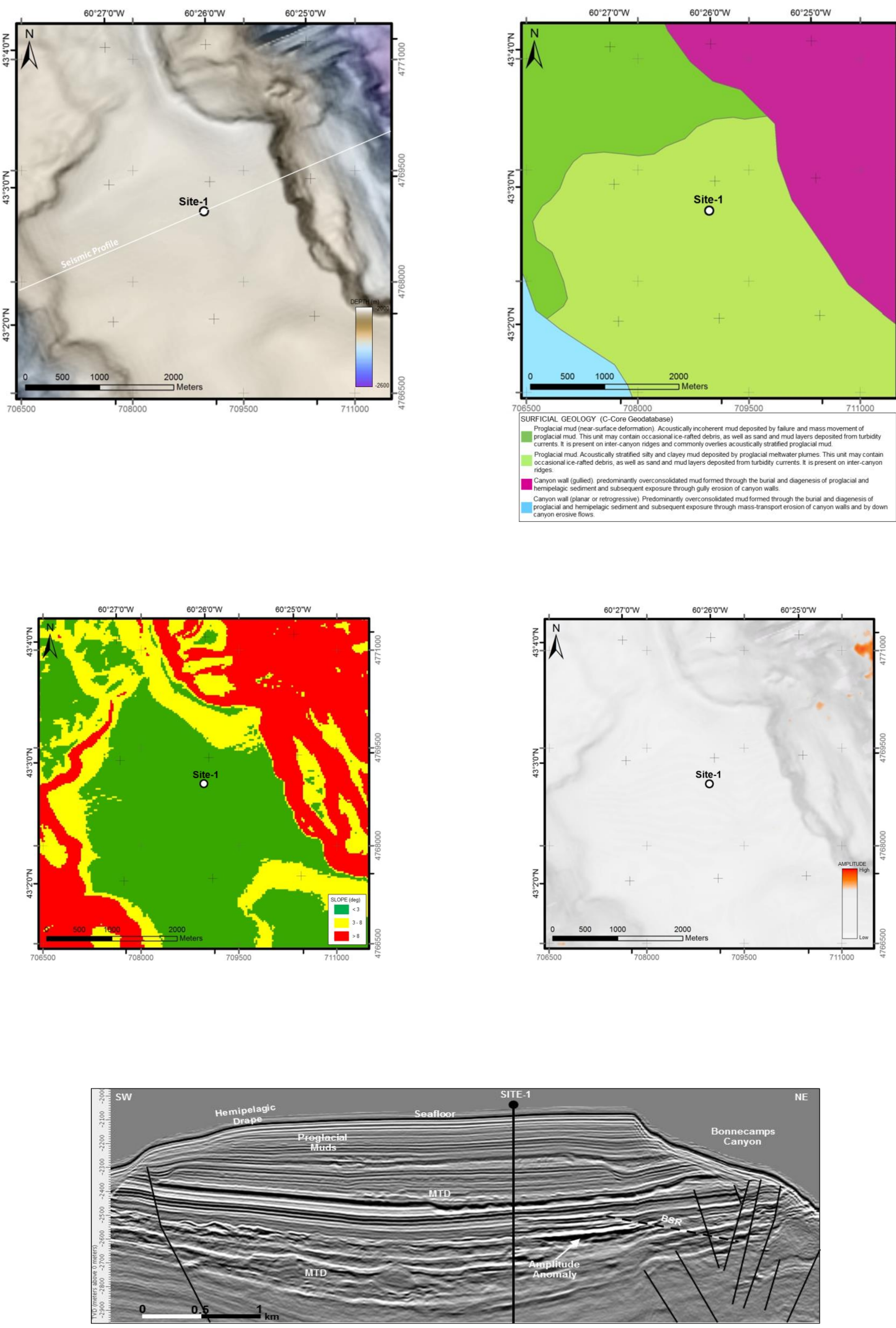


Figure 5.2.11 Characterization of Site 1 Using GBR Data, showing Water Depth, Surficial Geology, Seafloor Gradient, Seafloor Amplitude and Shallow Amplitude Anomaly Assessment.

Site 2

Site 2 is located in EL 2432 at a water depth of approximately 2652 m. Site 2 is located in an area of heavy seafloor erosion on the Scotian slope. This preliminary assessment investigates site conditions in a 2500 m radius around the proposed wellsite. Seafloor conditions are interpreted to be generally favourable in the vicinity of the proposed wellsite. These are summarized as follows:

- The seabed slopes approximately 3.4° to the southeast in an area heavily impacted by past seafloor erosion.
- Seafloor sediments are composed of a surficial layer of fine-grained, hemipelagic drape, underlain by proglacial muds. These muds are acoustically incoherent sediments deposited by failure and mass movement. This unit may contain occasional ice-rafted debris, as well as sand and mud layers deposited from turbidity currents.
- The seafloor morphology is characterized by retrogressive failures as well as mounds (erosional remnants) and pits related to past erosional events.
- The potential for large scale mass transport events impacting the proposed location over the course of exploration drilling activities is negligible. Past events are related to sealevel lowstands and progradation of glaciers onto the continental shelf.
- Small scale debris flows are possible, but unlikely and if present are not expected to negatively affect exploration drilling operations.
- There is no indication of faults that offset the seafloor. Faults are observed in the subsurface with some that come close to the seafloor, but are eroded and covered by proglacial muds and hemipelagic drape.
- Evidence of seafloor fluid expulsion mounds or pockmarks is not found within the Site 2 study area.
- Seafloor amplitudes in the vicinity of the proposed well location are generally high, related to past erosion of shallow sediments and presence of coarse-grain and/or overconsolidated sediments near the seafloor. Coarse-grained and/or overconsolidated sediments may cause operational difficulties related to conductor installation operations.
- While the generally rugose seafloor character and presence of amplitude anomalies related to the underlying sediments makes identification of aggregated benthic communities somewhat less certain, there are no interpreted amplitude anomalies or topographic features observed with the current dataset that would suggest the presence of aggregated benthic communities. This will be confirmed by an imagery based seabed survey prior to spud.
- Seafloor debris and man-made obstructions have not been identified on the 3D seismic data. There are no reported anthropogenic features such as shipwrecks or debris within the Site 2 study area however this will be confirmed by an imagery based seabed survey prior to spud.

Figure 5.2.12 displays the results of the GBR analysis for Site 2.

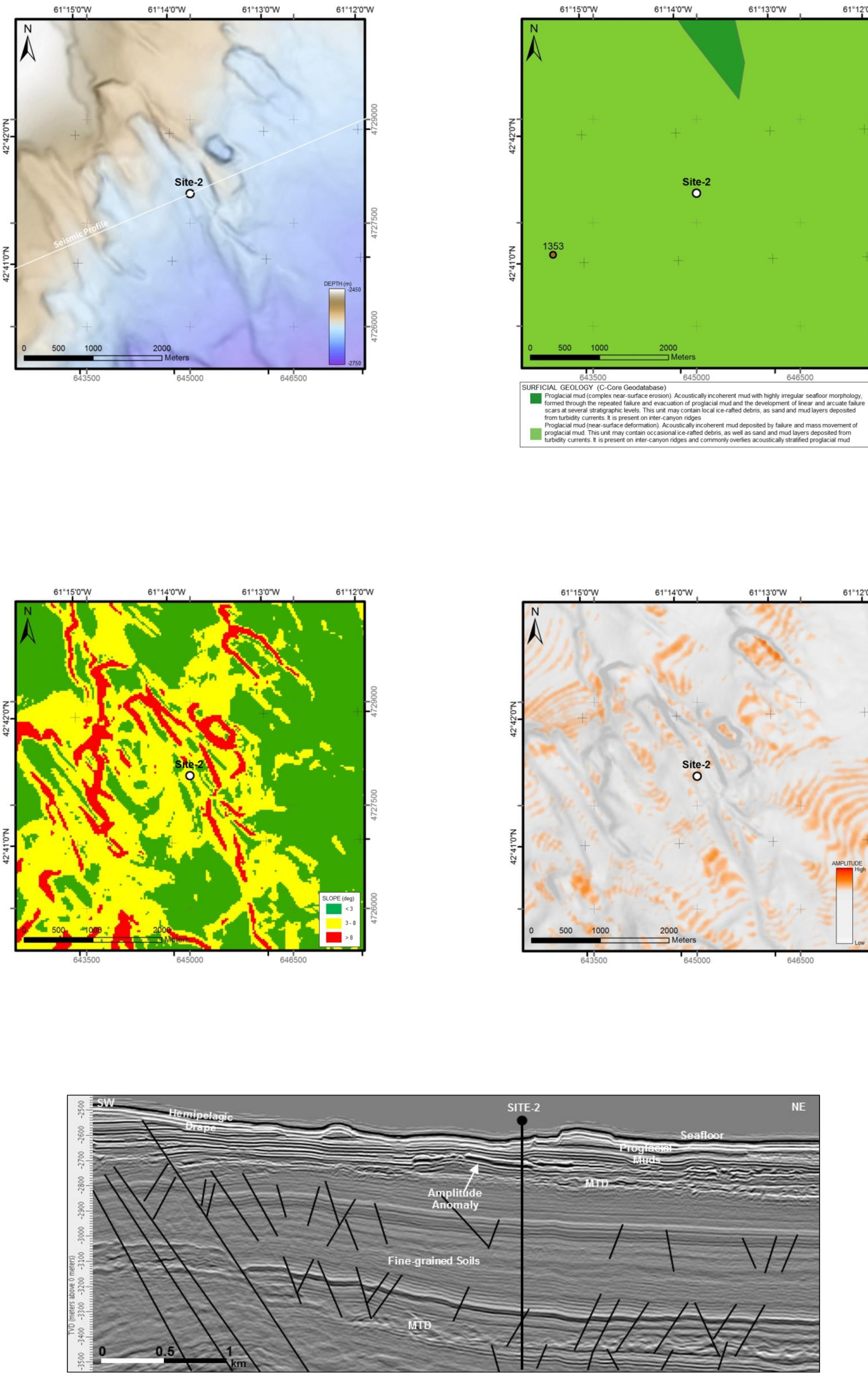


Figure 5.2.12 Characterization of Site 2 Using GBR Data, showing water depth, surficial geology, seafloor gradient, seafloor amplitude and shallow amplitude anomaly assessment

Seabed Survey

BP will confirm information gathered as part of the GBR and site specific shallow hazards assessment through a seabed survey. Features such as shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk will be identified, if present, through the use of an imagery based seabed survey.

The survey will be carried out once the drilling rig is in place at a proposed wellsite, prior to drilling. The survey will be carried out using a remote operated vehicle (ROV) which will be deployed from a boat or the drilling rig. Footage will be captured over an area with a 500 metre radius in an eight leg pattern in 45 degree increments.

If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.

5.2.3 Corals and Sponges

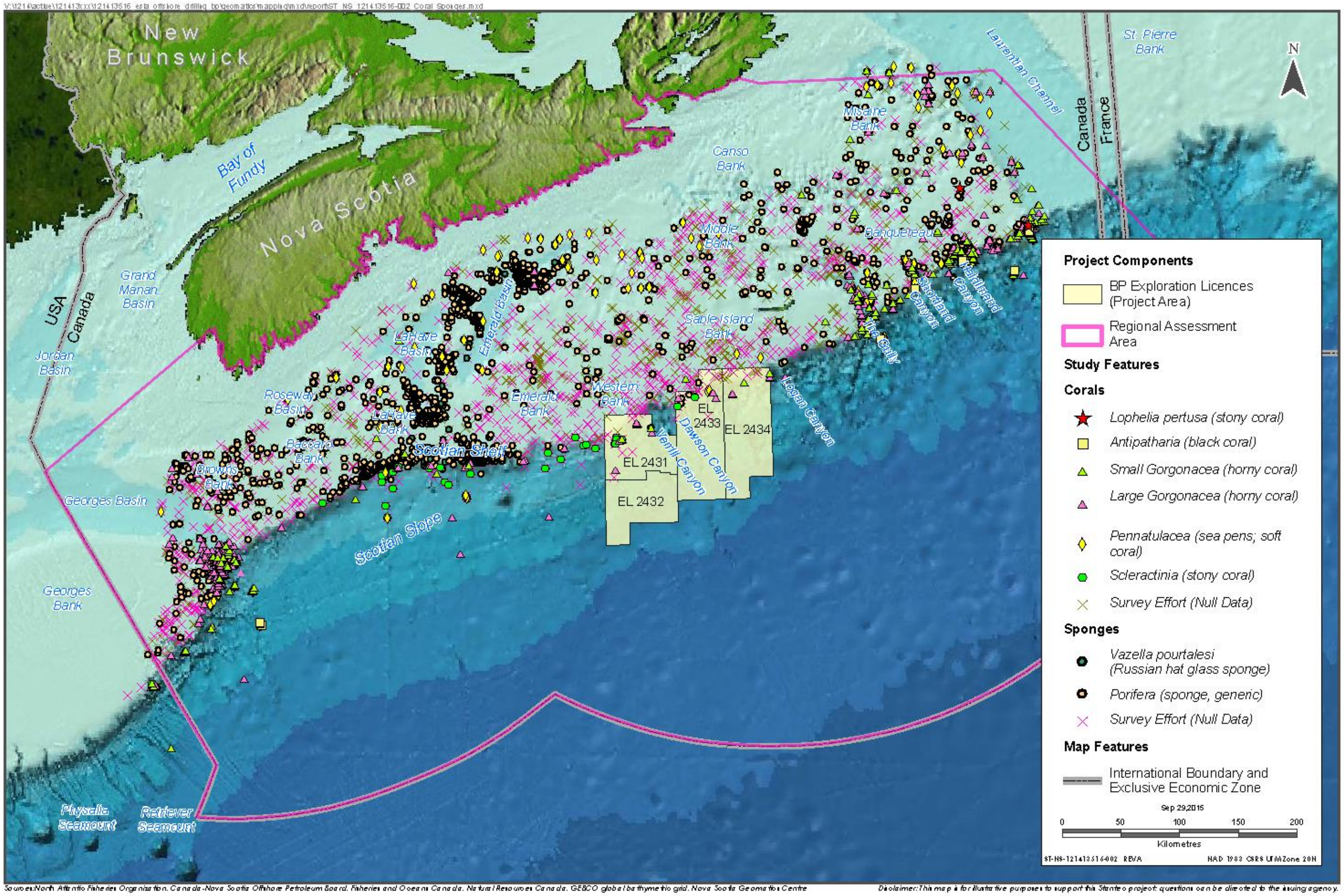
Corals and sponges are marine benthic invertebrates that attach themselves to bottom substrates and filter-feed on suspended particles in the water column. Corals and sponges provide various ecological functions. Dense aggregations of corals and sponges can alter bottom currents and provide a niche space for other organisms, increasing the biodiversity of the area. In particular, corals and sponges provide marine fish and invertebrate protection from strong currents and predators, and can serve as nursery areas for larval and juvenile life stages, feeding areas, breeding and spawning areas, and resting areas (Campbell and Simms 2009). Corals and sponges also contribute to biogeochemical processes, including nutrient cycling between the sea bottom and the water column (Kenchington *et al.* 2012). Slow growth rates, longevity, variable recruitment, and habitat-limiting factors make corals and sponges particularly vulnerable to direct physical impacts and limit recovery (DFO 2013d).

There are two major groups of cold-water corals offshore Nova Scotia: hard/stony corals (*Scleractinia*) and octocorals or soft corals. Unlike hermatypic corals that are true reef-building corals and live in warm, shallow waters and contain symbiotic algae, ahermatypic corals are cold-water corals that can live at depths without the influence of sunlight, and can occur in solitary or reef formations. Most corals require a hard substrate to attach to, although some species are able to anchor themselves into soft sediments (ASZISC 2011).

In general, cold-water corals are poorly studied, in part due to their inaccessibility as most species are found at water depths greater than 200 m on continental slopes, canyons, or seamounts (DFO 2011a). DFO has led coral research on the Scotian Shelf, Slope, and in the Gulf of Maine, including various research surveys, since the late 1990s. The Gully has the highest known diversity of corals in Atlantic Canada (Moors-Murphy 2014). Figure 5.2.13 displays the known distribution of corals and sponges on the Scotian Shelf (data courtesy of DFO). While it is noted that the extent of the survey did not extend over the full ELs, the data do show the general distribution and diversity of coral and sponge species on the Scotian Shelf and Slope, including the rare *Lophelia* (reef-building) coral species that is present approximately 200 km to the northeast of the ELs, at a water depth of approximately 300 m.

A few benthic stations sampled in the former EL 2381 and EL 2382 that overlap with the Project Area contained corals, which included sea whips, the soft coral *Anthomastus* spp., and the octocorals *Umbellula* (refer to Section 5.2.2.1). All of the coral species were observed at depths less than 2,000 m (JWEL 2003). Therefore, there is potential for these corals to occur in the Project Area. However, no regions containing substantial coral development were observed in the former two ELs (JWEL 2003). Reef structures are more likely to be encountered on hard substrates which can be observed along the end of channels between fishing banks and in submarine canyons. The largest octocorals reported on the Scotian Shelf are gorgonian corals (*e.g.*, bubblegum and seacorn corals) of which the highest concentration in the Maritimes occurs in the Northeast Channel and is now protected from bottom fishing disturbances in the Northeast Channel Coral Conservation Area. Other designated areas on the Scotian Shelf and Slope offering protection to corals includes the Gully Marine Protected Area (MPA) and the Lophelia Coral Conservation Area on the southeastern slope of Banquereau Bank (refer to Section 5.2.10 for more information on designated protected areas).

At least 34 species of sponge have been identified on the Atlantic coast, including the Russian hat glass sponge (*Vazella pourtalesi*) which is known only to occur in specific locations on the Scotian Shelf, the Gulf of Mexico, and the Azores. Globally unique sponge grounds for this species on Sambro Bank and Emerald Basin (see Figure 5.2.13) have recently received protection as DFO closed these areas to bottom-contact fishing in 2013 to help protect these sponges from further damage (DFO 2013d).



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.13 Known Coral and Sponge Locations on the Scotian Shelf and Slope

5.2.4 Marine Plants

Marine plants can include macrophytic marine algae (also referred to as seaweeds), flowering plants (*e.g.,* seagrasses), and phytoplankton (refer to Section 5.2.1.2 for a discussion on phytoplankton). Seaweeds found along rocky shores of Nova Scotia include species of green algae, red algae and brown algae. Green algae require a large amount of light and are generally found closer to the surface in intertidal or shallow subtidal areas. Red algae (*e.g*., Irish moss) are able to grow at greater depths and are generally found in the intertidal zone, below the low water mark. Brown algae (*e.g.,* kelp, rockweeds) are the dominant seaweeds and are found in subtidal and intertidal zones (DFO 2013b). Irish moss (*Chondrus crispus*) and rockweed (*Ascophyllum nodosum*) are harvested commercially in Nova Scotia.

Seagrass is a general term for flowering plants that live in low intertidal and subtidal marine environments (DFO 2013b). Seagrass beds (particularly eelgrass beds) are recognized as being among the most highly productive ecosystems in the world (DFO 2013b). Eelgrass (*Zostera marina*), the dominant seagrass found in coastal and estuarine areas around Nova Scotia, provides food and shelter for many species of fish and waterfowl and plays an important role in stabilizing sediments (DFO 2013b; Hastings *et al*. 2014; Allard *et al.* 2014). Eelgrass is very sensitive to environmental changes and has declined considerably along the Nova Scotia coastline in recent decades (DFO 2009c; DFO 2013b; Hastings *et al*. 2014).

5.2.5 Marine Fish

5.2.5.1 Groundfish

Table 5.2.5 and the following text summarize the characteristics and distribution of groundfish of commercial, recreational, or Aboriginal (CRA) value likely to occur in the vicinity of the Project and on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a), as well as the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of groundfish SAR and SOCC (which have the potential to be caught in a CRA fishery) are provided in Section 5.2.5.4.

Atlantic Halibut

Atlantic halibut are distributed from north of Labrador to Virginia. On the Scotian Shelf, halibut are most abundant between 200 and 500 m, in deep-water channels between banks and along the edge of the Continental Shelf. They prefer temperatures from 3 to 5°C, and larger individuals move to deeper water in winter (DFO 2015c). They prefer sand, gravel or clay substrates. The species can grow to sizes of over 2.5 m in length and reach weights of over 300 kg. The Atlantic halibut is the largest and most commercially-valuable groundfish in the Atlantic Ocean (DFO 2009f). This species preys on benthic organisms and shift from invertebrates to fish as the halibut grows larger in size. Small halibut (<30 cm) feed on hermit crabs, shrimp, crabs, and mysids, while larger fish (>70 cm) consume various species of flatfish, redfish, and pollock (DFO 2013u).

Females mature at 10 to 14 years with spawning occurring from December to June in deep water depths ranging from 300 to 700 m. Large females may lay up to several million eggs. The eggs are 3 to 4 mm in diameter and float freely in the ocean until they hatch 16 days later. Larvae are approximately 7 mm in length and survive on a yolk sac for four to five weeks until they begin feeding on plankton. Atlantic halibut may live for up to 50 years, with a typical lifespan of 25 to 30 years (DFO 2009f).

Table 5.2.5 Groundfish of Commercial, Recreational or Aboriginal Value Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	Potential for Occurrence in the Project Area[1]	Timing of Presence
Acadian redfish[2]	*Sebastes fasciatus*	Low	Year-Round
American plaice[2]	*Hippoglossoides platessoides*	Low	Year-Round
Atlantic cod[2]	*Gadus morhua*	Low	Year-Round
Atlantic halibut	*Hippoglossus Hippoglossus*	Moderate	Year-Round
Atlantic wolffish[2]	*Anarchichas lupus*	Low	Year-Round
Deepwater redfish[2]	*Sebastes mentella*	Low	Year-Round
Haddock	*Melanogrammus aeglefinus*	Low	Year-Round
Hagfish	*Myxine glutinosa*	Moderate	Year-Round
Monkfish	*Lophius americanus*	Low	Year-Round
Pollock	*Pollachius virens*	Low	Year-Round
Red hake	*Urophycis chuss*	Low	Year-Round
Sand lance	*Ammodytes dubius*	Low	Year-Round
Silver hake	*Merluccius bilinearis*	Low	Year-Round
Turbot – Greenland halibut	*Reinhardtius hippoglossoides*	Moderate to High	Year-Round
White hake[2]	Urophycis tenuis	Moderate	Year-Round
Witch flounder	*Glyptocephalus cynoglossus*	Low	Year-Round
Yellowtail founder	*Limanda ferruginea*	Low	Year-Round

Note:
[1]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2]SAR or SOCC.

Sources: DFO 2009f, 2009g, 2009h, 2010b, 2013p, 2013q, 2013r, 2013s; Horseman and Shackell 2009; NOAA 2006, 2013h, 2013i, 2013j, 2013k

Haddock

Haddock is a member of the cod family found on both sides of the North Atlantic and are generally associated with broken ground, gravel, pebbles, clay, smooth hard sand, sticky sand of gritty consistency, and shell beds. They are most commonly found in water depths from 50 to 250 m (DFO 2013p). Haddock can be found from Greenland to Cape Hatteras, and are common on the Scotian Shelf on all of the banks and basins. Juveniles are more common in the shallower banks and shoals with adults being found in the deeper basins and shelf edge locations (NOAA 2013h). Haddock feed on a variety of benthic organisms including mollusks, polychaetes, crustaceans, echinoderms, and fish eggs. Adults sometimes prey upon small fish including herring, skates, spiny dogfish, and a variety of groundfish, including other haddock (NOAA 2013h).

Haddock is a fast-growing species, maturing from one to four years of age and generally living from three to seven years. Spawning occurs from January to July over rock, sand, gravel and mud bottom on areas of Georges Bank and eastward to Sable Island Bank and the shelf edge. Spawning also takes place in nearshore areas from Halifax to Liverpool (Horseman and Shackell 2009). Haddock are highly fecund, producing on average 850,000 eggs, with larger fish producing up to 3 million eggs (NOAA 2013h). Eggs and larvae are pelagic until larvae reach a size of 25 mm and settle into deeper waters.

Hagfish

Hagfish is a benthic species that can be found in the Northwest Atlantic from the coast of Florida to the Davis Strait and Greenland (DFO 2009g). They can be found in water depths up to 1,200 m. They prefer soft substrates and areas with low current velocities. They live in burrows which collapse once they emerge; taking approximately 4 to 11 minutes to rebuild them once they return (DFO 2009g).

Spawning occurs year-round with each female carrying 1 to 30 large, horny-shelled eggs that are deposited into the burrows (DFO 2009g). Newly hatched hagfish resemble adults and range in size 6 to 7 cm in length. Hagfish feed on a variety of infaunal and epifaunal invertebrates including nemerteans, polychaetes, and crustaceans. They also scavenge on vertebrate and invertebrate remains that settle down from the pelagic zone.

Monkfish

Monkfish can be found from the Northern Gulf of St. Lawrence to Cape Hatteras. They have been found inhabiting areas up to 800 m in water depth, but are most commonly found from 70 to 190 m (DFO 2010a). They prefer water temperatures ranging from 3 to 9°C. Concentrations of monkfish can be found on the banks and basins and the edge of the Scotian Shelf. Monkfish can grow to a size of over 1 m and have a lifespan of up to 12 years. Monkfish live on the ocean floor, typically with sand, mud, and shell substrates (NOAA 2013i). They are opportunistic feeders preying upon anything that is available. Juveniles prey mostly on small fish, shrimp, and squid, while adults prey on fish (including other monkfish), crustaceans, mollusks, seabirds, and diving ducks.

Sexual maturity occurs between three and four years, with spawning typically occurring during the summer months from Georges to Banquereau Banks and the shelf edge (Horseman and Shackell 2009). Females lay eggs in a veil, which is a clear, ribbon-like mucous sheet that can contain up to a million tiny pink eggs. Once the female sheds the veil, the sheet floats on the ocean's surface. The veil of eggs can measure 6 to12 m in length and be between 0.15 m and 1.5 m wide (NOAA 2013i).

Pollock

Pollock is a member of the cod family. This fish is found from southern Labrador to Cape Hatteras, with major concentrations on the Scotian Shelf, including the banks and basins of the shelf. Adults live over a variety of substrate types including sand, mud, rock and various types of vegetation (NOAA 2013j). Pollock swim in schools and travel between the Scotian Shelf and Georges Bank, with some fish veering into the Gulf of Maine.

Adults mature at 4 to 7 years and spawning occurs from September to March in Canadian waters. Spawning takes place on Georges to Western Banks as well as in nearshore areas from Halifax to Yarmouth (Horseman and Shackell 2009). An average female produces 225,000 eggs which are buoyant and hatch in approximately nine days. Larvae measure 3 to 4 mm long upon hatching and grow rapidly. Larvae feed on copepods. Following the larval stage, young pollock move into shallow waters and feed on small crustaceans.

Red Hake

The red hake can be found from the Gulf of St. Lawrence to North Carolina from water depths of 10 to 500 m at temperatures of 5 to 12°C. Red hake prefer a soft sand or muddy substrate (NOAA 2006).On the Scotian Shelf, they are generally found in the LaHave and Emerald Basins, as well as along the shelf edge. During the spring and summer the species migrates to shallower waters to spawn, returning to the deeper waters of the shelf edge and slope during the winter months (NOAA 2006). They feed on a variety of items including crustaceans, as well as fish including: haddock, silver hake, sand lance, and mackerel.

Spawning occurs in the summer to early fall. Females produce buoyant free floating eggs and hatch larvae measuring 1.8 to 2.0 mm long. Larvae are pelagic for two to three months, until reaching a size of 25 to 30 mm long when they become demersal.

Sand Lance

In the northwest Atlantic, sand lance can be found from Cape Hatteras to Greenland and are generally found in water depths of less than 90 m (DFO 2015d). They are generally found along coastal zones and on the shallow waters of offshore banks on sand or small gravel substrates. Sand lance do not make extensive migrations, but will travel between resting and feeding grounds. The sand lance will bury itself in the substrate in-between feeding periods, which it does mainly during the day (DFO 2015d). Sand lance feed on a variety of organisms with its main prey consisting of copepods, and are themselves an important prey species for red and silver hake, shortfin squid, Atlantic sturgeon, and minke and humpback whales, as well as commercially important species such as cod and yellowtail flounder (DFO 2015d).

Sand lance mature at two years of age and spawn on sand in shallow water depths during the winter months (DFO 2015d). The eggs stick to the substrate and remain there until they hatch. Upon hatching, the larvae become pelagic and remain in the surface waters for a few weeks and are an important food source for predators. Once the larvae reach a few centimetres in length they develop into juveniles and descend to the seabed (DFO 2015d).

Silver Hake

Silver hake is a member of the cod family and can be found from southern Newfoundland to South Carolina. On the Scotian Shelf and Slope this species can be found in the LaHave and Emerald Basins as well as along the shelf edge. The species can be found most commonly at water depths ranging from 150 to 200 m and in temperatures ranging from 5 to 10°C (DFO 2013r). Silver hake feed mainly on shrimp, krill, and sand lance, and are prey for monkfish, pollock, Atlantic halibut, cod, and seals (DFO 2013r).

Silver hake have a lifespan of 12 years and mature at 2 years (DFO 2013r). Seasonal migrations occur during the spawning period which takes place from June to September, peaking in July and August on Browns to Sable Island Banks as well as the Shelf edge (Horseman and Shackell 2009). Silver hake move from the deeper waters of the LaHave and Emerald Basins and move to the shallow waters of the Emerald, Western, and Sable Island Banks. Eggs are buoyant and remain in the water column for a few days before hatching. Larvae measure 2.6 to 3.5 mm in length and are pelagic for 3 to 5 months before migrating to the seabed.

Turbot – Greenland Halibut

Greenland halibut can be found in water depths ranging from 90 to1,600 m from western Greenland to the southern edge of the Scotian Slope. This species is most common along the shelf edge and slope and prefer soft mud substrates, and feeds on various finfish and shellfish species and squid (NOAA 2013k).

Females mature at approximately nine years of age (NOAA 2013k). Spawning is believed to occur during the winter and early spring with females producing 30,000 to 300,000 eggs. After hatching, the young rise to 30 m below the surface where they live until they are 70 mm long when they migrate to the seabed.

Witch Flounder

Witch flounder is a deep-water flatfish that can commonly be found from Labrador to Georges Bank in water depths from 185 to 400 m, although they have been found at depths of over 1,500 m off southern Nova Scotia (DFO 2015e). They occur most commonly in deep holes and channels and along the shelf slope on sand and muddy bottoms at temperatures ranging from 2 to 6°C (DFO 2013s). On the Scotian Shelf area they can be found in areas of high abundance along the edge of the Laurentian Channel, between Sable Island and Banquereau Bank, in the deep holes of Banquereau, and at the mouth of the Bay of Fundy. Witch flounder are a fairly sedentary species, congregating in water which is suitable for spawning and dispersing to surrounding areas to feed. Their primary prey include polychaetes, small crustaceans, shrimp, and occasionally small fish (DFO 2015e).

Spawning occurs from May to October with a peak occurring from July to August. Spawning takes place on the Scotian Shelf and shelf edge from Georges Bank to Banquereau Bank, as well as in nearshore areas from Halifax to Southwest Nova Scotia (Horseman and Shackell 2009; DFO 2015e). Eggs and larvae are pelagic and drift in the currents until settling to the benthos. The pelagic stage of the witch flounder life history is longer than other flatfish, lasting from four months to one year. During this time eggs and larvae drift in the water column and settle where temperatures are suitable for survival. Eggs and larvae which originate from the southern banks of the Scotian Shelf will not travel great distances as they are trapped in slow circular currents. Occasionally eggs and larvae will drift out over the slope (DFO 2015e).

Yellowtail Flounder

Yellowtail flounder is a flatfish found in relatively shallow waters of the Continental Shelf from southern Labrador to Chesapeake Bay. It prefers sandy habitats and is generally found in water depths of approximately 40 to 91 m (NOAA 2012b; DFO 2015f). A major concentration of yellowtail flounder occurs on Georges Bank, from the Northeast Peak to the Great South Channel. Adults feed on amphipods, shrimp, polychaetes, crabs, mollusks, and small fish species (DFO 2015f). Tagging studies have indicated yellowtail flounder are capable of long distance migrations, although migration patterns have yet to be identified (DFO 2015f).

Both male and female yellowtail flounders mature at two to three years. Spawning takes place near the substrate on Georges, Browns, and Emerald to Banquereau Banks, as well as in nearshore areas, from May to July. The number of eggs produced ranges from 350,000 to over 4 million. The eggs are fertilized and rise to the surface waters where they drift during development. The eggs hatch in approximately 5 days rearing 11 to 16 mm larvae. The larvae remain in the top water layers for a short amount of time before settling to the seabed (DFO 2015f).

5.2.5.2 Pelagic Fish

Table 5.2.6 summarizes the characteristics and distribution of pelagic fish of CRA value likely to occur in the vicinity of the Project Area. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited’s Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of pelagic SAR and SOCC (which have the potential to be caught in a CRA fishery) are provided in Section 5.2.5.4.

Table 5.2.6 Pelagic Fish Species of Commercial, Recreational, or Aboriginal Value Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	Potential for Occurrence in the Project Area[1]	Timing of Presence
Albacore tuna	*Thunnus alalunga*	Low	July to November
Alewife	*Alosa pseudolarengus and A. aestivalis*	Low	July to February
Atlantic herring	*Clupea harengus*	Low	Year-round
Atlantic mackerel	*Scomber scombrus*	Low	Winter – deep water on the Shelf Spring/Summer – Migrate to shallower coastal zones
American eel[2]	*Anguilla rostrata*	Low	March to November
Bigeye tuna	*Thunnus obesus*	Low	July to November
Black dogfish	*Centroscyllium fabricii*	Low	Year-round
Bluefin tuna[2]	*Thunnus thynnus*	Low	June to October
Blue shark[2]	*Prionace glauca*	Moderate	June to October
Capelin	*Mallotus villosus*	Low	Year-round
Cusk[2]	*Brosme brosme*	Moderate	Year-round
Porbeagle shark[2]	*Lamna nasus*	Moderate	Year-round
Shortfin mako shark[2]	*Isurus oxyrinchus*	Moderate	July to October
Swordfish	*Xiphias gladuis*	Moderate	July to October
White marlin	*Kajikia albida*	Moderate	July to October
Yellowfin tuna	*Thunnus albacares*	Low	July to October

Note:
[1]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2]SAR or SOCC.

Sources: DFO 1997; GMRI 2014; FLMNH 2013a, 2013b; NOAA 2013a, 2013b, 2013c, 2013d, 2013f, 2013g.

Albacore Tuna

Albacore tuna are sparsely distributed along the Scotian Shelf edge and slope, with higher numbers further offshore above the abyssal plain, but there is potential for them to occur sporadically in the vicinity of the Project. They enter Canadian waters in July and remain until November feeding on forage species. Spawning occurs from March to July in subtropical areas of the Atlantic and Mediterranean Sea. Females produce between 800,000 and 2.5 million buoyant eggs that hatch in one to two days. After hatching, the larvae grow quickly and remain in the spawning grounds until the second year when, during the spring, they begin their migration to the North American coast (NOAA 2013a).

Alewife

Alewives range along the Atlantic coast from Newfoundland to South Carolina. A preferentially anadromous species, alewives will survive as a landlocked population. Anadromous alewives utilize freshwater streams for spawning and abundant in large rivers during migration between March and June (DFO 2015g). The timing of the spawning migration is related to water temperature and begins earlier in southern habitats.

Adults return to sea shortly after spawning, with juvenilles spending the summer and fall in the freshwater environment. At sea, juvenilles typically school and remain in the nearshore. Adult alewives may remain in inshore waters for the majority of the year but have been found during summer in the offshore such as George's and Emerald Banks (DFO 2015g). Alewives are opportunistic feeders, foraging on zooplankton at the surface though may also forage on benthic invertebrates.

Atlantic Herring

Atlantic herring are found on both sides of the North Atlantic. In the northwest Atlantic, they are found from Labrador to Cape Hatteras (DFO 2015g). They are common along the coast of Nova Scotia and offshore banks and known to be present in the Roseway, LaHave, and Emerald Basins. The species has a life expectancy of 15 years and matures at four years of age. Atlantic herring primarily feed on zooplankton, krill, and fish larvae (NOAA 2013b).

Atlantic herring form massive schools prior to spawning and migrate to spawning grounds in both coastal waters and offshore banks (GMRI 2014). Once profuse along the Atlantic Coast, active herring spawning areas are now relatively scarce (Hastings *et al*. 2014). Coastal spawning areas include areas off southwest Nova Scotia as well as in the Bay of Fundy and off Grand Manan Island. Offshore, spawning occurs in areas of Georges Bank. Spawning begins in August in Nova Scotia and eastern Maine regions and begins later (October to November) in the southern Gulf of Maine and Georges Bank. Females produce 30,000 to 200,000 eggs that are deposited on rock, gravel, and sand substrate. Schools of herring can produce such a large number of eggs that the ocean floor becomes covered in a dense carpet of eggs several centimetres thick. The eggs hatch within seven to ten days and by late spring the larvae grow into juveniles foraging in large schools in the summer. Larvae are carried by ocean currents for approximately six months before becoming active swimmers (GMRI 2014).

Atlantic Mackerel

Atlantic mackerel are pelagic schooling fish which occupy moderately deep water (70 to 200 m) along the Continental Shelf from Sable Island Bank to Chesapeake Bay and migrate over Sable Island Bank in the spring and summer months. They are sensitive to water temperatures and make migrations on a seasonal basis to feed and spawn. Mackerel mainly feed on crustaceans including copepods, krill, and shrimp, and opportunistically on squid and small fish (NOAA 2013c).

The species has two major spawning groups with one group spawning in the Mid-Atlantic Bight from April to May, with the second group spawning in June and July in the Gulf of St. Lawrence. Spawning takes place close to shore with females releasing batches of eggs five to seven times during the spawning season. The eggs are buoyant and hatch within four to eight days (NOAA 2013c).

Bigeye Tuna

Bigeye tuna are a tropical species that can be found in temperate to tropical waters from Nova Scotia to Brazil. They have a life expectancy of nine years and mature at about three years of age. Mature bigeye tuna enter Canadian waters including the Scotian Shelf in July and remain until November to feed. Bigeye tuna have a similar distribution as the albacore with a few fish inhabiting waters along the Scotian Shelf edge and slope, with higher numbers further offshore (NOAA 2013d).

Spawning takes place in tropical waters throughout the year with a peak during the summer months (NOAA 2013d). Females spawn at least twice a year and release between 3 to 6 million eggs. The larvae remain in tropical waters and as juveniles grow they move into more temperate waters.

Black Dogfish

The black dogfish is a deepwater species found in temperate to boreal waters over the outer continental shelves and slopes of the North Atlantic Ocean. They have been observed at depths up to 1,600 m, but are most common at depths of 550 to 1,000 m and temperatures between 3.5 and 4.5°C. The black dogfish preys on squid, benthic and pelagic crustaceans, shrimp, jellyfish, and fish species including redfish (FLMNH 2013a).

Black dogfish reproduce year-round. Females are ovoviviparous giving birth to 4 to 40 pups that measure 13 to 19 cm in length. In Canadian waters they give birth in parts of the Laurentian Channel.

Capelin

Capelin are a cold-water pelagic schooling fish, generally occurring in waters with temperatures between -1.5 and 14.0°C (Carscadden *et al.* 1989, Stergiou 1989, Brown 2002 in Bruneau and Gregoire 2011) and at depths between 40 and 150 m. Migration associated with spawning is influenced by water temperature (Carscadden *et al.* 1997, Carscadden *et al.* 2002, Mowbray 2002 in Bruneau and Gregoire 2011).

Capelin are not normally found in the Scotian Shelf or Bay of Fundy region and are unlikely to occur in the vicinity of the Project. However, there have been exceptions observed in recent years. During the mid-1960s capelin were abundant in the Bay of Fundy and have been abundant on the Eastern Scotian Shelf since the 1980s (DFO 1997).

Capelin are a very short-lived species and grow rapidly during the first four years of their lives, with growth rates averaging 2 to 3 cm/year and reaching a maximum size of 20 cm (DFO 1997). Capelin mature at three years of age, with spawning occurring during June and July. Capelin feed on plankton, copepods, euphausiids, and amphipods, and they are an important prey item for many species of fish and marine mammals.

Swordfish

Swordfish can be found along the Gulf Stream and as far north as the Grand Banks. They migrate into Canadian waters in the summer as part of their annual seasonal movement, following spawning in subtropical and tropical areas. Swordfish can be found along the Scotian Shelf edge and Slope as well as on the edges of the banks feeding in cooler, more productive waters. Swordfish feed on a variety of fish species as well as invertebrates including squid (NOAA 2013f). Spawning takes place in the Sargasso Sea and in the Caribbean from December to March and off the southeast United States from April to August.

White Marlin

In western Atlantic waters, white marlin can be found in warm temperate waters and tropical waters. During the summer months, marlin migrate into Canadian waters off Nova Scotia and can be found along the Scotian Shelf edge and Slope. They are a pelagic species usually found swimming above the thermocline in waters over 100 m in depth (FLMNH 2013b). They are often found in areas with upwelling and distinct geographic features including shoals, drop-offs, and canyons. White marlin feed on squid, mahi mahi, mackerel, herring, flying fish, and bonito. Spawning occurs once per year in the Caribbean Sea, northwest of Grand Bahama Island (FLMNH 2013b).

Yellowfin Tuna

Yellowfin tuna migrate into Canadian waters, including the Scotian Shelf to feed during the summer months. Yellowfin have similar distributions as the albacore and bigeye tunas, sparsely populating the shelf edge and slope with higher numbers further offshore.

Yellowfin tuna have life expectancies of up to seven years and mature between two and three years of age. Spawning takes place from May to August in the Gulf of Mexico and from July to November in the southeastern Caribbean (NOAA 2013g). Females spawn every three days during spawning season producing one to four million eggs.

5.2.5.3 Invertebrates

Table 5.2.7 summarizes the characteristics and distribution of invertebrate species of commercial, recreational, or Aboriginal value that are likely to occur in the Project Area. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history.

Table 5.2.7 Invertebrate Species of Commercial, Recreational or Aboriginal Value Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	Potential for Occurrence in the Project Area[1]	Timing of Presence
American lobster	*Homarus americanus*	Low	Year-round
Clams (Atlantic Surf, Soft-shelled, quahaugs)	*Spisula solidissima, Mya areniaria, Mercenaria mercenaria.*	Low	Year-round
Green sea urchin	*Strongylocentrotus droebachiensis*	Low	Year-round
Jonah crab	*Cancer borealis*	Low	Year-round
Atlantic sea scallop	*Placopecten magellanicus*	Low	Year-round
Northern shrimp	*Pandalus borealis*	Low	October to April – Nearshore May to September- Offshore
Shortfin squid	*Illex illecebrosus*	High	April to November[2]
Snow crab	*Chionoecetes opilio*	Low	Year-round

Note:
[1]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2]This is based on theoretical / assumed spawning times.

Sources: Choi *et al.* 2012; DFO 2009g, 2009i, 2013m, 2013n, 2013q, 2013t; NOAA 2004.

Although not in the immediate vicinity of the Project Area, other commercial invertebrates more commonly found on the Eastern Scotian Shelf (*e.g.*, Sable Island, Middle, Canso Banquereau and Misaine Banks) include striped shrimp (*Pandalus montagui*), Stimpson's surf clam (*Mactromeris polynyma*), and sea cucumber (Class *Holothuroidea*) which are prevalent on Sable Island Bank and Middle Bank.

American Lobster

Lobster can be found along the Atlantic coastline and on the Continental Shelf from Northern Newfoundland to South Carolina. Adult American lobsters are typically found in waters shallower than 300 m, and fished in waters less than 40 m, but have been found at depths up to 750 m. They prefer substrate with rock and boulder shelter so that they can shield themselves from predators and daylight as they are nocturnal animals. They can also be found in areas with sand, gravel or mud substrates (DFO 2015h). Lobster can be found along the edges of the shelf; however, they are not fished offshore in the vicinity of the Project (Pezzack *et al.* 2009). Inshore populations can be found on almost all locations of the nearshore shelf. Lobsters can be found inhabiting waters ranging in temperature from -1.5 to 24°C (DFO 2015h).

During the summer months, lobsters migrate to shallower water to take advantage of warm water temperatures. During the winter season they migrate to deeper waters to avoid winter storms, ice, and extreme cold water temperatures (DFO 2015h). Lobsters are active hunters feeding on a variety of species including crab, mollusks, polychaetes, gastropods, sea stars, sea urchins, and fish. They also act as scavengers and eat the dead remains of animals if they are available (Carter and Steele 1982, Elner and Campbell 1987, Gendron *et al.* 2001, Jones and Shulman 2008 in Pezzack *et al.* 2009).

Egg-bearing females will move inshore to hatch their eggs during the late spring to early summer. Once the larvae have hatched, they remain planktonic for approximately four moulting periods that last 10 to 20 days each before settling to the seabed (DFO 2015h).

Clams

Atlantic surf clams, soft-shelled clam, and northern quahog generally inhabit the inshore waters though individuals have been found at depths of 75 m (Duggan 1996). Spawning for all three species generally occurs in the summer months of June through August (Gibson 2003). The larvae remain planktonic for approximately two weeks before beginning settling into benthic habitats. Juvenilles are motile covering short distances, whereas adults are predominantly sessile. Inhabiting burrows in the silty to sandy substrates. Quahogs and Atlantic surf clams generally grow to marketable size in four to five years with soft-shelled clams growing at a slower rate (Gibson 2003).

Green Sea Urchin

Green sea urchins have a circumpolar distribution, ranging into the Arctic regions of both the Atlantic and Pacific Oceans. Urchins live mostly in shallow waters, with a preference for rocky bottom in areas that are not subject to extreme wave action, but they have been found occasionally at depths of more than 1,000 m (Miller 2000). Spawning occurs in early spring and the larvae are planktonic for 8 to 12 weeks before settling to the seafloor. Sea urchins predominantly graze on algae but will consume mussels, echinoderms, barnacles, whelks, sponges and fish carcases (Miller 2000).

Jonah Crab

Jonah crab are found from Newfoundland to South Carolina and Bermuda. Offshore Nova Scotia they are generally found at depths of 50 to 300 m. In coastal areas they prefer rocky substrates, and silt and clay substrates on the continental slope. They mainly feed on benthic invertebrates and will opportunistically scavenge on dead fish (DFO 2015 g).

Research on Jonah crab in Canadian waters has been limited. Studies along the eastern seaboard of the United States has shown inshore movement from spring through fall, followed by winter migration to deeper, warmer waters. Size and sexual segregation were also reported, with small females identified in waters less than 150 m depth, and males most abundant at depths greater than 150 m (Carpenter 1978, in Pezzack *et al.* 2011).

Although not commercially fished in the Project Area, ovigerous (egg-carrying) females have been reported on the Scotian Shelf (DFO 2015i).

Atlantic Sea Scallop

Atlantic sea scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina, and are prevalent on Browns and Georges Banks. They live in discrete, and sometimes large, aggregates (beds) on the seabed. They feed by filtering planktonic organisms from the water column and can live up to 20 years (DFO 2015j; NOAA 2013q).

Spawning occurs in the late summer to early fall with females producing hundreds of millions of eggs per year. Once eggs have hatched, the larvae drift in the water column for four to six weeks before settling on the sea floor, generally in the vicinity of existing scallop aggregates (beds) (DFO 2015j; NOAA 2013q).

Northern Shrimp

Northern shrimp is the most abundant shrimp species in the northwest Atlantic (DFO 2013t). They can be found from Massachusetts to Greenland at water depths from 10 to 350 m (DFO 2015k; NOAA 2013m). On the Eastern Scotian Shelf, northern shrimp concentrate in "holes" at depths of more than 180 m, and nearshore concentrations have also been identified. They prefer water temperatures of 2 to 6°C and soft muddy substrates with high organic content (DFO 2015l).

Northern shrimp are important in marine food webs as they are an important prey item for many species of fish and marine mammals. Although a benthic species, northern shrimp migrate vertically through the water column at night (diel vertical migration) to feed on plankton in the pelagic zone (DFO 2015k). They also prey on benthic invertebrates (NOAA 2013m).

The northern shrimp is a hermaphroditic species (possesses the reproductive organs of both sexes). On the Scotian Shelf, they first reach maturity as a male at age of 2, and change gender by age of 4, and spend 1 to 2 years as a female (DFO 2015l). In the northwest Atlantic, mating occurs during the late summer to fall in offshore waters, with fertilized eggs remaining attached to the females until the following spring. Females migrate to nearshore waters during the late fall to early winter. After approximately seven to eight months the eggs hatch during April and May. The larvae are pelagic and feed on planktonic organisms. After 3 to 4 months they settle to the seabed. Juveniles will remain in coastal waters for over a year before migrating to deeper offshore waters and mature as males. Overall northern shrimp migrate with seasonal changes in water temperature spending the fall and winters in nearshore waters when the water is the coolest and migrating offshore during the spring and summer (NOAA 2013m).

Shortfin Squid

The life cycle of the shortfin squid is approximately one year in length (DFO 2015m). The shortfin squid may reproduce during any part of the year although most reproduction occurs during the winter months over the Continental Shelf south of Cape Hatteras, North Carolina. Once the female has spawned she also dies off. The fertilized mass of eggs is pelagic and travels north in the Gulf Stream (DFO 2015m).

Squid larvae (known as paralarvae) are abundant in the convergence zone of Gulf Stream water and slope water where there is an area of high productivity. Once reaching a size of 5 cm the paralarvae become juveniles and feed mainly on crustaceans (euphausiids) at night near the surface waters; they also feed on nematodes and fish (NOAA 2004). During the spring, juveniles and adults migrate to the Scotian Shelf area from the slope frontal zone and feed on fish including cod, mackerel, redfish, sand lance, herring, and capelin. Adults will also cannibalize smaller squid. Juvenile and adult squid have diel vertical migrations in which they rise in the water column to feed at night and migrate to deeper depths during the day. During the fall months the shortfin squid will migrate off the shelf to spawn presumably in the Gulf Stream and south of Cape Hatteras (DFO 2015m).

Snow Crab

Snow Crab are a dominant macro-invertebrate on the Scotian Shelf since the decline of groundfish in the late 1980s and early 1990s. They generally are found in large numbers in water depths from 60 to 280 m and on soft-bottom substrates. On the Shelf they are generally found at water temperatures less than 6°C, and are at the southern-extreme of their geographic distribution in the northwest Atlantic (DFO 2015n). They are found in high concentrations on Western, Sable Island, and Banquereau Banks and their respective shelf edges (DFO 2013u).

Snow crab typically feed on shrimp, fish (capelin and lumpfish), sea stars, sea urchins, polychaetes, detritus, large zooplankton, other crabs, mollusks and anemones (DFO 2013u). Atlantic halibut, Atlantic wolffish, and skate species are the main predators of snow crab on the Scotian Shelf, though snow crab does not appear to be an important part of their diet (DFO 2015n).

Snow crabs are brooded by their mothers for up to two years depending on water temperatures, food availability, and the maturity of the mother. Rapid development of eggs has been known to occur (12–18 months) on the Scotian Shelf with 80% of females following this reproductive cycle. Females spawn approximately 100,000 eggs that hatch between April and

June. Upon hatching, the larvae are pelagic and feed on plankton for three to five months. Larvae settle to the benthos in the fall and winter. Once larvae have settled to the benthic zone they grow rapidly, moulting twice a year (Choi *et al.* 2012). Adult males are defined by their terminal molt and only a portion will recruit into the fishery, with a minimum carapace width of 95 mm. It takes on average eight years for snow crab to be large enough to be retained by the fishery (DFO 2015n).

5.2.5.4 Species at Risk and Species of Conservation Concern

There are various fish SAR and SOCC that may be present on the Scotian Shelf or Slope (refer to Table 5.2.8). Status and presence in the vicinity of the Project for all identified marine fish SAR and SOCC is provided in Table 5.2.8. SOCC in Table 5.2.8 includes species that are listed by COSEWIC as endangered, threatened, or of special concern, but not yet listed in Schedule 1 of SARA. Details on mating, spawning and potential times and locations of species' larvae and eggs are provided in Table 5.2.3. Detailed descriptions for SAR and SOCC species are provided below. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history.

Table 5.2.8 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	Low	Year-round
American eel	*Anguilla rostrata*	Not Listed	Threatened	Transient	November -Silver eel out migration from NS March to July - Larvae and glass eels on the Slope and Shelf
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened	Low	Year-round
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered	High	June to October
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered	Low	Year-round
Atlantic cod (Southern population)		Not Listed	Endangered	Low	Winter – Deep water of Browns and LaHave Banks Summer- Southern Northeast Channel, shallow waters of Browns and LaHave Banks
Atlantic salmon (Outer Bay of Fundy population)	*Salmo salar*	Not Listed	Endangered	Transient	March to November
Atlantic salmon (Inner Bay of Fundy population)		Endangered	Endangered	Transient	March to November
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered	Transient	March to November

Table 5.2.8 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered	Transient	March to November
Atlantic sturgeon (Maritimes population)	*Ancipenser oxyrinchus*	Not Listed	Threatened	Low	Year-round
Atlantic wolffish	*Anarhichas lupus*	Special Concern	Special Concern	Low	Year-round
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern	Low to Moderate	Year-round
Blue shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern	Moderate to High	June to October
Cusk	*Brosme brosme*	Not Listed	Endangered	Low to Moderate	Year-round
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened	Low	Year-round
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened	Low	Year-round
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered	High	Year-round
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern	Moderate	Year-round
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered	Moderate to High	Year-round
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened	Moderate	July to October
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern	Moderate	Year-round
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern	High	Year-round
Spotted wolffish	*Anarhichas minor*	Threatened	Threatened	Low	Year-round
Striped bass (Southern Gulf of St. Lawrence population)	*Morone saxatilis*	Not Listed	Special Concern	Low	June to October

Table 5.2.8 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Striped bass (Bay of Fundy population)		Not Listed	Endangered	Low	
Thorny skate	*Amblyraja radiate*	Not Listed	Special Concern	Low to Moderate	Year-round
White shark	*Carcharodon Carcharias*	Endangered	Endangered	Low	June to November
White hake	*Urophycis tenuis*	Not Listed	Special	Moderate	Year-round

Note:

[1]Species of conservation concern (SOCC) listed as endangered, threatened, or of special concern by COSEWIC, but not listed in Schedule 1 of SARA.

[2]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.

Sources: BIO 2013a; Campana *et al.* 2013; COSWEIC 2006a, 2006b, 2007a, 2008a, 2009b, 2009c, 2010a, 2010b, 2010c, 2010d, 2011a, 2012a, 2012b, 2012c, 2012d, 2012e; DFO2013b, 2013e, 2013l, 2013j, 2013k; Horseman and Shackell 2009; Maguire and Lester 2012; NOAA2013e; SARA 2015

Acadian Redfish

The Acadian redfish live primarily along the Scotian Shelf edge and slope and in deep channels in water depths ranging from 150 to 300 m (DFO 2013 k). Migratory movement information is unknown for the species given they cannot be tagged (gas bladder ruptures when brought to the surface). Dispersal and migration is believed to be limited; however, the species can be found in a wide range of habitats and is known to use rocks and anemones as protection from predators.

The Acadian redfish reaches sexual maturity very late and has highly successful abundance every 5 to 12 years (COSEWIC 2010c). They are a slow-growing species that can attain an age of up to 75 years. Females are ovoviviparous, keeping fertilized eggs inside until the larvae have hatched. Breeding occurs between September and December and larval extrusion occurs in the spring. Larvae may be present in the water column May to August feeding on copepods and fish eggs and can be found over the entire shelf and slope (Horseman and Shackell 2009). At the larval stage, Acadian redfish feed on the eggs of fish and invertebrates until they reach juvenile and adult stages where they will feed on copepods, euphausiids, and fish (COSEWIC 2010c). Abundance estimates for the mature population of Acadian redfish are based on scientific surveys conducted by DFO. The Acadian redfish has shown a substantial (>95 %) decline over one to two generations in areas where they were historically abundant, although in some areas abundance indices have been stable or increasing since the mid-1990s (COSEWIC 2010c). The abundance indices for this species fluctuate widely, but show no overall trends.

American Eel

American eels can be found in Canadian freshwater, estuarine, coastal, and marine environments from Niagara Falls to Labrador and have a very complex life history (DFO 2013j). Mature Silver eels spawn in the Sargasso Sea with hatching occurring from March to October and peaking in August. Larvae are transparent and willow-shaped and are transported to North American coastal waters by the Gulf Stream (COSEWIC 2012c). After approximately 7 to 12 months, larvae enter the Continental Shelf area and become glass eels taking on an eel shape while remaining transparent. As glass eels migrate towards freshwater coastal streams they are known as elvers and will run into the freshwater streams, peaking from April to June in Nova Scotia. Elvers eventually transform into yellow eels, which is the major growth phase for the species. Yellow eels will spend years maturing in freshwater streams and coastal areas before making a major transformation to return to the Sargasso Sea to spawn. Yellow eels will remain in coastal areas or freshwater on average for 9 to 22 years before metamorphosing both morphologically and physiologically into silver eels (COSEWIC 2012c). Nova Scotian silver eels begin their outmigration to the Sargasso Sea in November travelling over 2,000 km to spawn for the only time during their life.

The population of American eels was examined using time series data to estimate the percent change in indices of abundance from the 1950s to the 2000s resulting in an almost uniformly negative (-7.1% to -96.2 %) within the species North American western range, while trends were mixed within the eastern portion of its range (COSEWIC 2012c). The index of recruitment for the Maritimes is based on elver catches and counts in the East River, Chester, Nova Scotia. The index shows wide annual fluctuations in elver recruitment with no apparent trend (COSEWIC 2012c).

American Plaice

The American plaice is a benthic marine flatfish with a laterally compressed body. The Maritime Population of American plaice is concentrated in the Gulf of St. Lawrence and on the Scotian Shelf. The species is closely associated with the seafloor and commonly found in water depths of 100 to 300 m where soft or sandy sediments are present (DFO 2013i). Females are batch spawners and spawn batches of eggs for up to one month during April and May. Eggs and larvae are pelagic and may be present in the water column between May and June (COSEWIC 2009b). Major spawning areas on the Scotian Shelf include the Banquereau, Western and Browns Banks (Horseman and Shackell 2009).

American plaice prefer water temperatures ranging from 1 to 4°C on the Scotian Shelf. They are opportunistic feeders consuming a variety of prey items such as polychaetes, echinoderms, mollusks, crustaceans, and small fish. Throughout their Canadian range, American plaice are limited to local movements made in response to seasonal changes in temperatures or prey availability (COSEWIC 2009b).

Estimates of mature population size are obtained from catch rates of fish of reproductive age from fishery-independent research surveys conducted by DFO. Rates of decline in adult abundance over a 36-year (2.25 generation) time series depicted that the Scotian Shelf Population has declined by 67% (COSEWIC 2009b).

Atlantic Bluefin Tuna

Atlantic bluefin tuna are highly migratory, with long and varied routes. Bluefin tuna are distributed throughout the North Atlantic Ocean, occupying waters up to a depth of 200 m from Newfoundland to the Gulf of Mexico (Maguire and Lester 2012) and can usually be found in Canadian waters in the summer. They have a life expectancy up to 20 years, maturing at about eight years of age. Spawning takes place in the Gulf of Mexico and the Mediterranean Sea. Females produce up to 10 million eggs in a year that are fertilized in the water column by males and hatch after two days.

Important prey items for the species include: herring, mackerel, capelin, silver hake, white hake, and squid. However; they are opportunistic and will feed on jellyfish, salps, and demersal and sessile fish and invertebrate species (NOAA 2013e).

Adult bluefin tuna enter Canadian waters from June to October and can be found distributed in high concentrations along the shelf edge and in the Northeast Channel (Hell Hole) (Maguire and Lester 2012). They can also be found in the pelagic zone over the Scotian Shelf and Slope. Bluefin tuna are pelagic species and can tolerate a wide range of temperatures due to their ability to regulate their own body temperatures.

Population estimates for the Atlantic bluefin tuna (mature population) show an initial steep decline from 1970 into the 1990s, with a small increase until the late 1990s, followed by a steady decline to the last data point in 2010. Population (age >9) numbers decreased from 264,842 individuals in 1970 to 66,865 in 1992 (75% decline), increased to 84,306 in 1998 (26%), and then declined to 65,923 in 2010 (22%)(COSEWIC 2011a).

Atlantic Cod

Atlantic Cod can generally be found in coastal, nearshore and offshore areas from depths of a few metres to 500 m. Atlantic Cod have been observed spawning in both offshore and inshore waters at all times of the year depending on location (COSEWIC 2010d). Peak spawning has been observed during the spring and occurring in batches. Eggs and larvae are pelagic and float on the surface and drift with the oceanographic conditions at the time of spawning. Each female will produce several million eggs, with usually only one egg surviving to maturity. Eggs and larvae may be present in the upper water column of the Scotian Shelf year-round.

Juvenile cod (up to the age of four) prefer habitats that provide protection and cover such as nearshore waters with eelgrass or areas with rock and coral (COSEWIC 2010d). For the first few weeks of life, Atlantic cod reside in the upper 10 to 50 m of the ocean. Prey availability and temperature are the primary factors determining habitat selection for cod.

Laurentian South Population

Cod from this population overwinter in the waters off eastern Cape Breton and the Continental Shelf south of the Laurentian Channel returning to the Gulf between May to October, although there may be a resident population which does not return (COSEWIC 2010d). The Laurentian South population has declined 90 to 91% over the past three generations (COSEWIC 2010d).

Southern Population

Atlantic cod from this population inhabit waters from the Bay of Fundy and southern Nova Scotia, including the Scotian Shelf south and west of Halifax, to the southern extent of the Grand Banks. This population spends winters in the deeper waters of Browns and LaHave Banks as well as on inshore waters close to Nantucket. It summers in the southern Northeast Channel and in shallow waters of Browns and LaHave Banks (COSEWIC 2010d). The southern population has declined 59 to 64% over the past three generations (COSEWIC 2010d).

Atlantic Salmon

Atlantic salmon return to natal rivers to spawn after the completion of ocean scale migrations (COSEWIC 2010a). Adult salmon return to freshwater rivers after a feeding stage at sea from May to November and as early as March. Female salmon deposit eggs in gravel nests usually in gravel riffle sections of streams in October and November. Fertilization typically involves multiple males competing aggressively for access to multiple females. This leads to multiple paternities for a given female's offspring. Spawned-out or spent adults (kelts) return to sea immediately after spawning or remain in freshwater until the following spring (COSEWIC 2010a). Fertilized eggs incubate in nests over the winter begin to hatch in April and remaining in the gravel riverbed for several weeks while living off a large yolk sac. Once the yolk sac has been absorbed, free swimming parr begin to actively feed and remain in freshwater for 1 to 8 years before they begin a behavioural and physiological transformation and migrate to sea as smolts, completing the life cycle.

In general, Atlantic salmon make long oceanic migrations from May to November from their over wintering at sea locations to their native freshwater streams (COSEWIC 2010a). The majority of Atlantic salmon overwinter in the Labrador Sea and Flemish Cap Area with the major controlling factor for habitat choice of at sea being temperature. Salmon at sea can be found in temperatures ranging from 1 to 12.5°C, with the majority being found at temperatures of 6 to 8°C.

Outer Bay of Fundy Population

This population extends from the Saint John River westward to the US border. Migration patterns to the North Atlantic may cause the population to be present in the Project Area; however, any presence will be transient in nature. It is believed that some of the Outer Bay of Fundy population overwinters in the Bay of Fundy and Gulf of Maine (COSEWIC 2010a). The most recent (2008) estimate for the Outer Bay of Fundy population was 7,584 adult salmon (COSEWIC 2010a).

Inner Bay of Fundy Population

This population extends from Cape Split around the Inner Bay of Fund to a point just east of the Saint John River estuary. It is believed that some of the Inner Bay of Fundy Salmon overwinter in the Bay of Fundy and Gulf of Maine (COSEWIC 2010a). The most recent (2008) estimate for the Inner Bay of Fundy population was less than 200 adult salmon (COSEWIC 2010a).

Eastern Cape Breton Population

This population extends from the northern tip of Cape Breton to northeastern Nova Scotia (mainland). Migration to the North Atlantic is not likely to cross the Project Area (COSEWIC 2010a). The most recent (2008) estimate for the Eastern Cape Breton population was 1,150 adult salmon (COSEWIC 2010a).

Nova Scotia Southern Upland Population

This population extends from northeastern Nova Scotia (mainland) along the Atlantic and Fundy coasts up to Cape Split. Migration between freshwater rivers and the North Atlantic poses the potential of the population passing through the Project Area with a presence being transient in nature (COSEWIC 2010a). The most recent (2008) estimate for the Southern upland population was 1,427 adult salmon (COSEWIC 2010a).

Atlantic Sturgeon

Atlantics sturgeon can be found throughout the coastal waters of the Maritimes and on the Scotian Shelf, generally concentrated in water depths less than 50 m and are highly migratory (COSEWIC 2011b). Adults migrate into estuaries and rivers in the autumn between August and October or in the spring between May and June prior to reproduction. Adults will often overwinter in deep channels and pools in rivers and estuaries downstream of the spawning sites. Adults and large juveniles move both inwards and seawards in response to season and salinity. They can be found in the Bay of Fundy, along the coast of Nova Scotia, and offshore as far as Banquereau and Sable Island Banks (COSEWIC 2011b).

Atlantic sturgeon use a variety of habitats at various points in their life cycle including rivers, estuaries, bays, and the open ocean (COSEWIC 2011b). They prey on benthic organisms such as polychaete worms, shrimp, amphipods, isopods, gastropods and small fish (sand lance). Reliable population estimates do not exist for the Atlantic sturgeon, but it is believed there are a minimum of 1,000 to 2,000 adults in the Maritimes population (COSEWIC 2011b).

Atlantic Wolffish

Atlantic wolffish occurs along the Scotian Shelf with a higher concentration around Browns Bank, along the edge of the Laurentian Channel, and into the Gulf of Maine. They are typically found inhabiting the seafloor in water depths of 150 to 350 m and have been found in depths as deep as 918 m (COSEWIC 2012b). An examination of wolffish landings in NAFO Division 4X revealed that Atlantic wolffish were concentrated on the western peak of Browns Bank, west of German Bank and in three isolated areas inshore of the 100 m contour line (LGL 2014). Juvenile and adult Atlantic wolffish live on the Scotian Shelf on rocky or sandy substrates; they do not use soft benthic habitats. Atlantic wolffish prey on mostly invertebrates (85%) including whelks, sea urchins, hermit crabs, crabs and scallops. A smaller portion of their diet consists of fish with their main prey being redfish (COSEWIC 2012b).

Atlantic wolffish make short migrations to spawning grounds, which are generally boulder and cave habitat in shallow waters, during the fall (COSEWIC 2012b). Eggs / larvae may be present on the seafloor in fall to early winter. The eggs are deposited in crevices on rocky substrates and are guarded by males until they hatch. Larvae have been found in coastal regions south of Bridgewater and off Southwest Nova Scotia. Larvae have also been observed in the Roseway and LaHave Basins. Juvenile Atlantic wolffish are capable of wide dispersion, while adults are fairly sedentary (COSEWIC 2012b). The number of Atlantic wolffish individuals in Canadian waters is estimated to exceed 49 million, with over 5 million mature individuals (COSEWIC 2012b). On the eastern Scotian Shelf, the abundance of mature individuals has declined by 99% since 1970, while the abundance of immature individuals has increased over the same period (LGL 2014). On the western Scotian Shelf, both immature and mature abundances have declined since 1970.

Basking Shark

Basking sharks are believed to have a life span of 50 years, with males maturing between 12 to 16 years of age and females maturing between 16 to 20 years of age (COSEWIC 2009c). Males and females pair up in the summer, presumably to mate. Females have a gestation period of 2.6 to 3.5 years and give birth to about six pups with an average length at birth of 1.5 to 2 m. The species feeds on zooplankton that congregate in oceanic fronts.

They can be found throughout the North Atlantic with concentrations in coastal waters of Newfoundland and near the mouth of the Bay of Fundy. Observations have also been recorded on Georges Bank, the Northeast Channel, and the LaHave and Emerald Banks. Some sightings have also shown the species on Sable Island Bank and over the slope. Basking sharks are frequently seen during summer months, particularly the LaHave and Emerald Basins, where they may mate. They are rarely seen in other seasons but are believed to be found on the Scotian Slope at great depths during the winter. There is limited information regarding population sizes and trends, with total population estimates for Atlantic Canada ranging from a conservative estimate of 4,918 individuals to 10,125 individuals (COSEWIC 2009c).

Habitat requirements have not been investigated in Canada, but it is believed that the basking shark lives primarily in oceanic front locations where their main food source, zooplankton, congregates (COSEWIC 2009c). Tagging studies have shown the species occupying surface waters to depths of over 1,200 m.

Blue Shark

Blue sharks are widespread, highly migratory and can be found worldwide in temperate and tropical oceans, generally in the offshore surface water (COSEWIC 2006a). Blue sharks are viviparous (bearing live young) with an average litter size of 26 pups. Blue sharks typically mate in the spring to early summer (COSEWIC 2006a). The female may store sperm for months to years while waiting for ovulation to occur. The gestation period lasts 9 to 12 months, with birth usually occurring in the spring to fall. Abundance indices based on catch rates in or near Canadian waters show varying decline rates of blue sharks between near 0 to 53% since the mid–1990s (COSEWIC 2006a). The length of newborn pups averages 40 to 50 cm, taking four to five years to mature to a length of 193 to 210 cm. Blue sharks are opportunistic predators and prey upon bony fish, squid, birds, and marine mammal carrion.

Blue sharks are commonly found in offshore waters in depths up to 350 m, abundant along the coast of Nova Scotia including the shelf and slope during summer and fall from June to October. Blue sharks can be found in water temperatures between 5.6 to 28°C but prefer temperatures of 8 to 16°C. Temperature is believed to be a primary factor in migration (COSEWIC 2006a). Canadian waters provide habitat for primarily immature individuals although mature species are occasionally observed (COSEWIC 2006a).

Cusk

Cusk are commonly found between the Gulf of Maine and southern Scotian Shelf, particularly along the southwestern Shelf as well as noted as far up the shelf as Sable Island (SARA 2013b). Additionally, cusk can be found within the Gully and the Laurentian Channel. They prefer water depths of 200 to 600 m, inhabit benthic area consisting of a hard and rocky seabed, and feed on invertebrate species.

Cusk are a slow-growing and later-maturing species with males maturing at five years and females at seven (SARA 2013b). Spawning occurs between May and August with females laying from 100 000 to over a million eggs. The eggs are buoyant and hatch 4 mm larvae that remain buoyant until settling to the bottom at a size of 50 to 60 mm. Larvae can be found over Georges and Roseway Basins, as well as from Browns to Sable Island Banks and respective shelf edges (Horseman and Shackell 2009). Population trends for the species indicate a decline of 93.4% from 1970 to 2001 (COSEWIC 2003).

Deepwater Redfish

Deepwater redfish have similar life history characteristics as the Acadian redfish, with the major difference being that they release their larvae 15 to 25 days earlier (COSEWIC 2010c). They are closely associated with the seafloor and commonly found inhabiting waters deeper than the Acadian redfish. The deepwater redfish extends from the Grand Banks to Baffin Bay and includes the Gulf of St. Lawrence, Laurentian Channel and the Labrador Sea (COSEWIC 2010c). They can be found in a wide range of habitats, using rocks and anemones as protection from predators. Commonly found inhabiting waters 350 to 500 m deep, the species can be found on the edge of the banks and in deep channels from the Labrador Sea to Sable Island. Redfishes are considered semi-pelagic because they make long daily vertical migration (COSEWIC 2010c). Migratory movement information is unknown because they cannot be tagged (gas bladder ruptures when brought to the surface). It is believed that once they have settled to the seafloor dispersal is limited (COSEWIC 2010c). Given the impossibility of rapidly differentiating between deepwater redfish and Acadian redfish, particularly in commercial catches, redfish stock assessments have always been done for all species combined (COSEWIC 2010c). The deepwater redfish has shown a substantial (>95%) decline over one to two generations in areas where they were historically abundant, although in some areas abundance indices have been stable or increasing since the mid-1990s (COSEWIC 2010c). The abundance indices for this species fluctuate widely, but show no overall trends.

Northern Wolffish

Northern wolffish range from northeast Newfoundland and across the North Atlantic with occasional occurrences on the Scotian Shelf (COSEWIC 2012d). On the Shelf, most northern wolffish are found in deep water, up to 1,500 m, in a narrow water temperature range of 3 to 5°C, and it is believed that temperature is a limiting factor in their distribution (COSEWIC 2012d). Before the decline of the northern wolffish, they were caught on substrates of all types. Today they are most often found on sand and shell hash (COSEWIC 2012d).

During the summer months females lay up to 30,000 large eggs in a nest on the seafloor. Larvae may be present on the seafloor in fall to early winter (COSEWIC 2012d). Due to the occasional nature of this species on the Scotian Shelf, it is unlikely that larvae would be found in the vicinity of the Project. This species has only been caught in 30 of 7,200 research tows since 1970 on the Scotian Shelf, preventing an analysis of population trends for the species in this area (COSEWIC 2012d). Analysis of DFO commercial fishery landings data, which covers the periods April to September from 2005 to 2010, indicate that no northern wolffish were harvested in the Project Area within that six-year period (LGL 2014).

Porbeagle Shark

Porbeagle sharks are a pelagic species that can be found from the coast to the open sea; however, they are known to commonly inhabit continental shelves and ocean basins at depths up to 700 m. They have also been found closer to shore, although this is more occasional (SARA 2013a). Generally, porbeagle sharks in Canadian waters can be found at temperatures ranging from 5 to 10°C, with little variation from one season to the next, suggesting that they travel about to remain in the cold waters they prefer (SARA 2013a).

Male porbeagle sharks mature at eight years, with females mature at 13 and have a life expectancy of 25 to 46 years. Mating occurs from late September to November and females are ovoviviparous having a gestation period of eight to nine months. Females leave the Continental Shelf in December travelling at great depths (>500 m), swimming up to 2,500 km to the Sargasso Sea (DFO 2013e). Females give birth here in March and April inhabiting the deep, cool waters. The young start appearing in Atlantic Canadian waters in June and July. It is believed that the young sharks "hitch a ride north" on the deep cool sections of the Gulf Stream (DFO 2013e).

Immature porbeagle sharks inhabit the Scotian Shelf with mature individuals migrating along the shelf waters to mating grounds located on the Grand Banks, off the mouth of the Gulf of St. Lawrence, and on Georges Bank from September to November. There is a population which undertakes extensive annual migrations and from January to February, this population can be found in the Gulf of Maine, Georges Bank and the Southern Scotian Shelf. By the spring they can be found on the edge of the Scotian Shelf and in offshore basins. In the summer and fall, they can be found off the southern coast of Newfoundland and in the Gulf of St. Lawrence (Campana *et al.* 2013).

The most recent population estimate for this species in 2009 was thought to be approximately 197,000 to 207,000 individuals, which included 11,000 to 14,000 spawning females (COSEWIC 2014b). Since 1961, the abundance of this species has declined by 56 to 70%. This decline has been reduced over the last decade, due to a reduction in this fishery.

Roughhead Grenadier

The roughhead grenadier is a benthopelagic species that is closely associated with the seafloor. They are commonly found in water depths of 200 to 2,000 m on or near the continental slope of the Newfoundland and Labrador Shelves, the northeastern slope of the Grand Banks and off the Flemish Cap; however, they have been observed from Davis Strait to the southern Grand Banks. They have also been observed on Banquereau, Sable Island, Browns and Georges Banks. The species is an opportunistic predator feeding on invertebrates, small fish, and squid (COSEWIC 2007a).

Roughhead grenadier are a slow-growing and late-maturing fish species with a long life cycle and low population turnover rate. Females mature at approximately 13 to 15 years of age. Spawning may occur within the southern Grand Banks during the winter and early spring, although it is possible that the species spawns year-round. Females lay over 25,000 pelagic eggs over a lengthy spawning period (COSEWIC 2007a).

Roundnose Grenadier

The roundnose grenadier is a continental slope species with the deeper part of its geographic range not well surveyed (COSEWIC 2008a). It is more abundant in the northern portion of its Canadian range including Labrador and Northeast Newfoundland shelves and Davis Strait, although some captures have been made along the Scotian Slope. It is closely associated with the seafloor and commonly found inhabiting waters 800 to1,000 m in depth but has been found in water depths of up to 2,600 m. The species prefers areas absent of currents and can be found in aggregations in troughs, gorges, and lower parts of the Scotian Slope. Aggregations have been found around the North Atlantic Sea Mounts.

Like the roughhead grenadier, the roundnose grenadier is a relatively long-lived, slow-growing species. Females reach maturity at about 10 years of age and have been reported with a maximum age of 60 years (COSEWIC 2008a). Spawning is believed to occur year-round with peaks at different times for different areas. Females will spawn 12,000 to 25,000 pelagic eggs.

Roundnose grenadier have been observed moving up and down continental slopes, moving to deeper water in the winter and shallower water in the summer. They have also been observed to carry out diurnal vertical migrations of 1000 m off the bottom. The species feeds in the water column on a variety of prey items including: copepods, amphipods, squid, and small fish (COSEWIC 2008a).

Shortfin Mako

The shortfin mako is a pelagic species that migrates north following food stocks (*i.e.*, mackerel, herring, and tuna) during the late summer and fall. The species prefers warm-water temperatures ranging from 17 to 22°C and is typically associated with Gulf Stream waters and occurring at depths from the surface to 500 m (COSEWIC 2006f). It has been observed from Georges and Browns Banks to the Grand Banks and is rarely found in waters with temperatures less than 16°C.

The species can reach lengths of over 4 m. Females mature at 2.7 to 3 m at an average age of 17 years old. Females are ovoviviparous and have litters of 4 to 25 pups after a 15 to 18 month gestation period and have an estimated three-year parturition cycle. Pups are born at a length of 70 cm. Shortfin makos have a lifespan ranging from 25 to 45 years (COSEWIC 2006f). There are no reliable population-level stock estimates available for the shortfin mako in the North Atlantic. Trend estimates, based on declines in catch rates in the entire Northwest Atlantic, suggest that the shortfin mako populations may have decreased by up to 50% in the past 15 to 30 years (COSEWIC 2006f).

Smooth Skate

The smooth skate can be found from the Grand Banks to South Carolina. In Canadian waters it is common from the Grand Banks along the Scotian Shelf and into the Gulf of Maine area. The species has been recorded at shallowest and deepest water depths of 25 m and 1436 m, respectively; however, densest concentrations occur between 150 and 550 m (COSEWIC 2012g). They can be found over a relatively narrow range of temperatures ranging from -1.3 to 15.7°C (BIO 2013a). Smooth skates prefer soft mud substrates consisting of silts and clay, but they have also been found on sand, shell hash, gravel and pebble substrates. Smooth skates primarily feed on small crustaceans, and will eat fish once they reach later (largest) stages of their life.

The smooth skate is a slow-growing, late-maturing and long-lived species that are capable of spawning year-round with no known observed peak in spawning rates. Smooth skate are generally slow to reproduce, producing 40 to 100 egg capsules per year. Females mature at an average age of 11 years. Females will lay an egg-capsule on the benthic substrate. Larval smooth skates develop in the egg capsule in one to two years before hatching (BIO 2013a). The estimate for the Laurentian-Scotian population of smooth skates is approximately 5,704,000 individuals (COSEWIC 2012g).

Spiny Dogfish

Spiny dogfish can survive in a variety of habitats occurring world-wide, from the intertidal zone to the shelf slope up to 730 m water depths, and in temperate and boreal waters. They are most abundant between Nova Scotia and Cape Hatteras with the highest concentration in Canadian waters being on the Scotian Shelf. The Atlantic population is believed to consist of resident and migrating species. They prefer a temperature range of 6 to 12°C and show no strong association with substrate type (COSEWIC 2010b). Spiny dogfish follow a general seasonal migration between inshore waters during the summer-fall and offshore waters during the winter-spring.

Spiny dogfish reach a maximum size of 1.5 m and have a lifespan of 25 to 30 years. Females mature at 15 years and mate during the fall and early winter. After a gestation period of 18 to 24 months an average of six pups are born live in the winter which are approximately 25 cm in length (COSEWIC 2010b). Population estimates for this species on the Scotian Shelf from 2003 to 2007 are in the range of 150,000,000 individuals (COSEWIC 2010b).

Spotted Wolffish

The main range of the spotted wolffish is west of Greenland to the Grand Banks with some occurrence on the Eastern Scotian Shelf off Cape Breton, but only occasionally seen on the Scotian Shelf (COSWEIC 2012e). The species is commonly found inhabiting the seafloor in water depths of 50 to 800 m. The species prefers a substrate of coarse sand and a sand and shell mix with rocks to provide shelter.

On the Scotian Shelf, spotted wolffish are found in deep water, in a water temperature range of 2 to 8°C, and it is believed that temperature is a limiting factor in their distribution. The waters of the Scotian Shelf are generally too warm for spotted wolffish (COSEWIC 2012e).

The spotted wolffish grows slower than other wolffish species. Females mature at seven years and spawning occurs in the summer to late fall/early winter. Approximately 50 000 large eggs are laid on the seafloor and are guarded by the male until they hatch (COSWEIC 2012e). Due to the occasional nature of this species on the Scotian Shelf, it is unlikely that eggs or larvae would be found in the vicinity of the Project. On the Scotian Shelf, this species has been caught in only 22 of 7,200 research tows since 1970. As a result, there are insufficient catch rates to estimate their population (COSEWIC 2012e). Analysis of DFO commercial fishery landings data, which covers the periods April to September from 2005 to 2010, indicate that no spotted wolffish were harvested in the Project Area within that six-year period (LGL 2014).

Striped Bass

The natural range of the striped bass extends along the Atlantic coast of North America from the St. Lawrence Estuary to the St. Johns River in northeast Florida. There is historical evidence of striped bass spawning in five rivers of Eastern Canada including the St. Lawrence Estuary, the Miramichi River in the southern Gulf of St. Lawrence, and the Saint John, Annapolis and Shubenacadie rivers in the Bay of Fundy (COSEWIC 2004). There are two genetically distinct populations in Eastern Canada which could potentially be found in coastal waters in the vicinity of the Project: the Bay of Fundy population and the Southern Gulf of St. Lawrence population. Given the coastal/freshwater nature of this species, interaction with the Project is considered to be highly remote. This species has been considered in recognition of its importance to recreational and Aboriginal fisheries.

The striped bass is anadromous species meaning it spawns in fresh water before moving downstream to brackish and salt water to feed and mature. Young-of-the-year move downstream over the summer where they continue to feed and grow in estuaries and coastal bays. Older fish migrate along the coast in search of prey such as juvenile herring, smelt and tomcod. In the fall, the striped bass move back upstream where they overwinter in brackish or fresh water, likely to avoid low ocean temperatures (COSEWIC 2004).

Thorny Skate (*Amblyraja radiate*)

The thorny skate can be found from Baffin Bay, Davis Strait, Labrador Shelf, Grand Banks, Gulf of St. Lawrence, Scotian Shelf and Bay of Fundy to Georges Bank. Highest concentrations can be found on the Eastern Scotian Shelf and the Lower Bay of Fundy (COSEWIC 2012a). The species is present in a range of water depths, but primarily from 18 to 1,200 m on substrates including sand, shell hash, gravel, pebbles, and soft muds. They are typically found in water temperatures of 0 to 10°C.

Thorny skates are a slow-growing species reaching maturity at 11 years of age. Females lay 6 to 40 eggs per year. It is believed that peak spawning occurs in the fall and winter months. On the Scotian Shelf, the most recent population numbers from 2008 to 2010 show that there are 21,706,610 thorny skates, including 1,145,152 mature individuals (COSEWIC 2012a).

White Shark

The white shark is rare in the northwest Atlantic (32 records in 132 years), as it is the northern edge of their range. Recorded sightings in the vicinity of the Project include the Bay of Fundy, Laurentian Channel, and Sable Island Bank. They can range in water depth from the surface to 1,300 m, are highly mobile, and migrate seasonally (COSEWIC 2006b). Individuals in Atlantic Canada are likely seasonal migrants belonging to a widespread Northwest Atlantic population (LGL 2014).

Females are ovoviviparous with a gestation period of 14 months, giving birth to an average of 7 pups. It is believed that pupping takes place in the Mid-Atlantic bight (COSEWIC 2006b). There have been no surveys in Canadian waters to determine the population size of the white shark. Information on the global population size is sparse, although most sources agree that the species is relatively rare (COSEWIC 2006b).

White Hake

In general, white hake reside on the Scotian Shelf and upper slope and prefer soft bottom substrates in water temperatures ranging from 5 to 11°C (DFO 2013l). High concentrations have been found on Georges Bank and the offshore banks of the Scotian Shelf. They are generally found near the bottom and are commonly captured over fine sediment substrates such as mud but have also been recorded on sand and gravel (COSEWIC 2013). Depth distribution is adjusted to find temperatures in the range of 4 to 8°C. Juvenile white hake feed on shrimp, polychaetes, and small crustaceans. Adults feed on herring, cod, haddock, other hake species, redfish, mackerel and other species found in the area.

Males reach maturity at 2 to 4 years with females maturing at 3 to 5 years. Female white hake can produce several million eggs each during the spawning season (DFO 2013l). Once released, the eggs are buoyant and float near the surface until they hatch. Larvae and juveniles are pelagic until they reach a size of 50 to 60 mm, which can take 2 to 6 months (DFO 2013l). From June to September, spawning occurs in the Northumberland Strait with peak spawning in June. Additionally, a second summer spawning has been recorded on the Scotian Shelf (COSEWIC

2013). The abundance of juvenile and mature individuals has been estimated (COSEWIC 2013). In the 1970s the abundance of juveniles was estimated to be 12 million, which increased to 32 million in the 1980s and since then has declined to an average of 13 million in 2006-2011 (COSEWIC 2013). The abundance of mature individuals was estimated to be 15 million in the 1970s, declining to 6 million in 1980 and rebounding to 30 million in the mid-1980s. Since then, the adult abundance has declined to an average of 8.3 million between 2006-2011 (COSEWIC 2013).

5.2.6 Marine Mammals

5.2.6.1 Overview

There are three groups of marine mammals that can be found on the Scotian Shelf and Slope including the Mysticetes (toothless/baleen whales), Odontocetes (toothed whales), and Phocids (Seals).

There are six species of Mysticetes and eleven species of Odontocetes known to occur on the Scotian Slope (Stantec 2014a and 2014b) that could potentially be present in the Project Area (refer to Table 5.2.9). On the Scotian Shelf and Slope there is also critical habitat for endangered species including the North Atlantic right whale and the northern bottlenose whale. Critical habitat for the endangered North Atlantic right whale has been identified in Roseway Basin on the Scotian Shelf within the RAA (Brown *et al.* 2009). Critical habitat for the endangered northern bottlenose whale has been designated in the Gully and in the Shortland and Haldimand Canyons on the east of the Scotian Shelf and Slope, although there have also been sightings along the shelf break and within Dawson and Verrill Canyons that are within the Project Area. Table 5.2.10 presents information on presence and timing of marine mammals known to occur in the vicinity of the Project Area based on a review of existing literature incorporated within the SEA for the Scotian Slope (Phase 1B and 3B) (Stantec 2012a, 2014b).

Figures 5.2.14 and 5.2.15 display sightings data of Mysticetes and Odontocetes, respectively, between 1911 and 2013 as provided by DFO. Data have been collected from various sources over the years, including sightings from fishing and whaling in the 1960s and 1970s, opportunistic observer programs on fishing vessels, and scientific expeditions by DFO, non-government organizations, and Dalhousie University research teams. The various survey efforts are not consistent or rigorously applied and the lack of sightings does not necessarily represent lack of species presence in a particular area. Given these inconsistencies across all data collections areas, the data have not been completely error-checked nor undergone comprehensive quality control. The data set shown in the figures provides an insight into the long term distribution of the species however it is important to note that it does not give a representation of a typical day, week, month or even year of sightings or animal presence.

Individual species maps are provided in Appendix E and use data from the Ocean Biogeographic Information System (OBIS). This data set combines marine mammal data from a variety of sources including but not limited to:

- Bureau of Land Management (BLM) Cetacean and Turtle Assessment Program (CETAP);
- Canadian Wildlife Services – Environment Canada (CWS-EC) Eastern Canada Seabirds at Sea (ECSAS);
- Programme Intégré de recherches sur les oiseaux pélagiques (PIROP) Northwest Atlantic 1965–1992;
- DFO Maritimes Region Cetacean Sightings;
- National Oceanic and Atmospheric Administration (NOAA); and
- NOAA Northeast Fisheries Science Center (NEFSC) surveys.

Table 5.2.9 Marine Mammals Known to Occur in the Vicinity of the Project Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area[1]	Timing of Presence
Mysticetes (Toothless or Baleen Whales)					
Blue whale (Atlantic population)	*Balaenoptera musculus*	Endangered	Endangered	Moderate	Summer to Fall
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Special Concern	High	Year- round (highest concentrations in Summer)
Humpback whale (Western North Atlantic population)	*Megaptera novaeangliae*	Not Listed	Not at Risk	Low to Moderate	Summer
Minke whale	*Balaenoptera acutorostrata*	Not Listed	Not at Risk	Moderate	Spring to Summer
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered	Low	Summer
Sei whale	*Balaenoptera borealis*	Not Listed	Not Listed	Low to Moderate	Summer to early Fall
Odontocetes (Toothed Whales)					
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Not Listed	Not at Risk	Moderate to High	Late Spring to late Fall
Bottlenose dolphin	*Tursiops truncates*	Not Listed	Not at Risk	Low	Year-round
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Not Listed	Special Concern	Low	Summer to Fall
Killer whale	*Orcinus orca*	Not Listed	Special Concern	Low to Moderate	Summer
Long-finned pilot whale	*Globicephala melas*	Not Listed	Not at Risk	High	Year-round

Table 5.2.9 Marine Mammals Known to Occur in the Vicinity of the Project Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area[1]	Timing of Presence
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Endangered	Endangered	Low	Year-round
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Special Concern	Low	Year-round
Short-beaked common dolphin	*Delphinus delphis*	Not Listed	Not at Risk	High	Summer to Fall
Sperm whale	*Physeter macrocephalus*	Not Listed	Not at Risk	High	Summer
Striped dolphin	*Stenella coeruleoalba*	Not Listed	Not at Risk	Low	Summer to Fall
White-beaked dolphin	*Lagenorhynchis albiorostris*	Not Listed	Not at Risk	Low	Year-round
Phocids (Seals)					
Grey Seal	*Halichoerus grypus*	Not Listed	Not at Risk	High	Year-round
Harbour Seal	*Phoca vitulina*	Not Listed	Not at Risk	Moderate	Year-round
Harp Seal	*Pagophilus groenlandicus*	Not Listed	Not at Risk	Moderate	Winter to early Spring
Hooded Seal	*Cystophora cristata*	Not Listed	Not at Risk	Moderate	Winter to early Spring
Ringed Seal	*Pusa hispida*	Not Listed	Not at Risk	Low	Winter to early Spring

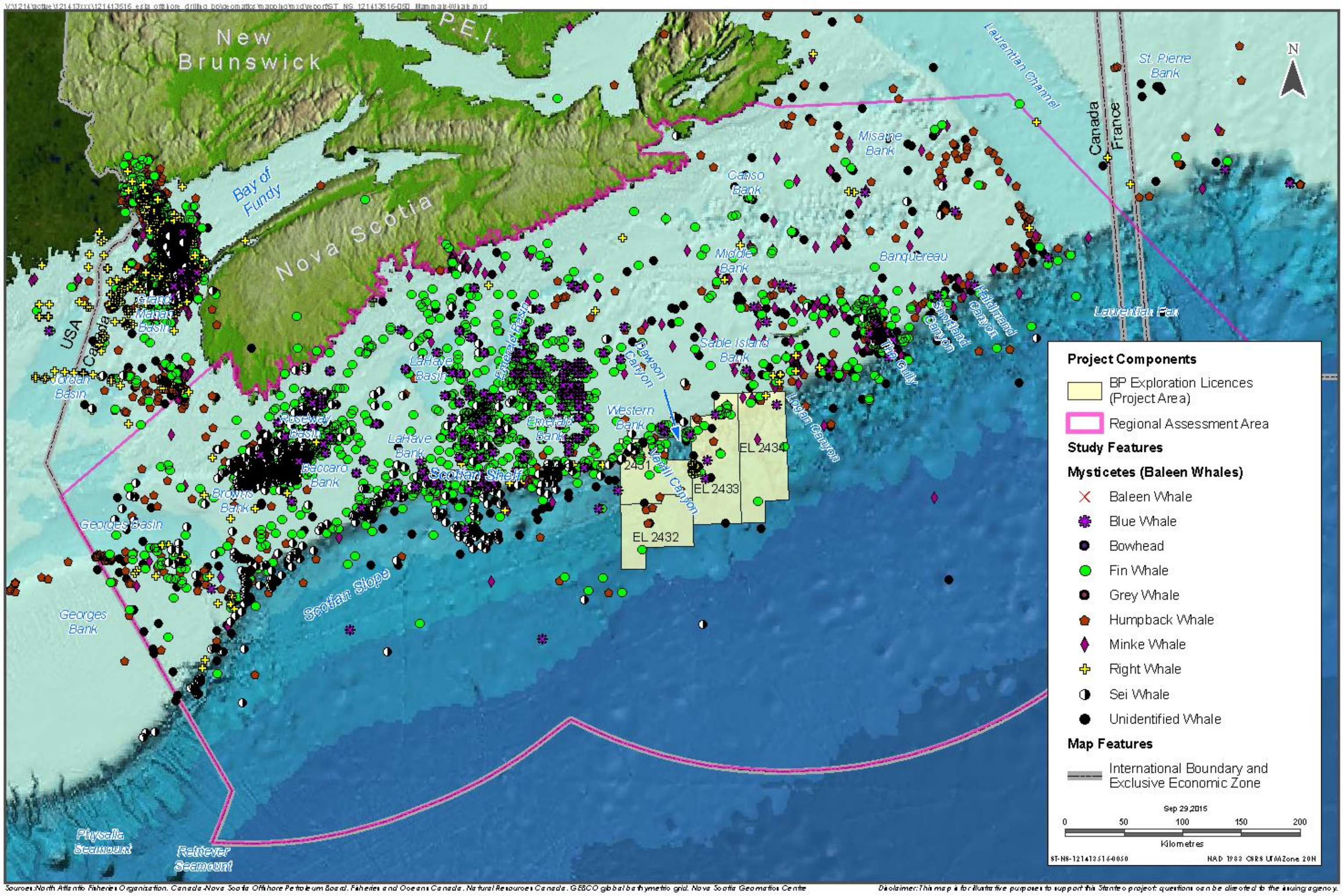
Note:
[1]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and sightings data for each species within the Project Area.

Sources: Modified from Stantec 2014b and Stantec 2012a

Table 5.2.10 Marine Mammal Presence on the Scotian Shelf and Slope

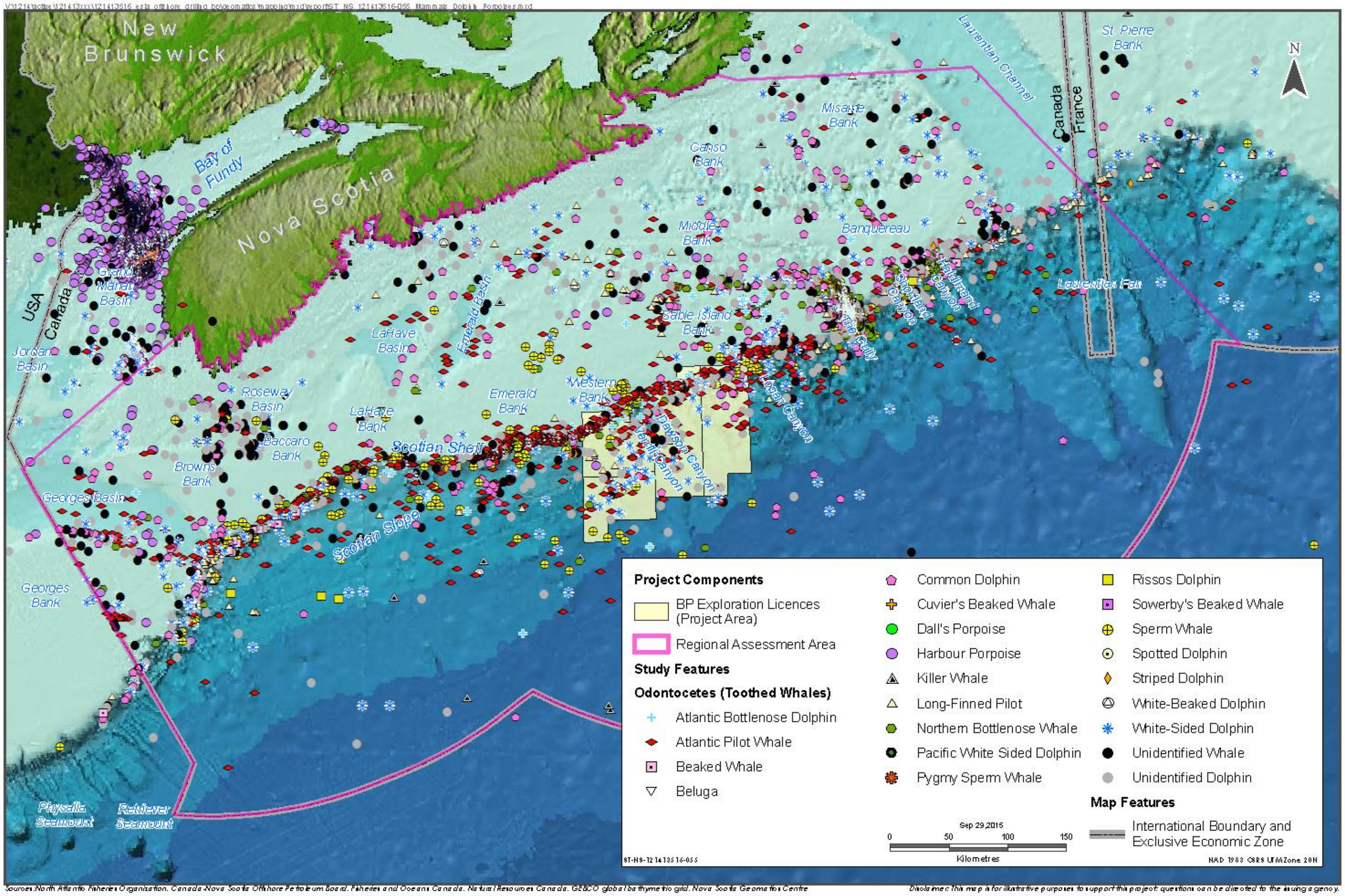
Common Name	Scientific Name	January	February	March	April	May	June	July	August	September	October	November	December
Mysticetes (Baleen Whales)													
Blue whale	*Balaenoptera musculus*					■	■	■	■	■	■	■	
Fin whale	*Balaenoptera physalus*	■	■	■	■	■	■	■	■	■	■	■	■
Humpback whale	*Megaptera novaeangliae*					■	■	■	■	■			
Minke whale	*Balaenoptera acutorostrata*			■	■	■	■	■	■	■			
North Atlantic right whale	*Eubalaena glacialis*					■	■	■	■	■			
Sei whale	*Balaenoptera borealis*					■	■	■	■	■	■		
Odontocetes (Toothed Whales)													
Atlantic white-sided dolphin	*Lagenorhynchus acutus*						■	■	■	■	■	■	■
Bottlenose dolphin	*Tursiops truncates*	■	■	■	■	■	■	■	■	■	■	■	■
Harbour porpoise	*Phocoena phocoena*					■	■	■	■	■	■	■	
Killer whale	*Orcinus orca*					■	■	■	■	■			
Long-finned pilot whale	*Globicephala melas*	■	■	■	■	■	■	■	■	■	■	■	■
Northern bottlenose whale	*Hyperoodon ampullatus*	■	■	■	■	■	■	■	■	■	■	■	■
Sowerby's beaked whale	*Mesoplodon bidens*	■	■	■	■	■	■	■	■	■	■	■	■
Short-beaked common dolphin	*Delphinus delphis*					■	■	■	■	■	■	■	
Sperm whale	*Physeter macrocephalus*					■	■	■	■	■			
Striped dolphin	*Stenella coeruleoalba*					■	■	■	■	■	■	■	
White-beaked dolphin	*Lagenorhynchus albirostris*	■	■	■	■	■	■	■	■	■	■	■	■
Phocids (Seals)													
Grey Seal	*Halichoerus grypus*	■	■	■	■	■	■	■	■	■	■	■	■
Harbour Seal	*Phoca vitulina*	■	■	■	■	■	■	■	■	■	■	■	■
Harp Seal	*Pagophilus groenlandicus*	■	■	■									■
Hooded Seal	*Cystophora cristata*	■	■	■									■
Ringed Seal	*Pusa hispida*	■	■	■									■
■	Timing of Presence on the Scotian Shelf and Slope												

Source: Modified from Stantec 2014a



Sources: Data provided from NAFO, CNSOPB, DFO, and NSDNR (n/d).

Figure 5.2.14 Total Mysticetes Sightings (1911–2013) on the Scotian Shelf and Slope

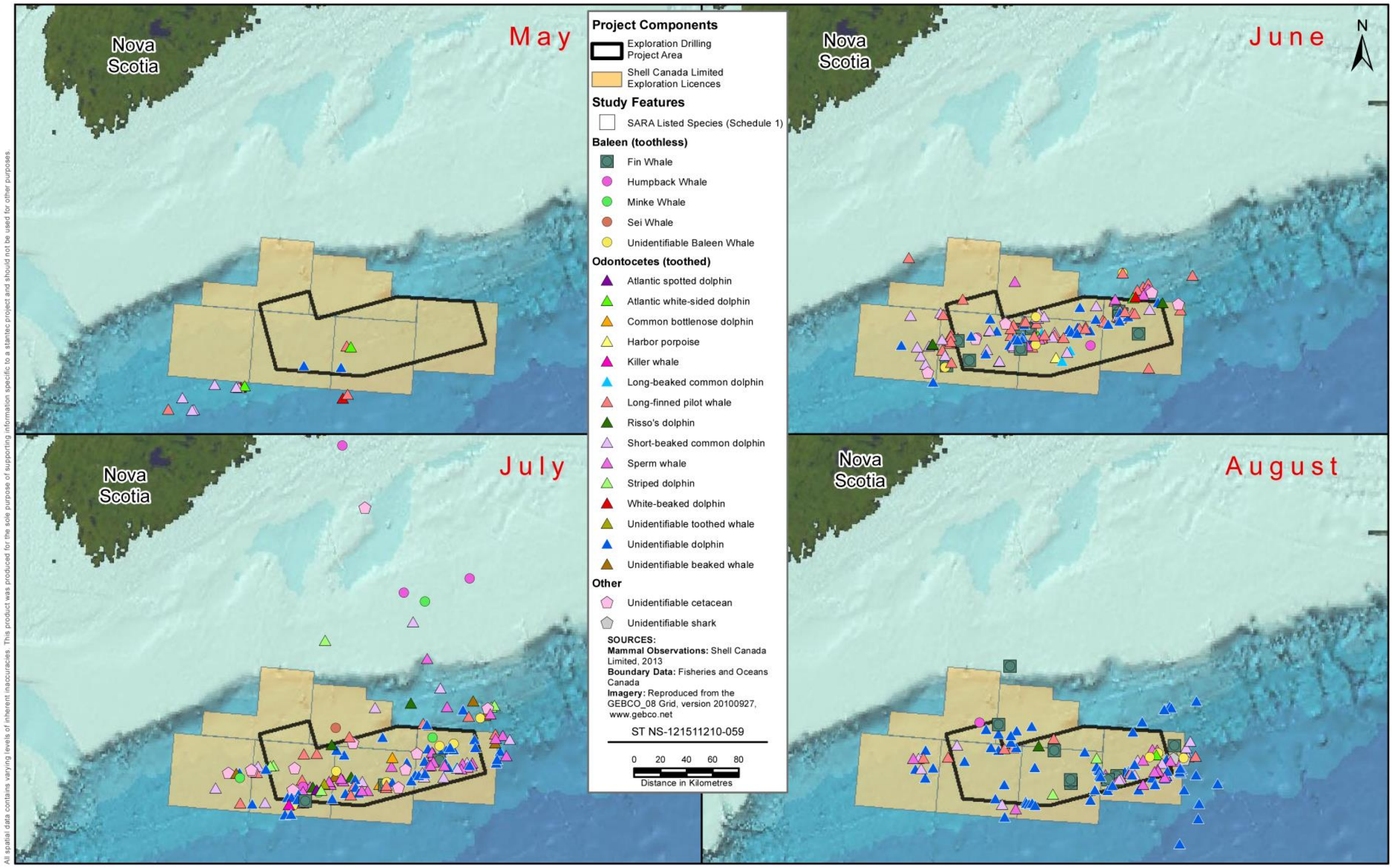


Sources: Data provided from NAFO, CNSOPB, DFO, and NSDNR (n/d)

Figure 5.2.15 Total Odontocete Sightings (1911–2013) on the Scotian Shelf and Slope

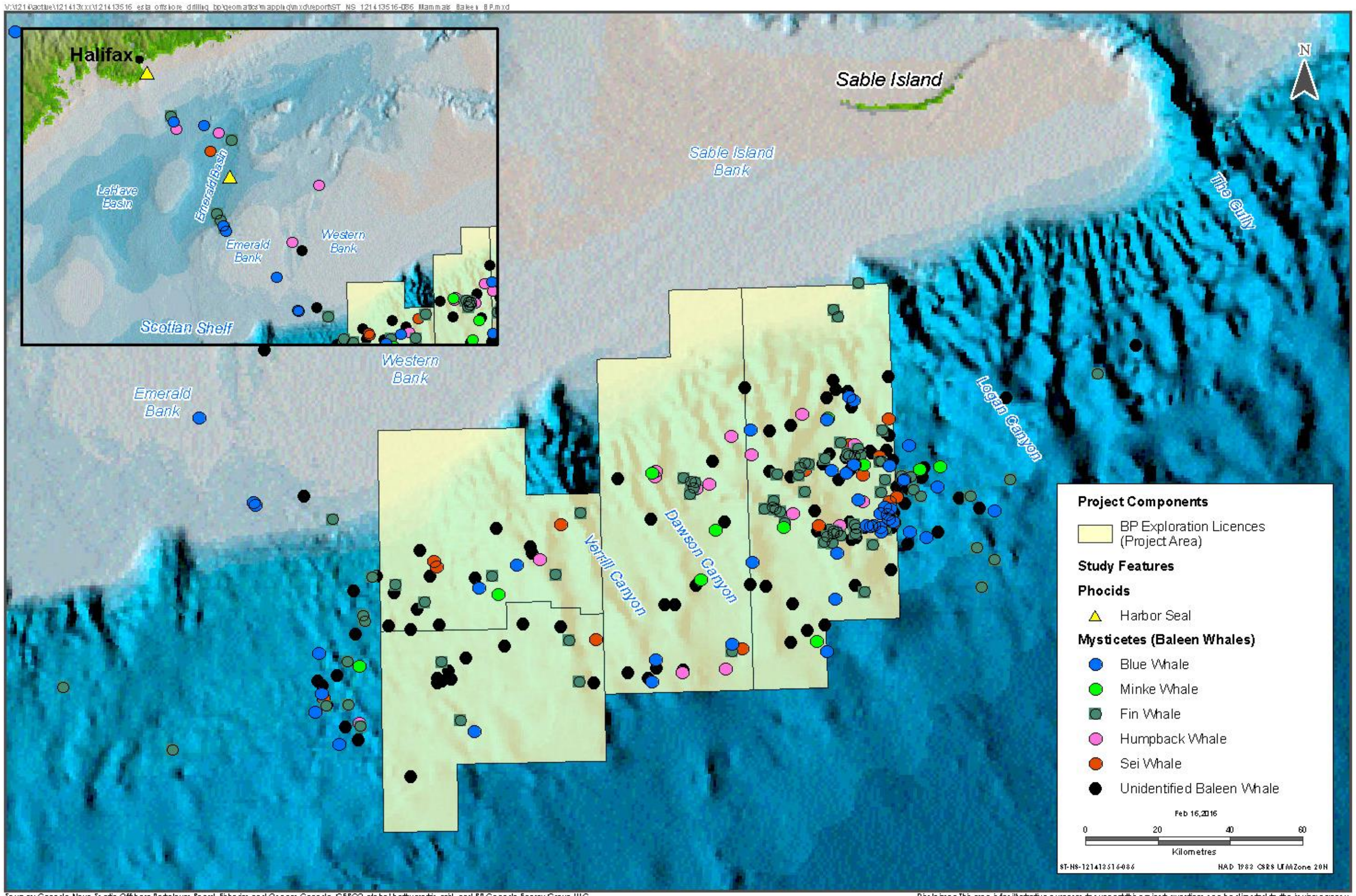
As shown on Figures 5.2.14 and 5.2.15, cetaceans are sighted more often in areas where there are greater bathymetric changes such as along the shelf edge, in the slopes of basins on the shelf, and in the canyons connecting the deep slope waters up to the shallower waters of the shelf. These figures do not include observational data collected during the Shelburne Basin 3D Seismic Survey by Shell Canada Limited between June and August 2013 and the Tangier 3D Seismic Survey by BP conducted in 2014 between May and September. These data for the Shelburne Basin 3D Seismic Survey were recorded daily and reported on a weekly basis and provide some insight on the types of species observed in the area located directly adjacent and west of the Project Area during the summer months (refer to Figure 5.2.16). Similarly, data from the Tangier 3D Seismic Survey provided insight on the types of species observed within the Project Area using visual and acoustic monitoring efforts (refer to Figures 5.2.17 and 5.2.18). As a result of multiple vessels with Marine Mammal Observers (MMO) collecting observational data at the same time, the observational data may over-estimate the number of sightings as a result of the same marine mammal having been recorded more than once.

Marine wildlife monitoring during BP's Tangier 3D Seismic Survey identified 15 odontocete (*i.e.*, toothed whale) species, 5 mysticete (*i.e.*, baleen whale) species and one phocid species. Sperm whales (*Physeter macrocephalus*) were overall the most commonly observed species during the monitoring program accounting for 20% of all visual detections (RPS 2014). Long-finned pilot whales (*Globicephala melas*) and short-beaked common dolphins (Delphinus delphis) were the most commonly observed odontocete species, and fin whales *(Balaenoptera physalus*) and blue whales (*Balaenoptera musculus*) the most commonly observed baleen whales (RPS 2014). A summary of marine mammal detections from the Tangier 3D Seismic Survey in 2014 is shown in Table 5.2.11.



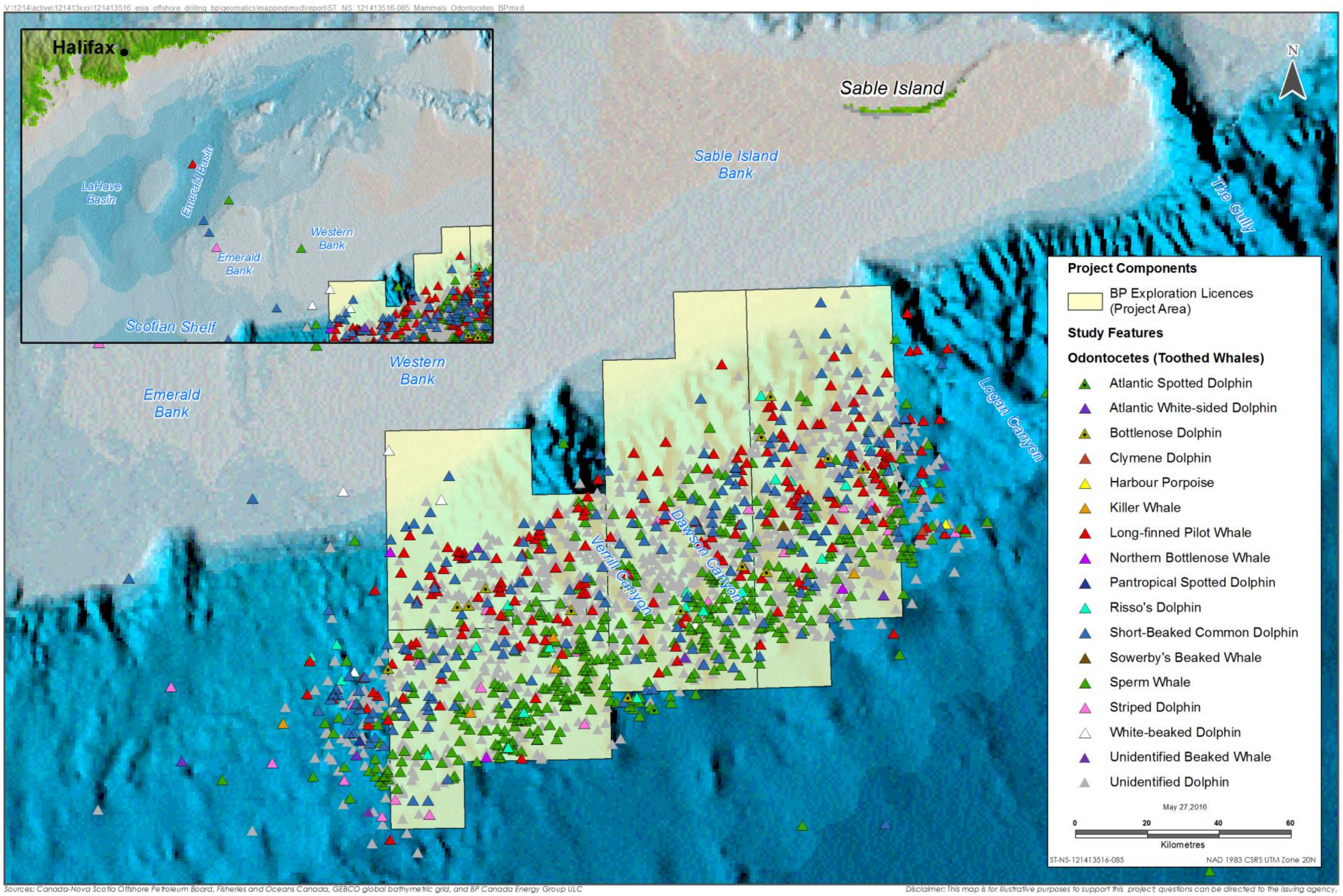
Source: Stantec 2014a

Figure 5.2.16 Marine Mammal Observations Collected during the 2013 Shelburne Seismic Survey



Sources: Data provided from CNSOPB, DFO, and BP Canada Energy Group ULC

Figure 5.2.17 Mysticetes and Phocid Observations Collected during the 2014 Tangier 3D Seismic Survey



Sources: Data provided from CNSOPB, DFO, and BP Canada Energy Group ULC

Figure 5.2.18 Odontocete Observations Collected during the 2014 Tangier 3D Seismic Survey

Table 5.2.11 Summary of Marine Mammal Detections during the 2014 Tangier 3D Seismic Survey

Common Name (months/periods of peak abundance)	Number of Visual Detections			Number of Acoustic Detections			Number of Concurrent Visual and Acoustic Detections			Grand Total[2]
	Source Active[1]	Source Inactive	Total	Source Active	Source Inactive	Total	Source Active	Source Inactive	Total	
Mysticetes										
Blue Whale (July and August)	20	22	42	0	0	0	0	0	0	42
Fin Whale (June to August)	41	32	73	0	0	0	0	0	0	73
Humpback Whale (June and August)	12	10	22	0	0	0	0	0	0	22
Minke Whale (June and July)	4	6	10	0	0	0	0	0	0	10
Sei Whale (July and August)	5	13	18	0	0	0	0	0	0	18
Unidentified Baleen Whale (June to August)	53	43	96	1	0	1	0	0	0	97
Odontocetes										
Northern Bottlenose Whale (June)	0	1	1	0	0	0	0	0	0	1
Sowerby's Beaked Whale	0	0	0	0	1	1	0	0	0	1
Sperm Whale (August)	163	40	203	109	25	134	4	1	5	342
Unidentified Beaked Whale (May)	0	1	1	0	1	1	0	0	0	2
Harbour Porpoise (August)	0	1	1	0	0	0	0	0	0	1
Atlantic Spotted Dolphin (September)	1	0	1	0	0	0	0	0	0	1
Atlantic White-Sided Dolphin (September)	0	5	5	0	0	0	0	0	0	5
Bottlenose Dolphin (July)	4	3	7	0	0	0	0	1	1	8
Clymene Dolphin (August)	0	0	0	0	0	0	0	1	1	1
Killer Whale (August)	0	1	1	1	0	1	0	0	0	2
Long-Finned Pilot Whale (June)	92	68	160	2	0	2	0	4	4	166
Pantropical Spotted Dolphin (August)	0	1	1	0	0	0	0	0	0	1
Risso's Dolphin (July and August)	14	9	23	0	0	0	0	0	0	23
Short-Beaked Common Dolphin (June and July)	63	72	135	2	17	19	0	3	3	157
Striped Dolphin (July and August)	5	12	17	0	0	0	0	0	0	17
White-Beaked Dolphin (May)	0	5	5	0	0	0	0	0	0	5
Unidentified Dolphin (June and July)	67	51	118	634	225	859	0	1	1	978
Phocids										
Harbour Seal (August)	0	3	3	0	0	0	0	0	0	3

Note: There is the potential for MMOs to double count an individual, thereby affecting the total number counted.
[1]Seismic source array active.
[2]Grand Total is the total of all observed species.

Source: Modified from RPS 2014

5.2.6.2 Mysticetes (Baleen Whales)

The following section describes mysticetes that may be found in the Project Area or on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of SAR and SOCC mysticetes can be found in Section 5.2.6.4.

Minke Whale (*Balaenoptera acutorostrata)*

Minke whales can be found in every ocean around the world. Minke whales found in Canadian waters belong to the Canadian East stock inhabiting areas from the Gulf of Mexico in the south to the Davis Strait in the north (DFO 2011a). Generally, Minke whales are found along the Continental Shelf feeding on plankton, krill, and small fish including capelin, cod, eels, herring, mackerel, salmon, sand lance, and wolffish. Minke whales are common in Canadian waters during the spring and summer.

Minke whales have a lifespan of 50 years, reaching maturity at approximately six years of age for males and seven years of age for females (DFO 2011a). It is believed that mating occurs during the winter in tropical and subtropical waters, followed by a gestation period of 10 to 11 months. Females give birth to a single calf. Figure 1 in Appendix E represents observation data for minke whales from 1964 to 2013.

Sei Whale (*Balaenoptera borealis*)

In Atlantic Canadian waters sei whales can be found from Georges Bank in the south to Labrador in the north with a large portion of the population on the Scotian Shelf during the summer and early autumn months. The southern portion of their range extends to the Gulf of Maine and Georges Bank with an abundance of sightings on eastern Georges Bank and along the southwest edge of the Bank (DFO 2011a). Sei whales generally use pelagic habitats over deeper water of up to the 2,000 m depth. Along the Scotian Shelf they are most associated with the shelf edge and the upper slope waters feeding mainly on copepods and plankton floating in the upper layers of the water column.

Sei whales reach maturity between 5 and 15 years of age, with a lifespan ranging from 50 to 70 years. Mating and calving occurs at lower latitudes during the winter months followed by a gestation period of 10 to 12 months (DFO 2011a). Calves are weaned from their mothers at approximately six months of age. Figure 2 in Appendix E represents observation data for sei whales from 1964 to 2013.

Humpback Whale (*Megaptera novaeangliae*)

The humpback whale is considered special concern under Schedule 3 of SARA and is not listed under COSEWIC. Humpback whales can be found in every ocean in the world (DFO 2011a). In Atlantic Canadian waters humpback whales are generally sighted in coastal waters from the Gulf of Mexico to southeastern Labrador and are common in the summer (DFO 2011a).

Humpback whales undergo extensive seasonal migrations with Newfoundland and Gulf of Maine subpopulations migrating to the Scotian Shelf and Slope during the summer months to forage. Humpbacks migrate to southern waters to overwinter and breed in tropical waters in the fall and back to northern waters to feed in the summer (DFO 2011a). The estimated North Atlantic population (including Gulf of Maine and Scotian Shelf stocks) is 7698 based on genetic tagging data. Humpback whales are seasonal filter feeders, feeding on crustaceans including krill and copepods, plankton, and small fish including herring, mackerel, capelin and sand lance.

Humpback whales reach sexual maturity after approximately nine years of age. Mating occurs in tropical waters during the winter months with a gestation period of approximately one year. Birthing usually occurs between January and April in tropical waters, with females giving birth usually every two years (DFO 2011a). Figure 12 in Appendix E represents observation data for humpback whales from 1966 to 2013.

5.2.6.3 Odontocetes (Toothed Whales)

The following section describes odontocetes that may be found in the Project Area or on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of SAR and SOCC odontocetes are provided in Section 5.2.6.4.

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

Atlantic white-sided dolphins are distributed throughout the Continental Shelf and Slope areas of the North Atlantic, primarily found on the Continental Shelf in waters up to 100 m in depth and from western Greenland to North Carolina (NOAA 2013n). There are believed to be three stocks of the species including a Gulf of Maine stock, a Gulf of St. Lawrence stock, and a Labrador Sea stock. The Gulf of Maine stock is most common in continental shelf waters from the Hudson Canyon to Georges Bank and in the Gulf of Maine to the lower Bay of Fundy. The Atlantic white-sided dolphin has been observed to carry out seasonal distribution shifts. Generally, they move inshore and to the north in the summer, and offshore and south during the winter (NOAA 2014b). Atlantic White-sided dolphins can be found throughout the RAA year-round and are more common during the summer and fall months. Figure 3 in Appendix E represents observation data for Atlantic white-sided dolphins from 1967 to 2013.

Bottlenose Dolphin (*Tursiops truncates*)

The bottlenose dolphin has been observed in the Project Area, although it has been more commonly observed in and around canyons on the Scotian Slope, including, but not limited to, the Gully. The bottlenose dolphin is one of the most well-known species of marine mammals, as it is the most common cetacean species held in captivity (OBIS-SEAMAP 2014). Bottlenose dolphins are found primarily in coastal and continental shelf waters of tropic and temperate regions, are considered generalists in terms of habitat, and have highly diverse and adaptable behavioral and social systems (OBIS-SEAMAP 2014). They use high-frequency echolocation to locate and capture prey, which can include benthic invertebrates and fish in the nearshore, or pelagic squid and fish in the offshore (NOAA 2014d). The main threats to this species include direct harvests and fisheries bycatch (OBIS-SEAMAP 2014). The Atlantic Ocean population of bottlenose dolphin is assessed by COSEWIC as Not at Risk. Figure 4 in Appendix E represents observation data for bottlenose dolphins from 1968 to 2013.

Long-finned Pilot Whale (*Globicephala melas*)

Long-finned pilot whales can be found from the waters off North Carolina to North Africa and north to Iceland, Greenland and the Barents Sea (Waring *et al*. 2015) and can be found on the Scotian Shelf and Slope year-round. They frequent coastal waters of Cape Breton during the summer months moving further offshore during the winter. The species tend to inhabit areas of high relief and submerged banks as well as being associated with the Gulf Stream and thermal fronts along the Continental Shelf (NOAA 2013n).

Long-finned pilot whales in the North Atlantic mate and calve between April and September following a gestation period of 12 to 16 months (Reeves *et al.* 2002; NOAA 2014c). The reproductive cycle for this species lasts between three and five years as females are not pregnant and lactating at the same time. The species feeds primarily on squid and mackerel. Figure 5 in Appendix E represents observation data for long-finned pilot whales from 1967 to 2013.

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin is a widely distributed cetacean species, inhabiting tropical, sub-tropical, and temperate areas. In the Northwest Atlantic, the species can be found from Newfoundland to Florida (Reeves *et al.* 2002). During the summer and autumn months, the species can be found on the Scotian Shelf and Slope once water temperatures increase above 11°C (NOAA 2013n; Waring *et al*. 2015). Females remain in lower latitudes during calving and lactation periods in the late spring to early summer after a gestation period of 10 to 11 months (Reeves *et al.* 2002). Short-beaked common dolphins feed primarily on schooling fish and squid. Figure 6 in Appendix E represents observation data for short-beaked common dolphins from 1967 to 2013.

Sperm Whale (*Physeter macrocephalus*)

The sperm whale can be found along the Scotian Shelf edge and commonly in the submarine canyons of the shelf as it is regularly seen in the Gully and on the eastern end of the Scotian Shelf and Slope in water depths of 200 to 1,500 m. Sperm whales are also found along the edge of the Laurentian and Northeast Channels and in areas where water mixes to produce areas of high primary productivity. Only adult male sperm whales travel to northern waters to feed, while all age classes and sexes can be found in tropical and temperate waters further south (Reeves *et al.* 2002).

Sperm whales breed in tropical and sub-tropical waters where the majority of mating occurs during the spring. The gestation period lasts up to 18 months (Reeves *et al.* 2002) and nursing lasts for at least two years with some calves nursing longer. Sperm whales feed on or near the bottom of the ocean where their primary prey include squid, octopus, skates, sharks, and various benthic fish species. Figure 7 in Appendix E represents observation data for sperm whales from 1919 to 2013.

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin can be found from Cape Hatteras to the southern margin of Georges Bank as well as offshore on the continental slope and the mid-Atlantic regions. They prefer the warm waters found on the shelf edge and are often seen in the Gully. In general, striped dolphins prefer continental slope waters offshore to the Gulf Stream (NOAA 2013n). Striped dolphins have been occasionally sighted on the Scotian Shelf over the winter months. Striped dolphins prey upon small schooling fish species such as herring, capelin, mackerel, and squid (Reeves *et al.* 2002).

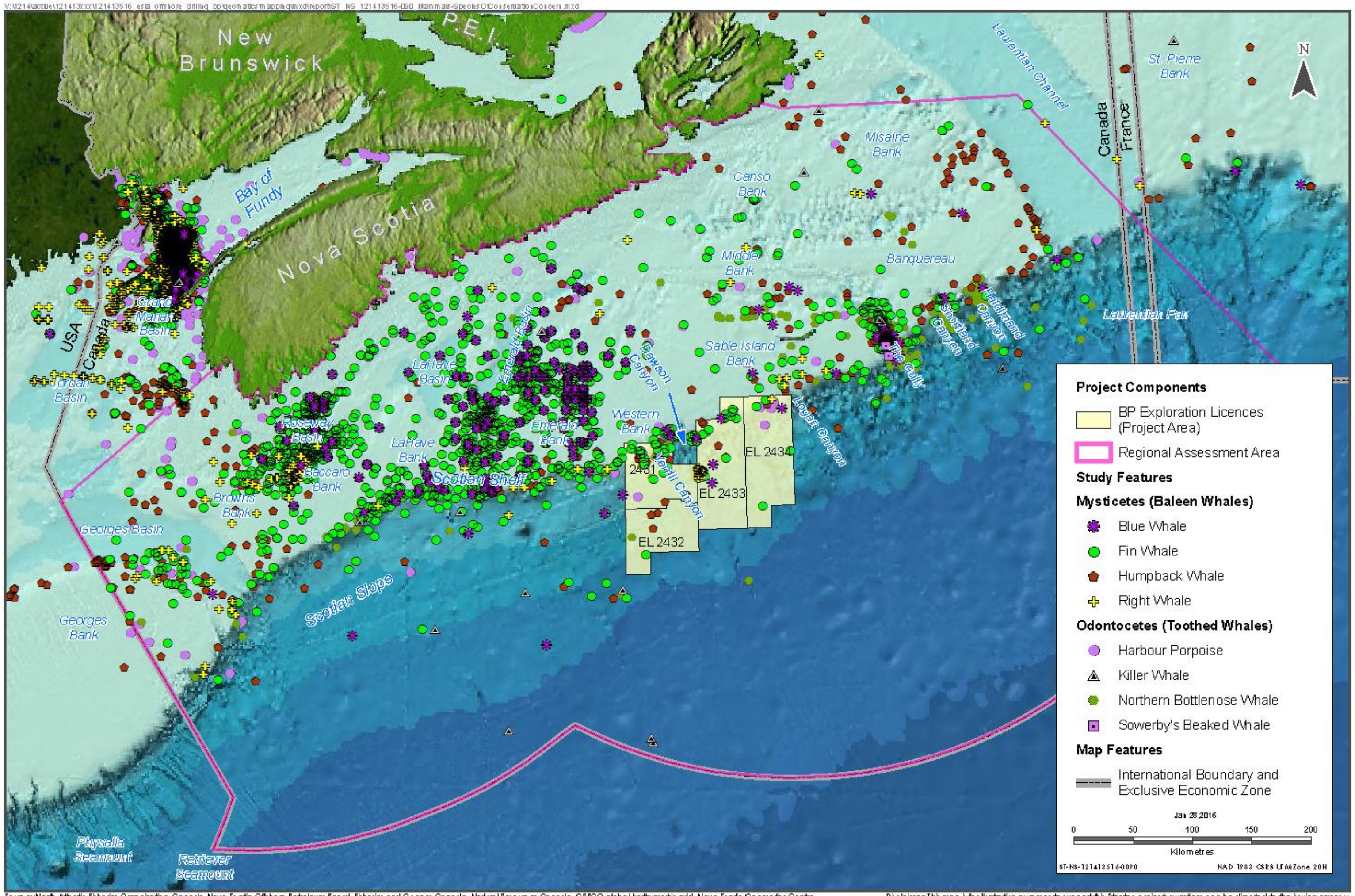
Striped dolphins are born in the late summer or early fall after a gestation period of one year. Calving takes place in large schools of 30 or more individuals comprised of adults, calves and juveniles for a period lasting four years (Reeves *et al.* 2002). Figure 8 in Appendix E represents observation data for striped dolphins from 1967 to 2013.

White-beaked Dolphin (*Lagenorhynchus albirostris*)

The white-beaked dolphin is a year-round resident in waters from Cape Cod to Greenland. They are usually found in social groups of 5 to 30 individuals, and occasionally in groups as large as 1500 (NOAA 2012b.) Little information is known about the reproductive cycle of the white-beaked dolphin. It is believed that the species calves from May to September after a gestation period of 11 to 12 months (NOAA 2012b). White-beaked dolphins prey on small schooling fish species such as herring and capelin, squid, cod, haddock, octopus, as well as crustaceans (Reeves *et al.* 2002). Figure 9 in Appendix E represents observation data for white-beaked dolphins from 1968 to 2013.

5.2.6.4 Species at Risk and Species of Conservation Concern

There are seven marine mammal SAR and SOCC species that may be present on the Scotian Shelf or Slope (refer to Table 5.2.9 and Figure 5.2.19). Marine mammal SAR and SOCC are defined as those that are listed as endangered, threatened, or of special concern by SARA or by COSEWIC. See below for detailed descriptions of each marine mammal SAR and SOCC. For details on the presence of various marine mammal species in the vicinity of the Project Area and on the Scotian Shelf and Slope refer to Tables 5.2.9 and 5.2.10.



Source: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d)

Figure 5.2.19 Marine Mammal Species of Conservation Concern

Mysticetes (Baleen Whales)

Blue Whale (*Balaenoptera musculus*)

The blue whale is listed as endangered under both SARA (Schedule 1) and COSEWIC. The blue whale has a large range with the Atlantic population observed mainly in the St. Lawrence Estuary and shallow coastal zones where mixing and upwelling produces high numbers of krill (Beauchamp *et al.* 2009; LGL 2014). Blue whales feed in these cold upwelling zones in temperate and polar waters from spring to early winter. Between 20 and 105 blue whales are seen annually in the Gulf of St. Lawrence with a total of 382 individuals catalogued in the Gulf since 1979 (SAR Registry website). Little is known about the population size of blue whales except for the Gulf of St. Lawrence area (LGL 2014). Given the small proportion of the distribution range that has been sampled and considering the low number of blue whales encountered and photographed in a given year, the current data based on photo-identification do not allow for an estimate of abundance of this species in the Northwest Atlantic with a minimum degree of certainty (LGL 2014). DFO suggests that 400 to 600 individuals may be found in the western North Atlantic, while COSEWIC (2002b) estimates that the number of mature adults is less than 250 (LGL 2014).

On the Scotian Shelf, they can be found from May to October in areas of high primary productivity. The species has been more commonly sighted on Sambro, Emerald, Western, and LaHave Banks. They have also been sighted along the slope and between Roseway Bank and Basin. Blue whales were sighted regularly by whalers on the Scotian Shelf from 1966 to 1969, although they have been rarely sighted since this time period (COSEWIC 2002b). The blue whale has a low population density and can be found in small migrant herds, surfacing every 5 to 15 minutes for breathing.

Blue whales mate and calve from late fall to mid-winter in the Northern Hemisphere (COSEWIC 2002b). Male and female blue whales reach sexual maturity from 5 to 15 years. Females give birth to a single calf every two to three years after a gestation period of 10 to 11 months. The life expectancy of blue whales is believed to be approximately 70 to 80 years, possibly longer. Blue whales feed almost exclusively off krill in both coastal and offshore waters, especially in areas of upwelling where productivity is high (DFO 2011a). Figure 10 in Appendix E represents observation data for blue whales from 1966 to 2012.

Fin Whale (*Balaenoptera physalus*)

The fin whale is listed as special concern under SARA Schedule 1 status and COSEWIC. Fin whales are the most commonly sighted whale species along the Scotian Shelf concentrated in the northwest Atlantic region during summer months for feeding but seen year-round. They have been sighted throughout the Scotian Shelf between Western and LaHave Banks and on the Scotian Slope and shelf edge. Based on aerial surveys conducted from northern Labrador to the Scotian Shelf in July to August 2007, an estimated 1,967 fin whales occur in this region (LGL 2014). The abundance estimate for the western North Atlantic stock is 3,522 individuals (LGL 2014).

Fin whales reach sexual maturity at 5 to 15 years of age. There is little known information on where they spend their winter months or the location of calving and breeding areas (DFO 2011a). It is believed that mating and calving occur in temperate waters at low latitudes during the winter months and is followed by a gestation period of 11 to 12 months. The calf will wean from its mother for six to seven months until reaching a winter feeding ground. Females give birth every two to three years. The fin whale is a filter feeder, feeding on small schooling fish such as herring and capelin, squid, and crustaceans including mysids and krill. Figure 11 in Appendix E represents observation data for fin whales from 1964 to 2013.

North Atlantic Right Whale (*Eubalaena glacialis*)

The North Atlantic right whale is listed as endangered under Schedule 1 of SARA and COSEWIC. The North Atlantic right whale can be found from the coastal waters of the United States to Newfoundland and the Gulf of St. Lawrence (DFO 2011a). Adult females give birth in the warm waters of the coastal southern US, whereas males and non-calving females are rarely seen in this area, with their winter locations largely unknown (DFO 2011a). There are over-wintering aggregations which are known to reside in Cape Cod Bay and the central Gulf of Maine. A northern migration occurs in the late winter and early spring from calving grounds with mother and calf pairs moving along the shore. During the spring, right whales can be seen feeding and socializing in the Great South Channel, Cape Cod Bay, and Massachusetts Bay. By July, right whales can be found in their critical habitats, including the Grand Manan Basin in the lower Bay of Fundy and the Roseway Basin on the Western Scotian Shelf. From October into the winter a southern migration can be observed with whales returning to the warmer waters of the southern US coast (DFO 2011a).

Right whales migrate to Canadian waters to feed. Their main prey items include large and oil-rich copepods as well as other small zooplankton and barnacle larvae. The population of right whales in the Northwest Atlantic is estimated to be approximately 522 (Pettis and Hamilton 2014). Figure 13 in Appendix E represents observation data for right whales from 1964 to 2013.

Odontocetes (Toothed Whales)

Harbour Porpoise (*Phocoena phocoena*)

The harbour porpoise is listed as threatened under Schedule 2 SARA and special concern under COSEWIC. Harbour porpoises can be found from the Bay of Fundy to Baffin Island in the Northwest Atlantic. Harbour porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region in the summer from July to September in waters generally less than 150 m deep (Gaskin 1977; Kraus *et al*. 1983; Palka 1995a; Palka 1995b in Waring *et al*. 2015). During the fall from October to December and the spring from April to June, they are widely dispersed from New Jersey to Marine (Waring *et al*. 2015). From January to March, harbour porpoises can be found in waters off New Jersey to North Carolina with some sightings in waters off New York to New Brunswick. The estimated population size of harbour porpoises in the Gulf of Maine/Bay of Fundy region is 89,054 based on 2006 surveys conducted in the region. Compared to other cetaceans the harbour porpoise reaches sexual maturity at a relatively early age in approximately three years and is highly productive (COSEWIC 2006c). Mating occurs during late spring to early summer followed by a gestation period of 10 to 11 months, followed by a lactation period of six months. Most females mate each year therefore spending their entire adult lives both lactating and pregnant. Figure 14 in Appendix E represents observation data for harbour porpoise from 1966 to 2013.

Killer Whale (*Orcinus orca*)

Killer whale is listed as special concern under COSEWIC and is not listed under SARA. Killer whales in the Northwest Atlantic and eastern Canadian Arctic can be found from Baffin and Hudson Bay to US coastal waters (COSEWIC 2008b). Killer whales are characterized as relatively uncommon or rare and are now only occasionally sighted in the Gulf of St. Lawrence and the St. Lawrence estuary. Sighting events from 1785 to 2012 found that sightings were more common from June to September and have been more frequent over the last ten years potentially due to increased public awareness and increased boating, people and cameras during these months (Warning *et al*. 2015).

Male killer whales reach sexual maturity at an average of 12.8 years with females reaching maturity at an average of 14.1 years (COSEWIC 2008b). In the Northwest Atlantic, killer whales have been observed preying on harp seals, white-beaked dolphins, minke whales, beluga whales, humpback whales, auks, bluefin tuna, and herring. Figure 15 in Appendix E represents observation data for killer whales from 1964 to 2012.

Northern Bottlenose Whale (*Hyperoodon ampullatus*)

The northern bottlenose whale is listed as endangered under Schedule 1 SARA and COSEWIC. The northern bottlenose whale is distributed in the North Atlantic from Nova Scotia to the Davis Strait, along east coast of Greenland and from England, Norway, Iceland and the Faroe Islands to the south coast of Svalbard (Waring *et al*. 2015). They can be found along the continental slope at depths of 800 to 1,500 m with a major concentration off the eastern Scotian Shelf around the Gully and Shortland and Haldimand Canyons (all designated Critical Habitat under SARA), east of the Project Area. There have been sightings primarily along the shelf break, including at Dawson and Verrill Canyons located within the Project Area and in deeper waters off the slope. It is thought that northern bottlenose whales from the Gully population spend 40% of their time in the Gully concentration area, 15% of their time in Shortland Canyon, and 15% of their time in Haldimand Caynon. It is unknown where the whales spend the remaining 30% of their time (LGL 2014). The species is non-migratory and can be found year-round in the area. Figure 16 in Appendix E represents observation data for northern bottlenose whales from 1964 to 2013. Females reach sexual maturity at 8 to 13 years of age and males reach maturity at an earlier age of 7 to 9 years (COSEWIC 2011c). Females give birth to a single calf every two years after a gestation period of 12 months. They feed primarily on deepwater fishes and squid, and as a result fit into a very narrow ecological niche. O'Brien and Whitehead (2013) used photo-identification data collected in 2010 and 2011 and mark-recapture techniques to estimate the current population size of northern bottlenose whales on the Scotian Shelf. The results of their studies indicate that the current population size is 143 individuals (O'Brien and Whitehead 2013).

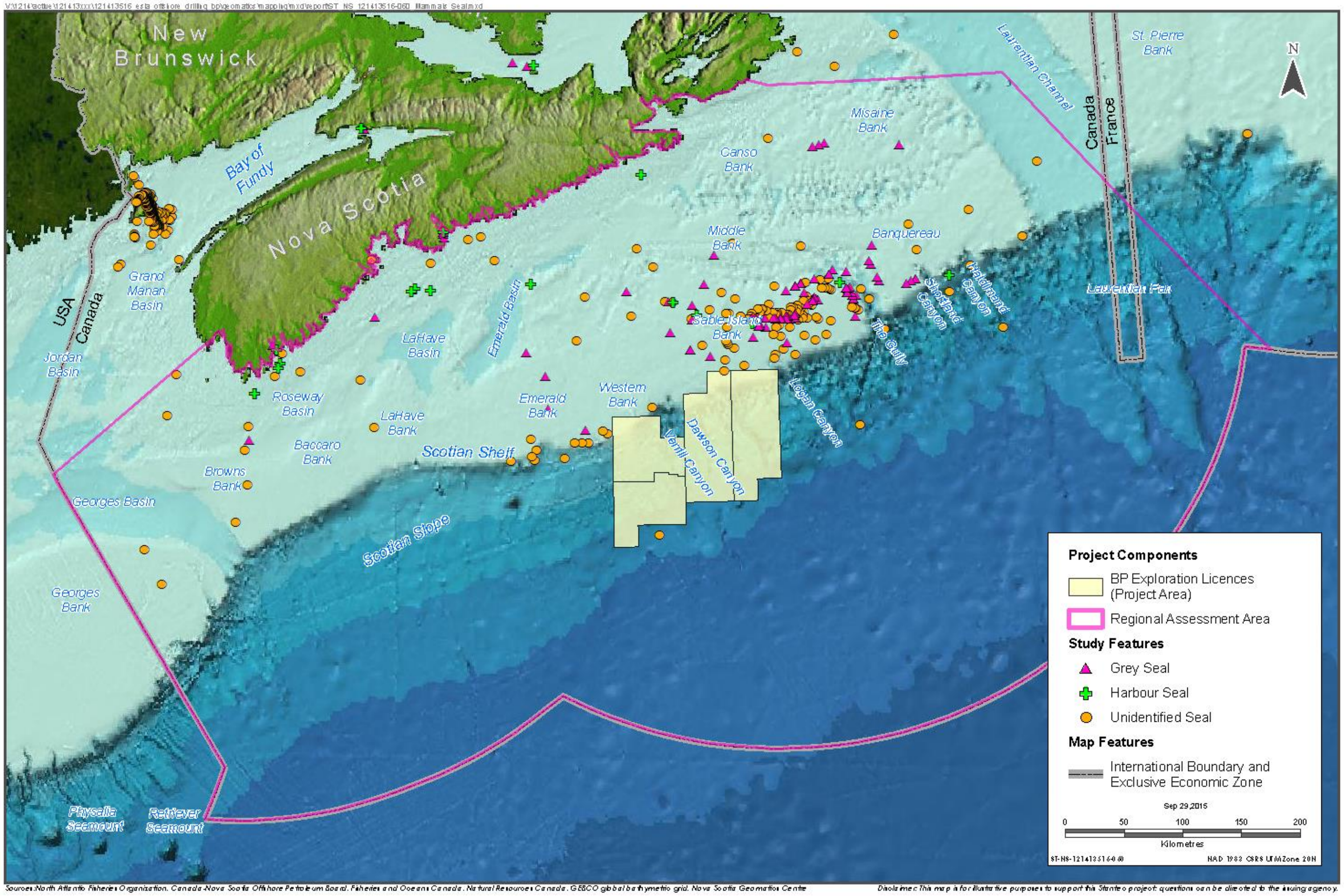
They also used models to examine population trends and to investigate changes in the sex ratio since 1988. Their results indicate that the population size and sex ratios have been stable since before MPA legislation was implemented in the Gully.

Sowerby's Beaked Whale (*Mesoplodon bidens*)

Sowerby's beaked whale is listed as special concern under Schedule 1 SARA and is only found in the North Atlantic with known occurrences along the Scotian Shelf and only rarely seen in coastal waters. Although sightings are rare, the species has been observed in the Gully with significant increase in sightings in the Gully, Shortland, and Haldimand Canyons in recent years. The species were not sighted in the canyons or the Gully before 1994. In the Gully there were 8 sightings between 1995 and 2000, 20 between 2001 and 2006, and 87 in 2011 and 2012 (Whitehead 2013). Whitehead theorizes that this large jump in population size could be explained by a reduction in anthropogenic disturbance as a result of implementing an MPA in the area. They are also found on the Western Scotian Shelf on the edges of Browns and Baccaro Banks as well as the entrance to the Northeast Channel (NOAA 2013n). Habitat tends to concentrate around shelf edges and slopes and has been found in waters deeper than 1,500 m (COSEWIC 2006d). The timing and age of breeding for Sowerby's beaked whale is largely unknown. The species feeds mainly on mid-depth to deepwater fish and squid (COSEWIC 2006d). No estimate of population size exists for individuals in Canadian waters. The rarity of sightings suggests that the Sowerby's beaked whale is rare, although this could reflect the limited effort in the deepwater areas and the difficulties of detecting and identifying the species at sea (COSEWIC 2006d). Figure 17 in Appendix E represents observation data for Sowerby's beaked whales from 1998 to 2004.

5.2.6.5 Phocids

Five species of phocids are known to occur on the Scotian Shelf, with Sable Island hosting breeding populations of grey seals (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*). Other species known to forage in the area include harp (*Pagophilus groenlandica*), hooded (*Cystophora cristata*) and ringed (*Pusa hipsida*) seals. No seal populations on the Scotian Shelf are designated at risk under SARA or by COSEWIC. Phocids are most commonly found on the Shelf (particularly around Sable Island) and nearshore waters and are less likely to be found in the Project Area. Sable Island is a significant area for seals as it hosts the world's largest breeding colony of grey seals (DFO 2011a; Freedman 2014). Smaller breeding colonies have also been found on coastal islands along southwestern Nova Scotia at Flat, Mud, Noddy, and Round Islands (Bowen *et al.* 2011). Grey seals pup from mid-December to late January, while harbour seals pup from mid-May to mid-June. Harp seal, hooded seal, and ringed seal are considered to be infrequent visitors and have occasionally been observed foraging offshore Nova Scotia (DFO 2011a). Although harp, hooded and ringed seals are not frequently found offshore Nova Scotia, when they are sighted they occur in large numbers. Figure 5.2.20 shows where seal observations have been recorded on the Scotian Shelf and Slope between 1911 and 2013.



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR

Figure 5.2.20 Seal Sightings on the Scotian Shelf and Slope (1911–2013)

5.2.7 Sea Turtles

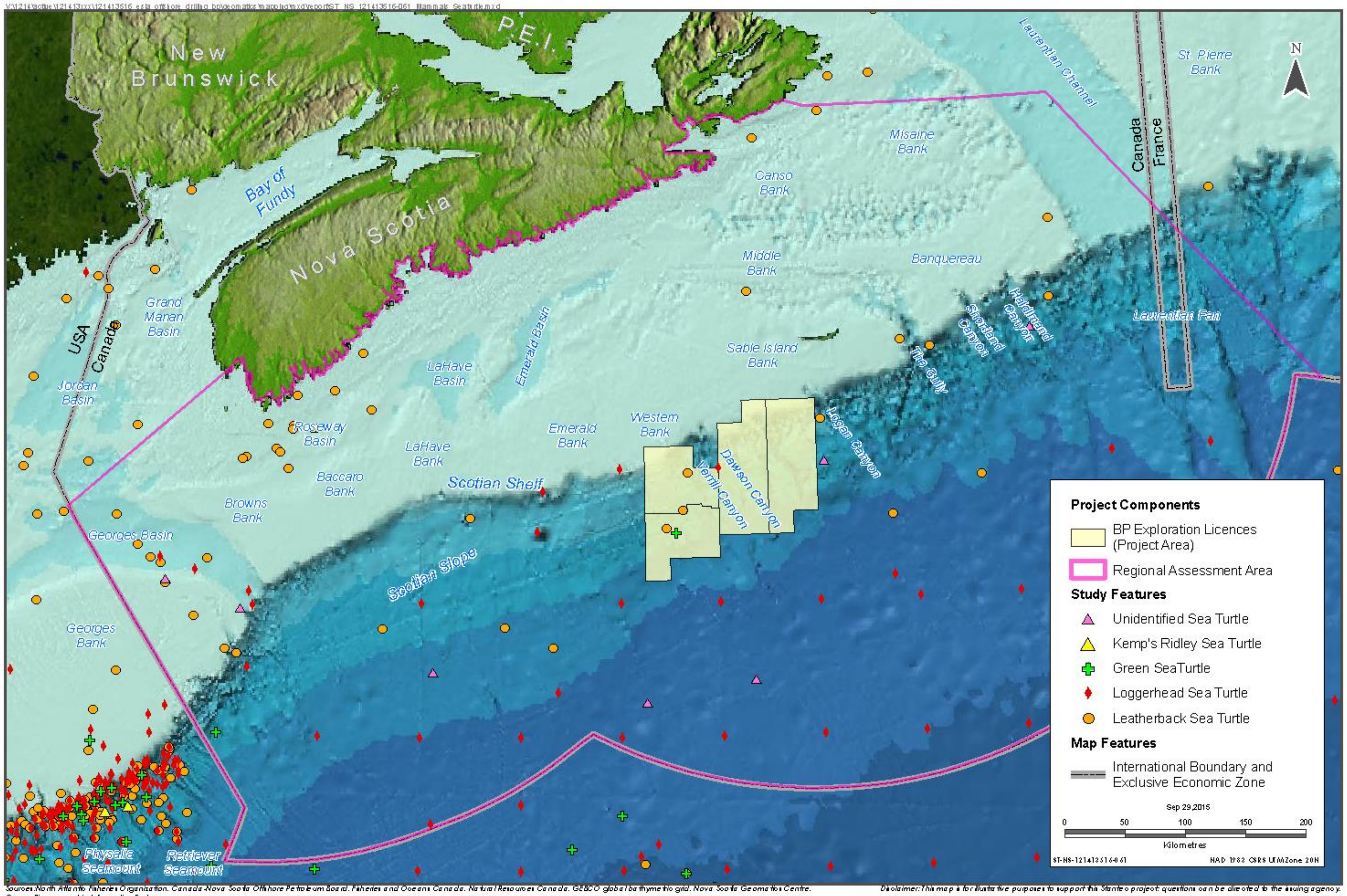
Four species of sea turtles can be found migrating and foraging on the Scotian Shelf and Slope (Table 5.2.12) with the endangered leatherback sea turtle (*Dermochelys coriacea*) and the loggerhead sea turtle (*Caretta caretta*) the most likely to occur. Critical habitat for the leatherback turtle was not identified in the 2006 Recovery Strategy. DFO has used satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada for the purpose of identifying critical habitat for designation under SARA (DFO 2011b). Research has identified three primary areas of important habitat for leatherback turtles in Atlantic Canadian water (DFO 2013c) which are now being considered for designation as critical habitat under SARA (DFO 2015o): 1) waters east and southeast of Georges Bank, along the southwestern Scotian Shelf near the southwest boundary of the Atlantic Canadian Exclusive Economic Zone (EEZ); 2) the southeastern Gulf of St. Lawrence and waters off western and 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 and Labrador, including parts of Placentia Bay. It is expected that these areas will be included as critical habitat once the amended recovery strategy (DFO 2015o) is finalized.

Figure 5.2.21 depicts sea turtle sightings recorded from 1911 to 2013, according to the DFO Marine Mammals Sightings Database. Figures 5.2.22 and 5.2.23 present the locations where sea turtles were observed during Shell's 2013 Shelburne Basin 3D Seismic Survey and BP's 2014 Tangier 3D Seismic Survey. The leatherback and loggerhead turtles, as well as the green sea turtle (*Chelonia mydas*) were observed during BP's 2014 wildlife monitoring program (RPS 2014). The likelihood of Kemp's ridley turtle (*Lepidochelys kempii*) being present in the Project Area is low.

Table 5.2.12 Sea Turtle Species Known to Occur in the Vicinity of the Project Area

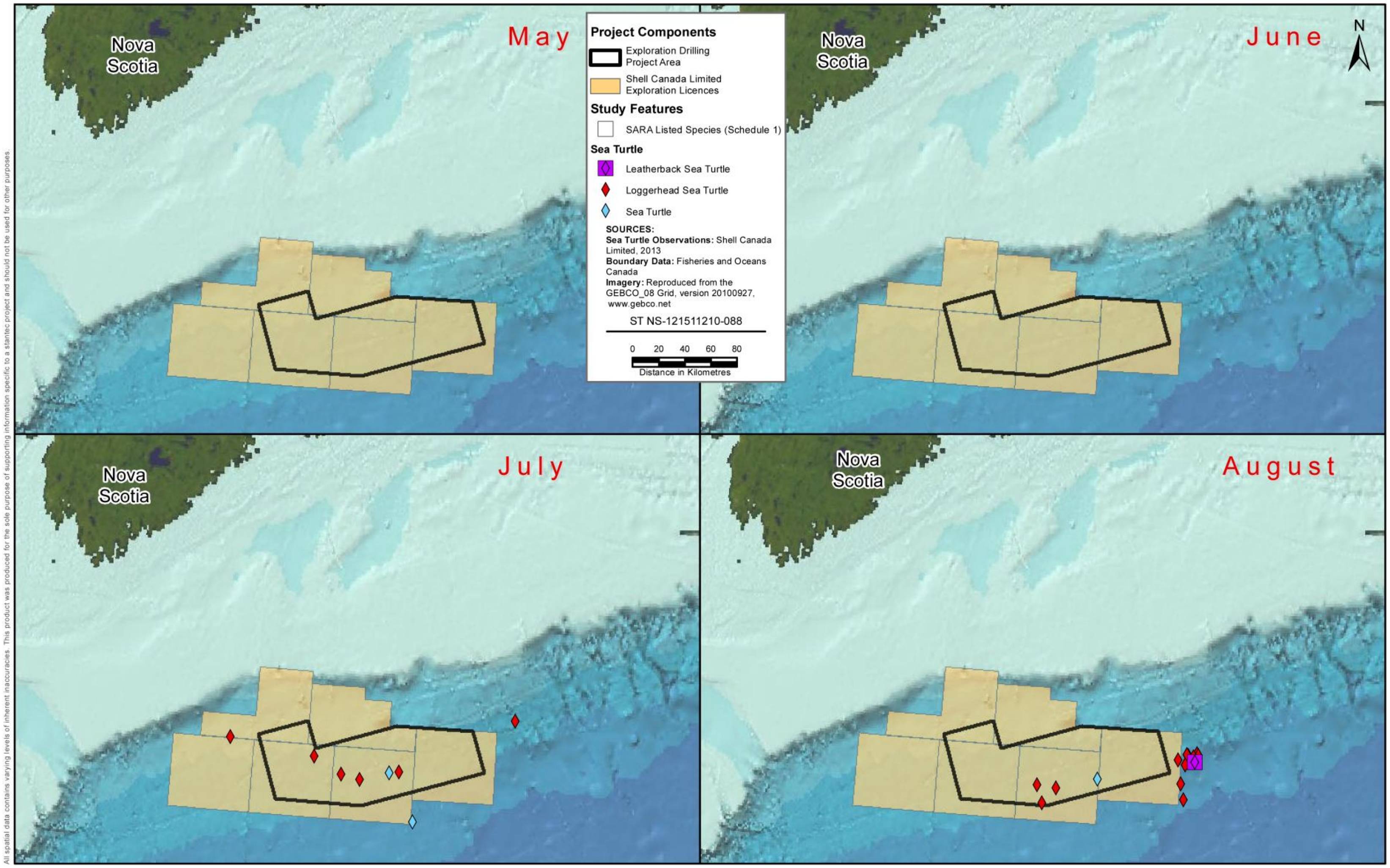
Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential Occurrence in Study Area[1]	Timing of Presence
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1, Endangered	Endangered	High	April to December
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered	High	April to December
Kemp's ridley turtle	*Lepidochelys kempii*	Not Listed	Not Listed	Low	Summer
Green sea turtle	*Chelonia mydas*	Not Listed	Not Listed	Low	Summer
Note: [1]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and sightings data for each species within the Project Area.					

Source: Modified from Stantec 2014a



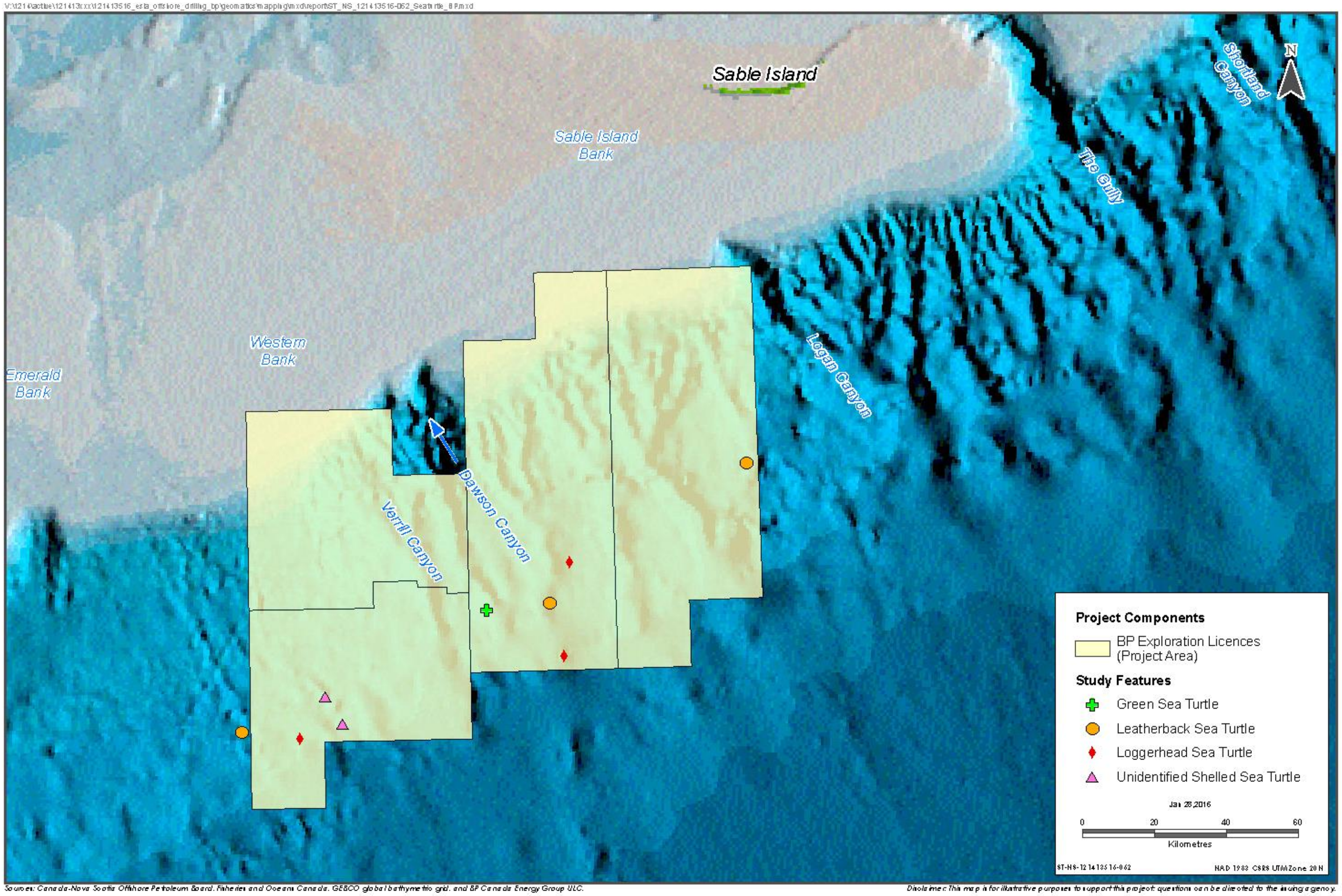
Sources: NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.21 Sea Turtle Sightings on the Scotian Shelf and Slope (1911–2013)



Source: Stantec 2014a

Figure 5.2.22 Sea Turtle Observations Collected during the 2013 Shelburne 3D Seismic Survey



Sources: Data provided from CNSOPB, DFO, and BP Canada Energy Group ULC (n/d)

Figure 5.2.23 Sea Turtle Observation Collected during the 2014 Tangier 3D Seismic Survey

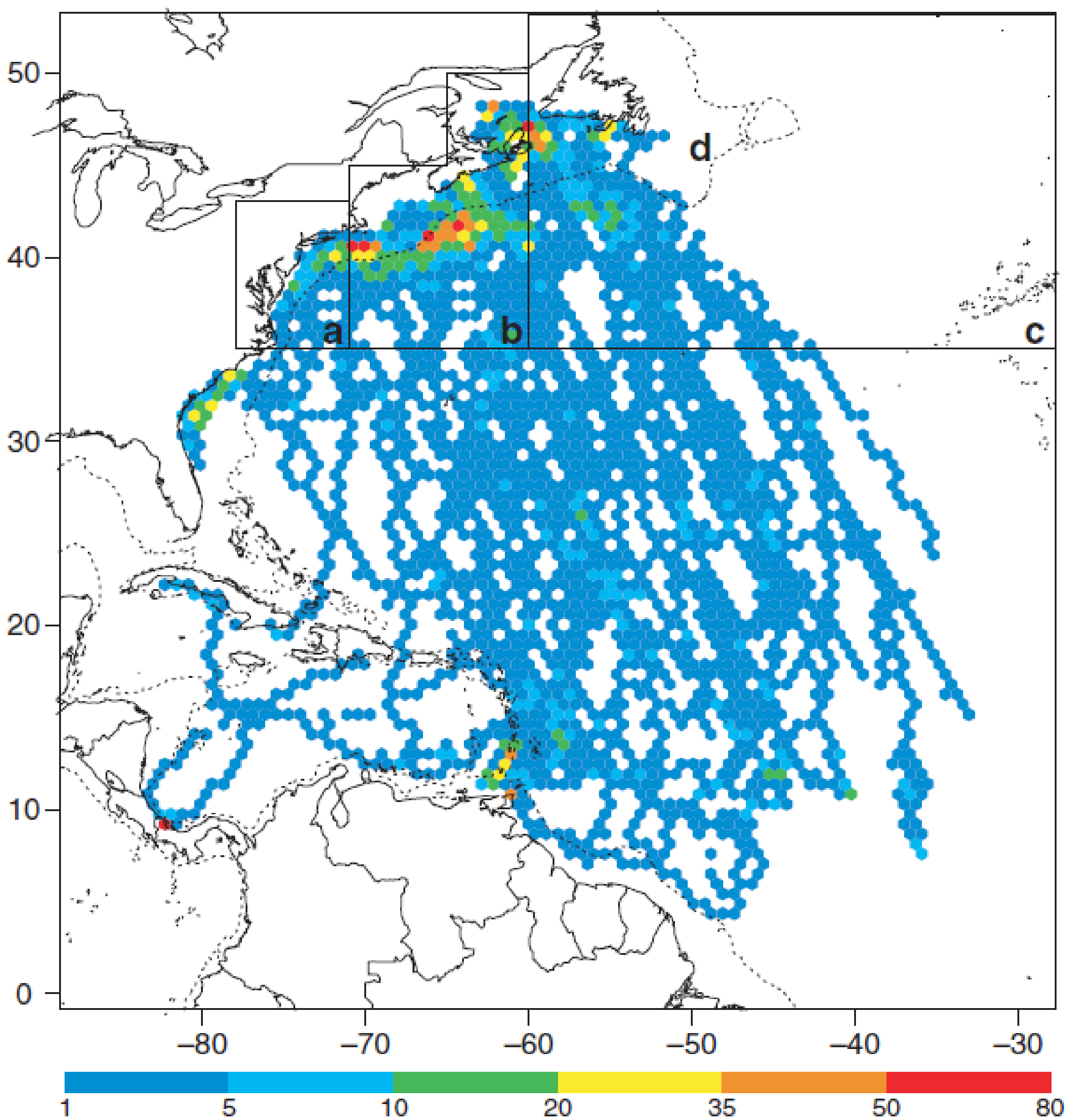
Leatherback Sea Turtle (*Dermochelys coriacea*)

The leatherback sea turtle is the largest and most widely distributed of all marine turtles. In the Northwest Atlantic, they can be found in both the shelf and offshore slope waters as well as in the Gulf of St. Lawrence (COSEWIC 2012f). Data comprised of satellite tracking studies and sighting information indicate that the species is present in Atlantic Canadian waters from April to December with the highest densities from July to September. Generally, the species distribution shifts from the southwest to the northeast as the foraging period progresses (COSEWIC 2012f). Slope waters off the Northeast Channel are also thought to provide habitat throughout the summer and fall. The species can be found in high densities in the shelf waters off Cape Breton Island, off the south coast of Newfoundland, the southern Gulf of St. Lawrence, as well as in offshore slope waters including the Northeast Channel (LGL 2014). The Atlantic population of the leatherback turtle is cautiously considered stable containing approximately 15,000 females (SAR Registry website).

It is believed their distribution in Canadian waters is based primarily on maximizing foraging habits. During the summer and fall months, the species forages on gelatinous zooplankton (primarily jellyfish consuming on average 330 kg/day) in the waters of the Scotian Shelf. The species follows a predictable migratory cycle including annual return trips between southern feeding and breeding areas and northern foraging habitat (COSEWIC 2012f). The leatherback may swim more than 10,000 km between nesting locations in the tropics and foraging areas in the north. Leatherbacks found in Atlantic Canada originate from nesting beaches in the wider Caribbean, South and Central America, and Florida. James *et al.* (2005) tagged 38 leatherback turtles from 1999 to 2003 with satellite tags and tracked their migration patterns. Figure 5.2.24 depicts the number of days that each turtle spends in a particular area. It should be noted that the Scotian Slope is a high area of use for foraging by the species. Although critical habitat for this species has not yet been defined under SARA, a draft Recovery Strategy for the Leatherback Sea Turtle Atlantic population identifies three areas of critical habitat, the closest to the Project Area being located south and southeast of Georges Bank extending to the southwest boundary of the Canadian EEZ on the southwestern Scotian Slope (DFO 2015o).

There are five life-history stages in the leatherback sea turtle's life cycle including: egg and hatching, post-hatchling, juvenile, sub-adult, and adult. The age of maturity is uncertain but is estimated to range from 6.8 to 29 years (COSEWIC 2012f). Mating observations have been rare and occur in the southern latitudes of their nesting sites. Males will travel with nesting colonies in advance of the nesting season and remain until peak nesting has finished. Females generally nest on sandy, tropical beaches at 2 to 4-year intervals. Both the time and duration of nesting varies with geographic location, lasting between three and six months in a nesting year. Females generally lay on average 80 eggs several times over a nesting season, typically at 8 to 12 day intervals. Nesting is generally nocturnal, with occasional daytime nesting.

Three leatherback sea turtle sightings were recorded (one in June and two in August) during the marine mammal observation program for the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014 (refer to Figure 5.2.23).



Source: James *et al.* 2005

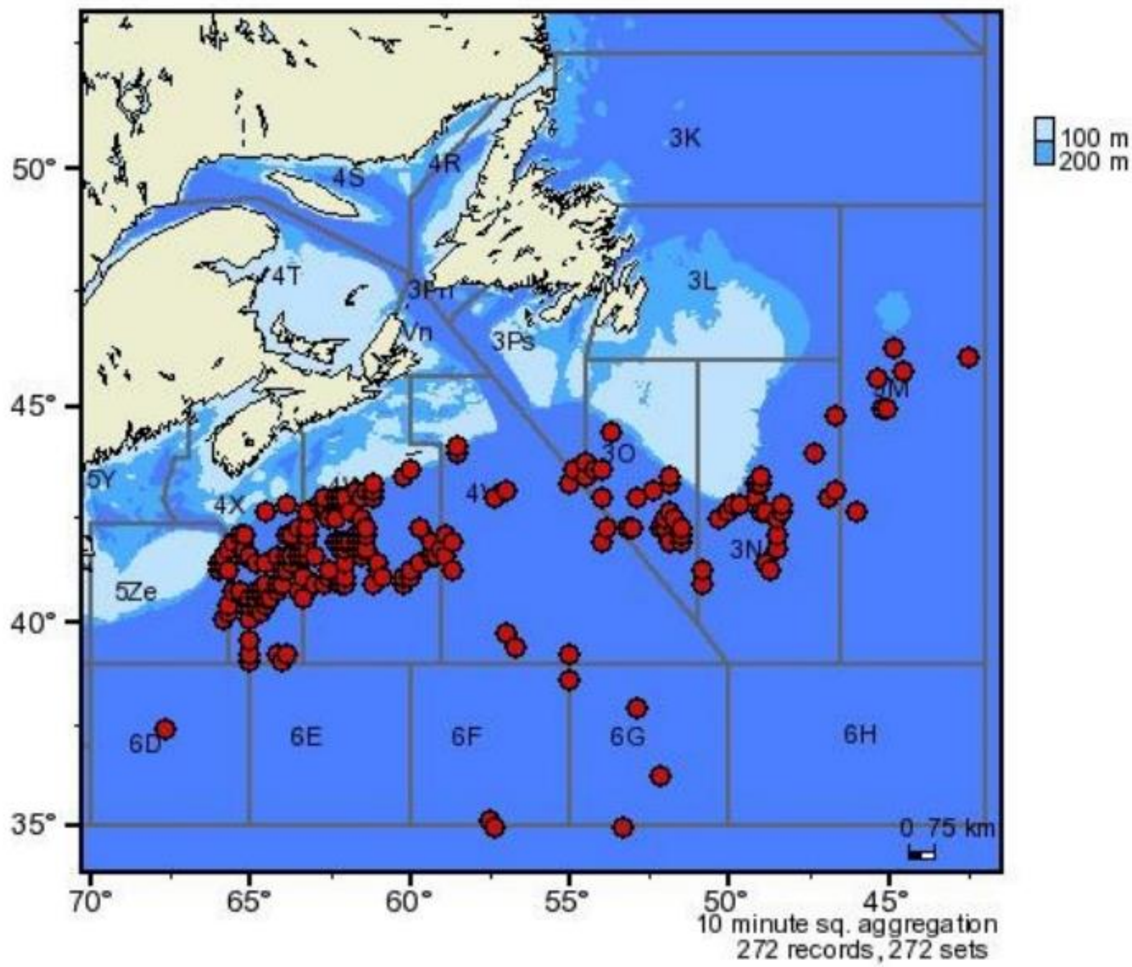
Figure 5.2.24 The spatial use of 38 leatherback turtles equipped with satellite tags in the waters off Nova Scotia. Leatherback Turtles were tagged from 1999–2003 with an average observation period of 218 days. Colour denotes the number of day(s) each turtle was tracked in a particular polygon.

Loggerhead Sea Turtle (*Caretta caretta*)

Immature loggerhead sea turtles occur regularly at the edge of the Scotian Shelf and Slope and are routinely found foraging on the Scotian Shelf and Slope and Georges Bank. They migrate to Atlantic Canadian waters during the spring months returning south for the winter. They are known to breed as far north as Virginia with the largest breeding colony in North America in Florida (COSEWIC 2010e). Recent findings have determined that not all loggerheads leave the area during the winter months. Telemetry data have shown that some turtles move east and northeast during the winter. Based on observations, the loggerhead sea turtles are found mostly within the 20 to 25°C water temperature contours with loggerheads absent when temperatures were below 15°C. Generally, they are associated with the warm waters of the Gulf Stream in Atlantic Canada and occasionally are found closer to shore when warm core rings break off and intrude over the Scotian Shelf.

Loggerhead sea turtles generally make predictable migrations from southern breeding grounds in the Southern US, Caribbean, Gulf of Mexico, and South America to temperate foraging grounds in the Northern Atlantic (COSEWIC 2010e). Nesting occurs on beaches and occasionally estuarine shorelines at night with females returning to the site of their birth to nest. Females nest on a 2 to 3 year interval laying three to four clutches of 112 eggs on average with 14 days inbetween events. Eggs hatch in approximately 7 to 13 weeks.

Three loggerhead turtle sightings were recorded in August during the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014. Figure 5.2.25 depicts the location of loggerhead turtle captures recorded by at-sea observers on Canadian pelagic longline fishing trips between 1999 and 2008.



Source: COSEWIC 2010e

Figure 5.2.25 The location of loggerhead sea turtle captures recorded by at-sea observers on Canadian pelagic longline fishing trips 1999–2008. Each point represents a location where one or more loggerhead turtles were caught.

Kemp's Ridley Turtle (*Lepidochelys kempii*)

Kemp's ridley turtle, the smallest of sea turtles, is distributed throughout the Gulf of Mexico and along the US eastern seaboard and occasionally in the waters of Nova Scotia (NOAA 2013o). Adult Kemp's ridleys can be found in depths of less than 50 m over sand or muddy substrates, feeding on crabs, fish, jellyfish, and mollusks. Nesting occurs almost exclusively on three main beaches in Mexico. Kemp's ridley turtles were not observed during the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014.

Green Sea Turtle (*Chelonia mydas*)

Green sea turtles are widely distributed in tropical and sub-tropical waters between 30° North and 30° South. In the Western Atlantic they are found from the Gulf of Mexico to Massachusetts. The nesting season of the green sea turtle varies from location to location but females usually nest in the summer months from June to July on beaches throughout their southern range (NOAA 2013p). The green sea turtle is unique among sea turtles in that it is herbivorous, feeding on plants (NOAA 2013p).

A green turtle and green turtle-loggerhead hybrid documented in nearshore waters off Nova Scotia by James *et al.* (2004) represent the most northerly confirmed records of green turtle in the Northwest Atlantic. There is some evidence that the green turtle occurs regularly on the Scotian Shelf seasonally, although their observed numbers are much lower than the leatherback and loggerhead. One green sea turtle was observed in August during the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014.

5.2.8 Migratory Birds

5.2.8.1 Overview

Waters off the Scotian Shelf are nutrient rich and highly productive due to the complex oceanographic conditions of the area with an estimated 30 million seabirds using the eastern Canadian waters each year (Fifield *et al.* 2009). Throughout the year large numbers of breeding marine birds and millions of migrating birds from the southern hemisphere and northeastern Atlantic can be found using the area (Gjerdrum *et al*. 2008, 2012). Species diversity peaks during the summer months, when northern hemisphere breeders have returned to their breeding grounds and southern hemisphere breeders have returned from their winter breeding season to spend the summer in more northern waters (Fifield *et al.* 2009). The combination of northern hemisphere birds and southern hemisphere migrating birds results in a diversity peak during spring months (Fifield *et al.* 2009). During the fall and winter significant numbers of overwintering alcids, gulls, and Northern Fulmars (*Fulmarus glacialis*) can be found in Atlantic Canadian waters (Brown 1986), whereas in the summer, species assemblages are dominated by shearwaters, storm-petrels, Northern Fulmars, and gulls (Fifield *et al.* 2009). During the Tangier 3D seismic program in 2014, 2,736 birds were observed with shearwaters and storm-petrels the most commonly observed (RPS 2014).

Marine related birds can be divided into four groups:

- pelagic seabirds;
- neritic seabirds;
- waterfowl and divers; and
- shorebirds.

Additionally, landbirds (*i.e.*, those with principally terrestrial life cycles) may occur in the marine environment during migration and can occur in coastal areas at any time of the year.

Pelagic seabirds are a marine species, feeding and resting at sea and only coming to land to breed, usually on rocky cliffs and islands. Non-breeding seabirds can be found on the Scotian Shelf and Slope during all times of the year (Lock *et al.* 1994). Large numbers of Great and Sooty Shearwaters (*Puffinus gravis* and *P. griseus*) migrate from the sub-Antarctic through the North Atlantic during the summer months first appearing in April and reaching a peak during July. Also during this time, Wilson's Storm Petrels (*Oceanites oceanicus*) migrate from the same regions with the highest concentrations over Georges Bank and the southern Scotian Shelf (Lock *et al*. 1994). In contrast, the winter seabird fauna consists mainly of Arctic breeding birds. Dovekies (*Alle alle*) can be found wintering in ice-free waters throughout the Atlantic. Northern Fulmars, auks (including Black Guillemot, Thick-billed Murre, Common Murre, Razorbill and Atlantic Puffin), and Black-legged Kittiwakes (*Rissa tridactyla*) can also be found in the area throughout the winter months. In total, at least 19 species of pelagic seabirds regularly occur on the Scotian Shelf and Slope throughout the year (Table 5.2.13).

Neritic seabirds typically feed in shallow coastal waters and return to land to rest at night. Neritic species such as terns, gulls and cormorants have the potential to be found over the Scotian Shelf and Slope. There are approximately 14 species of neritic seabirds that may occur on the Scotian Shelf and Slope throughout the year including the endangered Ivory Gull (*Pagophila eburnea*) and Roseate Tern (*Sterna dougallii*)(Table 5.2.13). Most neritic seabirds are more commonly found in coastal waters and therefore are infrequent visitors of the offshore Project Area. The presence of these species is highest in summer, as some species, including Common and Arctic Terns, migrate to more southern areas for the winter.

Waterfowl can be broadly divided into seaducks, dabbling ducks, swans and geese. All of the waterfowl species found in association with the Scotian Shelf (with the exception of eiders) nest near fresh water. Generally, eiders nest on coastal islands where fresh water is available and raise their broods in coastal waters. Outside of the breeding season, seaducks are typically found on coastal waters, over reefs and banks where benthic prey are accessible. During the non-breeding season, dabbling ducks forage in fresh water or sheltered coastal waters such as bays, salt marshes and estuaries. In addition, Canada Goose (*Branta canadensis*) are attracted to deltaic areas, where they rely on shallow, open, fast-flowing water for foraging when they arrive in early spring. For nesting, this species prefers peatlands and fluvial sites in boreal regions. Waterfowl are infrequent visitors of the Project Area as they are generally associated with the coastline; however, they could occur in the Project Area and/or Sable Island during migration or as vagrants (Freedman 2014). A few waterfowl species have also been known to breed on Sable Island, albeit in low numbers (generally less than 5 breeding pairs), including the American Duck (*Anas rubripes*), Mallard (*Anas platyrhynchos*), Northern Pintail (*Anas acuta*), and Red-breasted Merganser (*Mergus serrator*) (Freedman 2014).

During the winter months, waterfowl are distributed fairly evenly along the coast of Nova Scotia. Eiders are the only abundant waterfowl in the coastal area during the summer months (Lock *et al*. 1994). In the fall months, the number of coastal waterfowl is variable as birds move through the area on migration routes to the south (Lock *et al*. 1994). There are approximately 18 species of waterfowl that regularly occur in association with coastal waters of Nova Scotia including the endangered Harlequin Duck (*Historonicus historonicus*) and Barrows Goldeneye (*Bucephala islandica*), a species of Special Concern (Table 5.2.13).

Many shorebirds nest in wetland or upland habitats using coastal stopover sites for feeding and resting during migration; however, species such as Willet (*Tringa semipalmata*) and Piping Plover (*Charadrius melodus*) raise their young in coastal environments. Most shorebirds forage along coastal beaches, exposed mud flats or salt marshes during migration, with high concentrations of birds often being found associated with sites that provide an abundant food source. The exception is Purple Sandpipers (*Calidris maritima*) that primarily use rocky shorelines during migration and overwintering. Stopover sites can be crucial to the survival of shorebird species as they provide important energy reserves that are necessary for undertaking long, uninterrupted flights (COSEWIC 2007a). Of exception to these coastal associations, phalaropes (*Phalaropus* spp.), typically forage on the surface of the sea in areas where upwelling brings plankton to the surface and therefore often are found offshore. There are approximately 22 species of shorebirds that regularly occur in association with the Scotian Shelf and Slope and associate coastlines, including the endangered Red Knot (*Calidris canutus rufa*) and Piping Plover (Table 5.2.13).

Landbirds may occur in the marine environment during migration and can occur in coastal areas at any time of the year. Landbirds can also be found on Sable Island, the majority of which are migrants or vagrants. The Savannah (Ipswich) Sparrow (*Passerculus sandwichensis princeps)* is the only landbird to nest in large numbers on Sable Island, although there are a few other species that breed in few numbers (*e.g.*, less than 10 breeding pairs) (Freedman 2014).

Some migrant landbirds use the island as a regular stopover area during their overwater flights (*e.g.*, Blackpoll Warbler (*Dendroica striata*), Grey-Cheeked Thrush (*Catharus minimus*)). Migrants are much more abundant on Sable Island in fall than in spring (Freedman 2014), although migrant landbirds found in the marine environment are more abundantly found on coastal islands than on Sable Island.

Vagrant landbirds (*i.e.*, birds occurring well outside their regular range) may also be found in the offshore environment. Sable Island attracts an unusually large number of vagrant species compared to other offshore islands on the Atlantic coast, most likely due to the isolation of Sable Island making it a rare landfall habitat as well as its location along frequent storm tracks (McLaren 1981).

Table 5.2.13 Marine Birds of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Pelagic Seabirds					
Northern Fulmar	*Fulmarus glacialis*	-	-	-	Likely
Cory's Shearwater	*Calonectris diomedea borealis*	-	-	-	Likely
Great Shearwater	*Puffinus gravis*	-	-	-	Likely
Sooty Shearwater	*Puffinus griseus*	-	-	-	Likely
Manx Shearwater	*Puffinus puffinus*	-	-	-	Likely
Wilson's Storm-Petrel	*Oceanites oceanicus*	-	-	-	Likely
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	-	-	-	Likely
Northern Gannet	*Morus bassanus*	-	-	-	Likely
Pomarine Jaeger	*Stercorarius pomarinus*	-	-	-	Likely
Parasitic Jaeger	*Stercorarius parasiticus*	-	-	-	Likely
Long-tailed Jaeger	*Stercorarius longicaudus*	-	-	-	Likely
Great Skua	*Stercorarius skua*	-	-	-	Likely
South Polar Skua	*Stercorarius maccormicki*	-	-	-	Likely
Black-legged Kittiwake	*Rissa tridactyla*	-	-	-	Likely
Dovekie	*Alle alle*	-	-	-	Likely
Common Murre	*Uria aalge*	-	-	-	Likely
Thick-Billed Murre	*Uria lomvia*	-	-	-	Likely
Razorbill	*Alca torda*	-	-	-	Likely
Atlantic Puffin	*Fratercula arctica*	-	-	-	Likely
Neritic Seabirds					
Great Cormorant	*Phalacrocorax carbo*	-	-	-	Unlikely
Double-Crested Cormorant	*Phalacrocorax auritus*	-	-	-	Unlikely
Black-headed Gull	*Larus ridibundus*	-	-	-	Unlikely
Bonaparte's Gull	*Larus philadelphia*	-	-	-	Unlikely
Ring-billed Gull	*Larus delawarensis*	-	-	-	Likely
Herring Gull	*Larus argentatus*	-	-	-	Likely

Table 5.2.13 Marine Birds of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Iceland Gull	*Larus glaucoides*	-	-	-	Likely
Glaucous Gull	*Larus hyperboreus*	-	-	-	Likely
Great Black-backed Gull	*Larus marinus*	-	-	-	Likely
Ivory Gull	*Pagophila eburnea*	Endangered	Endangered	-	Likely
Roseate Tern	*Sterna dougallii*	Endangered	Endangered	Endangered	Likely
Common Tern	*Sterna hirundo*	-	-	-	Likely
Arctic Tern	*Sterna paradisaea*	-	-	-	Likely
Black Guillemot	*Cepphus grylle*	-	-	-	Unlikely
Waterfowl					
Red-throated Loon	*Gavia stellata*	-	-	-	Unlikely
Common Loon	*Gavia immer*	-	-	-	Unlikely
Canada Goose	*Branta Canadensis*	-	-	-	Unlikely
American Green-winged Teal	*Anas crecca*	-	-	-	Unlikely
American Black Duck	*Anas rubripes*	-	-	-	Unlikely
Mallard	*Anas platyrhynchos*	-	-	-	Unlikely
Greater Scaup	*Aythya marila*	-	-	-	Unlikely
Lesser Scaup	*Aythya affinis*	-	-	-	Unlikely
Common Eider	*Somateria mollissima*	-	-	-	Unlikely
Harlequin Duck	*Histrionicus histrionicus*	Special Concern	Special Concern	Endangered	Unlikely
Long-tailed Duck	*Clangula hyemalis*	-	-	-	Unlikely
Black Scoter	*Melanitta nigra*	-	-	-	Unlikely
Surf Scoter	*Melanitta perspicillata*	-	-	-	Unlikely
White-winged Scoter	*Melanitta fusca*	-	-	-	Unlikely
Common Goldeneye	*Bucephala clangula*	-	-	-	Unlikely
Barrows Goldeneye	*Bucephala islandica*	Special Concern	Special Concern	-	Unlikely
Bufflehead	*Bucephala albeola*	-	-	-	Unlikely
Red-breasted Merganser	*Mergus serrator*	-	-	-	Unlikely

Table 5.2.13 Marine Birds of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Shorebirds					
Black-bellied Plover	*Pluvialis squatarola*	-	-	-	Unlikely
American Golden-Plover	*Pluvialis dominica*	-	-	-	Unlikely
Semipalmated Plover	*Charadrius semipalmatus*	-	-	-	Unlikely
Piping Plover (melodus subspecies)	*Charadrius melodus melodus*	Endangered	Endangered	Endangered	Unlikely
Killdeer	*Charadrius vociferus*	-	-	-	Unlikely
Greater Yellowlegs	*Tringa melanoleuca*	-	-	-	Unlikely
Lesser Yellowlegs	*Tringa flavipes*	-	-	-	Unlikely
Willet	*Tringa semipalmata*	-	-	-	Unlikely
Spotted Sandpiper	*Actitis macularius*	-	-	-	Unlikely
Whimbrel	*Numenius phaeopus*	-	-	-	Unlikely
Ruddy Turnstone	*Arenaria interpres*	-	-	-	Unlikely
Red Knot rufa ssp	*Calidris canutus rufa*	Endangered	Endangered	Endangered	Unlikely
Sanderling	*Calidris alba*	-	-	-	Unlikely
Semipalmated Sandpiper	*Calidris pusilla*	-	-	-	Unlikely
Least Sandpiper	*Calidris minutilla*	-	-	-	Unlikely
White-rumped Sandpiper	*Calidris fuscicollis*	-	-	-	Unlikely
Pectoral Sandpiper	*Calidris melanotos*	-	-	-	Unlikely
Purple Sandpiper	*Calidris maritima*	-	-	-	Unlikely
Dunlin	*Calidris alpina*	-	-	-	Unlikely
Short-billed Dowitcher	*Limnodromus griseus*	-	-	-	Unlikely
Red-necked Phalarope	*Phalaropus lobatus*	-	Special Concern	-	Likely
Red Phalarope	*Phalaropus fulicarius*	-	-	-	Likely

Table 5.2.13 Marine Birds of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Terrestrial Birds					
Peregrine Falcon	*Falco perigrinus anatum/tundrius*	Special Concern	Special Concern	Vulnerable	Likely
Savannah Sparrow (*princeps* subspecies)	*Passerculus sandwichensis*	Special Concern	Special Concern	-	Likely

Note:

[1] Excluding rare transients / vagrants, except for Species at Risk which are known to occasionally occur (*e.g.*, Ivory Gull).

[2] Spatial boundaries of the Project Area are shown in Figure 5.2.26; potential occurrence considers known spatial and temporal use of the waters near the Project Area; Unlikely: generally restricted to coastline and nearshore waters; Likely: regular occurrence in offshore waters and may be expected to occur in the Project Area during the breeding season (*i.e.*, for feeding), migration, and/or overwintering.

Source: Modified from Stantec 2014a

The monitoring program undertaken for the Tangier 3D Seismic Survey included bird monitoring surveys with up to three, one-hour seabird surveys occurring daily between May 17 and September 14, 2014 following the CWS Seabirds at Sea protocol (Gjerdrum *et al.* 2012). Results are presented below in Table 5.2.14. The most commonly observed species was the Greater Shearwater, with a total of 940 observations and accounting for 34% of all seabird sightings. Other very common species include Wilson's Storm-Petrel and Leach's Storm-Petrel. Incidental observations by marine mammal observers indicated the same trend, with Greater Shearwater and Wilson's Storm-Petrels accounting for the first and second most commonly observed species, respectively. During these surveys, vessel crews encountered 19 stranded birds and 26 dead birds. The stranded birds consisted of 18 storm-petrels and one Magnolia Warbler. The majority of deceased birds were passerines (RPS 2014).

Table 5.2.14 Summary of 2014 CWS Bird Surveys by Vessel during the Tangier 3D Seismic Survey

Species	Number of Individuals Observed by Vessel						
	Western Neptune	***Ocean Odyssey***	***Geco Diamond***	***Western Patriot***	***Western Pride***	***Western Regent***	**Total**
Atlantic Puffin				2			2
Black-Legged Kittiwake	2			2			4
Common Loon			1				1
Common Murre		3	1	1		1	6
Common Tern				1	1		2
Cory's Shearwater	3	2	55	20	5		85
Double Crested Cormorant		1		2			3
Dovekie			4				4
Great Back-Backed Gull		1			2		3
Great Skua	1	1	3	5		3	13
Greater Shearwater	53	123	146	338	135	145	940
Herring Gull	3	1	3	1			8
Laughing Gull	2		2			1	5
Leach's Storm-Petrel		11	103	13	83	43	253
Little Gull			1				1
Manx Shearwater	10	2	18	8		4	42
Northern Fulmar		1	4	1		4	10
Northern Gannet	1		3	6		3	13
Parasitic Jaeger				5			5
Pomarine Jaeger						1	1
Red-Necked Phalarope		1					1
Sooty Shearwater	4	1	63	17	10	1	96
Thick-Billed Murre		1					1

Table 5.2.14 Summary of 2014 CWS Bird Surveys by Vessel during the Tangier 3D Seismic Survey

Species	Number of Individuals Observed by Vessel						
	Western Neptune	*Ocean Odyssey*	*Geco Diamond*	*Western Patriot*	*Western Pride*	*Western Regent*	Total
Unidentified Alcid		1					1
Unidentified Gull	1	2	20		3	1	27
Unidentified Murre		10	2				12
Unidentified Shearwater	37	13	135	1	35	2	313
Unidentified Storm Petrel	36	63	160	4	99	22	384
Unidentified Tern					2		2
Wilson's Storm-Petrel	1	86	1	402	7	1	498

Source: Modified from RPS 2014

5.2.8.2 Seasonal Distribution of Migratory Birds in Association with the Scotian Shelf and Slope

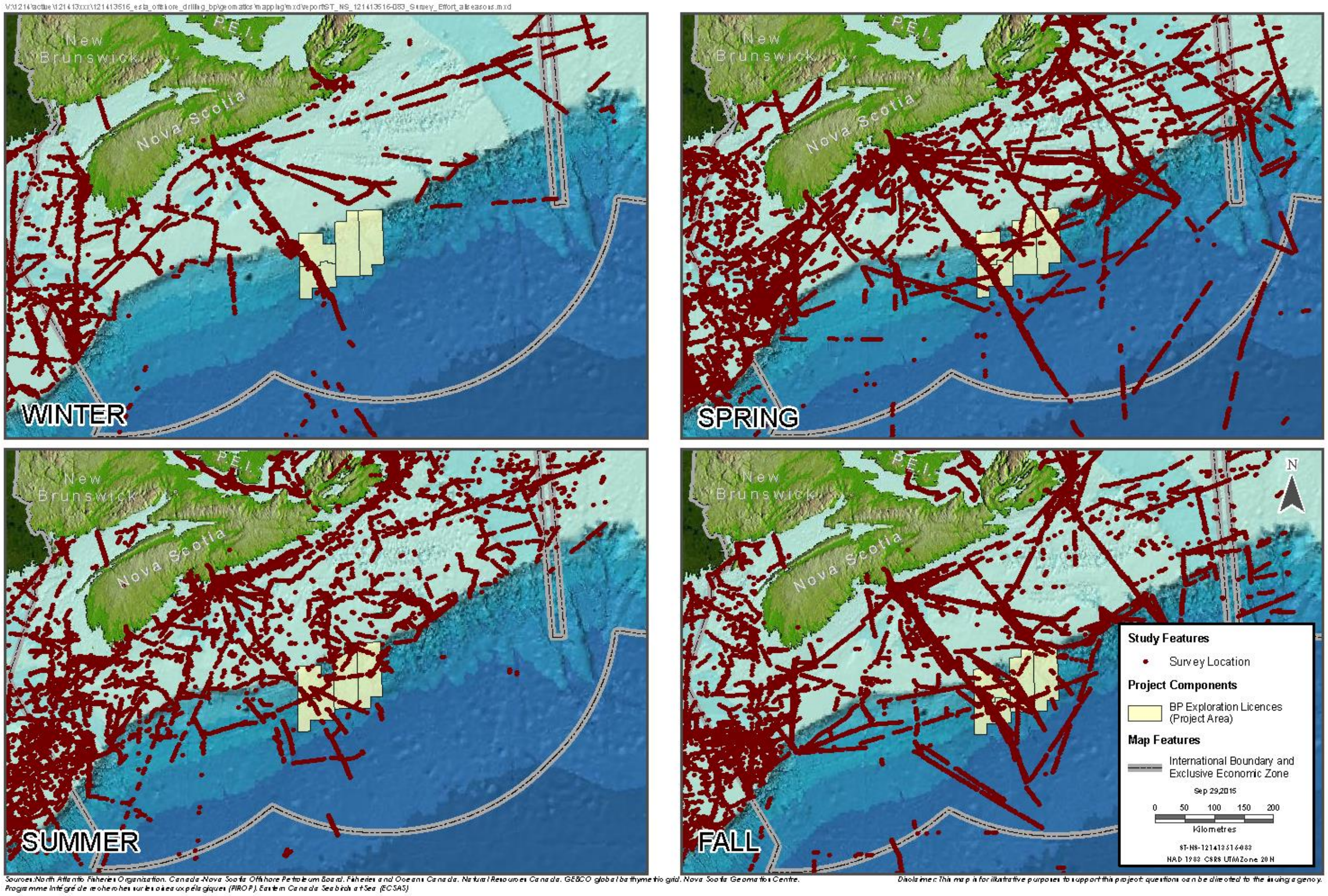
The following section describes migratory birds which may be found in the Project Area or on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of SAR and SOCC migratory birds can be found in Section 5.2.8.4.

Information on the distribution and abundance of marine birds in association with the Scotian Shelf and Slope was primarily obtained from the PIROP and ECSAS databases. Seabird observations within these databases are from ship-based surveys and mapped according to season (see Figures 1 to 15 in Appendix F), including spring (March, April, and May), summer (June, July, and August), fall (September, October, and November), and winter (December, January, and February). Data from the ECSAS and PIROP were integrated into common maps, despite variances in the survey methods, to convey information on the relative distribution and abundance of seabirds. Maps are included for pelagic seabirds, neritic seabirds and waterfowl. Shorebirds are not included, as they are unlikely to be found offshore near the Project Area. Species were either mapped individually or combined into guilds or taxonomic groups depending on their abundance and distribution on the Scotian Shelf and Slope. Those which were mapped individually included Black Guillemot (*Cepphus grylle*), Dovekie, Northern Fulmar, Northern Gannet (*Morus bassanus*), and Black-legged Kittiwake. Guilds and taxonomic groups were used to convey patterns for other species and included large alcids, cormorants, gulls, jaegers, phalaropes, shearwaters, skuas, storm-petrels, terns, and waterfowl. The distribution and abundance of seabird observations made during ship-based surveys were considered with respect to the locations of large seabird colonies. Detailed information on the location of colonies and the types and abundances of species they support are provided in Section 5.2.8.3.

Additional information on the densities of seabirds in association with the Scotian Shelf was obtained from Fifield *et al.* (2009) that presented results from a 3.5-year offshore seabird monitoring program (Table 5.2.15). This program was intended to assess seabird abundance and distribution in areas of eastern Canada with oil industry activity. Data from Fifield *et al.* (2009) were collected as part of the larger ECSAS initiative, which used distance sampling methods to account for varying seabird detectability. Most of the surveys were conducted from either oil industry supply ships or DFO research/fishery patrol vessels with a small number of surveys conducted from ferries, cargo vessels, seismic ships or sailboats (Fifield *et al.* 2009). The data from this study is encompassed in the larger ECSAS database; however, it has been referenced here to provide a comparison between the Scotian Shelf (and nearby Gulf of Maine) to other waters of the Northeast (particularly the Gulf of St. Lawrence, and the Newfoundland and Labrador Shelves).

Information on the spatial distribution and timing of PIROP and ECSAS survey effort is provided in Figure 5.2.26. As illustrated on Figure 5.2.26, survey effort varies with season and that more effort has been directed at certain locations along the Scotian Shelf and Slope than others. ECSAS and PIROP survey effort has been relatively lower in winter compared to summer, spring, and fall (Figure 5.2.26). Surveys have been more abundant on than off the Scotian Shelf, and more frequent along certain shipping lanes than others (Figure 5.2.26).

Overall, seabirds are present throughout the Scotian Shelf and Slope during the summer months and are often encountered in relatively high abundance. Data from Fifield *et al.* (2009) suggest that the abundance of seabirds on the Scotian Shelf and Slope (and Gulf of Maine) is highest during the summer months (Table 5.2.15). Additionally, the abundance of waterbirds on the Scotian Shelf at this time of year are estimated to be greater than those associated with the Gulf of St. Lawrence, but less than with the Newfoundland and Labrador Shelves (Fifield *et al*. 2009). PIROP and ECSAS datasets obtained for this Project indicated the most abundant species observed on the Scotian Shelf and Slope during summer are Great Shearwater (*Puffinus gravis*), phalaropes (red and red-necked) and Wilson's Storm-Petrel (*Oceanites oceanicus*). In addition, Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Great Black-backed Gull (*Larus marinus*), Herring Gull (*Larus argentatus*) and Sooty Shearwater (*Puffinus griseus*) are also abundant during this time of year. The richness and abundance of seabirds on the Scotian Shelf and Slope during summer months strongly reflects the presence of migrating birds. At this time of year, species that breed mostly in the high Arctic are starting to migrate through the area on the way to their winter grounds (*e.g.,* Red Phalarope) whereas those that breed in the South Atlantic migrate to the North Atlantic during the austral winter (*e.g.*, Great Shearwater and Wilson's Storm-Petrel). Additionally, marine birds that breed in nearby areas (*e.g.*, Leach's Storm-Petrel) have arrived in the area and begun nesting by June. The offshore distribution of breeding birds during this period for June to August is restricted as they become central-place foragers while attending nests and chicks and therefore at-sea observations in the Project Area are not necessarily indicative of species' abundance within the broader region at this time.



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.26 Seasonal ECSAS and PIROP Survey Effort on the Scotian Shelf and Slope

Seabirds may be encountered throughout the Scotian Shelf and Slope during the fall; however, data suggest that their concentrations at this time of year are lower than other seasons (Fifield *et al.* 2009). For example, the seasonal weighted mean of seabirds on the Scotian Shelf during fall (4.23 birds/km^2) was estimated to be approximately half of that calculated for the summer months (8.30 birds/km^2) (Table 5.2.15). Furthermore, during the fall, the weighted mean of seabirds on the Scotian Shelf (and nearby Gulf of Maine) has been estimated to be less than half than that associated with the Gulf of St. Lawrence and Labrador Shelves (Fifield *et al.* 2009). The species and abundances observed on the Scotian Shelf and Slope during fall reflect migrating species, the departure of adults and newly fledged young from local seabird colony sites, and an influx of wintering species. ECSAS and PIROP data indicate that the most abundant species along the Scotian Shelf during the fall is Great Shearwater, which would be migrating to the North Atlantic as well as relatively large numbers of Herring Gull, Northern Gannet, Great Black-backed Gull, Black-legged Kittiwake, and Northern Fulmar.

PIROP and ECSAS data indicate that relatively high concentrations of Black-legged Kittiwake are present during the winter, along with the Northern Fulmar, Dovekie, Great Black-backed Gull, Herring Gull, Common Eider (*Somateria mollissima*). The diversity and abundance of species found on the Scotian Shelf and Slope between December and February primarily reflects the overwintering presence of birds that migrate to the region from more northern latitudes and the year-round residents.

Data indicate that particularly high concentrations of Dovekie, Northern Fulmar, Herring Gull and Thick-billed Murre are observed along the Scotian Shelf during the spring. Other abundant species include Great Black-backed Gull, Murres, Northern Gannet and Leach's Storm-Petrel. The diversity and abundance of species observed at this time of year is due to the lingering presence of species overwintering along the Scotian Shelf and Slope but breed in more northern areas (*e.g.*, Dovekie, Thick-billed Murre), the passage migration of species that breed in the South Atlantic but migrate to the North Atlantic during the austral winter (*e.g.*, Great Shearwater), and the return of those that breed in the area (*e.g.*, Leach's Storm-Petrel). Data from Fifield *et al.* (2009) suggest that seabird concentrations on the Scotian Shelf and Slope (and Gulf of Maine) during spring months are higher than the concentrations in the Gulf of St. Lawrence, but lower than that found in association with the Newfoundland and Labrador Shelf ocean regions (Table 5.2.15).

Table 5.2.15 Seasonal Weighted Median (and range) of Seabird Densities (birds/km^2) in each of the Marine Ecoregions of Atlantic Canada (from Fifield *et al.* 2009)

Species	Season	Scotian Shelf - Gulf of Maine	Gulf of St. Lawrence	Newfoundland and Labrador Shelves
All Seabirds	Spring	7.92 (0.68 to 25.37)	3.10 (0.37 to 4.52)	14.30 (1.89 to 31.77)
	Summer	8.30 (1.73 to 148.56)	5.27 (2.21 to 14.31)	11.51 (0.34 to 48.78)
	Fall	4.23 (0.97 to 21.18)	11.57 (7.41 to 12.11)	9.24 (0 to 46.73)
	Winter	7.67 (4.39 to 29.44)	-	9.53 (2.31 to 45.12)
Northern Fulmars	Spring	0.75 (0 to 4.24)	1.19 (0 to 1.61)	1.00 (0 to 22.44)
	Summer	0.15 (0 to 1.64)	0.64 (0 to 4.19)	0.48 (0 to 24.17)

Table 5.2.15 Seasonal Weighted Median (and range) of Seabird Densities (birds/km²) in each of the Marine Ecoregions of Atlantic Canada (from Fifield *et al.* 2009)

Species	Season	Scotian Shelf - Gulf of Maine	Gulf of St. Lawrence	Newfoundland and Labrador Shelves
	Fall	0.30 (0 to 3.31)	0.27 (0.17 to 0.39)	0.65 (0 to 7.59)
	Winter	1.08 (0 to 12.37)	-	1.91 (0 to 36.77)
Shearwaters	Spring	0 (0 to 0.46)	0 (0 to 0)	0 (0 to 6.30)
	Summer	1.78 (0.29 to 84.02)	0.24 (0 to 0.87)	0.12 (0 to 16.39)
	Fall	2.20 (0 to 18.40)	5.06 (0.20 to 8.27)	0.80 (0 to 31.57)
	Winter	0 (0 to 3.74)	-	0 (0 to 7.20)
Storm-Petrels	Spring	0 (0 to 1.36)	0.12 (0 to 0.12)	0.08 (0 to 6.66)
	Summer	0.78 (0 to 12.74)	0 (0 to 0.21)	0.17 (0 to 8.46)
	Fall	0.02 (0 to 1.47)	0 (0 to 0)	0.26 (0 to 4.41)
	Winter	0 (0 to 0)	-	0 (0 to 0.04)
Northern Gannets	Spring	0.40 (0 to 1.03)	0.94 (0 to - 0.94)	0 (0 to 2.75)
	Summer	0 (0 to 1.69)	0.42 (0 to 1.37)	0 (0 to 3.31)
	Fall	0.19 (0 to 2.83)	2.42 (0.88 to 2.42)	0 (0 to 0.83)
	Winter	0.04 (0 to 0.22)	-	0 (0 to 0)
Large Gulls	Spring	1.22 (0 to 21.33)	0.34 (0 to 0.64)	0.74 (0 to 23.43)
	Summer	0.08 (0 to 8.39)	0.40 (0.16 to 1.70)	0.16 (0 to 9.38)
	Fall	0.58 (0 to 2.86)	0.93 (0.28 to 0.93)	0.13 (0 to 4.51)
	Winter	0.62 (0 to 2.31)	-	0.95 (0 to 20.83)
Black-legged Kittiwakes	Spring	0.06 (0 to 3.74)	0.50 (0 to 0.50)	0.72 (0 to 7.06)
	Summer	0 (0 to 0.76)	0.14 (0 to 2.34)	0.38 (0 to 7.87)
	Fall	0.11 (0 to 1.39)	0.79 (0.15 to 5.81)	0.05 (0 to 14.81)
	Winter	1.96 (0 to 21.31)	-	2.45 (0 to 19.93)
Dovekies	Spring	0.71 (0 to 36.98)	0 (0 to 0)	0.59 (0 to 32.10)
	Summer	0 (0 to 2.68)	0 (0 to 0.25)	0.18 (0 to 47.62)
	Fall	0 (0 to 0.25)	0.10 (0.10 to 4.37)	0.20 (0 to 35.76)
	Winter	2.13 (0 to 10.93)	-	0.93 (0 to 11.20)
Murres	Spring	0.88 (0 to 4.37)	0.74 (0 to 2.33)	3.73 (0 to 12.49)
	Summer	0.06 (0 to 2.60)	0.65 (0 to 4.62)	1.79 (0 to 46.57)
	Fall	0 (0 to 0.14)	0 (0 to 0.11)	0.07 (0 to 11.59)
	Winter	0.61 (0 to 7.71)	-	3.05 (0 to 15.21)
Other Alcids	Spring	0.14 (0 to 1.53)	0.20 (0 to 0.20)	0.25 (0 to 9.36)
	Summer	0.04 (0 to 0.91)	0.11 (0 to 4.03)	0.13 (0 to 13.06)
	Fall	0.05 (0 to 0.65)	0.04 (0.04 to 1.12)	0 (0 to 3.16)
	Winter	0.37 (0 to 4.69)	-	0.36 (0 to 3.45)

Source: Modified from Stantec 2014a

Large Alcids

Large alcids, including Common Murre (*Uria aalge*), Thick-billed Murre, Razorbill (*Alca torda*), and Atlantic Puffin (*Fratercula arctica*), are common in the waters off the Scotian Shelf and Slope and may be present in the vicinity of the Project Area during all times of the year, although generally more abundant during the spring. As a group, they are distributed throughout the Scotian Shelf and Slope in association with both coastal features and more offshore waters (Figure 1 in Appendix F). Thick-billed Murres accounted for the majority of PIROP and ECSAS alcid observations with relatively higher occurrences being recorded in spring and winter than the summer and fall. Thick-billed Murres, Common Murres, Razorbills, and Atlantic Puffins all overwinter on the Scotian Shelf and Slope but only Atlantic Puffin and Razorbill are known to breed along the southwestern coast of Nova Scotia (Sibley 2000; Tufts 1986; Environment Canada 2013d).

Breeding activities for these species occur in spring and summer and colonies are located on cliffs and islands (see Section 5.2.8.3 for information on the locations of seabird colonies), where the young are provisioned until fledged. Atlantic puffins typically fledge in August (Nettleship 1972), at which time they can fly, are independent of parents (Harris and Birkhead 1985), and disperse out to sea far from the colonies. Razorbills fledge earlier in the summer and although flightless at the time, they maintain a coastal affinity and are accompanied by one parent (typically the male) that cares for the chick for several weeks (Harris and Birkhead 1985). In addition to some species having flightless young, auks are flightless during a molting period, which may last more than a month, and occurs at sea during late winter for Atlantic Puffins (Harris 1984) and in early fall for Razorbills (Bédard 1985; Freethy 1987).

Dovekie

Dovekies nest in the high Arctic and do not breed in Canada in significant numbers. They occur on the Scotian Shelf and Slope from the fall to spring. Dovekies are at their highest numbers during winter and spring (Figure 2 in Appendix F) and when they are amongst the most abundant pelagic seabird species on the Scotian Shelf and Slope. Data from Fifield *et al*. (2009) suggest that Dovekies are more abundant in association with the Scotian Shelf (and Gulf of Maine) during winter and spring than the Newfoundland and Labrador Shelves, but have considerably lower concentrations than this region in summer and fall (Table 5.2.15).

Black Guillemot

Black Guillemots are largely restricted to coastal areas (Figure 3 in Appendix F). Black Guillemots breed in Nova Scotia and during summer they are only commonly encountered in close proximity to their widely distributed nesting colonies (Tufts 1986). As a result of their preference for coastal areas, Black Guillemots are not expected to regularly occur in the offshore Project Area.

Cormorants

Data on the distribution and abundance of cormorants indicate that they are typically restricted to coastal environments, with only infrequent offshore observations of few individuals (Figure 4 in Appendix F). The majority of the ECSAS and PIROP observations are of Double-crested Cormorants (*Phalacrocorax auritus*) as well as several observations of Great Cormorants. Cormorants are most abundant during the summer and fall months and breed along much of Nova Scotia's coastline, including southwestern parts of the province (NSDNR 2011a).

Cormorants are not expected to regularly occur in or adjacent to the Project Area because of its distance from the coastline.

Black-legged Kittiwake

Black-legged Kittiwakes, pelagic gulls, spend the majority of their time in offshore waters except during the breeding season when they come ashore to nest. High numbers of Black-legged Kittiwakes overwinter on the Scotian Shelf and Slope, and ECSAS and PIROP data indicate that they are the most abundant species recorded during winter. However, their abundances are less for this time of year when compared to more northern ecoregions (Table 5.2.15), such as the Newfoundland and Labrador Shelves (Fifield *et al.* 2009). Black-legged Kittiwakes are also common on the Scotian Shelf and Slope during fall, to a lesser extent in spring, and are relatively uncommon during summer months when the majority of the population is congregated at colony sites at more northern latitudes (Figure 5 in Appendix F). Black-legged Kittiwakes are known to nest along the southwestern coast of Nova Scotia at Pearl Island, near Lunenburg (Environment Canada 2013d) and may be encountered foraging in the vicinity of colonies or far offshore during this time.

Gulls

As a guild, gulls are amongst the most abundant marine related birds present on the Scotian Shelf and Slope, and data indicate that they are present throughout the region during all seasons (Figure 6 in Appendix F). Large and small gulls are included in this group, with the exception of Black-legged Kittiwakes that have been described separately. The most abundant species recorded during ECSAS and PIROP surveys were Herring Gull and Great Black-backed Gull which both breed along the coast of Nova Scotia. Other gull species recorded and that may be found on the Scotian Shelf include (in order of decreasing abundance) Iceland Gull (*Larus glaucoides*), Ring-billed Gull (*L. delawarensis*), and Glaucous Gull (*L. hyperboreus*), along with several vagrant species. Although seasonal patterns vary depending on the particular species, gulls in general are expected to occur near the Project Area during all seasons. Data from Fifield *et al.* (2009) suggest that large gulls are most common during spring with higher concentration on the Scotian Shelf (and Gulf of Maine) compared to northerly regions of the Gulf of St. Lawrence or the Newfoundland and Labrador Shelves (Table 5.2.15). The reverse is true in summer (Fifield *et al.* 2009).

Jaegars

Jaegers do not breed in Atlantic Canada but are present in offshore waters of the region during their spring and fall migration to and from their Arctic nesting sites (Figure 7 in Appendix F). The majority of PIROP and ECSAS records on the Scotian Shelf are of Pomarine Jaegars (*Stercorarius pomarinus*), with lesser amounts of Parasitic (*S. parasiticus*) and Long-tailed Jaegers (*S. longicaudus*) also being present. Jaegers may also be present during the summer, although it is more common on the Western Scotian Shelf and Georges Bank during this time (Figure 7 in Appendix F). It is not expected to occur on the Scotian Shelf during the winter season.

Northern Fulmar

Large colonies of Northern Fulmar are located in the Arctic. They do not breed in the vicinity of the Scotian Shelf and Slope in significant numbers and are present in offshore waters year-round (Figure 8 in Appendix F). ECSAS and PIROP data indicate that they are amongst the most abundant species encountered throughout the year, with particular high numbers being encountered in winter in the southern portion of the Scotian Shelf near Georges Bank. They are likely present in and around the Project Area all times of the year; however less so during the summer months. Although relatively common in the waters on the Scotian Shelf, data from Fifield *et al*. (2009) indicate their abundance throughout the year is less than that for the Newfoundland and Labrador Shelves (Table 5.2.15).

Northern Gannet

Northern Gannets are most common on the Scotian Shelf and Slope during the spring and fall with lesser numbers in the winter and summer (Figure 9 in Appendix F). Although they do not breed along the Scotian Shelf coastline, a small summer population of immature Northern Gannets regularly occurs around Nova Scotia (Tufts 1986). In Nova Scotia, their southward migration is typically observed to begin in early September and to peak during mid-October (Tufts 1986), with some individuals remaining there in winter (Sibley 2000). Generally, birds migrating north during spring are first observed in March with peak migration in Nova Scotia from mid-April to mid-May (Tufts 1986).

Phalaropes

Phalaropes are surface plankton feeders and generally concentrated in upwelling areas. Phalaropes use the Scotian Shelf and Slope area during migration between their arctic nesting grounds and more southerly wintering areas. PIROP and ECSAS data indicate that phalaropes are most common during spring and fall. During these times, they have been encountered in greatest abundance in the waters off southwestern Nova Scotia, near Georges Basin and the Northeast Channel (Figure 10 in Appendix F). The majority of phalaropes recorded are Red Phalaropes, although small numbers of Red-necked Phalarope (*P. lobatus*) have also been encountered during spring and fall.

Shearwaters

Shearwaters are common summer and fall visitors on the Scotian Shelf and Slope but spend the winter months in the southern hemisphere, where they breed. PIROP and ECSAS data indicate that they are particularly abundant in offshore waters in summer and fall and widely distributed along Scotian Shelf and Slope (Figure 11 in Appendix F). Although encountered less frequently during spring, they may occur throughout much of the area at this time of year, with larger concentrations often occurring near the edge of the shelf (Figure 11 in Appendix F). Great Shearwater account for the majority of shearwater observations in the PIROP and ECSAS databases, although Sooty Shearwaters are also relatively abundant. Other species of shearwater that have been observed on the Scotian Shelf and Slope include Cory's Shearwater

(*Calonectris diomedea*), Manx Shearwater (*Puffinus puffinus*), Audubon's Shearwater (*P. lherminieri*), and Yelkouan Shearwater (*P. yelkouan*).

Skuas

Although low in abundance, Skuas may be encountered on the Scotian Shelf and Slope throughout the year (Figure 12 in Appendix F). The majority of records in the area are of Great Skua (*Stercorarius skua*) with South Polar Skua (*S. maccormicki*) also frequenting the waters off Nova Scotia during migration. Great Skua nest on islands in the northeast Atlantic but are known to overwinter in waters of the northwest Atlantic (Sibley 2000), and occur on the Scotian Shelf and Slope during that time. The majority of PIROP and ECSAS records for this species on the Scotian Shelf and Slope are during the fall.

Storm-Petrels

Storm-petrels arrive in the Scotian Shelf and Slope in spring and stay until late fall with very few records during the winter months. Peak densities are reached in summer as a result of the return of Leach's Storm-Petrels to their breeding colonies and an influx of Wilson's Storm-Petrels from their breeding grounds in the southern hemisphere to the North Atlantic. The majority of ECSAS and PIROP storm-petrel observations on the Scotian Shelf and Slope were in summer (Figure 13 in Appendix F). During this time Wilson's Storm-Petrels were observed to be almost four times as abundant as Leach's Storm-Petrel. Although the breeding range of the Leach's Storm-Petrel in the western North Atlantic is centered on Newfoundland, a number of Leach's Storm-Petrel breeding colonies have been recorded in Nova Scotia. The largest of the colonies is on Bon Portage Island near Cape Sable Island and is estimated to be comprised of over 48 000 pairs (Environment Canada 2013d). Smaller colonies consisting of up to a couple hundred pairs are found elsewhere in the area, including on Sable Island, Bald Tusket Island, Half Bald Island, Inner Bald Tusket Island, and Pearl Island (Environment Canada 2013d).

Terns

Most terns arrive on the Scotian Shelf and Slope during May from their more southern wintering grounds and they are of greatest abundance in the summer months (Tufts 1986). Common Tern (*Sterna hirundo*) was the most abundant species of tern encountered during PIROP and ECSAS surveys but Arctic Terns (*Sterna paradisaea*) are also common. Data indicate that terns may be present throughout the region, but were most frequently encountered in proximity to coastal features and in vicinity of their breeding colonies (Figure 14 in Appendix F). Southward winter migration for Common Terns occurs during August and September and for Arctic Terns it begins in mid-July and is largely completed by mid-September (Tufts 1986). Arctic Terns are the most likely tern species to occur near the Project Area as they forage offshore, unlike Common Terns which are largely restricted to coastal areas (Erskine 1992). In addition, Roseate Terns (*Sterna dougallii*) breed at select sites on mainland Nova Scotia, as well as Sable Island, and have the potential to forage near the Project Area. Sable Island has supported between 1,000 and 9,000 pairs of Common, Arctic, and Roseate Terns over the past 50 years, nesting in 3 to 20 colonies across the island (Freedman 2014). Although PIROP and ECSAS data indicate that Least Tern

(*Sternula antillarum*), some unidentified noddies (*Anous sp*.) and skimmers (*Phychops sp*.) have also been recorded in the Scotian Shelf and Slope, however, none of these species are known to regularly frequent close to the Project Area.

Waterfowl

A variety of waterfowl are present in the waters of the Scotian Shelf throughout the year. Waterfowl may occur near the Project Area during the spring and fall months, but generally are infrequently observed in offshore waters and are more closely associated with the coastline (Figure 15 in Appendix F). Common Eiders are one of the most abundant waterfowl species in coastal waters of the Scotian Shelf during the breeding season nesting on islands scattered along the mainland Nova Scotia, with relatively dense aggregations of nesting islands present between Yarmouth and Cape Sable Island, and in Mahone Bay (NSDNR 2013). ECSAS and PIROP data also indicate that White-winged Scoter (*Melanitta fusca*), Canada Goose, Black Scoter (*Melanitta nigra*), Long-tailed Duck (*Clangula hyemalis*), and Common Loon (*Gavia immer*) were also encountered in the waters of the Scotian Shelf and Slope.

5.2.8.3 Areas of Significance to Migratory Birds

While migratory birds can be found throughout the RAA, certain areas are of particular importance and support a large abundance of birds. In the marine environment, birds are associated in areas with upwelling and mixing of water regularly occurs, such as the shelf edge. The Western Gully and the area north of Sable Island also have mixing waters, which result in high levels of phytoplankton, zooplankton and fish (Breeze *et al*. 2002). Seabirds concentrate in these areas because of the abundance of small prey fish. These areas of seabird concentration are discussed in relation to seasonal seabird abundance in Section 5.2.7.2.

Many important terrestrial areas are also of importance to marine-associated birds. Many near-shore islands provide important breeding habitat for large colonies of seabirds. Sable Island is located on the Scotian Shelf and is designated as a Migratory Bird Sanctuary (Breeze *et al*. 2002) and as an Important Bird Area (IBA). Areas of significance to migratory and marine-associated birds are discussed in the following sections.

Sable Island

Sable Island is a crescent shaped, treeless island located approximately 156 km off the coast of mainland Nova Scotia. It is an emergent portion of the Sable Bank, a sandy outwash plain (Freedman 2014). More than 330 species of birds have been identified on Sable Island. A high proportion of these species are vagrants that arrived by displaced winds or by misguided navigational behaviour (Freedman 2014). There have been 30 species recorded as breeding on the island with only seven having more than ten pairs nesting every year (Freedman 2014). Sable Island has supported between 1,000 and 9,000 pairs of Common, Arctic and Roseate Terns over the past 50 years (Freedman 2014). Herring Gull and Black-backed Gull are the only gull species nesting on Sable Island with about 900 pairs and about 45 loose colonies of Herring Gulls and about 400 pairs of Black-backed Gulls that nest more solitarily or in aggregations of a few birds

(Freedman 2014). There are two additional seabird species that have nested on Sable Island including Black-legged Kittiwake and Leach's Storm-petrels. Ipswich Sparrow is the only landbird to nest in large numbers on Sable Island with recent censuses estimate being five to six thousand adult birds summer on the island (Freedman 2014). Waterfowl and Shorebirds known to nest on the island include: Least Sandpiper, Spotted Sandpiper, Semipalmated Plover, Killdeer, Willet, yellowlegs (unspecified as either greater or lesser), American Black Duck, Red-breasted Merganser and occasionally Northern Pintail and perhaps Mallard (Freedman 2014).

The Sable Island National Park Reserve is a breeding site for six species of seabirds including mixed colonies of Common Tern, Arctic Tern, and Roseate Tern, dispersed colonies of Herring Gull, solitary nests of Great Black-backed Gull, and occasional records of Leach's Storm-Petrel (McLaren 1981; Zoe Lucas, unpublished data in Freedman 2014).

Migratory Bird Colonies

The coastline of the Scotian Shelf within the RAA for the Project supports over two hundred colonies of nesting marine birds (Table 5.2.16, Table 5.2.17, Figure 5.2.27 and Figure 5.2.28), ranging in size from a few individuals to thousands of breeding pairs (Table 5.2.17). In general, nesting colonies are distributed all along the coast of mainland Nova Scotia. Areas of dense aggregation include the area between Cape Sable and Yarmouth, the Eastern Shore islands along the southeast coast, and near Country Harbour and Tor Bay.

Leach's Storm-Petrel is the most numerous breeding seabird in the RAA with an estimated 64 014 breeding pairs across 18 colonies (Table 5.2.16). The vast majority (75%) of Leach's Storm-Petrels are found on Bon Portage Island near Cape Sable Island, with other relatively large colonies being found on Country Island, the Bird Islands, Little White Island, Inner Bald Tusket Island and Half Bald Tusket Island (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17).

Table 5.2.16 Summary of Migratory Bird Nesting Data in the RAA

Species	Unit of Measure	Number of Nesting Colonies		Abundance	
		Mainland Nova Scotia	Sable Island	Mainland Nova Scotia	Sable Island
Atlantic Puffin[1]	Pairs	4	0	262	0
Black-legged Kittiwake[1]	Pairs	1	0	5	0
Common Eider[2]	None	0	0	0	0
Cormorant[3]	Nests	42	0	2850	0
Leach's Storm-Petrel[1]	Pairs	17	1	63 914	100
Great Black-backed Gull[4,6]	Pairs	130	6	3792	978
Herring Gull[4,6]	Pairs	106	6	2991	1421
Razorbill[1]	Pairs	1	0	5	0

Table 5.2.16 Summary of Migratory Bird Nesting Data in the RAA

Species	Unit of Measure	Number of Nesting Colonies		Abundance	
		Mainland Nova Scotia	Sable Island	Mainland Nova Scotia	Sable Island
Terns[5,6]	Individuals	54	3	3594	4242

Note:
[1]Environment Canada 2013d
[2]NSDNR 2013
[3]NSDNR 2011a, primarily Double-crested Cormorant.
[4]Environment Canada 2013e
[5]CWS 2013a, includes Common Tern, Arctic Tern, and Roseate Tern.
[6]Ronconi 2013
[7]Based on an average of the two values provided by Ronconi (2013).
[8]Number of individuals estimated by multiplying the number of pairs identified by Ronconi (2013) by two.

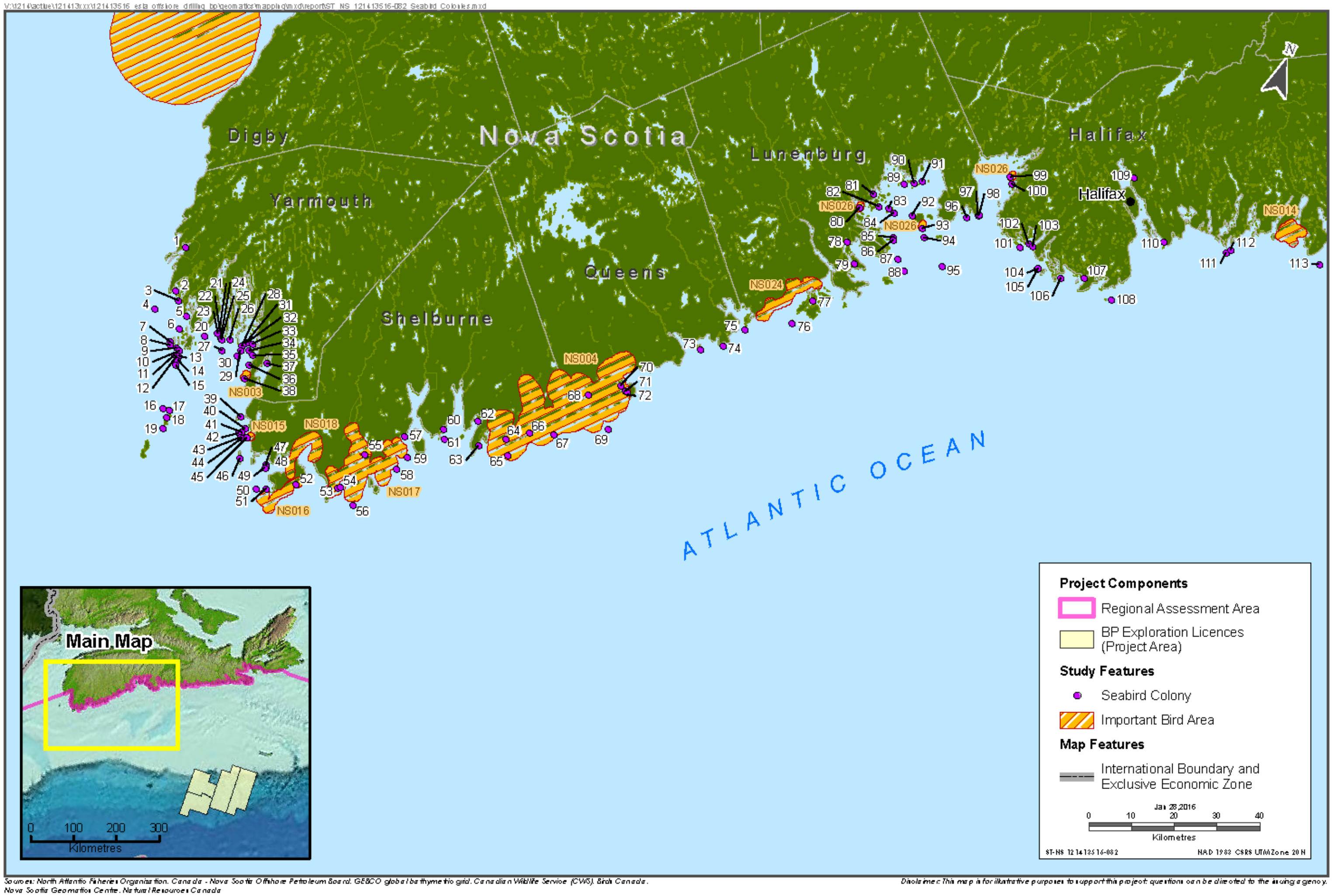
Nova Scotia is near the southern limit for nesting Atlantic Puffins, Razorbills and Black-legged Kittiwakes. The few breeding colonies for these species are patchily distributed along the coastline of the Scotian Shelf. The largest Atlantic Puffin colony is located on Pearl Island at the mouth of Mahone Bay, which is also the only site known to support Razorbills and Black-legged Kittiwakes within the RAA (Table 5.2.17).

Great Black-back Gulls and Terns are the second and third most abundant breeding seabirds in the RAA (Table 5.2.16). The largest concentrations of Great Black-backed Gulls are found on Sable Island that supports 20% of all nesting areas in the RAA. Larger numbers of Great Black-backed Gulls can also be found on Little Gooseberry Island, Green Island off Little Anse Cape Breton, Devil's Island, Green Island John's Island and Blanche Island. Terns can also be found on Sable Island representing 54% of nesting areas in the RAA. Country Island, South end of The Bar, Dung Cove and The Brothers islands also represent large abundance of Terns. All other tern colonies contain fewer than 100 nesting terns. Colonies in association with The Brothers Islands and Sable Island are particularly important because they support the endangered Roseate Tern.

Approximately 32% of Herring Gulls can be found on Sable Island with smaller colonies found on Devil's Island, Bon Portage Island, Pearl Island and Harbour Island as well as over a hundred other colonies on mainland Nova Scotia.

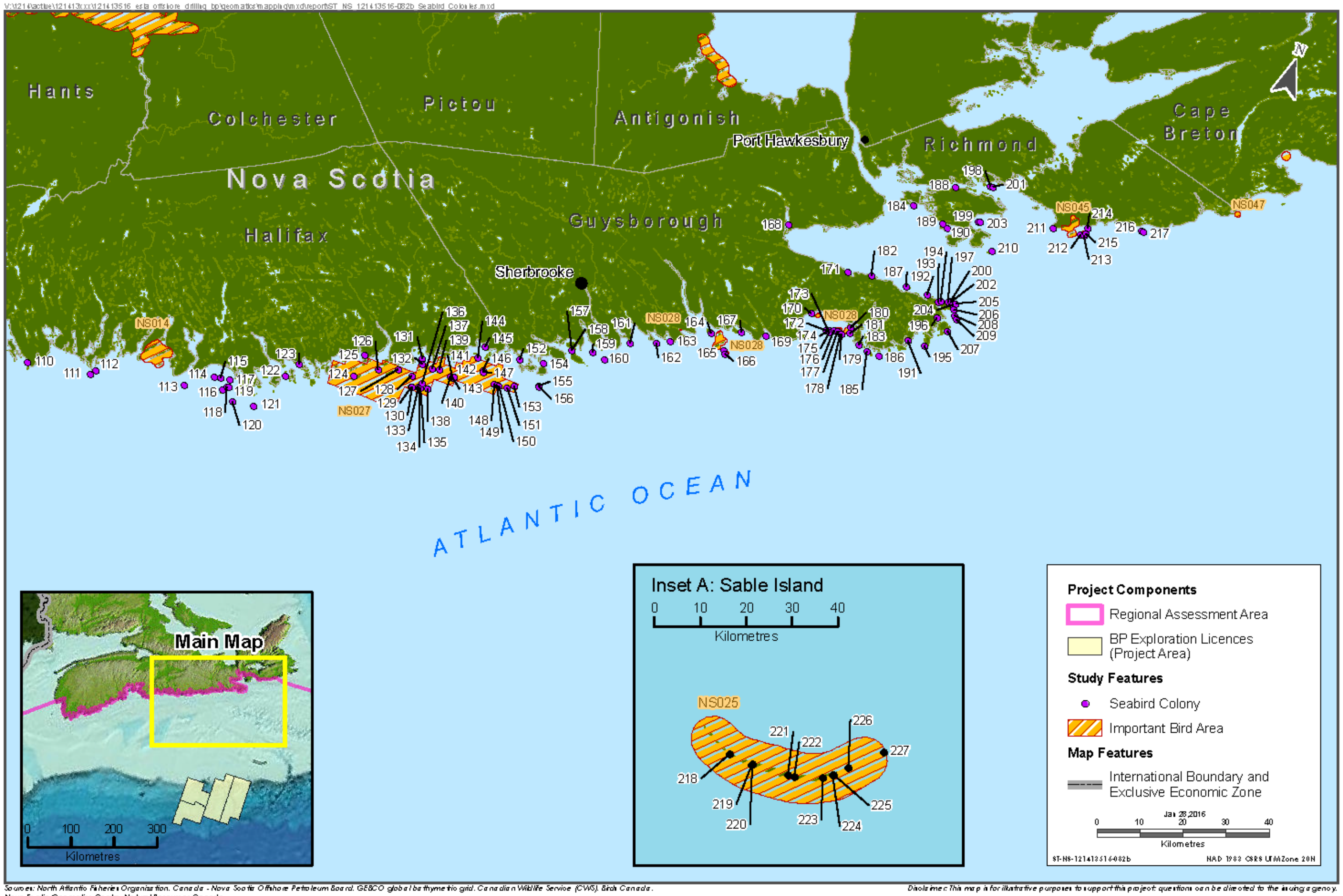
Cormorant colonies (Double-Crested Cormorants and Great Cormorants are not differentiated in the survey data) are scattered throughout the mainland Nova Scotia (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17). No abundance data are available for the known colony sites, and numbers associated with others are not necessarily accurate (NSDNR, pers. comm. 2014 in Stantec 2014a). Within the subset of cormorant colonies for which abundance data are available, the largest colonies are found on Little Duck Island in Mahone Bay and Blanche Island at the mouth of Port LaTour (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17). Together these two colonies account for 28% of the cormorant nests found in the 42 colonies for which abundance data is available.

Common Eider nesting sites are found on islands scattered along the mainland Nova Scotia with relatively dense aggregations of nesting islands present in the area between Yarmouth and Cape Sable Island and in Mahone Bay (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17). No abundance data are available for these nesting sites.



Sources: Data provided from NAFO, CNSOPB, CWS and NSDNR

Figure 5.2.27 Distribution of Seabird Colonies and Important Bird Areas within the RAA (western portion)



Sources: Data provided from NAFO, CNSOPB, CWS and NSDNR

Figure 5.2.28 Distribution of Seabird Colonies and Important Bird Areas within the RAA (eastern portion)

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
Mainland Nova Scotia										
1	Doctors Island				na					
2	Very small gravel island, near Crawleys Island								2	
3	Reef Island					28	65			
4	Green Island			na	50	36	36			
5	Ram Island, Little River Harbour					27	12			
6	Murder Island spit								65	
7	Holmes Island					2				
8	Northern Head Spectacle Islands								3	
9	Marks Island					3	25			
10	Peases Island					21	84			
11	Half Bald Tusket Island							180		
12	Little Half Bald Tusket Island					13				
13	Little Bald Tusket Island					14				
14	Inner Bald Tusket Island				30			200	10	
15	Bald Tusket Island							50		
16	Flat Island, (South of Tusket Island)			na		2				
17	Round Island	7		na		5	15			
18	Mud Island	75		na		11				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
19	Noddy Island	80		na		9				
20	Western Bar Island			na		5	45			
21	Fish Island, Inner					61				
22	Inner Fish Island			na	na					
23	Little Fish Island			na	na	17	11			
24	Eastern Bar Island (Gooseberry)			na	140					
25	Gooseberry Island, Lobster Bay					72				
26	East Money Island				143					
27	Gull Island			na		39			50	
28	The Thrum						25			
29	Pumpkin Island (LB)			na		22	22			
30	Whitehead Island				17	29	43			
31	Lears Island					104	56			
32	Little Gooseberry Island				12	176	44			
33	Big Gooseberry Island					39				
34	Ram Island (LB)					50				
35	Canoe Island					9	35			
36	Abbotts Harbour Island					57	14			
37	Chesapeake Island								60	
38	The Brothers			na			4		450	
39	John's Island			na		111	37			
40	Vigneau Island			na		39				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
41	Ram Island (GoM)					2				
42	Whale Island				na	7				
43	Goodwin Island			na		7				
44	Raspberry Island			na						
45	Solomans Island					4				
46	Bon Portage Island			na		81	150	48 244		
47	Double Island				70					
48	Round Island				6					
49	Good Landing Island				na					
50	Green Island					116	116		26	
51	Fish Island, Cape Sable								33	
52	Little Stoney Island				50	30	3			
53	Brooks Island					2				
54	Page Island					28				
55	Small unnamed island, Negro Harbour								2	
56	Blanche Island				410	106	26			
57	Small unnamed island, near Cranes Point, Shelb Hrb								27	
58	Gull Rock				60	12	6			
59	Grey Island			na	na	39	55		85	
60	South end of The Bar, Dung Cove								520	

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
61	Jordon Bay Gull Rock				140	12	27			
62	North tip of Egg Beach								31	
63	Potato Island					30	20			
64	Small unnamed island, Little Harbour Lake								15	
65	Ram Island			na	75	21	7			
66	Hughes Island, off Louis Head								33	
67	Green Rock				70	63	42			
68	Bijou Rocks, Port Joli (Furthest East)								36	
69	Little Hope Island				60					
70	Massacre Island				na	2	7			
71	Thrum Cap, near Jackie's Island				5					
72	Jackies Island					4	4			
73	Coffin Island					20				
74	Puddingpan Island					2				
75	Toby Island				na	58	19			
76	Indian Island			na	na	56	37			
77	Small unnamed island, near Round Island								24	
78	Unnamed island beside Corkum Island causeway								32	

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
79	Gully Island, Lower South Cove								46	
80	Westhaver Island, Mahone Harbour								29	
81	Crow Island								80	
82	Spectacle Island								24	
83	Andrew Island								3	
84	Rafuse Island			na						
85	Chockle Cap Island				30	66	99			
86	Indian Island			na						
87	Little Duck Island			na	400	73	31			
88	Big Duck Island			na						
89	Quaker Island								26	
90	Tip of Woody Island								2	
91	Saddle Island			na						
92	Star Island				na		94			
93	Grassy Island, Mahone Bay								38	
94	Flat Island			na		21				
95	Pearl Island	100	5	na		84	125	9		5
96	Gravel Island			na						
97	Southwest Island					39	42			
98	North of Southwest Island				na					

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
99	Wedge Island				20	35	53		70	
100	Franks George Island, North			na						
101	Dover Castle					18				
102	High Island					31				
103	Gull Island, Inner				na	28				
104	Hopson Island					17				
105	Duck Island (PB)					4				
106	Woody Island				na	74	8			
107	Thrumcap Island				13	4				
108	Sambro Island				70	33	6			
109	Island off of Dartmouth Yacht Club								28	
110	Devil's Island					119	691			
111	Shut-in Island				present				85	
112	Rat Rock						10			
113	Jeddore Rock				50	20				
114	Duck Island				35				10	
115	Duck Island (CB)					55				
116	Long Island				present					
117	Sugarloaf						14			
118	Goose Island (CB)					7				
119	Goose Island								13	
120	Egg Island				17	9	35		12	

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
121	Bald Rock, Clam Bay					35	9			
122	Small unnamed island west of Tuckers Cove Borgles Island								8	
123	Gravel Island								4	
124	Taylor Head Spit								12	
125	Hen Island, Mushaboom Harbour								6	
126	Sheet Rock				75	28				
127	Hardwood Island sandspit								180	
128	Speck Island				39	15				
129	Pumpkin Island (SH)					9				
130	Pumpkin Island							78		
131	Sandy Island				80					
132	Sandy Island (BH)					44				
133	Brother Islands					25	3			
134	Brother Islands, West							4		
135	Brother Islands, East							25		
136	Horse Island Ledge					4				
137	west end of Big Harbour Island								5	
138	Beaver Island						17			
139	Inside Eastern Harbour Island							7		
140	Bird Islands, East					6		350		

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
141	Bird Islands							1201		
142	Bird Islands, West				60	25		793		
143	East Gunning Rock				11					
144	Harbour Rock Southeast of Ship Island				35					
145	Boson Island								52	
146	Little Halibut Island							39		
147	Middle Halibut Island				39	18		30		
148	Camp Island				present	40	59	88		
149	Unidentified Island east of Camp Island					3				
150	Long Island, White Islands, main					20	2			
151	Round Island					13				
152	Small island west of Hapes Point near shore								85	
153	Little White Island				30	41		616		
154	Thrumcap Island				13	3				
155	Gull Rock				75				24	
156	Gull Ledge					14	2			
157	Point of the Beach					1	15			
158	Spit, east side Liscomb Island								11	
159	Tobacco Island				50	0	22			
160	Wedge Island				35	6	15			
161	Walter Island				70	18	70			

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
162	Fiddler's Head					4	9			
163	Bickerton Island					11				
164	Harbour Island (CH)					66	132			
165	Frying Pan (CH)					21				
166	Country Island							12000	950	
167	Thrumcap Island				present	9				
168	Big Island				10					
169	Shoal Point					25	8			
170	Small unnamed island west of Forster Island, Tor Bay								16	
171	Rock Island					54	6			
172	Topstone Ledge					6				
173	Western Island				present					
174	Middle Sugar Harbour Island					20				
175	Sugar Harbour Island, West					39				
176	Sugar Harbour Island, East					66				
177	Unnamed island, Tor Bay								16	
178	Unnamed island beside Cook's Island								80	
179	Cooks Island					1				
180	Hog Island Spit, Tor Bay								32	
181	Harbour Ledge					4				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
182	Half Island						6		12	
183	Inner Gull Ledge								160	
184	Green Island				present	62	92			
185	Middle Gammon Island					11	2			
186	Millstone Island				150	6				
187	Fox Island					31	13			
188	Berry Island				present	6	4			
189	Crid Islands, East					6				
190	Rocks off Jerseyman Island					5	4			
191	Small unmed island, Dover Bay								12	
192	Tickle Island					28			1	
193	Davis Island								4	
194	Bald Rock				50					
195	Unidentified island south of Dover Bay					3	2			
196	Small unnamed island, Spinney Gully								16	
197	Pigeon Island					29				
198	Ouetique Island				present					
199	Islet, Bay of Rocks				present					
200	Derabies Bar					15				
201	Quetique Island					31	123			
202	Unidentified island northwest of Derabies					17				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
	Island									
203	Les Rochers					61				
204	Derabie Island					11				
205	Gunning Rocks (East)					8	1			
206	Crow Island				10	50	6			
207	Gull Island, Canso					2				
208	Frying Pan Shoal					41	10			
209	Cranberry Islands				present				8	
210	Green Island off Little Anse Cape Breton					139	59			
211	Red Island				present	4				
212	South Basque Island					14				
213	East Basque Island					12				
214	Flat Rock				present					
215	Basques Islands - Green Island				present					
216	St. Esprit Island				45					
217	Guyon Island					66				
Sable Island										
218	Sable Island-6-eastern Spit					81	82			
219	Sable Island-5					131	183			
220	Main Station								2211	
221	Sable Island (general)							100		

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
222	Sable Island-4					134	163			
223	Sable Island-3					236	349			
224	Old East Light								13	
225	East Light								2018	
226	Sable Island-2					225	436			
227	Sable Island-1					171	208			

Note:
na = nesting area
[1]Environment Canada 2013d
[2]NSDNR 2013
[3]NSDNR 2011a
[4]Environment Canada 2013e
[5]CWS 2013a
[6]Ronconi 2013, HEGU and GBBG counts on Sable Island are for sectors and do not represent individuals colonies.

Important Bird Areas

IBAs are discrete areas that support nationally or globally important groups of birds including birds of conservation concern, areas where large concentrations of birds congregate, or support birds whose distribution is restricted by range or specific habitat requirements. IBAs are not legally protected but are often found within areas that have been designated as protected areas by federal or provincial authorities.

Fourteen coastal IBAs, including Sable Island, are present within the RAA (Figure 5.2.27 and 5.2.26), the attributes of which are described in Table 5.2.17. The fourteen IBAs are scattered throughout the RAA but many are located in the southeastern portion of Nova Scotia, between Halifax and Cape Breton Island. These areas have been designated as IBAs for a variety of reasons including the presence of breeding habitat for species at risk, important shorebird migration habitat, important coastal waterfowl habitat, and/or the occurrence of regionally significant colonial water bird colonies.

Species at risk that are known to be regularly associated with the IBAs in the RAA include Piping Plover (in IBAs NS004, NS014, NS016, NS017, NS018 and NS024), Roseate Tern (in IBAs NS003, NS025, NS026, and NS028), Harlequin Duck (in IBAs NS004, NS024, and NS028), and Red Knot (in IBA NS016) (Figure 5.2.27, Figure 5.2.28 and Table 5.2.18).

Important shorebird migration habitat is present in IBAs NS004, NS014, NS016, NS018, NS024, NS027, and NS045. These areas contain beaches, mud flats and salt marshes that attract large numbers of shorebirds during fall migration.

IBAs NS004, NS014, NS016, NS017, NS018, NS027, NS045, and NS047 contain regionally significant waterfowl habitat. These areas provide important staging and wintering habitat for sea ducks, American Black Ducks, Harlequin Ducks and geese. Regionally significant colonial water bird nesting areas are present in IBAs NS003, NS015, NS025, and NS045.

Nine of the fourteen IBAs present in the RAA are considered to be globally significant sites (NS003, NS015, NS016, NS024, NS025, NS027, NS028, NS045, and NS047) because they provide important habitat for important congregations of birds (Table 5.2.18). In particular, IBAs are considered globally significant if they support 1% or more of the global population of a bird species during breeding, wintering, foraging, roosting, rafting, or migration (Moore and Couturier 2011). NS025 (Sable Island) provides breeding habitat for up to 5% of the North American population of Common Terns and 1% of the North American populations of Herring Gull and Great Black-backed Gull as well as supports almost the entire population of the large Ipswich subspecies of the Savannah Sparrow (*Passerculus sandwichensis princeps*). NS027 (Eastern Shore Islands) provides overwintering grounds for approximately 3.3% of the Eastern population of Harlequin Ducks and is the breeding grounds for congregations of greater than 4,000 Common Eiders. NS028 (Country Island Complex) is a nesting habitat for Roseate, Common and Arctic Terns as well as habitat for over 50,000 pairs (approximately 2%) of the Western Atlantic population of Leach's Storm-Petrels. NS045 (Basque Islands and Michaud Point) provides nesting habitat for up to 3.6% of the North American Great Cormorant population and represents a unique location on Cape Breton Island as it provides habitat for a variety of shorebirds that occur regularly such as Least Sandpipers, Willets, and Common Snipe. In addition, Point Michaud provides breeding grounds for Common Eiders and migration habitat for geese and other waterfowl. NS047 (Rocks off Fourchu Head) supports habitat for at least 2% of the North American Great Cormorant population (IBA website). NS024 (South Shore - East Queens County Sector) provides breeding habitat for up to 3% of the Atlantic Canada Piping Plover population and up to 1% of the global population of Semi-palmated Plovers (*Charadrius semipalmatus*) have been recorded at this location during fall migration. NS016 (East Cape Sable Island) supports 4% of the Atlantic Canada Piping Plover population. During fall, up to 7% of the global population of Semi-palmated Sandpipers (*Calidris pusilla*) and 5% of the global population of Short-billed Dowitchers (*Limnodromus griseus*) have been recorded at this IBA site. NS015 (Bon Portage) is the site of the largest Leach's Storm-Petrel colony in the Maritime provinces which represents greater than 1% of the western Atlantic population of this species. NS003 (The Brothers) supports 50% of the breeding population of Roseate Terns in Canada.

The nearest IBA to the Project Area is Sable Island (NS025), located approximately 48 km to the north. The next nearest IBAs to the Project Area are located approximately 185 to 200 km to the north. These include IBAs NS014, NS027 and NS028 (Table 5.2.18). NS025 (Sable Island) is globally and nationally significant as it provides breeding habitat for the North American population of Common Terns, the North American population of Herring Gull and the Great Black-backed Gull. Sable Island also supports almost the entire population of the large Ipswich subspecies of the Savannah Sparrow, populations of Roseate Terns and large numbers of nesting colonial waterbirds. NS027 (Eastern Shore Islands) contains regionally significant waterfowl habitat, and provides important staging and wintering habitat for sea ducks, American Black Ducks, Harlequin Ducks and geese. NS028 (Country Island Complex) is globally and nationally as it supports an important nesting habitat for Roseate Terns and Common and Arctic Terns, and is being considered designated as a potential migratory bird sanctuary by Environment Canada.

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km^2)	Status	Bird Species	Description	Conservation Status
Sable Island	NS025	Sable Island, NS	461.89	Globally Significant; Nationally Significant: Threatened Species, Restricted Range Species	Ispwich Savannah Sparrow *(ssp. princeps)*, Herring Gull, Great Black-backed Gull, Common Tern, Roseate Tern, Arctic Tern, Leach's Storm-Petrel, Least Sandpiper	Supports the population of Ispwich Savannah Sparrow (*ssp. princeps*), Roseate Terns, and large numbers of nesting colonial waterbirds.	Migratory Bird Sanctuary (federal) and National Park Reserve
Musquodoboit	NS014	Dartmouth, NS	28.54	Continentally Significant: Congregatory Species	Canada Goose, American Black Duck, Piping Plover	Supports migration and overwintering habitat for large congregations of geese, and breeding grounds for Piping Plovers.	Provincial Game Sanctuary, Provincial Park (including marine)
Eastern Shore Islands	NS027	Halifax, NS	269.06	Globally Significant: Congregatory Species; Continentally Significant: Congregatory Species; Nationally Significant: Threatened Species, Waterfowl Concentrations	Common Eider (*spp. dresseri*), Harlequin Duck, White-winged, Black and Surf Scoter, Leach's Storm-Petrel	Supports breeding, and large fall and spring congregations of Common Eiders. Also represents an important overwintering habitat for Harlequin Ducks and other waterfowl.	Provincial Wildlife Management Area
Grassy Island Complex	NS026	Mahone Bay and Margaret's Bay, NS	9.96	Nationally Significant: Threatened Species, Congregatory Species	Roseate Tern	Complex of three islands regularly support Roseate Terns.	IBA Conservation Plan written/being written

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km^2)	Status	Bird Species	Description	Conservation Status
Country Island Complex	NS028	Country Harbour/Tor Bay, NS	16.35	Globally Significant: Congregatory Species, Colonial Waterbirds/Seabird Concentrations; Nationally Significant: Threatened Species	Roseate Tern, Common Tern, Arctic Tern, Leach's Storm- Petrel	Supports an important nesting habitat for Roseate Terns and Common and Arctic Terns.	Tern Restoration Plan for Country Island. Environment Canada is considering Country Island as a potential Migratory Bird Sanctuary.
Basque Island and Michaud Point	NS045	Near Point Michaud, NS	11.21	Globally Significant: Congregatory Species	Great Cormorant, Common Eider, Canada Goose and a variety of shorebirds (Semi-palmated, Spotted and Least Sandpiper, Willets and Common Snipe).	Basque Island supports large congregations of Great Cormorants. Point Michaud supports a variety of shorebirds and provides nesting habitat for Common Eiders. The vicinity of Point Michaud supports migration habitat for geese and other waterfowl.	Provincial Park (including marine)
Rocks off Fourchu Head	NS047	Fourchu, NS	1.39	Globally Significant: Congregatory Species	Great Cormorant	Supports large congregations of Great Cormorants.	na

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km²)	Status	Bird Species	Description	Conservation Status
South Shore - East Queens Co. Sector	NS024	Bridgewater, NS	49.01	Globally Significant: Congregatory Species, Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, Semi-palmated Plover and other shorebirds, Harlequin Duck.	Supports nesting Piping Plovers, important shorebird migration habitat, occasional overwintering grounds for Harlequin Ducks.	Provincial Park (including Marine)
South Shore (Port Joli Sector)	NS004	Liverpool, NS	435.61	Continentally Significant: Congregatory Species, Nationally Significant: Threatened Species	Piping Plover, Harlequin Duck, Canada Goose, American Black Duck, Common Goldeneye, Common Loon, Common Eider, Black-bellied Plover, Semi-palmated Sandpiper, Willet, Least Sandpiper, Pectoral Sandpiper.	Supports nesting Piping Plovers, important shorebird migration habitat, overwintering grounds for Harlequin Ducks and other waterfowl.	Migratory Bird Sanctuary (federal), National Park, Provincial Park (including Marine)
Bon Portage Island	NS015	Shag Harbour, NS	3.00	Globally Significant: Congregatory Species, Colonial Waterbirds/Seabird Concentrations	Leach's Storm-Petrel, Great Blue Heron, Black-crowned Night Heron, Snowy Egret	Supports the largest known Leach's Storm-Petrel colony in the Maritimes and a mixed species heronry. A monitoring station for migrating birds is also established on the island.	Research Station (privately owned)
South Shore (Barrington Bay Sector)	NS018	Barrington Passage, NS	42.06	Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, sea ducks and shorebirds	Supports an important number of Piping Plovers and important migratory habitat	na

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km^2)	Status	Bird Species	Description	Conservation Status
Eastern Cape Sable Island	NS016	Clark's Harbour, NS	33.62	Globally Significant: Congregatory Species, Shorebird Concentrations; Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, Semi-palmated Sandpiper, Short-billed Dowitcher, Black-bellied Plover, Sanderlings, Ruddy Turnstone, Least Sandpiper, White-rumped Sandpiper, Greater Yellowleg, Willet, Black-bellied Plover, Sanderling, Red Knot, American Oystercatcher, Brant, Short-eared Owl, as well as loons, herons, egrets, cormorants, seaducks, bay ducks, alcids, pelagic species, warblers, vireos, tanagers and sparrows.	Nesting Piping Plover and important migratory habitat for a diversity of avifauna.	IBA Conservation Plan written/being written
South Shore (Roseway to Baccaro)	NS017	Shelburne, NS	156.55	Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, scoters, eiders, American Black Duck.	Includes four Piping Plover beaches and provides important habitat for migrating waterfowl.	na
The Brothers	NS003	Lower West Pubnico, NS	4.51	Globally Significant: Congregatory Species; Nationally Significant: Threatened Species	Roseate Tern, Arctic Tern, Common Tern	Supports approximately half of the Canadian Roseate Tern population.	IBA Conservation Plan written/being written

Note:
[1]Refer to Figure 5.2.27 and Figure 5.2.28 for location.

Source: http://www.ibacanada.com

5.2.8.4 Species at Risk and Species of Conservation Concern

There are nine migratory bird SAR/SOCC that are known to occur on the Scotian Shelf and Slope and could be present in the RAA: Peregrine Falcon (*Falco perigrinus anatum*), Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, Red-necked Phalarope (*Phalaropus lobatus*), Savannah Sparrow (Ipswich subspecies) (*Passerculus sandwichensis princeps*) and Barrow's Goldeneye. A variety of reference material was used to obtain information on the distribution of these species within the region, including data from PIROP and ECSAS. Information on the regional importance, abundance, and distribution of marine bird SAR/SOCC is provided in the following sections, along with other key information on habitat requirements, general life history, and recovery strategies. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) has been drawn on extensively for this information such as species life history.

Peregrine Falcon

The Peregrine Falcon (*anatum*/*tundrius*) was listed as Special Concern in Schedule 1 of SARA in 2012. It has been listed as a species of Special Concern under COSEWIC since April 2007. The primary decline of the Peregrine Falcon was attributed to organochlorine pesticides (particularly dichlorodiphenyltrichloroethane [DDT]), which causes reproductive failure (COSEWIC 2007c). Although many types of organochlorine pesticides, including DDT, are no longer used in Canada and the US, they continue to be used in the South American wintering range of the Peregrine Falcon. Between 1970 and 2005, there was an increase in the population of Peregrine Falcons following the restriction of organochlorine pesticide use. Additionally, about 1,500 *anatum* Peregrine Falcons that were raised in captivity were released in Canada from 1975 to 2001 (SAR Registry 2014). By 2005, there was an estimated minimum population size of 696 mature individuals of the *anatum* subspecies in Canada (COSEWIC 2007c).

There are three subspecies of Peregrine Falcon found in Canada (*anatum, tundrius and pealei*), each of which has a distinct geographic distribution. However, only the *anatum*/*tundrius* subspecies occurs in Atlantic Canada. Its breeding range extends from the interior of Alaska and northern Canada up to southern Greenland, and across continental North American up to northern Mexico, including all Canadian territories and provinces except Prince Edward Island, Nunavut and the Island of Newfoundland (SAR Registry 2014). Peregrine Falcons can be found in various habitat types including wetlands, sea coasts and meadows (NSDNR, no date). Foraging areas are typically associated with coastal habitats. In Nova Scotia, this species is known to nest on the steep cliff ledges along the Bay of Fundy (NSDNR, no date). Most Peregrine Falcons nest on cliff ledges or crevices near good foraging areas, where nests are composed of scrapes in the substrate (COSEWIC 2007c). One brood is raised annually, with a mean clutch size of 3.72 in the mid-latitudes (White *et al*. 2002). The Peregrine Falcon can be found in Nova Scotia throughout the year (eBird 2015). This species is largely terrestrial and is not expected to occur offshore.

A management plan was developed in 2015 with the objective for the Peregrine Falcon anatum/tundrius population to be self-sustaining throughout its Canadian range within the next 10 years (Environment Canada 2015g2015). The primary factor for the collapse of Peregrine Falcon populations was from the use of organochlorine pesticides from the late 1940s through the 1970s. The plan poses a number of conservation measures aimed at reducing threats, conservation, and protection of nesting sites where possible as well as improving knowledge of species populations (Environment Canada 2015g).

Ivory Gull

The Ivory Gull is a rarely encountered vagrant in Nova Scotia listed as endangered on Schedule 1 of SARA and provincially listed as "accidental" (NSDNR 2011b) and "SNA" (*i.e.*, a conservation status is not applicable) (ACCDC 2011). Ivory Gulls nest on flat terrain or on sheer cliffs in the high-Arctic from May to early June and outside their breeding season, they live near the edges of pack ice in the North Atlantic Ocean, particularly in the north Gulf, Davis Strait, the Labrador Sea, and the Strait of Belle Isle (COSEWIC 2006e). Vagrant Ivory Gulls are occasionally observed in coastal areas of Nova Scotia during winter months such as multiple records in the Halifax area as well as near Lunenburg, Cape Sable, and Sambro (Cornell Lab of Ornithology 2014; Tufts 1986). Although rare, vagrant Ivory Gulls may also occur at other times of the year as one was observed on Sable Island in June of 1969 (Tufts 1986). No Ivory Gulls were recorded within the ECSAS and PIROP datasets obtained for the Project.

Until recently, the Canadian Arctic was thought to support 20 to 30% of the entire global breeding population of Ivory Gull and to contain colonies of global importance. However, aerial surveys conducted during 2002–2005 suggest that the Canadian breeding population has declined and is now comprised of 500 to 600 individuals, representing an approximate 80% decline over the last 18 years (COSEWIC 2006e). Approximately 35,000 individuals were observed among the pack ice of the Labrador Sea in 1978 (Orr and Parsons 1982), representing the bulk of the world population. However, a 2004 survey conducted off the coast of Newfoundland and Labrador showed a decrease in Ivory Gull numbers, with sightings of 0.69 individuals sighted per 10 minutes observed in 1978 to 0.02 individuals sighted per 10 minutes in 2004 (COSEWIC 2006e). Confirmed threats to Ivory Gulls (in Canada and/or globally) include illegal shooting of adults for food, climate change that is altering ice conditions in the circumpolar Arctic, oiling at sea, and escalating diamond exploration and drilling activities at key breeding locations (COSEWIC 2006e).

As outlined in the management plan for Ivory Gull (Stenhouse 2004), the recovery goal is to return the breeding population to historic levels of approximately 1000 breeding pairs and the breeding range to historic areas to at least four regional breeding areas by 2014. The recovery objectives are to prevent further loss to the population; understand the life history and potential threats to Ivory Gull; protect known habitat; and to reach out to the public and cooperate internationally in recovery efforts (Stenhouse 2004). Although there have been advances in increased awareness and understanding of the Ivory Gull since the last status assessment

(COSEWIC 2006e), breeding populations appear to be remaining at low levels within Canada (Government of Canada 2012).

Piping Plover

The Piping Plover (*melodus* subspecies) is a migratory shorebird listed as endangered on Schedule 1 of SARA and by the NS ESA. It nests in sand, gravel, or cobble, in open elevated areas of coastal beaches, barrier island sandspits, or peninsulas in marine coastal areas (Haig and Elliot-Smith 2004). Within Canada, the *melodus* subspecies occurs in New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and Québec (Environment Canada 2012c). In Nova Scotia, Piping Plovers breed on less than 30 beaches along the South Shore (Shelburne to Halifax Co.), North Shore (Pictou and Antigonish Co.), and in Cape Breton (Victoria, Inverness and Cape Breton Co.) between the end of March and early May. The young hatch between late May and June onwards, depending on when nesting was initiated which may occur any time after the birds arrive until mid-July with nests only occasionally initiated after this time. Migration back to the wintering grounds begins in early to mid-July and by early September the bulk of the population has left Canada (Environment Canada 2012c). They are unlikely to occur within the Project Area as a result of their coastal affinity but they do have potential to pass through the Halifax Harbour area during migration.

The latest North American population estimate for the *melodus* subspecies obtained in 2006 was 3,323 adults, of which 460 (14%) were located in Canada (Goossen and Amirault-Langlais 2009). In 2008, the Nova Scotian population was estimated to include 44 pairs (Environment Canada 2012c). Data collected since the end of the banding research program in 2003 suggests that the population in southern Nova Scotia is declining (Environment Canada 2012c).

Threats to this species include human disturbance, predation (egg, chick and adult), habitat loss and degradation, and livestock disturbances. Additional threats that may directly affect the plovers include driving vehicles on beaches, pets, boats, oil spills, mosquito control, and hurricanes (Stucker and Cuthbert 2006). In addition to these stressors, the population found along the southern shore of Nova Scotia appears to be reproductively isolated from the rest of the eastern population (Environment Canada 2012c).

The 2012 recovery strategy for Piping Plover identifies critical habitat for this species as "any site with suitable habitat occupied by at least one nesting pair of Piping Plovers (*melodus* subspecies) in at least one year since 1991 (the first year of complete survey coverage)" (Environment Canada 2012c). "Suitable habitat" as identified by Boyne and Amirault (1999) are areas with the following key habitat features: a gently sloping foredune; wide stretches of beach that afford protection from flooding at normal high tide; a substrate combined of sand, gravel, or cobble, or some combination of these; and a foredune that is sparsely vegetated or relatively free of vegetation. Sites identified as critical habitat for Piping Plover correspond with its currently known nesting distribution in Eastern Canada and along the coastline of Nova Scotia (Environment Canada 2012c). There are approximately 30 sites identified as critical habitat along the southern coastline of Nova Scotia (Figure 5.2.29).

The short-term population objectives in the recovery plan are to "achieve and maintain a regional population of 255 pairs and an annual productivity of 1.65 chicks fledged per territorial pair" (Environment Canada 2012c). Long-term objectives include an increase in the population to 310 pairs across Eastern Canada and to 60 within Nova Scotia. Recovery strategy implementation will be measured annually against whether the population is maintained at 255 pairs and regional productivity target of 1.65 chicks fledged per territorial pair is achieved. Over three consecutive international censuses occurring every five years, recovery strategy implementation will be measured against whether the population is increased to 310 pairs and the population distribution is unchanged from the 1991 International Census (Environment Canada 2012c). The recommended strategy to address threats to this species is to "ensure enough suitable habitat to meet population objectives, reduce predation, reduce human disturbance, minimize impacts of adverse weather conditions, minimize impacts of poorly understood mortality factors, address key knowledge gaps to recovery, and monitor the population" (Environment Canada 2012c).

Sources: Data provided from CNSOPB, CWS and NSDNR

Figure 5.2.29 Critical Habitat for Piping Plover within the RAA

Roseate Tern

The Roseate Tern is listed as endangered on Schedule 1 of SARA and under the NS ESA. In Canada, this species breeds almost exclusively on coastal islands in Nova Scotia with small numbers also in Quebec and New Brunswick. Roseate Tern nesting sites are populated with beach grass and herbaceous plants. In northeastern North America these nesting sites are always in association with Common or Arctic Terns to provide protection from diurnal predators (Nisbet and Spendelow 1999, in COSEWIC 2009d).

Approximately 120 to 150 pairs of Roseate Terns can be found in Atlantic Canada, with another 4,000 pairs estimated to occur in the northeastern United States (Environment Canada 2010b). Those found in Nova Scotia are mainly associated with Country Island (>40 pairs) and the Brothers Islands (>80 pairs) of Nova Scotia, with small amounts also nesting on Sable Island and the Magdalen Islands (COSEWIC 2009d). PIROP and ECSAs data indicate that Roseate Terns are occasionally observed in the waters off Nova Scotia during ship-based surveys, with potential to occur in the Project Area.

Threats to the Roseate Tern include predation from gulls and animals such as foxes as well as high post-fledging mortality and a shortage of males (at least in some United States colonies) (Environment Canada 2010b). The population's restricted distribution makes it vulnerable to localized threats including human development, catastrophic weather events such as hurricanes (Nisbet and Spendelow 1999; Lebreton *et al*. 2003), pollution, and disease (Environment Canada 2010b). In addition, the reproductive rate of Roseate Tern is limited by delayed maturity to age of first reproduction, small clutch size, low annual adult survival for a seabird, and relatively low survival to first breeding (Environment Canada 2010b).

The Canadian Recovery Plan aims to maintain and enhance breeding productivity and to restore the population's range across broadly distributed colonies (Environment Canada 2010b). The long-term goal (*i.e.*, 10 years, currently to 2015) is to have at least 150 pairs of Roseate Terns nesting in at least three colonies in Canada. Specific objectives include maintaining high numbers of breeding pairs at Country Island(>40 pairs) and The Brothers (>80 pairs), enhancing productivity at managed colonies to high levels, restoring a broader distribution by establishing at least one more managed colony, removing or reducing threats, and maintaining small peripheral nesting colonies on Sable Island and the Magdalen Islands (Environment Canada 2010b). These objectives are to be achieved through monitoring population size, distribution, movement, and productivity; enhancing nesting habitat; managing additional colonies; identifying critical habitat; protecting habitat; identifying limiting factors at managed colonies; monitoring threats; and improving decision making and planning (Environment Canada 2010b).

Critical habitat has been identified for this species including Sable Island, specific coastal islands of Nova Scotia, and the Magdalen Islands (Environment Canada 2010b). An area of critical habitat for this species that is closest to the Project is Sable Island which at the closest point is 48 km from the ELs (Figure 5.2.30).

Source: Data provided from CNSOPB, CWS, and NSDNR

Figure 5.2.30 Critical Habitat for Roseate Tern within the RAA

Red Knot

The Red Knot *rufus* subspecies is a medium-sized shorebird listed as endangered on Schedule 1 of SARA and under the NS ESA. Its breeding range falls entirely within the central parts of the Canadian Arctic and overwinters in South America (COSEWIC 2007b). The Red Knot uses coastal areas with extensive sand flats during migration and is considered a fairly common transient along the coastline of Nova Scotia during fall migration (Tufts 1986). In Nova Scotia this species first appears in July, peaking in August and again in September to October (LGL 2014). There are ten areas in Eastern Canada identified in the status assessment for this species as being important sites for Red Knot migration, of which two are in Nova Scotia: southern Cape Breton Island and Cape Sable (COSEWIC 2007b). Other locations in Nova Scotia where Red Knot occur include coastal areas of Sable Island, Yarmouth, Shelburne, Lunenburg, and Dartmouth (Cornell Lab of Ornithology 2014; Tufts 1986). This species is known to occasional stop at beaches in the Halifax Harbour area during migration. Given its coastal affinity, Red Knot is unlikely to occur within the Project Area.

Based on surveys conducted in the wintering range in South America, the estimated Red Knot *rufus* subspecies population in 2006 was 18,000 to 20,000 birds, decreasing 73.4% since 1982. The principal threats to the Red Knot include deterioration of food resources during spring migration and habitat loss and degradation. The most important threat to the Red Knot is the dwindling supply of horseshoe crab eggs in Delaware Bay which is the most important food used during the final spring stopover. Various factors leading to decreased habitat availability during migration in eastern North America are also contributing threats to the population (COSEWIC 2007b).

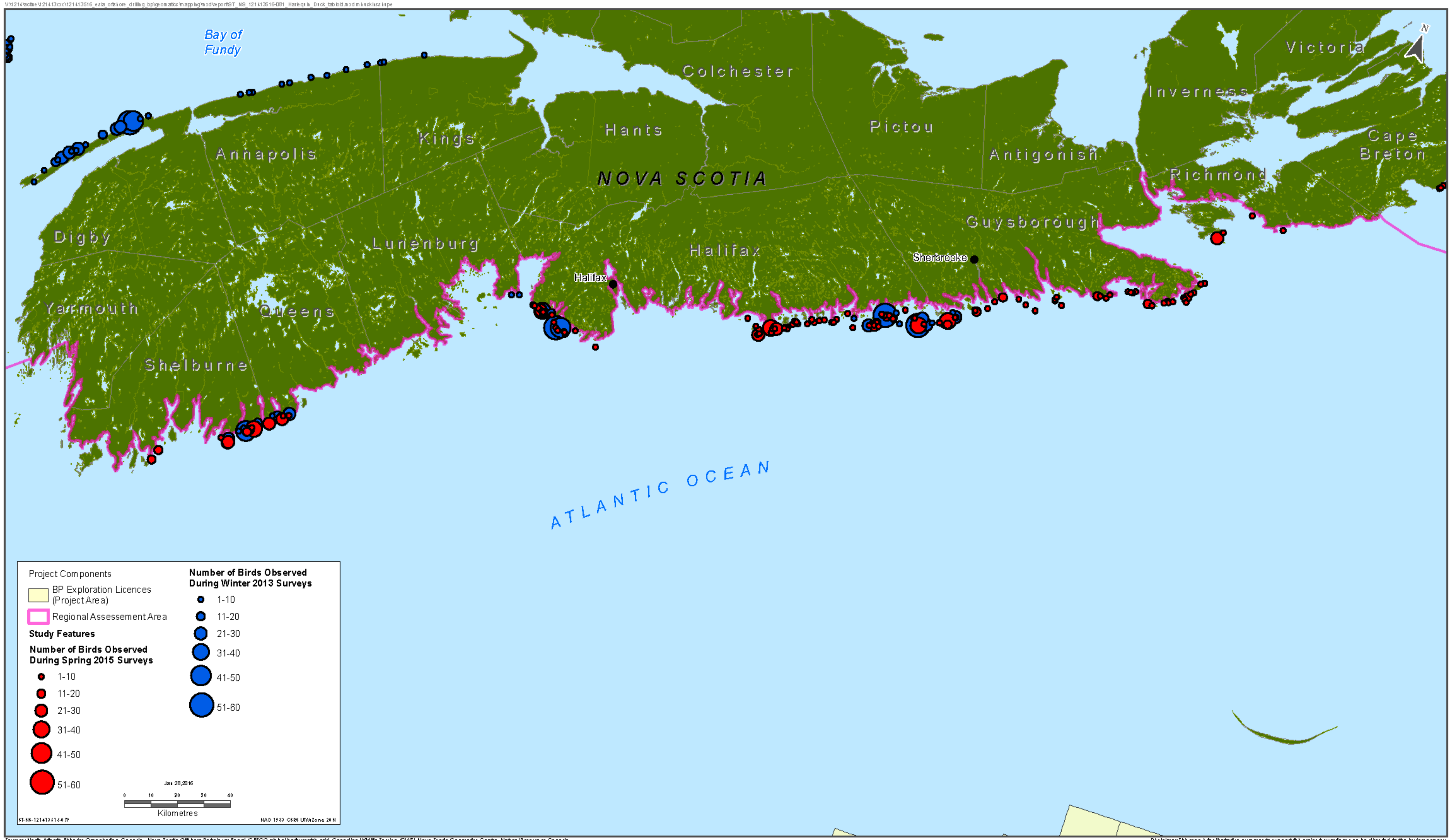
Harlequin Duck

The eastern population of Harlequin Duck is listed in Schedule 1 of SARA as a Species of Special Concern and as endangered under the NS ESA. Harlequin Ducks winter along rocky coastlines where they form pair bonds and in spring they fly inland to breed in fast-flowing rivers and streams. Four distinct breeding populations are present within the low arctic: Pacific, Icelandic, Greenlandic, and eastern North American. In Eastern Canada, the breeding range extends throughout a large portion of northern Quebec and Labrador, with isolated breeding ranges on the Northern Peninsula of Newfoundland, the northeast Gaspé Peninsula, and northern New Brunswick (Robertson and Goudie 1999). Although pairs of Harlequin Duck have been observed on the Margaree and Tusket Rivers during the breeding season (CWS pers. comm. 2012 in Stantec 2014a), they have not been confirmed to be breeding in Nova Scotia. They are known to forage in areas of rocky, high-energy shoreline around the coast of Nova Scotia during spring and fall migration and during the winter. Areas within the RAA where Harlequin Ducks are known to regularly overwinter include near Prospect and Little Port L'Hebert (Figure 5.2.31). An aerial survey along the Atlantic Coast of Nova Scotia on March 6, 2013 identified approximately 192 birds near Prospect and 224 in the area of Little Port L'Hebert, with additional concentrations within the province being associated with Digby Neck and the Bay of Fundy, the Eastern Shore Islands, and Louisbourg (CWS 2013b). This species is occasionally observed at the mouth of the Halifax Harbour (Cornell Lab of Ornithology 2014).

In 1990, COSEWIC designated the eastern North American population of Harlequin Duck as endangered due to declines during the 20th century. The eastern population of the species is currently rebounding and the COSEWIC designation was downgraded to Special Concern in 2001 to reflect this population increase. A census of the breeding population has been considered impractical because Harlequin Ducks are dispersed over a wide area on fast-flowing rivers of northern Newfoundland, Labrador, and Quebec. Wintering population estimates are known because they tend to concentrate in traditional areas during this time. Based on the best available information, a conservative winter population estimate for eastern North America is 2,925 individuals. Primary Canadian wintering locations include the southern and eastern coasts of Nova Scotia (approximately 600 Harlequin Ducks), the Bay of Fundy (approximately 300), and southern Newfoundland (approximately 450) (Thomas 2010). In winter, they are typically found close to shore where the surf breaks along exposed rocky headlands, reefs, and offshore islands. Harlequin Duck dive to feed on small shellfish and shrimp-like animals among these churning waters.

Threats to the eastern population of Harlequin Duck vary across its range but they are generally considered to be susceptible to disturbance on their wintering, moulting, and breeding grounds (Environment Canada 2007). This includes threats from interactions with fishing nets, aquaculture development, hunting activities, boats, and oil spills (Robertson and Goudie 1999; Thomas and Robert 2001). Hunting is considered a major factor that led to the low population estimate in the 1980s (Goudie 1990) but the legal hunt for this species has been closed in the Atlantic Flyway since 1990. While the abundance of Harlequin Ducks is increasing at key wintering locations, loss due to hunting remains a concern. Logging and hydroelectric development are considered to pose threats to some breeding populations (Robertson and Goudie 1999).

A Harlequin Duck federal management plan was completed in 2007 and had an initial goal of sustaining a population of 2,000 wintering individuals within eastern North America for at least three of five consecutive years (Environment Canada 2007). The long-term goal was to achieve at least 3,000 wintering individuals (with at least 1000 adult females) for at least three of five consecutive years by 2010. Although population levels are increasing at the four key wintering locations in eastern North America (Thomas and Robert 2001), the eastern North American wintering population has still not met the initial goal outlined in the recovery plan. Survey effort from 2005 to 2006 suggests that the 2,000 individual mark was met for these two years (CWS, pers. comm. 2012 in Stantec 2014a). The specific objectives include working with interested parties to clearly identify possible threats to the population and identify ways to reduce or eliminate these threats; accurately assess the population; identify habitats and areas that are important for breeding, moulting, wintering, and staging, and protect and manage these areas; further understand knowledge gaps; and, collaborate with Greenland in Harlequin Duck conservation efforts (Environment Canada 2007).



Sources: CNSOPB, CWS and NSDNR

Figure 5.2.31 Known Harlequin Duck Sites within the RAA

Barrow's Goldeneye

Barrow's Goldeneye is a medium-sized diving duck that primarily breeds and winters in Canada and wintering occurring in the inner Gulf and the North Shore of Québec. In the Atlantic provinces, they occur most commonly in winter in open-water areas associated with flow constrictions or in thermal effluent discharge zones (Environment Canada, Canadian Wildlife Service – Atlantic Region, unpublished data; cites in Environment Canada 2011). Their winter diet consists of marine molluscs and crustaceans.

The eastern population of Barrow's Goldeneye is listed as a Species of Special Concern under Schedule 1 of SARA. Although the range of the eastern population is unknown, data indicate that breeding is exclusive to Canada with the only confirmed breeding records being from Quebec. Generally, Barrow's Goldeneye breed at high elevations on alkaline wetlands around freshwater lakes. Wintering populations in Quebec are on small fish-less lakes above 500 m elevation, nesting in tree holes or cavities within 2 to 3 km of a water body (Todd 1963; Robert *et al.* 1999a, 1999b). The eastern North American population is approximately 6,800 individuals, the equivalent of 2,100 pairs (Robert *et al.* 2010). Fewer than 1,000 Barrow's Goldeneye winter in the Atlantic Provinces and in Maine (Daury and Bateman 1996; cited in Environment Canada 2011). Although PIROP, and ECSAS datasets obtained for the Project do not include records for Barrow's Goldeneye, this species is occasionally observed along the southern coast of Nova Scotia, including in association with Halifax Harbour and near Lunenburg and Liverpool (Tufts 1986; Cornell Lab of Ornithology 2014).

Population trends for this species are unknown, but the Eastern population is considered to have declined in the 20th century and have potential to still be in decline (Environment Canada 2011). Threats to this species include logging in its breeding grounds, fish stocking, oil spills (particularly in the St. Lawrence Estuary and the Gulf of St. Lawrence), hunting, and sediment contamination in areas where they congregate (Environment Canada 2011).

A management plan has been developed for the eastern population of Barrow's Goldeneye with the main objective to maintain and, if possible, increase its current population size and range. In order to achieve this objective, the size of the population is to be maintained for the next ten years at not less than 6,800 individuals across the species' range (Environment Canada 2011).

Red-Necked Phalarope

The Red-Necked Phalarope was listed as Special Concern by NS ESA in November of 2014 and is currently not listed under SARA. Over the past 40 years, this species has declined at an important staging area in Atlantic Canada. Threats to this species include habitat degradation associated with climate change, pollutants, and oil exposure (COSEWIC 2014a).

Although phalaropes are members of the shorebird family, they are functionally much more like seabirds. Phalaropes are generally pelagic outside of the breeding season and spend up to nine months of the year at sea (Rubega *et al*. 2000). This species breeds in the low Arctic or Subarctic regions of Canada and Alaska, where they build nests near freshwater lakes, ponds or marshes. In the fall, Red-Necked Phalaropes depart from their breeding grounds and migrate southward to their tropical wintering grounds off the coast of South America (Rubega *et al.* 2000). Red-Necked Phalaropes are most likely to occur in the RAA during the spring or fall migration periods and are most abundant in the fall when staging for migration. The Bay of Fundy is particularly important for Red-Necked Phalaropes; mixed flocks of thousands of red-necked phalaropes arrive around Brier Island in August (IBA Canada 2015).

Red-necked Phalaropes forage mostly while swimming and feed on insects, crustaceans and mollusks. They are known for their unusual behaviour of spinning in circles on shallow water, likely to stir it up and bring food to the surface (Elphick *et al*. 2001).

Savannah Sparrow (*princeps* subspecies)

The Savannah Sparrow (*princeps* subspecies, also known as the Ipswich Sparrow) is listed in Schedule 1 of SARA as a Species of Special Concern and assessed as Special Concern by COSEWIC. The Savannah Sparrow is Sable Island's best-known species and the subspecies nests almost exclusively on Sable Island (Freedman 2014). This very restricted breeding range and relatively small population is the reason for its designation. Threats include sea-level rise, increasing frequency and intensity of Atlantic storms as a result of climate change, and shoreline development in its wintering habitat (COSEWIC 2009a). The Savannah Sparrow is one of only two songbird taxa that breed solely in Canada (Freedman 2014). Individuals start arriving on Sable Island in mid-April. As many as four broods of three to five young are raised during the breeding season that lasts until late August (Freedman 2014). The most recent estimate of adults was 5500 individuals in 2013. The Savannah Sparrow breeds in all vegetated habitats of Sable Island; however, the preferred habitat is dense heath (Freedman 2014). During the breeding season the sparrow may use freshwater ponds and their associated riparian habitat when seeking invertebrates to feed their young, often leaving their territory and crossing others to reach the ponds (Freedman 2014). The Savannah Sparrow feed heavily on the seeds of marram grass on arrival on the island, and after breeding but before their autumn departure (Freedman 2014). The sparrows leave Sable Island beginning in late September and early October, with juveniles leaving before adults (Ronconi *et al.* 2014 in Freedman 2014), although up to 300 may winter on the island (Stobo and McLaren 1975, McLaren 1981, Z. Lucas, pers. comm. in Freedman 2014). The Savannah Sparrow winters in the Mid-Atlantic States between Nova Scotia and northern Florida (SAR Registry 2015).

A management plan was developed for the Savannah Sparrow in 2006 with a goal to maintain the breeding population at the current level, maintain the current amount and composition of breeding habitat, and remove or reduce threats to the species and their breeding and wintering habitat (Environment Canada 2006a). The various actions to obtain these goals are to monitor breeding populations and the breeding habitat, examine the conservation status and regulatory compliance of Sable Island, ensure precautionary approach to projects with potential to impact Savannah Sparrow, and implement education and communication programs (Environment Canada 2006a).

5.2.9 Species at Risk

Descriptions of SAR and SOCC have been provided in the applicable preceding sections. SAR species have a status on Schedule 1 under the *Species at Risk Act (*SARA) and SOCC are species designated under COSEWIC and which have the potential of being listed in the future under SARA. SARA came into force in June 2003, and is one part of a three-part Government of Canada strategy for the protection of wildlife species at risk (Species at Risk Public Registry 2016). It complements existing laws and agreements to provide for the legal protection of wildlife species and conservation of biological diversity. The Act aims to prevent wildlife species from becoming extinct, and to secure the necessary actions for their recovery. The Act establishes Schedule 1 as the official list of wildlife species at risk, classifying species as being extirpated, endangered threatened, or a special concern. Once a species is listed, the measures to protect and recover a species are implemented (Species at Risk Public Registry 2016).

COSEWIC was established in 1977 to provide Canadians with a single, scientifically sound classification of wildlife species at risk of extinction. In 2003, with the advent of SARA, COSEWIC was established as an independent body of experts responsible for identifying and assessing wildlife species considered being at risk. Wildlife species that have been designated by COSEWIC may then qualify for legal protection and recovery under SARA.

Table 5.2.19 summarizes the complete list of SAR and SOCC that have the potential to be found within the RAA.

Table 5.2.19 Species at Risk and Species of Conservation Concern with Potential to Occur within the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]
Marine Fish Species			
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened
American eel	*Anguilla rostrata*	Not Listed	Threatened
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered
Atlantic cod (Southern population)		Not Listed	Endangered
Atlantic salmon (Outer Bay of Fundy)	*Salmo salar*	Not Listed	Endangered
Atlantic salmon (Inner Bay of Fundy)		Endangered	Endangered
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered

Table 5.2.19 Species at Risk and Species of Conservation Concern with Potential to Occur within the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered
Atlantic sturgeon (Maritimes populations)	*Ancipenser oxyrinchus*	Not Listed	Threatened
Atlantic wolffish	*Anarhichas lupus*	Special Concern	Special Concern
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern
Blue shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern
Cusk	*Brosme brosme*	Not Listed	Endangered
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern
Spotted wolffish	*Anarhichas minor*	Threatened	Threatened
Striped bass (Bay of Fundy population)	*Morone Saxatilis*	Not Listed	Endangered
Striped bass (Southern Gulf of St. Lawrence population)	*Morone Saxatilis*	Not Listed	Special Concern
Thorny skate	*Amblyraja radiate*	Not Listed	Special Concern
White shark	*Carcharodon Carcharias*	Endangered	Endangered
White hake	*Urophycis tenuis*	Not Listed	Special
Marine Mammal Species			
Blue whale (Atlantic population)	*Balaenoptera musculus*	Endangered	Endangered
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Special Concern
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Not Listed	Special Concern
Killer whale	*Orcinus orca*	Not Listed	Special Concern
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Endangered	Endangered

Table 5.2.19 Species at Risk and Species of Conservation Concern with Potential to Occur within the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Not Listed
Sea Turtle Species			
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered
Migratory Bird Species			
Ivory Gull	*Pagophila eburnea*	Endangered	Endangered
Roseate Tern	*Sterna dougallii*	Endangered	Endangered
Barrows Goldeneye	*Bucephala islandica*	Special Concern	Special Concern
Harlequin Duck	*Histrionicus histrionicus*	Special Concern	Special Concern
Piping Plover (*melodus* subspecies)	*Charadrius melodus melodus*	Endangered	Endangered
Red Knot *rufa* ssp	*Calidris canutus rufa*	Endangered	Endangered
Peregrine Falcon (*anatum/tundrius* subspecies)	*Falco perengrinus anatum/tundrius*	Special Concern	Special Concern
Red-necked Phalarope	*Phalaropus lobatus*	Not Listed	Special Concern
Savannah Sparrow (*princeps* subspecies)	*Passerculus sandwichensis princeps*	Special Concern	Special Concern

Note:
[1]Species of conservation concern (SOCC) listed as endangered, threatened, or of special concern by COSEWIC but not listed in Schedule 1 of SARA.

Source: Modified from Stantec 2014a

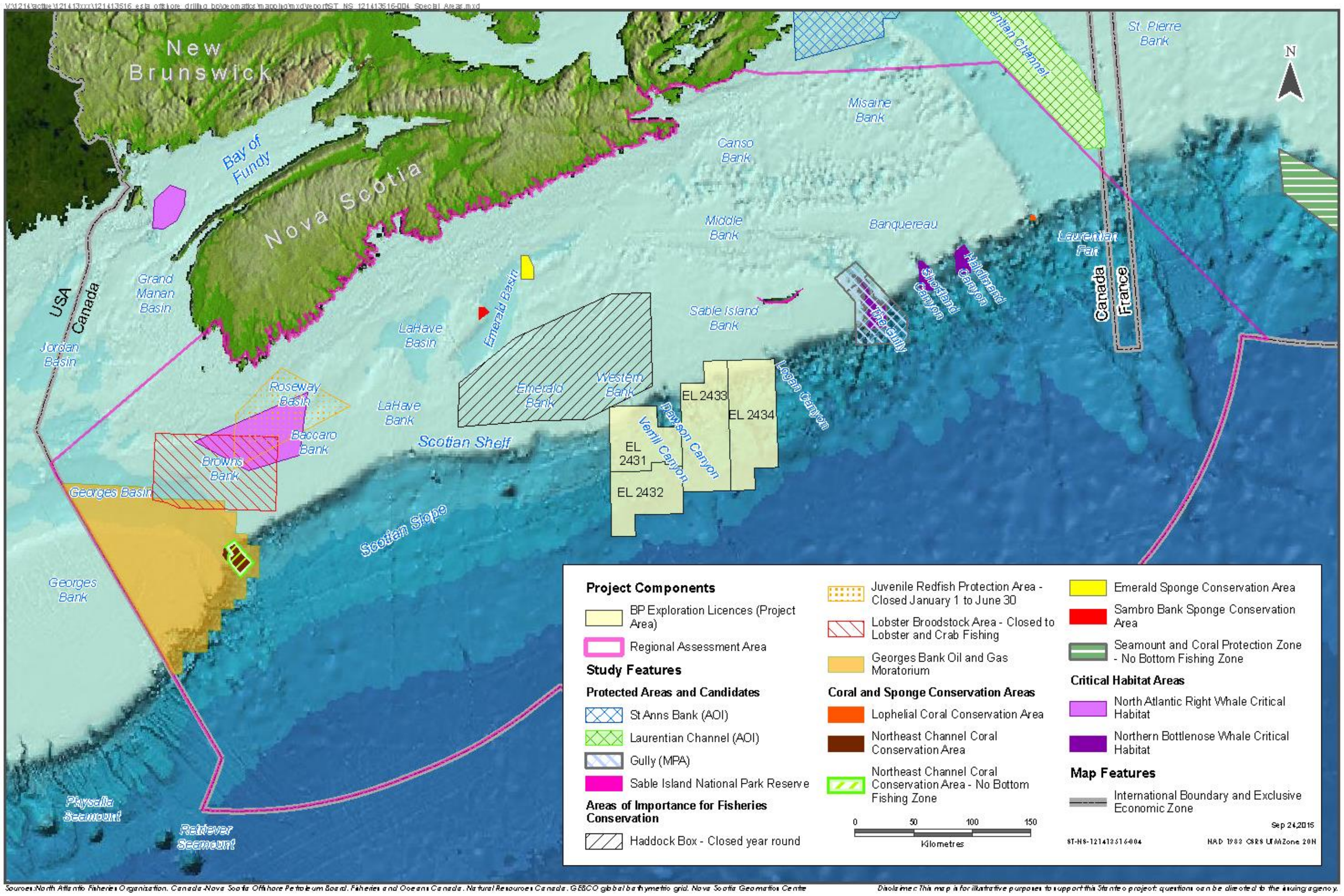
5.2.10 Special Areas

Special Areas include areas on the Scotian Shelf and Slope which have been recognized as being ecologically unique or sensitive and include a *National Parks Act* park, an *Oceans Act* MPA including candidate MPAs, *Species at Risk Act* Critical Habitat areas, *Fisheries Act* closure areas (*e.g.*, significant spawning areas and coral conservation areas), and Ecologically and Biologically Significant Areas (EBSAs). Special Areas located on the Scotian Slope and Shelf are shown in Table 5.2.20, however, most of them are more than 100 km from the Project Area. Special Areas are not equally ecologically significant or sensitive. For example, protected areas such as the Sable Island National Park Reserve and Gully MPA, Shortland and Haldimand Canyons Whale Critical Habitats for the northern bottlenose whale, are afforded more significance given their legal designations and long-term protection (Stantec 2012a). Fisheries closures may not have direct significance to oil and gas activities, but they do indicate areas of importance for fish spawning and/or protection of juveniles, and therefore have been included for consideration as relevant Special Areas (Stantec 2014a).

The nearest Special Area to the Project Area is the Sable Island National Park Reserve, located 48 km away at its closest point from the ELs and particularly EL 2434 (Figure 5.2.32). Sable Island, located in the open northwestern Atlantic Ocean close to the edge of the Scotian Shelf (continental shelf), was formally proclaimed to be a national park reserve on December 1, 2013 (Freedman 2014). The Island is a significant site with important features including the largest breeding colony of grey seals in the world, a population of wild horses, one of the largest dune systems in eastern North America, an important freshwater lens, a number of species at risk and endemic species, and an extremely dynamic ecology (Freedman 2014).

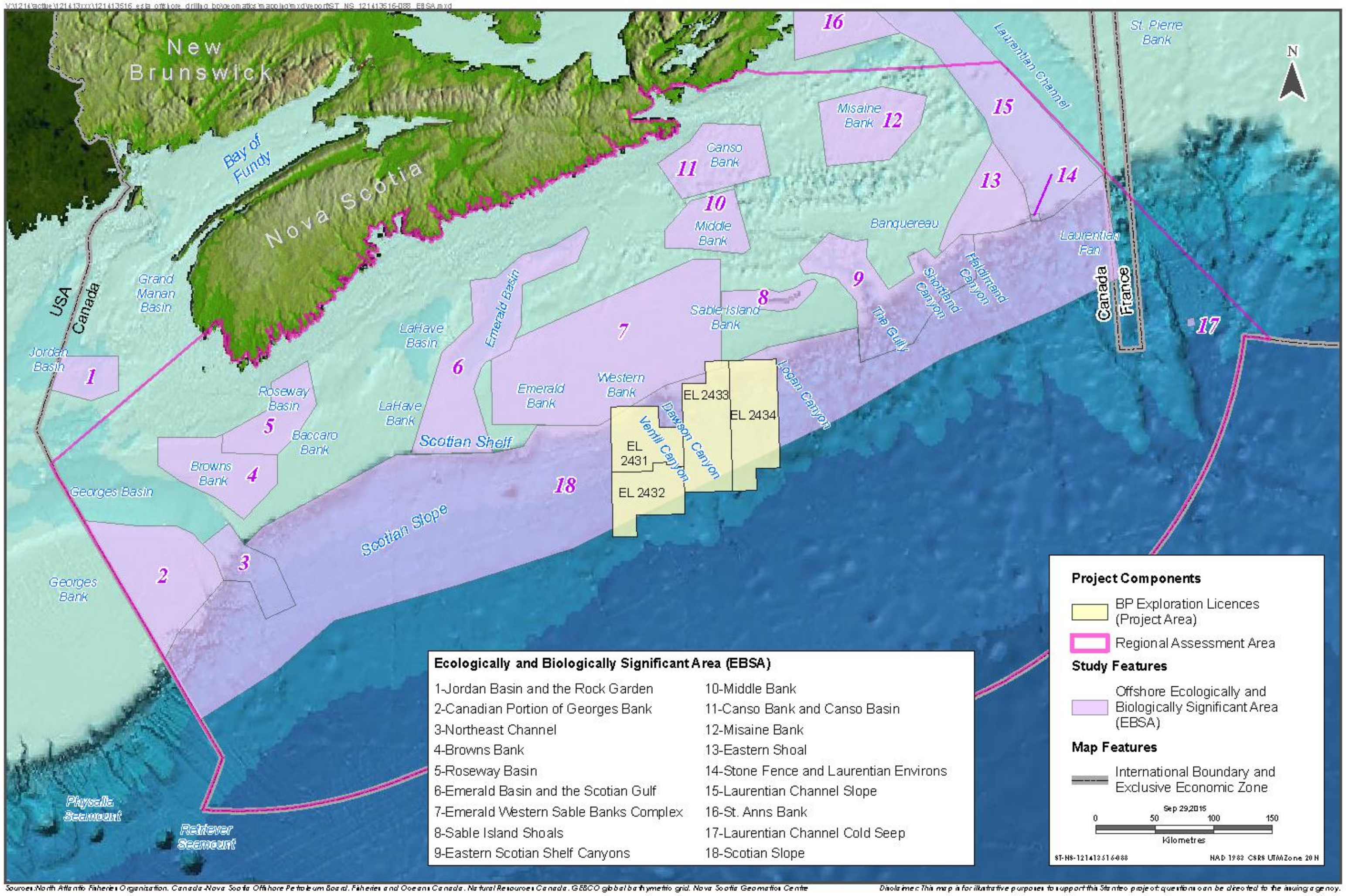
There are several EBSAs, many of which are incorporated in the protected areas described above. EBSAs have been identified based on a compilation of scientific expert opinion and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf (Doherty and Horsman 2007). EBSAs are areas of particularly high ecological and biological significance that may require greater than usual degree of risk aversion in the management of activities in these areas (DFO 2014b). The classification of an EBSA does not give the area any special legal status; however, they are considered in a broad range of coastal management and planning processes such as environmental assessments, environmental emergency response, sustainable fisheries policies and MPA planning (DFO 2014b). Seventeen EBSAs have been identified on the Scotian Shelf and Slope. Of particular relevance to the Project Area are the EBSAs highlighted in the SEA for the Western Scotian Slope (Stantec 2014b) including the Scotian Slope, which runs through the Project Area and the Emerald-Western-Sable Island Bank Complex which runs north of the Project Area. The Scotian Slope EBSA is recognized as being an area of high primary productivity, high fish species diversity, high small fish and small invertebrate species richness, important for groundfish, migratory route for cetaceans and large pelagic fishes, important for seabirds, and unique habitats and sensitive benthic communities (DFO 2014b). The Emerald-Western-Sable Island Bank Complex was identified as being important for groundfish, high larval fish abundance and diversity, commercial and non-commercial invertebrates, high fish and invertebrate biomass, high fish species diversity, high invertebrate species diversity, and important seabird habitat, as well as the Western Gully area is of significance to cetaceans (DFO 2014b).

Figures 5.2.32 and 5.2.33 depict designated Special Areas including protected areas, fisheries conservation areas, and EBSAs on the Scotian Shelf and Slope. Table 5.2.20 includes an overview of relevant Special Areas as drawn from various SEAs that have been prepared for the Scotian Shelf and Slope between 2012 and 2014 (Stantec 2012a, Stantec 2013a, Stantec 2014b).



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.32 Special Areas



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.33 Ecologically and Biologically Sensitive Areas

Table 5.2.20 Special Areas in the RAA

Sable Island National Park Reserve	
Location and Proximity to Project Area	• With its western tip being about 156 km east of the closest landfall on the mainland of Nova Scotia and 290 km southeast of Halifax, Sable Island is a windswept crescent-shaped sandbar 49.5 km long by 1.3 km wide with an area of 29.8 km^2 that emerges from the Atlantic Ocean near the edge of the Continental Shelf (Scotian Shelf) (Freedman 2014). • Approximately 48 km from the Project Area.
Designation and Administration	• Sable Island is protected under the *Canada National Parks Act* which prohibits drilling from the surface of Sable Island and one nautical mile seaward of the low water mark of Sable Island as defined by the Canadian Hydrographic Service (Parks Canada 2011). • To comply with the *National Parks Act*, an *Amending Agreement of Significant Discovery Licence 2255E* was executed on December 21, 2011 (CNSOPB 2011). • As of April 1, 2012, Parks Canada is responsible for managing access to the island by coordinating registrations, schedules, logistics, and written authorizations from the Canadian Coast Guard pursuant to the *Canada Shipping Act*, as is required in the current legislative context until the Canada *National Parks Act* is amended to include Sable Island National Park Reserve. (J. Sheppard, Parks Canada, pers. comm., 2012). • Sable Island was designated as a Migratory Bird Sanctuary (MBS) in 1977 and is administered by the Canadian Wildlife Service (CWS) and is also an IBA (Environment Canada 2012d). • Sable Island is protected under the *Special Places Protection Act* for its rich archaeological and heritage resources. • The Meteorological Service of Canada, a branch of Environment Canada, maintains a continuous presence on the island. They also continue to provide operational services by agreement with Parks Canada, including all services related to landing on and visiting the island (J. Sheppard, Parks Canada, pers. comm. 2012). • There are seasonally occupied facilities belonging to the Department of Fisheries and Oceans and Coast Guard including a number of buildings, two lighthouses, two helicopter landing pads and a navigation beacon (Canadian Coast Guard 2006).
Ecological Significance	• Over 190 species of plants and 350 species of birds recorded. The Ipswich (Savannah) Sparrow and the Roseate Tern both breed on the island and are protected under SARA. • The Ipswich Sparrow nests almost exclusively on Sable Island and is the dominant terrestrial bird on the island. The birds breed on virtually all vegetated areas on Sable Island, including healthy terrain and areas dominated by Marram Grass. In winter, they occur in coastal dunes, especially in areas with dense beach grass (COSEWIC 2009a). The species' localized distribution makes it particularly vulnerable to potential threats such as chance events (*e.g.*, harsh weather and disease during breeding season), predation, human activity,

Table 5.2.20 Special Areas in the RAA

	and habitat loss. • The 2006 proposed Recovery Strategy for the Roseate Tern (Environment Canada 2006b) was the first recovery strategy for a migratory bird posted on the SARA Public Registry to identify "critical habitat" as defined in the Act (200 m buffer zone around tern colonies). The Amended Recovery Strategy for the Roseate Tern (Environment Canada 2010b) has the objective to continue to maintain the small peripheral colonies of Roseate Terns nesting on Sable Island. A former recommended focus on restoration of Roseate Terns to Sable Island was not attempted on Sable Island (primarily due to financial constraints) and since then, only one or two pairs of Roseate Terns have nested there each year (Environment Canada 2010b). • Home to the world's largest breeding colony of grey seals, which pup on the island between late December and early February. Harbour seals also breed on the island and are year-round residents. • Hundreds of harp and hooded seals and one or two ringed seals come ashore for a few hours or days during the winter and early spring (DFO 2011a). • Over 400 wild horses, believed to have been introduced sometime in the mid-1700s, inhabit the island (Parks Canada 2011).
The Gully Marine Protected Area (MPA)	
Location and Proximity to Project Area	• The Gully is located approximately 200 km south-east of Nova Scotia, east of Sable Island, on the edge of the Scotian Shelf (DFO 2008a). • In the Gully the seafloor drops away over 2.5 km extending approximately 65 km long and 15 km wide making it one of the most prominent undersea features on the east coast of Canada (DFO 2008a). • Approximately 71 km from the Project Area.
Designation and Administration	• In 1994, DFO identified part of the Gully as a Whale Sanctuary to reduce noise disturbance and ship collisions with whales (DFO 2008a). • In May 2004, the Gully was designated an MPA under the *Oceans Act* (DFO 2011b). • The *Gully Marine Protected Area Regulations* prohibit any activity within or in the vicinity of the MPA that disturbs, damages, destroys or removes any living marine organism or any part of its habitat within the MPA and in the vicinity of the MPA. These regulations apply to the entire water column and the seabed to a depth of 15 m (DFO 2011b). • The *Gully Marine Protected Area Management Plan* was developed to support the *Gully Marine Protected Area Regulations* and provide guidance to DFO, other regulators, marine users, and the public on protecting and managing this important ecosystem (DFO 2008a, DFO 2011b). • The MPA contains three management zones, each providing varying levels of protection based on conservation objectives and ecological sensitivities (DFO 2008a): Zone 1 consists of the deepest sections of

Table 5.2.20 Special Areas in the RAA

	the canyon and is preserved in a near-natural state with full ecosystem protection - this zone is highly restricted with few activities permitted (research and limited vessel transit); Zone 2 provides strict protection for the canyon sides and outer area of the Gully – some fisheries are allowed in this region; and Zone 3 includes the shallow water and sandy banks that are prone to regular natural disturbance and allows some fishing. • Fishing for halibut, tuna, shark and swordfish have been allowed in Zones 2 and 3 provided the activities are conducted under a federal fishing licence and approved management plan (DFO 2008a). Scientific research and monitoring may be approved in all three zones provided a plan is submitted and the research meets all regulatory requirements. Other activities may be permitted in Zone 3 provided they do not cause disturbance beyond the natural variability of the ecosystem and are subject to plan submission and Ministerial approval. • The CNSOPB has not allowed petroleum activities in the Gully since 1998 (CNSOPB 2012).
Ecological Significance	• The Gully has significant coral communities, a diversity of both shallow and deepwater fishes, and a variety of whales and dolphins including blue whales, sperm whales, Sowerby's beaked whales, and aggregations of prey of whale species. A resident population of endangered northern bottlenose whales is found in the deep canyon area. These whales are among the world's deepest divers and make regular trips to the canyon depths for food (DFO 2008a).
Northern Bottlenose Whale Critical Habitat (Sanctuaries): The Gully, Shortland Canyon, Haldimand Canyon	
Location and Proximity to Project Area	• Approximately 71km, 139 km and 171 km respectively from the Project Area on the Eastern Scotian Slope.
Designation and Administration	• In 1994, DFO designated a Whale Sanctuary in the Gully for the northern bottlenose whales. Using an annual Notice to Mariners, vessel operators are asked to avoid the Gully or transit it cautiously. • The Recovery Strategy for northern bottlenose whale identifies the entirety of Zone 1 of the Gully Marine Protected Area and areas with water depths of more than 500 m in Haldimand Canyon and Shortland Canyon as Critical Habitat under SARA for the Scotian Shelf population. Since northern bottlenose whales use the full depth range in these areas, breathing and socializing at the surface and diving to feed at or near the bottom, critical habitat for this species should be considered to include the entire water column and the seafloor (DFO 2011c). • Pursuant to section 58(5) of SARA, Critical Habitat for the northern bottlenose whale was identified in the Final Recovery Strategy for this species, and posted on the SARA Public Registry in May 2010. Note the portion of the northern bottlenose whale critical habitat located in the Gully MPA Zone 1 was described in the Canada Gazette 1 on August 14, 2010. The prohibition in section 58(1) of SARA came into force within the Gully MPA Zone 1 area on November 11, 2010 (DFO 2010b). Critical habitat is protected under SARA through provisions set out in section 32 of the Act.

Table 5.2.20 Special Areas in the RAA

Ecological Significance	• Northern bottlenose whales are sighted consistently, throughout the year, at the entrance of the Gully (COSEWIC 2002a). • The Scotian Shelf population of northern bottlenose whales live at the southern extreme of the species' range and appear to be largely or totally distinct from the populations further north, seem to be non-migratory, and spend an average of 57% of their time in a small core area at the entrance of the Gully, which has seafloor relief that is unique in the western North Atlantic. These characteristics make the population particularly sensitive to human activities (COSEWIC 2002a). Recent acoustic monitoring studies indicate that northern bottlenose whales feed year-round in the Gully, Shortland, and Haldimand Canyons, as well as in between these canyons (Moors 2012). • Various studies have shown the distribution of various cetacean species that use the Gully is not uniform throughout the canyon. Minke whales were observed only in shallow waters at the head of the canyon, sperm whales and Atlantic white-sided dolphins occurred throughout the canyon, and northern bottlenose whales known to prefer the deepest waters at the canyon mouth. These differences in habitat preferences are believed to be driven by the influence of oceanographic processes within the canyon on distribution of prey for these cetacean species (Moors-Murphy 2014). • Northern bottlenose whale habitat is characterized by waters of more than 500 m in bottom depth, particularly around steep-sided features (*e.g.,* underwater canyons and continental slope edge), and access to sufficient accumulations of prey (*Gonatus* squid) (DFO 2011c). • Distribution of this species extends west of the Gully and it is believed that other canyons along the Scotian Slope (*e.g.*, Logan Canyon) may also provide important habitat for this species (DFO 2011c).
Sambro Bank and Emerald Basin *Vazella* Closure Areas	
Location	• Sambro Bank *Vazella* Closure area is 62 km^2 on Sambro Bank, between LaHave Basin and Emerald Basin on the Scotian Shelf. • Emerald Basin *Vazella* Closure area is 197 km^2 in Emerald Basin on the Scotian Shelf. • Approximately 130 km (Sambro Bank) and 126 km (Emerald Basin) from the Project Area.
Designation and Administration	• In 2013, in accordance with DFO's *Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas* (DFO 2009d), DFO closed two areas on the Scotian Shelf known to contain the highest density of *Vazella pourtalesi* to bottom-contact fishing. • DFO's Sensitive Benthic Areas Policy is guided by the legal and policy framework designed to manage Canada's fisheries and ocean resources including the *Fisheries Act*, the *Oceans Act* and SARA as well as Canada's commitments under several international agreements including Canada's commitment under the United Nations Resolution 61/105 to protect vulnerable marine ecosystems in domestic waters (DFO 2009d).

Table 5.2.20 Special Areas in the RAA

Ecological Significance	• The glass sponge *Vazella pourtalesi* is known to exist in only three locations worldwide – the Gulf of Mexico, the Azores, and in Canada. • The locations on the Scotian Shelf are the only instances where large aggregations have been found and thus are regarded as being globally-unique aggregations; the Gulf of Mexico and the Azores populations exist as individuals or in small aggregations (DFO 2013d). • Slow growth rates, longevity, variable recruitment, and habitat-limiting factors make the sponges particularly vulnerable to physical impacts and limit recovery (DFO 2013d).
***Lophelia* Conservation Area (LCA)**	
Location and Proximity to Project Area	• The *Lophelia* Conservation Area (LCA) is 15 km^2 area located at the mouth of the Laurentian Channel on southeast Banquereau Bank, about 260 km southeast of Louisbourg. • Approximately 248 km from the Project Area.
Designation and Administration	• Created in 2004 to include the reef area and a one-nautical mile buffer closed to all bottom fisheries, based on consultation with active fisheries representatives (Cogswell *et al.* 2009). • The larger area surrounding the conservation area is regionally known to fishermen as the Stone Fence. • The *Lophelia* Conservation Area is closed to fishing under the *Fisheries Act*.
Ecological Significance	• Nine coral species, including the reef-building *Lophelia pertusa*, have been identified from the area (Cogswell *et al*. 2009). • The LCA contains the only known living *Lophelia pertusa* reef in Atlantic Canada (DFO 2011a). • Evidence of coral rubble, overturned rocks, and lost fishing gear indicate areas have been impacted by bottom fishing (Cogswell *et al*. 2009). • Predicted to contain high marine mammal diversity in entrances of channels, particularly dolphins and deep diving whales (Doherty and Horsman 2007).
Roseway Basin North Atlantic Right Whale Area to be Avoided/Critical Habitat (SARA)	
Location and Proximity to Project Area	• Approximately 3318 km^2 located in Roseway Basin between Baccaro and Browns Banks. • Approximately 264 km from the Project Area.

Table 5.2.20 Special Areas in the RAA

Designation and Administration	• In 1993, Roseway Basin was designated as a conservation area for right whales (Brown *et al.* 2009). • In 2007 Transport Canada submitted a proposal to the International Maritime Organization (IMO) for the designation of a recommend seasonal Area to be Avoided (ATBA) by ships 300 gross tonnage and upwards in transit during the period of 1 June through 31 December in order to significantly reduce the risk of ship strikes of the highly endangered North Atlantic right whale. This was adopted by IMO in 2007 and implemented in May 2008 (IMO 2007; Brown *et al.* 2009). • The North Atlantic right whale is listed as an endangered species on Schedule 1 of SARA. The Recovery Strategy for the North Atlantic right whale (*Eubalaena glacialis*) in Atlantic Canadian Waters (Brown *et al.* 2009) adopts the designated ATBA as provisional boundaries for a critical habitat designation under SARA.
Ecological Significance	• Right whales have shown an affinity for edges of banks and basins, upwellings and thermal fronts, and appear to be highly dependent on a narrow range of prey (*e.g.*, *Calanoid copepods*) (Brown *et al.* 2009). • Roseway Basin is an important area of right whale aggregation where right whales have been observed feeding and socializing in the summer and autumn months. Right whale abundance and stage C5 *Calanus finmarchicus* concentrations peak during this time (Brown *et al.* 2009). • Research is ongoing to evaluate prey distribution in Roseway Basin to refine critical habitat boundaries (Brown *et al.* 2009). • On average 17 whales (range 0–117) are sighted in the Roseway Basin habitat annually and these remain in the habitat for an average of 136.4 (±70.9) days in any given year (Vanderlaan *et al.* 2009).
Georges Bank Oil and Gas Moratorium Area	
Location and Proximity to Project Area	• Georges Bank is an offshore bank located on the outer continental shelf straddling the Canada-United States maritime boundary, with the northeast portion of the Bank in Canadian waters. • The moratorium area covers approximately 15 000 km^2 and includes the Canadian portion of Georges Bank and much of the Northeast Channel to the southwest edge of Browns Bank (DFO 2011a). • Approximately 300 km from the Project Area.
Designation and Administration	• In 1988, the Governments of Canada and Nova Scotia placed a moratorium on all petroleum activities on the Canadian portion of Georges Bank and adjacent areas. The moratorium was extended until 2012 following an independent panel review in 1999. • Schedule IV of the Accord Acts delineates the Canadian portion of the moratorium area. • In early 2010, the moratorium was extended by both governments to 2015 and in December 2010, the Province of Nova Scotia passed the *Offshore Licensing Policy Act* which prohibits the exploration or drilling for or the production, conservation, processing or transportation of petroleum on George Bank indefinitely. A

Table 5.2.20 Special Areas in the RAA

	public review, no earlier than December 31, 2022, may be ordered at the discretion of the Minister of Energy to re-examine the moratorium. There is currently no mirror legislation for the federal government. • Exploration rights issued to leaseholders on the Canadian portion prior to the moratorium are suspended while the moratorium remains in effect. • The Government of the United States established a moratorium on the United States portion of Georges Bank in 1990; this moratorium has been extended to 2017.
Ecological Significance	• Georges Bank is recognized internationally as a unique ecosystem that exhibits high levels of biological productivity and biodiversity. • Georges Bank is at the northern edge of southern assemblages of plankton and fish and at the southern edge of northern assemblages, therefore biodiversity is very high in this area (of both subpolar and subtropical assemblages); with the Northeast Peak being the most productive part of Georges Bank (NRCan and NSPD 1999). • Georges Bank supports a highly productive, diverse, and economically valuable fishing industry with landings of scallops, lobster, groundfish and large and small pelagics. Fish productivity has been reported to be two to two and half times that in other comparable areas such as the Gulf of Maine or the Scotian Shelf (NRCan and NSPD 1999). • The high and persistent productivity of phytoplankton and fish and the co-occurrence of spawning and nursery areas on the Northeast Peak are biological features that contribute to Georges Bank uniqueness and ecological significance (NRCan and NSPD 1999). • Strong and persistent tidal currents (dominant physical factor on the Bank) result in high mixing rates, nutrient supply and overall dispersion (Boudreau *et al.* 1999). • Georges Bank serves as a feeding ground, nursery, and migration corridor for more than two dozen whale (including SARA-listed species) and four seal species (NRCan and NSPD 1999). • Georges Bank serves as an important feeding area for birds owing to high mixing rates and nutrient supply.
Northeast Channel Coral Conservation Area	
Location and Proximity to Project Area	• Approximately 424 km^2 in the Northeast Channel, east of Georges Bank. • Approximately 306 km from the Project Area.
Designation and Administration	• In June 2002 DFO established a Coral Conservation Area in accordance with the *Fisheries Act* and the *Oceans Act* with the objective of protecting high densities of intact octocorals (*Paragoria arborea*, bubblegum coral and *Primnoa resedaeformis*, seacorn coral). This is one of three areas of significance for cold-water corals offshore Nova Scotia (the Gully and Lophelia Coral Conservation Area in Laurentian Channel being the other two) (DFO 2006).

Table 5.2.20 Special Areas in the RAA

	• The Northeast Channel Coral Conservation Area is divided into two zones: 1. Restricted bottom fisheries zone - ~ 90% of the area is closed to all bottom fishing gear used for groundfish or invertebrate fisheries (*e.g.*, longline, otter trawl, gillnet, trap). The highest density of corals, as observed in scientific surveys, is found in this zone. 2. Limited bottom fisheries zone - about 10% of the area is open to authorized fishing activities. At the present time, the area is open only to longline gear for groundfish (with an At-sea Observer) and is closed to all other bottom fishing gear. • In 2006 DFO developed a coral conservation plan (DFO 2006) for the Maritimes Region which provides an objective and strategy to protecting and understanding important benthic habitats.
Ecological Significance	• The conservation area was primarily selected on basis of having the highest density of large branching octocorals (gorgonian), *Paragorgia arborea* and *Primnoa resdaeformis* in the Maritimes and visual evidence indicated vulnerability to bottom fishing damage (Cogswell *et al.* 2009). • The conservation area contains 12 taxa of coral (amalgamating the genus *Primnoa* and *Paragorgia*), including gorgonian corals, sea pens, and stony corals and is optimally positioned to protect the highest density and least impacted branching gorgonians in the area (Cogswell *et al.* 2009). • Corals provide various ecosystem functions and coral biomass has been shown to be closely correlated to fish biodiversity (Campbell and Simms 2009).
Scotian Slope EBSA	
Location and Proximity to Project Area	• The Scotian Slope EBSA (approximately 68 603 km^2) is located on the Scotian Slope from Georges Bank to the Laurentian Channel and runs through the Project Area.
Designation and Administration	• EBSAs have been identified based on a compilation of scientific expert opinion and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf. • Using the criteria of uniqueness, aggregation, fitness consequences, naturalness, and resilience, DFO experts identified EBSAs for consideration in a MPA network analysis exercise to address conservation objectives in accordance with the *Oceans Act*.

Table 5.2.20 Special Areas in the RAA

Ecological Significance	• Includes areas of unique geology (iceberg, furrows, pits, complex/irregular bottom). • High finfish diversity due to habitat heterogeneity provided by depth. • Primary residence for mesopelagic fishes. • Inhabited by corals, whales, sharks, tuna, swordfish. • Migratory route and foraging area for endangered leatherback turtles – the area supports concentrations of scalps which are a source of food for turtles. • High diversity of squid. • Overwintering area for number of shellfish species. • Halibut overwintering, lobster overwintering. • Seabird feeding/overwintering area. • Greenland sharks.
Emerald Bank, Western Bank and Sable Bank Complex EBSA	
Location and Proximity to Project Area	• The Emerald bank, Western Bank and Sable Bank Complex (approximately 17,900 km^2) is located on the Scotian Slope and Shelf north of the Project Area.
Designation and Administration	• EBSAs have been identified based on a compilation of scientific expert opinion and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf. • Using the criteria of uniqueness, aggregation, fitness consequences, naturalness, and resilience, DFO experts identified EBSAs for consideration in a MPA network analysis exercise to address conservation objectives in accordance with the *Oceans Act*.
Ecological Significance	• Area of highest larval fish diversity potential as a result of a gyre. • Area of concentration of spawning fish (*e.g.*, gadoids). • Juvenile nursery area for haddock, cod, monkfish, yellowtail, skate, flounder. • Recruitment source for downstream Browns Bank. Includes the defined 4W Haddock Box Nursery Area which has been closed to groundfish otter trawl since 1987 and to all groundfish fishing since 1993. Important overwintering area in the slope waters (Doherty and Horsman 2007).

Table 5.2.20 Special Areas in the RAA

Select Fisheries Closure Areas for Fisheries Conservation	
Haddock Nursery Closure, Emerald/Western Bank (Haddock Box)	• The Haddock Box is an important nursery area for the protection of juvenile haddock, and is closed year-round by DFO, pursuant to the *Fisheries Act*, to the commercial groundfish fishery. Scallop fishing continues to occur on the easternmost part of the closed area (O'Boyle 2011) • Established to protect juvenile haddock in NAFO Division 4VW (no considerations for biodiversity or habitat protection) (O'Boyle 2011). • Adult haddock aggregate to spawn within the Haddock Box, including Emerald Bank, from March to June, with peak spawning in March/April (BEPCo. 2004). • Closed area may be playing role in increasing haddock stock and abundance of other non-target species (*e.g.*, winter flounder, plaice, silver hake) (O'Boyle 2011). • Approximately 153 ha are within the Project Area, representing about 0.01% of the total area of the Haddock Box.
Redfish Nursery Closure Area (Bowtie)	• Located on Browns Bank, extending into Roseway Basin, this special management area (known informally as the "Bowtie") is closed January to June to fishing using small mesh gear (mesh <130 mm) to protect small redfish (DFO 2005a; LGL 2013). • Approximately 221km from the Project Area.
Lobster Fishing Area 40 (Georges Bank)	• A closure of LFA 40 area on Browns Bank to all lobster fishing has been in place since 1979 as a measure to protect lobster broodstock. • It has been surmised that the LFA 40 closure may also be beneficial to the protection of North Atlantic right whales and leatherback sea turtles given the proximity of the Roseway Basin (critical habitat for North Atlantic right whales) and decreased risk of entanglement in fishing gear (O'Boyle 2011). • Approximately284 km from the Project Area.
Hell Hole (Northeast Channel)	• The Hell Hole is an important area for bluefin tuna. Longline fisheries are not permitted to fish within the Hell Hole from July to November to reduce bluefin tuna bycatch (DFO 2005a). • Approximately 336 km from the Project Area.

Modified from Stantec 2014a and 2014b

5.3 SOCIO-ECONOMIC ENVIRONMENT

5.3.1 Land and Nearshore Ocean Use

PSVs will travel between the MODU and an onshore supply base located at Woodside Atlantic Wharf, on the Dartmouth side of Halifax Harbour. The supply base is not included in the approved scope of the Project to be assessed. Halifax Harbour is a major inlet of the North Atlantic Ocean. It extends inland for over 22 km to the northwest with a variable width ranging from approximately 385 m in The Narrows to approximately 4,225 m in the Bedford Basin and reaches depths of up to 70 m in the Bedford Basin and between 20 to 30 m in depth in other areas (Stantec 2014a).

The Port of Halifax accommodates cargo vessels and cruise ships on a year-round basis as well as bulk handling facilities, a high volume roll-on/roll-off terminal, oil wharves, rail facilities, and ferry terminals. Halifax Harbour is therefore subject to high levels of marine-related industrial activity (*e.g.*, ship loading and unloading, container handling, storage and laydown, rail and truck traffic, ship repair and rebuilding, servicing offshore oil rigs, and vessel layup), including associated noise, light, and other sensory disturbance. The Woodside supply base location has no natural intertidal zone, as the existing shoreline was previously infilled to accommodate present operations. Given this previous disturbance, the potential for previously undisturbed heritage, historic, or archaeological resources to be present on-site is therefore assumed to be low.

5.3.1.1 Communities in Nova Scotia

Halifax Harbour is surrounded by the Halifax Regional Municipality in Halifax County and is bordered by the urban communities of Halifax to the west, Bedford to the north, and Dartmouth to the east. Most of the other coastal communities in Nova Scotia are rural. Statistics Canada distinguishes between urban and rural settings as "population centres" (*i.e.*, areas with population of at least 1,000 and no fewer than 400 persons per square kilometre) and "rural areas" (*i.e.*, all territory lying outside of population centres) (Statistics Canada 2015a). Based on the most recent available Canadian census data, 57% of Nova Scotia's population resides in one of the province's 37 population centres, and 43% reside in the remaining territory of rural areas (Statistics Canada 2011). Nova Scotia's largest population centre is Halifax (population of 297,943), followed by Sydney (population of 31,597). The distribution of population among Nova Scotian communities is shown on Figure 5.3.1.

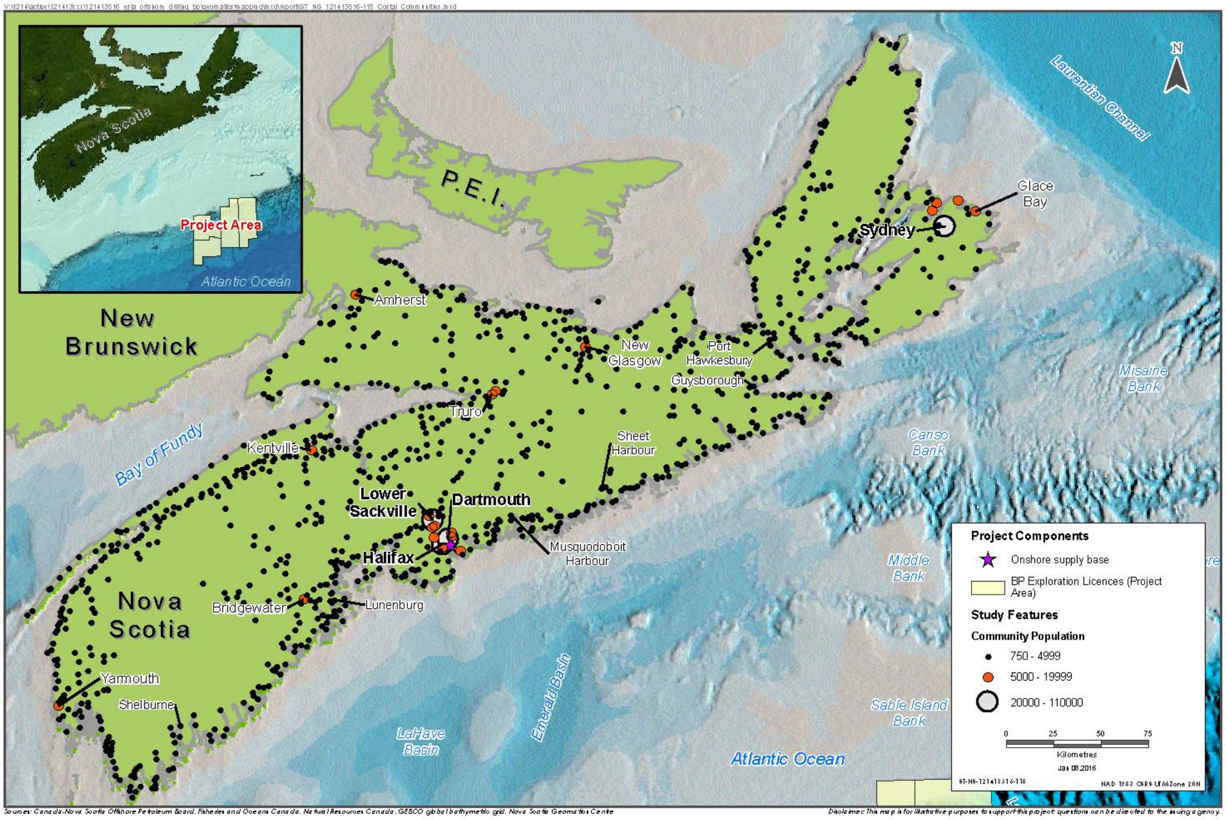


Figure 5.3.1 Communities in Nova Scotia

At its shortest distance, the Project Area is located approximately 230 to 370 km southeast of Halifax and 48 km from Sable Island National Park Reserve. Sable Island is the nearest permanent, seasonal or temporary residence to the Project Area except for workers inhabiting offshore platforms at the Sable Offshore Energy Project and the Deep Panuke developments.

5.3.1.2 Nearshore Fisheries

At least 69 species of fish have been recorded in the nearshore marine habitat of Nova Scotia within the 40 m depth of water (Stantec 2014a), many of which would be considered species of CRA fisheries. Halifax Harbour is located within NAFO Fishery Unit Area 4Wk and commercial fisheries include a small commercial finfish fishery seaward of McNabs Island consisting of groundfish (cod, haddock, pollock and halibut) and pelagic (herring and mackerel) species. Other areas throughout the harbour, particularly the Bedford Basin, support a bait fishery (pollock, herring, mackerel and smelt) for both commercial and recreational bait (Rozee 2000), typically fished using gillnets and hand-lines. Commercial and recreational fisheries for clams and mussels are closed due to fecal coliform levels in the Harbour. Some recreational groundfishing occurs just outside of the Harbour, but this type of fishing is not common within the Harbour itself.

Lobster is the primary commercial species harvested within Halifax Harbour with a total of 15 to 20 lobster fishers using the Harbour (Stantec 2014a). The Harbour is included within the boundaries of Lobster Fishing Area (LFA) 33, which extends from Cow Bay, Halifax County to Port La Tour, Shelburne County; however, the area around McNabs Island supports the majority of lobster fishing activity. Light lobster fishing also occurs in the Bedford Basin, with most traps placed intermittently along the shoreline, one or two traps located around Georges Island and in Tufts Cove. The majority of fishers in the Halifax area fish with 250 traps. Fishers licensed to fish in LFA 33 are not restricted to stay within a particular zone, therefore, certain users fish in the Harbour as one of several fishing grounds that they frequent (Stantec 2010).

LFA 34, which extends from the southwest boundary of LFA 33 (Port La Tour, Shelburne County) off southwestern Nova Scotia and into the Bay of Fundy, has the highest landings and most participants of any LFA in Canada (DFO 2013v). Both LFA 33 and LFA 34 share the same fishing season from the end of November to May 31; however, most lobsters are caught during the first three weeks of the season.

Inshore recreational fisheries include American eel, mackerel, herring, and scallop. There are several finfish (*e.g.,* salmon, cod, trout) and shellfish (*e.g.,* oyster, mussel, scallop, sea urchin, clam) aquaculture operations in the harbours and bays along the Nova Scotia coastline in the RAA (NSDFA 2013).

Information on offshore fisheries is provided in Section 5.3.5.

Nova Scotia's fishing industry (harvesting and processing) is a major source of direct and indirect employment, provincial income, and is a leading source of export earnings. Fisheries and aquaculture are of particular socio-economic importance to several rural coastal communities in the province, where the health of the industry can noticeably influence population growth, housing markets, and local business activity (CBCL Limited 2009, Government of Nova Scotia 2014). Labour and economy in Nova Scotia is discussed more generally in Section 5.3.2.

5.3.2 Labour and Economy

Nova Scotia has a labour force participation rate of 62%, an employment rate of 56.6%, and an unemployment rate of 8.6% (Statistics Canada 2015b). The majority (81%) of employed Nova Scotians work in the service producing sector, particularly in the health care and trade industries (Table 5.3.1). The labour market in the province has seen modest increases in wages and salaries, with average weekly wage (+1.9%) and compensation of employees (+2.0%) increasing at below historical rates in 2015 (Government of Nova Scotia 2015).

Table 5.3.1 Distribution of Employed People in Nova Scotia, by Industry (2015)

Industry	# of Employed People (thousands)
All Industries	**448.1**
Goods Producing Sector	**83.1**
Agriculture	5.4
Forestry, fishing, mining, quarrying, oil and gas	11.8
Utilities	3.7
Construction	33.6
Manufacturing	28.7
Service Producing Sector	**365.1**
Trade	71.8
Transportation and warehousing	20.5
Finance, insurance, real estate and leasing	23.4
Professional, scientific and technical services	27.8
Business, building and other support services	20.3
Educational services	36.4
Health care and social assistance	72.4
Information, culture and recreation	17.5
Accommodation and food services	30.9
Other services	17.1
Public administration	27.0

Source: Statistics Canada 2015b

Nova Scotia's economy declined 0.9% in 2012, remained stationary in 2013, and grew 0.6% in 2014. Nova Scotia is forecasting economic growth of 1.0% in 2015 and 0.8% in 2016 (Government of Nova Scotia 2015). Table 5.3.2 shows the relative contribution of different industries to Nova Scotia's gross domestic product (GDP).

Table 5.3.2 Annual Percentage Share of Nova Scotia's GDP, by Industry (2010-2014)

Industry	2010	2011	2012	2013	2014
By Category					
All industries	100.00	100.00	100.00	100.00	100.00
Goods-producing industries	21.24	20.50	19.80	19.92	20.08
Service-producing industries	78.76	79.50	80.20	80.08	79.92
By Industry					
Industrial production	13.01	12.16	11.20	11.65	12.05
Information and communication technology sector	4.00	3.91	4.07	4.02	4.15
Energy sector	4.34	4.01	3.42	3.77	4.04
Agriculture, forestry, fishing and hunting	2.24	2.36	2.52	2.60	2.90

Table 5.3.2 Annual Percentage Share of Nova Scotia's GDP, by Industry (2010-2014)

Industry	2010	2011	2012	2013	2014
Mining, quarrying, and oil and gas extraction	2.37	1.98	1.31	1.52	2.28
Utilities	1.81	1.97	2.11	2.22	2.19
Construction	6.24	6.24	6.33	5.94	5.40
Manufacturing	8.58	7.94	7.53	7.65	7.31
Wholesale trade	3.76	3.76	3.19	3.33	3.41
Retail trade	6.73	6.31	6.35	6.60	6.65
Transportation and warehousing	3.23	3.41	3.38	3.29	3.28
Information and cultural industries	3.32	3.37	3.57	3.49	3.50
Finance and insurance	5.60	5.71	5.61	5.75	6.02
Real estate and rental and leasing	15.03	15.15	15.82	15.93	16.02
Professional, scientific and technical services	3.84	3.86	3.95	3.96	3.98
Management of companies and enterprises	0.40	0.39	0.39	0.40	0.43
Administrative and support, waste management and remediation services	2.23	2.27	2.27	2.16	2.16
Educational services	6.93	6.97	6.96	6.63	6.43
Health care and social assistance	9.94	10.11	10.36	10.30	10.35
Arts, entertainment and recreation	0.55	0.55	0.57	0.63	0.62
Accommodation and food services	2.38	2.39	2.45	2.41	2.45
Other services (except public administration)	2.02	2.08	2.10	2.12	2.08
Public administration	12.78	13.18	13.23	13.07	12.54

Source: Statistics Canada 2015b

5.3.3 Human Health

Levels of ambient air pollution are monitored across Nova Scotia, and provincial standards and objectives are in place for O_3, PM, CO, NO_2, SO_2, volatile organic compounds (VOCs), and acid precipitation. These standards and objectives were developed to be protective of human health. Based on the results for the period of 2000 to 2007, NSE concluded that "air quality in Nova Scotia is generally good. Although some pollutants have elevated levels at times, pollutant levels usually meet [provincial] standards and objectives" (NSE n.d.).

Offshore air quality is discussed in Section 5.1.2.2. The location of the Project Area is far from any human receptors that would be sensitive to atmospheric air or noise emissions.

DFO's mandate includes the protection of human health through responsible management of fishery resources and administration of the Management of Contaminated Fisheries Regulations under the *Fisheries Act*, which authorize DFO to close recreational and commercial fishing areas when the presence of biotoxins, bacteria, chemical compounds or other substances in fish habitat may pose a risk to public health (DFO 2014a) (*e.g.*, through exposure to contaminated food sources from harvested fish). Various orders prohibiting fishing for contaminated fish have been issued by DFO for nearshore waters around Nova Scotia. Most recently, on April 10, 2014, DFO issued the Contaminated Fisheries Prohibition Order MAR-STN-2014-004, which closes portions of Ketch Harbour, Sandy Cove and Sambro Harbour, Halifax County, Nova Scotia, to fishing for all species of clams, all mussels, all whelks, all oysters and Bay scallops from May 1 to September 30 each year. Ten Orders were issued in 2013 (for several areas in Guysborough County, Victoria County, and Halifax County) and 12 were issued in 2012 (for several areas in Digby County, Yarmouth County and Inverness County (DFO 2015p).

In 2009, the Nova Scotia Health Research Foundation (NSHRF) commissioned review of demographic and epidemiological data, as well as reports on the status of Nova Scotia's health system, to inform their research priorities. The NSHRF study identified the following six major health issues for Nova Scotia: reducing health disparities; integrated approaches to chronic disease and injury prevention; chronic disease management; re-orienting the health system to emphasize primary health care; implementing sustainable continuing care models; and implementing best practices in recruitment, retention, role sharing and change among health human resources. The study did not include special consideration for major health-related issues affecting Aboriginal peoples in Nova Scotia; however, such issues have been identified elsewhere.

In 2008, the Health Working Committee (HWC) of the Mi'kmaq-Nova Scotia-Canada Tripartite Forum (a partnership between the Nova Scotia Mi'kmaq, the Province of Nova Scotia, and the Government of Canada) conducted community engagement sessions and surveys to identify health priorities, needs and challenges of Mi'kmaq people. Based on this study, the HWC identified the following as the top Mi'kmaq community health priority issues in Nova Scotia: mental health, addictions/substance abuse, non-insured health benefits coverage, elder care, obesity-related issues and funding (HCDA 2008).

The Atlantic Health Partnership (AHP, formerly the Mi'kmaq Maliseet Atlantic Health Board) is comprised of seven Chiefs, appointed by the various Atlantic Tribal Councils, and the Regional Executive Head of Health Canada's First Nations Inuit Health Branch (FNIHB). The AHP has three committees (Public Health and Primary Care, Mental Wellness and Non-Insured Health Benefits) and meets at least three times a year to provide input regarding programs and services delivered by FNIHB for the Atlantic region. Priorities identified by AHP include mental health and addictions, care of Elders, and partnership with Regional and District Health Authorities (HCDA 2008; APC 2014).

5.3.4 Ocean Use and Infrastructure

The following ocean uses and infrastructure, not including fishing, occurs on the Scotian Shelf and Slope in the vicinity of the Project Area:

- oil and gas exploration and production;
- military operations;

- marine traffic;
- tourism and recreational activities;
- marine research; and
- seabed hazards associated with human activities.

These uses are described in the following sections.

5.3.4.1 Oil and Gas Exploration and Production

Development of the offshore petroleum industry can be broadly assigned to three major categories: exploration; production; and decommissioning. There is no current offshore oil and gas activity in the Project Area. Although there have been other wells drilled in the Project Area (Shubenacadie H-100 drilled in 1982, Evangeline H-98 drilled in 1984, Newburn H-23 drilled in 2002 and Weymouth A-45 drilled in 2003), these wells have been plugged and abandoned. Figure 5.3.2 presents the locations of existing and proposed offshore oil and gas activities and infrastructure off the coast of Nova Scotia, as well as areas associated with ELs, significant discovery licences (SDLs), and production licences.

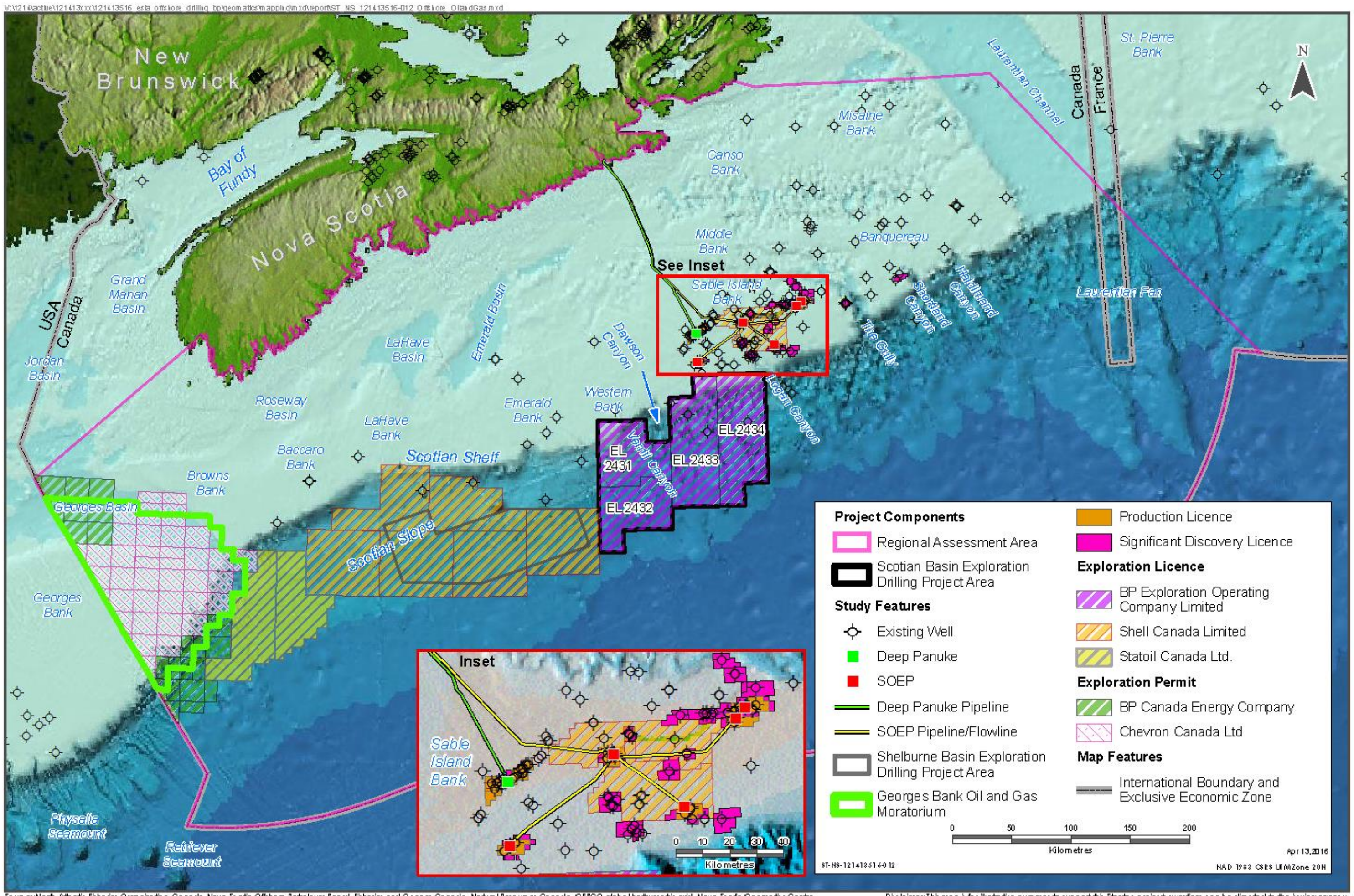


Figure 5.3.2 Offshore Nova Scotia Petroleum Activities and Infrastructure

The Shelburne Basin Venture Exploration Drilling Project is located immediately west of the Project Area. Shell initiated exploration drilling in October 2015. In November 2015 Statoil Canada Ltd. (Statoil) acquired exploration rights to two licence areas immediately adjacent to Shell's ELs on the Scotian Slope. Plans for exploration activities by Statoil were not available at the time of EIS preparation. The Sable Offshore Energy Project (SOEP), which comprises a central processing platform, four satellite platforms, subsea wells and flowlines, and a subsea pipeline to shore, is located approximately 11 km northeast from the Project Area. SOEP is operated by ExxonMobil Canada Limited (ExxonMobil) and partners and has been producing natural gas since 1999. There is the now-decommissioned Cohasset-Panuke Project, which was operated by Pan-Canadian (now Encana) and LASMO Nova Scotia Limited from 1992 to1999, and the Deep Panuke Offshore Gas Development Project (Deep Panuke) operated by Encana Corporation (Encana) that commenced natural gas production in 2013 which is located approximately 35 km from the Project Area.

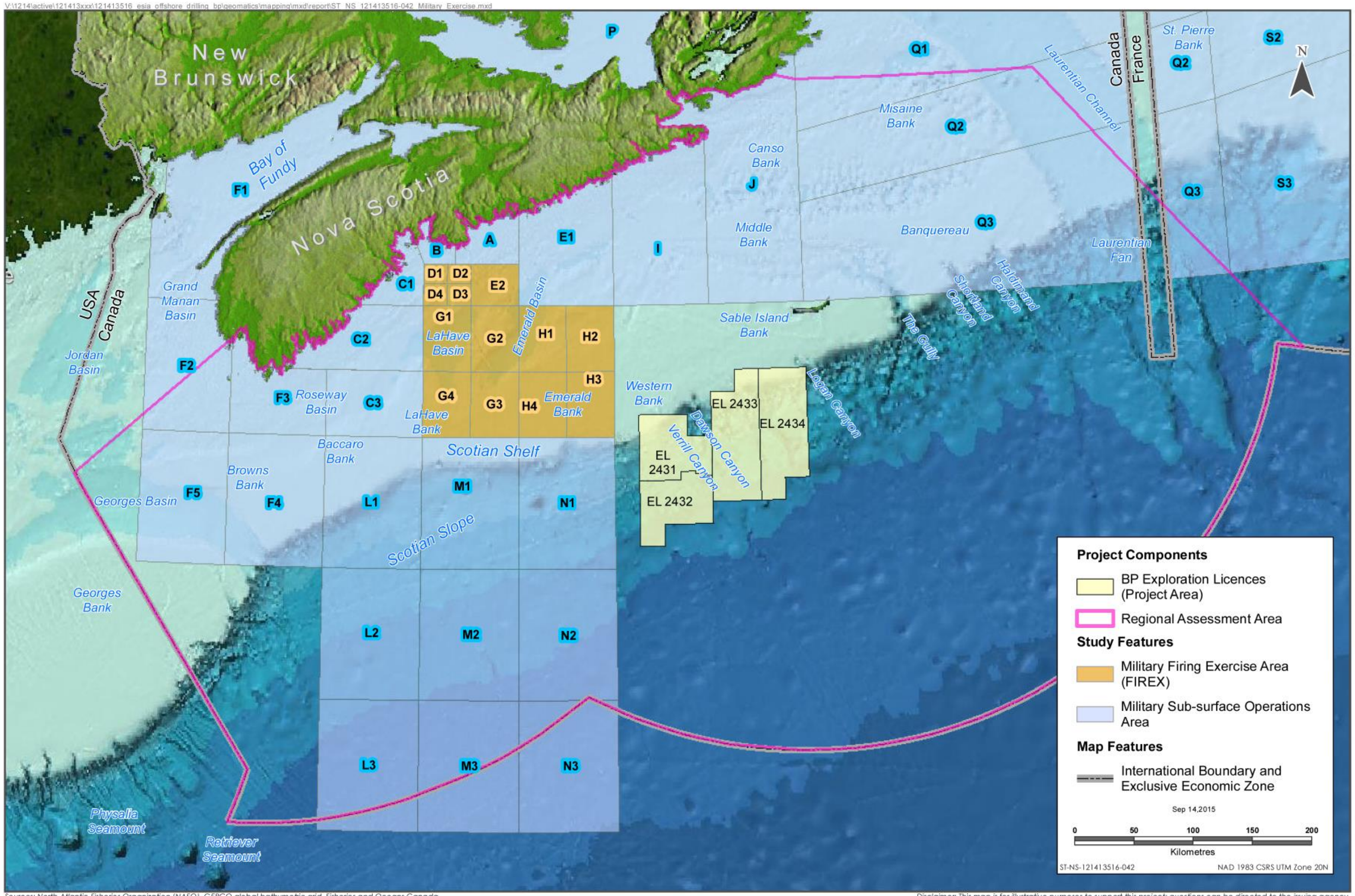
Related infrastructure on the Scotian Shelf includes two existing subsea natural gas pipelines for SOEP and Deep Panuke. The Maritimes & Northeast Pipeline (M&NP) – owned by Spectra Energy (77.53%), Emera Inc. (12.92%), and ExxonMobil (9.55%) (NSDOE 2009b) – connects the Sable gas field to Goldboro, Nova Scotia, where it ties in to an underground pipeline that transports the gas to markets in Nova Scotia, New Brunswick, and the United States (M&NP 2009). Natural gas from Deep Panuke is processed offshore and similarly transported via subsea pipeline to Goldboro, Nova Scotia where it joins with M&NP for further transport to market (Encana 2013).

5.3.4.2 Military Operations

The Department of National Defence and the Canadian Armed Forces (DND) conducts training and other activities off the coast of Nova Scotia, including sovereignty patrols, maritime surveillance, naval training and combat readiness, search and rescue, humanitarian relief and aid to civil authorities, and operational support to other government departments. Maritime Forces Atlantic (MARLANT) represents Canada's east coast naval presence and engages in various operations and training activities offshore Nova Scotia. MARLANT, which is headquartered in Halifax, Nova Scotia, uses a range of platforms, including patrol frigates, coastal defence vessels, destroyers, submarines, ship-borne helicopters and long-range patrol aircraft to carry out its missions.

Munitions are known to have been lost, discarded, or disposed offshore in association with past and present military activities within the RAA. The locations of these potential seabed hazards are discussed in Section 5.3.4.6.

DND also conducts naval training activities in designated nearshore and offshore exercise areas, shown on Figure 5.3.3. Maps, coordinates and descriptions of military activities permitted in these exercise areas are provided in the Canadian Coast Guard's Annual Notice to Mariners. The most common military activity in the region is training involving aircraft, surface vessels, and submarines. Live fire training is not usually conducted (DFO 2005a). As illustrated on Figure 5.3.3, the Project Area does not fall within DND exercise areas.



Sources: North Atlantic Fisheries Organization (NAFO), GEBCO global bathymetric grid, Fisheries and Oceans Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.3 Department of National Defence Operations Areas

5.3.4.3 Marine Traffic

Several established routes are commonly used for international and domestic commercial shipping in Canadian waters with four distinct regional traffic patterns off the coast of Nova Scotia including (Stantec 2014b):

- international shipping over the Scotian Shelf as part of the "great circle route" (*i.e.*, shortest distance over the earth's surface) between Europe and the eastern seaboard of the United States and Canada;
- international and domestic shipping along the coast of Nova Scotia to and from the United States, Bay of Fundy, Gulf of St. Lawrence, and Newfoundland;
- shipping through the Cabot Strait, a major sea route linking trans-Atlantic shipping lanes to the St. Lawrence Seaway and the Great Lakes; and
- traffic associated with the major ports of Halifax, Saint John, Port Hawkesbury (Strait of Canso) and Sydney; smaller ports along Nova Scotia's coastline include Liverpool, Lunenburg, Shelburne and Sheet Harbour.

There is no designated shipping corridor through the Project Area with much of the shipping traffic along the Scotian Shelf, adjacent to the Project Area. The Scotian Slope, however, is host to a variety of ocean vessel traffic (refer to Figure 5.3.4). Outside of the main shipping corridors, it is left to the vessel captain's discretion to select a preferred routing (Hurley 2011).

Commercial shipping in the region is generally in the form of tankers and general, bulk and containerized cargo carriers as well as a range of cruise ships, government vessels, and fishing vessels (DFO 2005a). Fishing vessels account for over 70% of marine traffic volume southeast of Nova Scotia between Cape Breton and Yarmouth out to the EEZ (Stantec 2014b). Shipping traffic volumes offshore Nova Scotia is in the range of 44,263 vessels a year, with highest volumes between May and September when fishing vessels are most active (Pelot and Wootton 2004).

A designated ballast water exchange zone extending from the Scotian Slope to the EEZ provides ships the opportunity to exchange ballast waters mid-ocean to reduce the risk of introduction and transfer of non-indigenous (including invasive) aquatic species.

The Atlantic Pilotage Authority has designated Halifax Harbour as a compulsory pilotage area under the *Pilotage Act* including two designated anchoring areas (Anchorage Areas A and B) located in the approaches to Halifax Harbour.

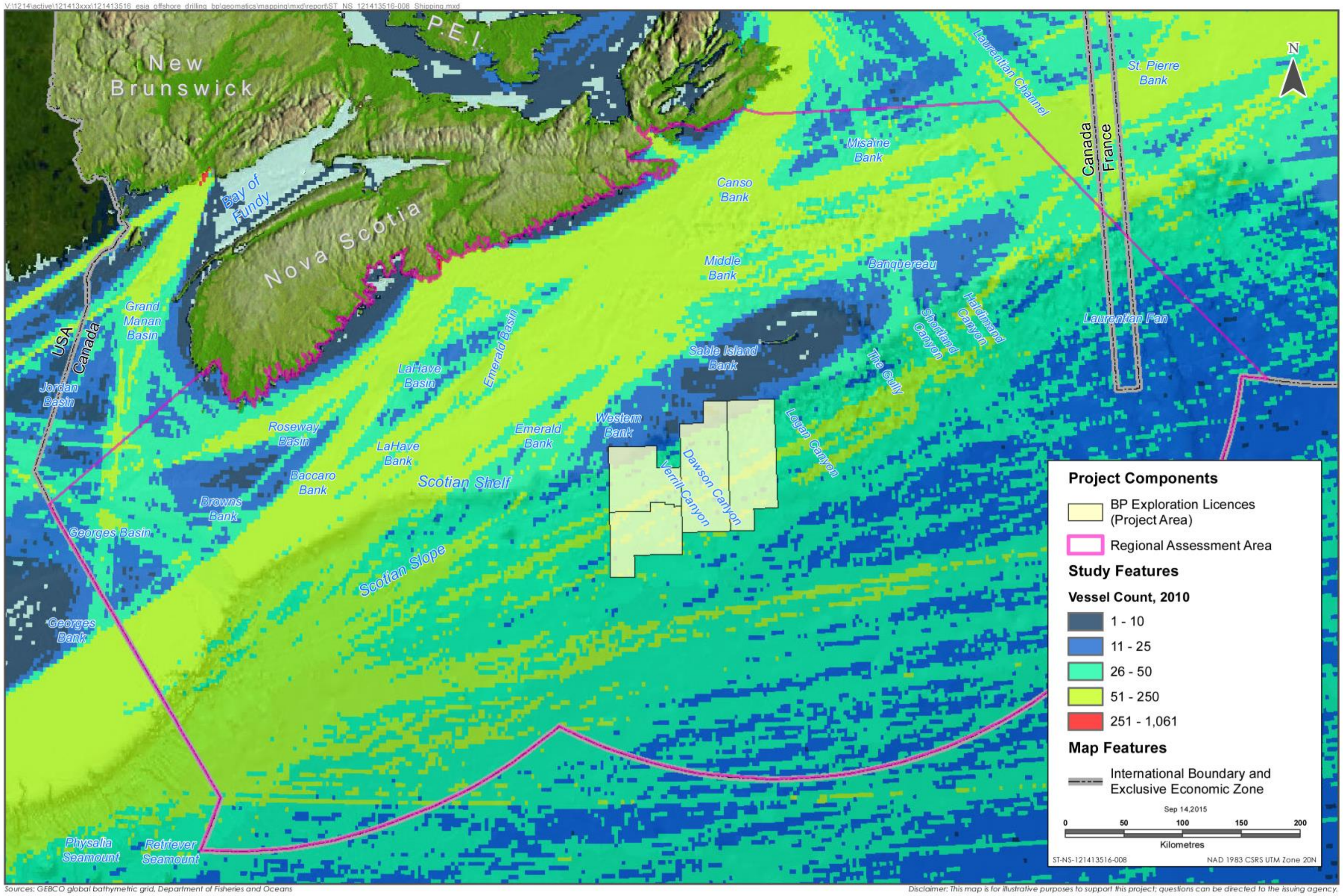


Figure 5.3.4 Shipping Traffic in 2010

5.3.4.4 Tourism and Recreational Activities

Recreational activities off the coast of Nova Scotia may include: swimming, sailing/yachting, kayaking, scuba diving, and other water sports; recreational fishing; whale and seabird watching; and the transiting of cruise ships.

In 2003, there were at least 174 marine tourism operators throughout Nova Scotia with the majority associated with whale and seabird watching tours. Sport-fishing and boat tours also represent a large proportion of marine tourism operators in Nova Scotia. In 2000, approximately 5% of all visitors to the province took part in a whale or seabird watching tour and 7% participated in a sport-fishing or sightseeing cruise (DFO 2005a).

Whale watching activities tend to be located in areas of whale congregation, particularly around the mouth of the Bay of Fundy and off northern Cape Breton. Most marine tourism activities occur in coastal rather than offshore areas with the vast majority of tourism activities off the coast of Nova Scotia occurring between May and October (DFO 2005a).

As indicated in the SEA for the Western Scotian Slope (Stantec 2014b), recreational fisheries in the vicinity of the Project Area are limited though may include fishing charters and tournaments for large pelagics (*e.g.*, sharks, tuna). According to DFO, there are no recreational licences that would fish in the offshore proximal to the Project Area. Recreational tuna and shark derby licence holders often hire commercial vessels for derby fishing; however, they typically fish inshore of Sable Island in eastern Nova Scotia and venture to the Hell Hole in southern Nova Scotia and do not typically venture offshore beyond the Shelf Break (DFO, pers. comm. 2014 in Stantec 2014a).

In the past, there has been limited tourism activity on Sable Island, although with the recent designation of Sable Island as a National Park Reserve, it is anticipated that there will be an increase in visitation by tourists. The majority of people travelling to Sable Island are generally involved in various aspects of operational work (*i.e.*, stations staff, maintenance contractors, inspectors), industry-related projects or scientific research and monitoring programs. Tourists have also been able to visit the island for general interest. Tourists include politicians and dignitaries, journalists, artists, students on educational cruises, and ordinary citizens with personal interest for the island (Freedman 2014). Although tourism is not restricted on the island, access is restricted and permission must be applied for and obtained from Parks Canada. There has been no formalized tourism on Sable Island; in the past two decades there have been about 50 to 100 people visiting Sable Island during an average year (Freedman 2014). Travel to the island is generally by private yacht or chartered small fixed-wing aircraft. Yachts generally visit Sable Island in July and August while August through October offers the most favourable conditions to travel by air. In 2014 there were two cruises by Adventure Canada in which Sable Island was the primary advertised destination, along with the nearby marine Gully (Freedman 2014).

5.3.4.5 Marine Research

Marine research activities include various scientific studies such as DFO's annual multi-species trawl surveys to monitor fish populations; ongoing data collection from Environment Canada weather buoys and moorings for the RAPID Climate Change Program; and the DFO Atlantic Zone Off-Shelf Monitoring Program to collect physical, chemical and biological oceanographic data. Figure 5.3.5 presents locations of known ongoing programs, but may not capture short-term research initiatives.

A number of buoys are moored on the Scotian Shelf and Slope for marine research and monitoring purposes (Figure 5.3.5), including those operated by the Gulf of Maine Ocean Observing System, the United States National Data Buoy Center, and Environment Canada.

The Scotian Shelf and Slope also contain research transects associated with the Atlantic Zone Monitoring Program (AZMP) study which is a comprehensive environmental monitoring program designed and implemented by DFO in 1999. The program was introduced to increase DFO's capacity to understand, describe, and forecast the ocean conditions and to relate these changes to the predator/prey relationships of marine resources. The Halifax Line of the AZMP runs through the western portion of the Project Area whereas the Browns Bank Line is to the west of the Project Area. There is also a fixed station (Halifax Station 2) on the Halifax Line located on the Scotian Shelf and outside the Project Area. AZMP transects and stations are sampled by DFO on a bi-weekly or monthly schedule during the ice-free season. Through the related Scotian Slope and Rise Monitoring Program, DFO collects and analyzes physical, chemical and biological observations at deepwater stations added to the offshore end of AZMP's Halifax Line (Stantec 2014b). These deepwater stations, referred to as the Extended Halifax Line and part of the AZOMP, are located over the continental rise and complement the AZMP stations over the continental slope and shelf (BIO 2013b). The locations of AZMP transects and moorings are shown on Figure 5.3.5 with some moorings located in the Project Area. The Ocean Tracking Network (based at Dalhousie University) and DFO jointly operate a fixed and semi-permanent series of almost 200 acoustic receivers along the ocean bottom along the Halifax Line.

Biological data for the Scotian Shelf and Slope is collected through various means. Scientists at DFO monitor fish populations of the Scotian Shelf, Bay of Fundy, and Gulf of Maine on an ongoing basis. Some of the most important sources of information on the state of marine fish populations are bottom trawl surveys, which are generally conducted in March and July within the Scotian Shelf and Slope area.

Scientists from DFO and Dalhousie University conduct cetacean studies in the region, with a particular focus on the Scotian Shelf population of northern bottlenose whales and trends in cetacean abundance in the Gully and neighbouring submarine canyons. The Continuous Plankton Recorder Survey, run by the Sir Alister Hardy Foundation for Ocean Science, has been using vessels of opportunity to collect plankton samples on the Scotian Shelf and Slope since 1931 (Stantec 2014b).

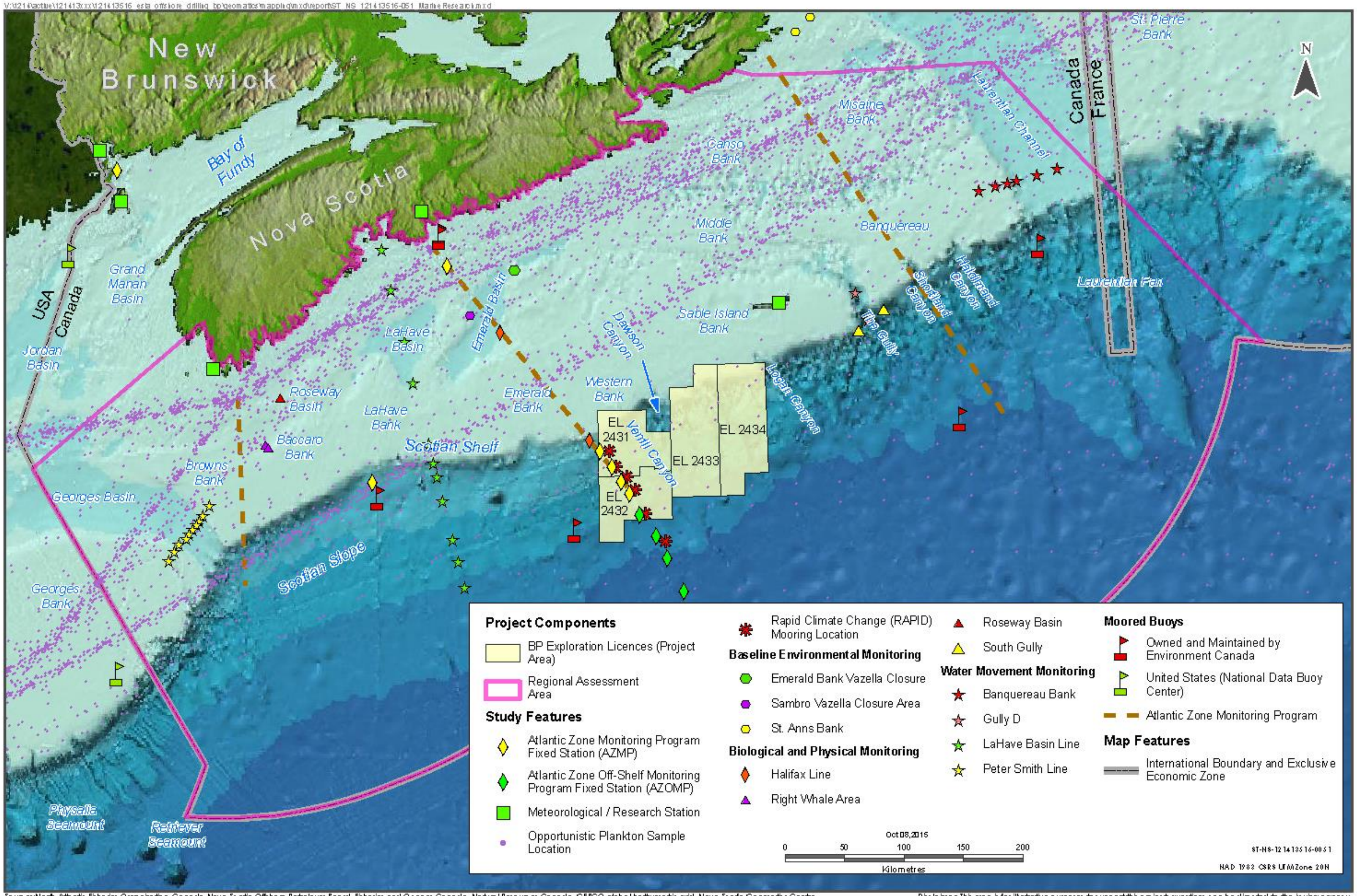


Figure 5.3.5 Marine Research Locations

5.3.4.6 Seabed Hazards Associated with Human Activities

Seabed hazards associated with human activities on the Scotian Shelf and Slope include pipelines (see Section 5.3.4.1), cables, explosives, shipwrecks, and disposal sites.

In the last 150 years, there have been many submarine cables laid on the seafloor, including copper telegraph cables, telephone cables, and fibre optic cables. As shown on Figure 5.3.6, there are several inactive cables that cross through the Project Area. In 2015, Hibernia Express completed the installation of a subsea fibre optic cable connecting Halifax, NS and Brean, UK; however, this cable is not located within the Project Area. The location of subsea cables are charted and as such will be avoided during the selection of drill sites. BP will consult with applicable cable owners prior to drilling to discuss proposed Project activities and components. Drilling activities will not interfere with active cable operation.

Halifax Harbour has been used as a military port for centuries and therefore lost or discarded unexploded ordnances (UXOs) could potentially be present at various locations on the Scotian Shelf, including in association with shipwrecks. Through the UXO Legacy Sites Program, Defence Construction Canada (DCC) and DND identify sites that may pose UXO risk as a result of past military activities. A number of publicly known explosives disposal sites are also located off the coast of Nova Scotia and have been documented by DCC. As illustrated on Figure 5.3.7, there is reportedly an explosive dumpsite located within the southeast corner of the Project Area. The most recent information available from DCC regarding Legacy Sites, explosives disposal sites, and recorded shipwrecks, are shown on Figure 5.3.7.

Sable Island, located approximately 48 km from the Project Area, is known as "*the graveyard of the Atlantic*", with more than 350 shipwrecks recorded on the Island since 1583. The most recent shipwreck around the Island was the sloop Merrimac in 1999 (Freedman 2014). Shipwrecks have occurred for various reasons such as relatively primitive navigation in earlier times, large number of traffic near the island, and the notoriously foggy conditions on the Sable Bank (Freedman 2014).

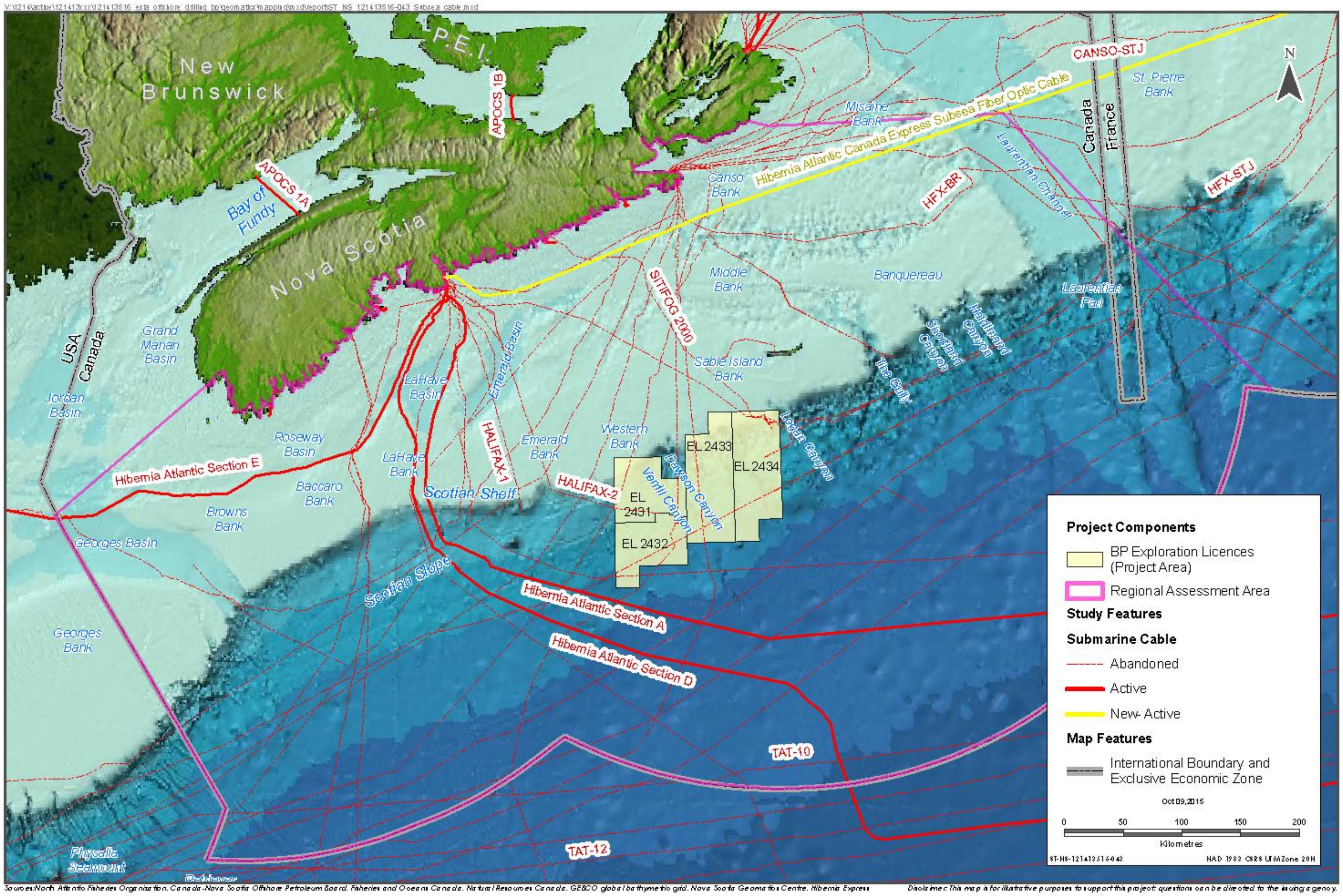


Figure 5.3.6 Subsea Cables

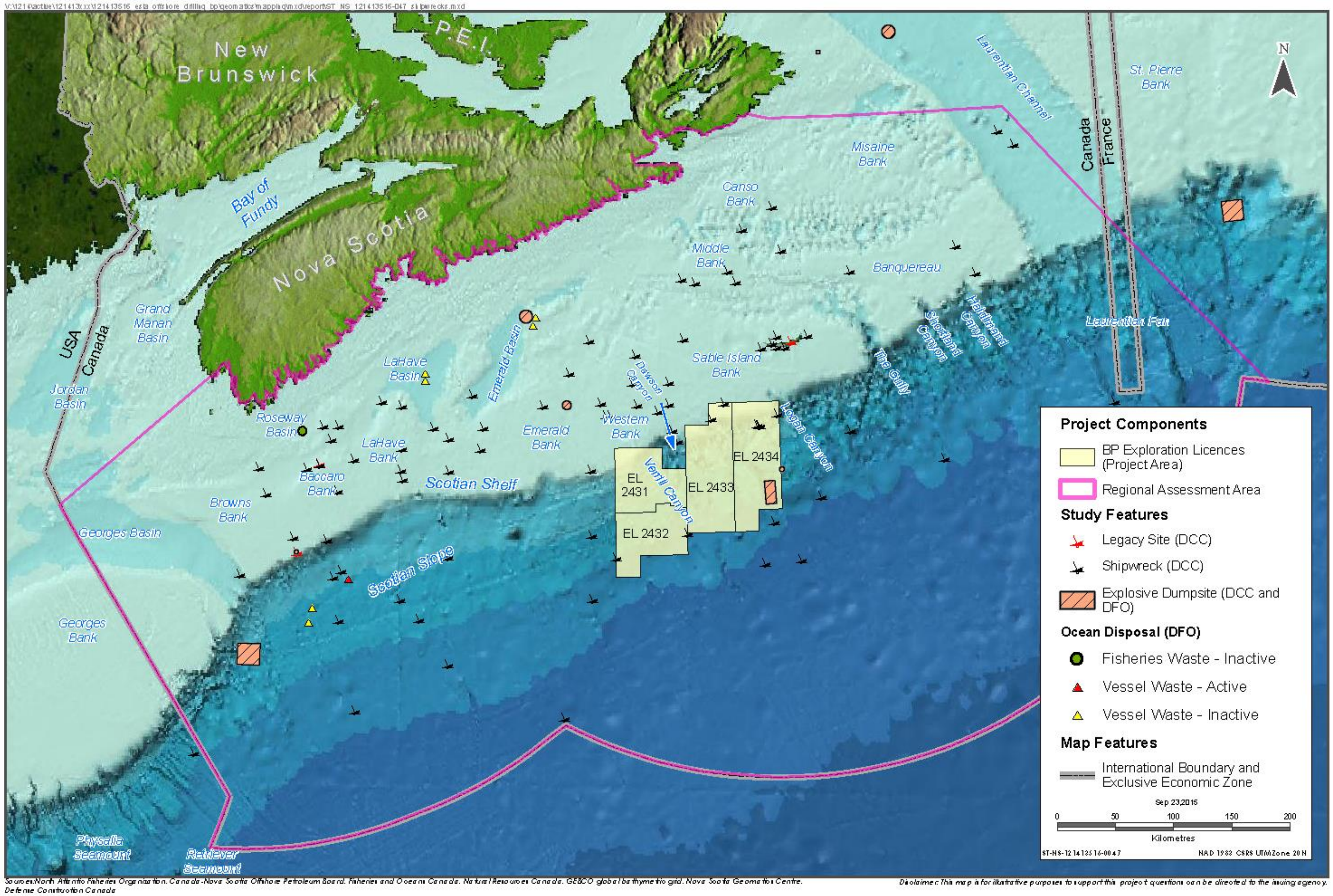


Figure 5.3.7 Shipwrecks and Ocean Disposal Sites

5.3.5 Offshore Commercial Fisheries

5.3.5.1 Historical Fisheries

Aboriginal peoples have been harvesting fish and shellfish offshore Nova Scotia for thousands of years, with commercial fishing starting in the mid-1500s. By 1700, Nova Scotia was a large exporter of cod, mackerel and herring. Catches continued to increase until 1973 when total landings of fish on the Scotian Shelf peaked, with catches exceeding 750,000,000 kg (750,000 tonnes) (Worcester and Parker 2010). Throughout this period of commercial fishing, groundfish landings dominated (mainly gadoids) with 450,000 tonnes landed in 1973; these landings decreased to less than 15,000 tonnes in 1997. This drastic decrease in landings was the primary factor in the imposition of a moratorium on fishing, especially for cod, in 1993. This moratorium remains in effect in NAFO Division 4W, though a small fishery is present in 4X (Worcester and Parker 2010; Best 2009).

5.3.5.2 Commercial Fisheries

Within and surrounding the Project Area, the socio-economic setting is dominated by commercial fisheries activity. Groundfish, pelagic, and invertebrate fisheries occur on the Scotian Shelf and Slope, with large pelagics (*e.g.*, swordfish, tuna, and shark) as the most commonly harvested fish in the Project Area. Following the collapse of the traditional groundfish stocks (*e.g*., cod, flatfish and pollock), shellfish stocks have grown significantly in their contribution to revenue and profitability of the Scotian Shelf fishery. Other groundfish species, such as Atlantic halibut and redfish, have also gained in commercial importance (MacLean *et al*. 2013). The Scotian Slope is commercially fished by fleets from all four Atlantic provinces; there has been no active foreign fleet since they were excluded after the first cod collapse in the 1970s (DFO 2005b).

Management of the commercial fishing activity on the Scotian Shelf by DFO is conducted through the Maritimes Regional offices. Management activities to control the commercial fisheries on the Scotian Shelf are outlined in the Integrated Fisheries Management (IFMP) and Conservation Harvesting Plans (CHP) consisting of catch controls including annual quotas and effort regulations (*i.e*., seasonal and spatial restriction, gear type, configuration and amount)(MacLean *et al*. 2013). To achieve conservation objectives, DFO implements spatial closures, most prominent being the Gully Marine Protected Area, St. Ann's Bank Area of Interest, the Coral Conservation Areas, and Sponge Conservation Areas (MacLean *et al.* 2013). Many of the major species are fished according to quota systems (groundfish), while others are fished according to availability (herring, mackerel and tunas) or specific season lengths (lobster and crab). Licences and quotas are set by DFO for individual species management areas, NAFO Divisions and Unit Areas. Aggregated landings maps included in Appendix G provide an overall picture of fishing activity in the area. Discussion of Aboriginal fisheries is provided in Section 5.3.6.

The Project Area is located within Commercial Fisheries Management Areas for lobster, shrimp, scallop and crab (Figure 5.3.8), and for fish (Figure 5.3.9). Data on commercial fisheries are generally obtained from DFO and based on the NAFO Unit Areas. The Project Area is located within NAFO Unit Area 4Wm, 4Wj, 4Wg and 4Wf, as illustrated in Figure 5.3.9.

Landings data for NAFO Divisions 4W for 2010 to 2013 were acquired from DFO Maritimes Region. These data from NAFO Division 4W, as well as from Divisions 4VN, 4VS, 4X, and 5ZE for comparative purposes, are presented in Table 5.3.3 and characterize the commercial fisheries within a broader region. Species-specific landing data could not be obtained from DFO due to confidentiality issues and updated policies for releasing fisheries data. Landings data from NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf are presented in Table 5.3.4, representing more specific data surrounding the Project Area. Although the landed value of fisheries harvests from these NAFO Divisions and Unit Areas fluctuates between years, the data from 2010 to 2013 was the most recent provided to Stantec by DFO during the preparation of the EIS and illustrates recent trends, presenting a general understanding of the extent and importance of commercial fisheries in Nova Scotia.

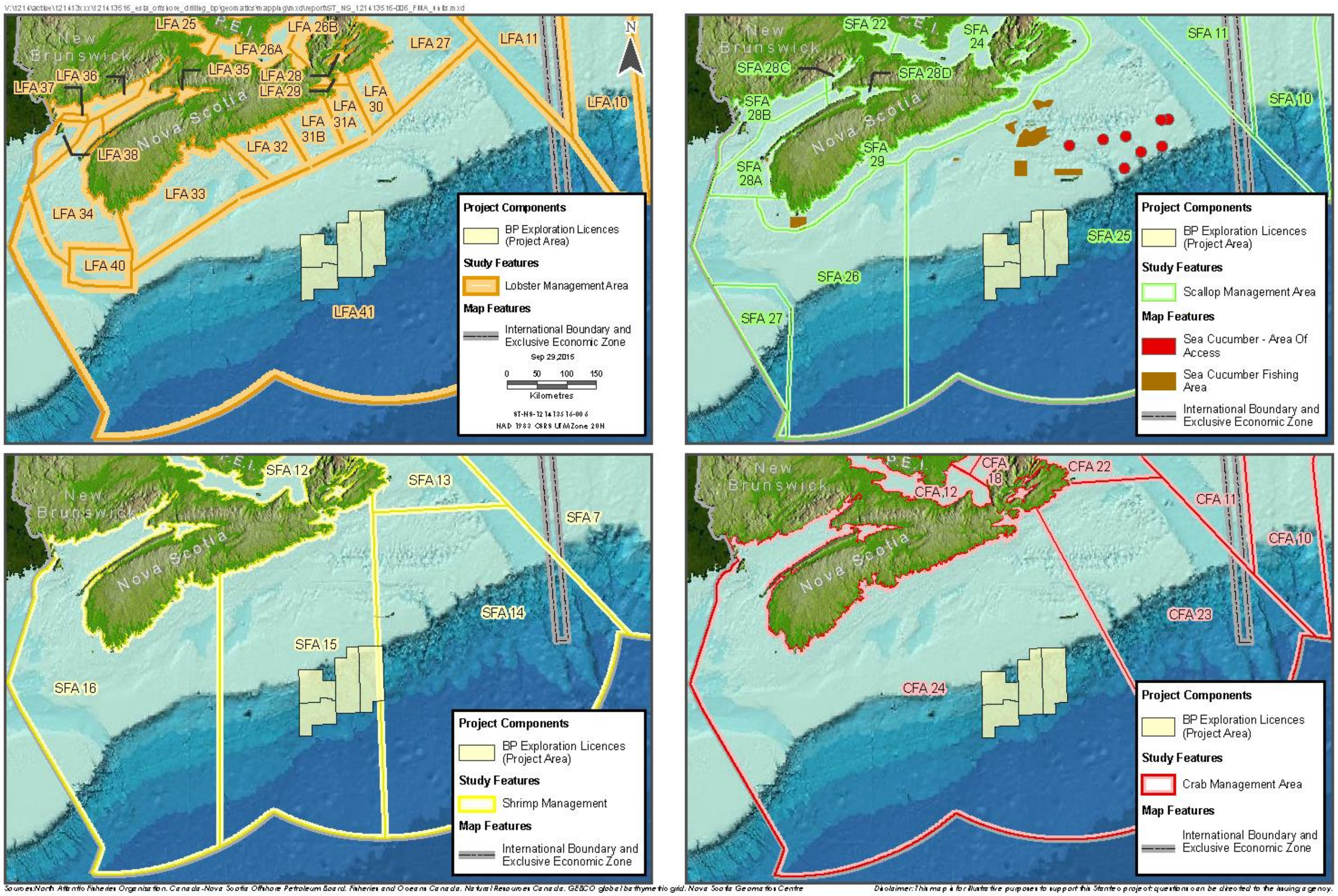


Figure 5.3.8 Commercial Fisheries Management Areas

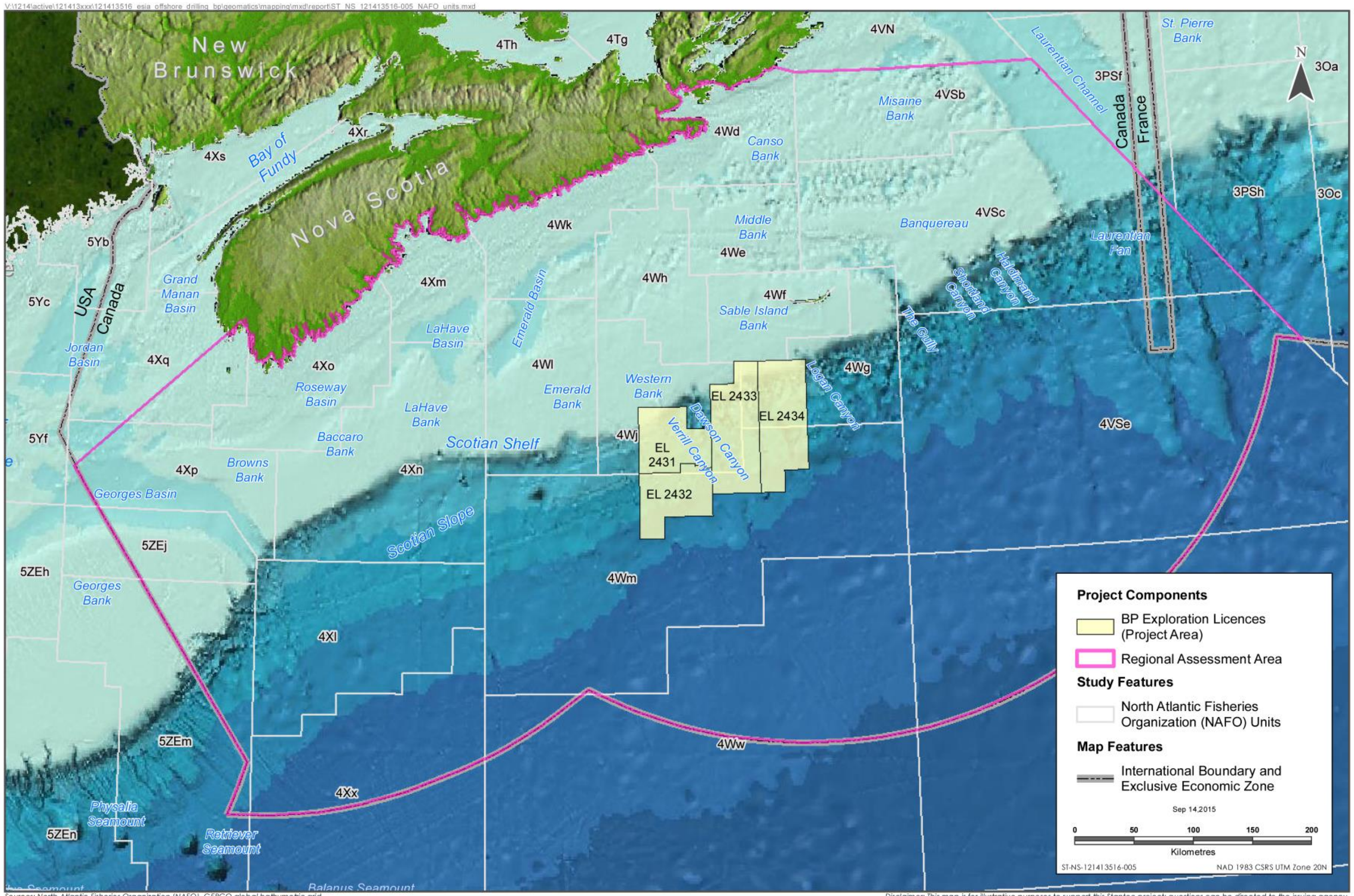


Figure 5.3.9 NAFO Unit Areas

Table 5.3.3 Landed Value of Fisheries Harvest within NAFO Divisions 4VN, 4VS, 4W, 4X, and 5ZE (2010-2013)

Species	2010		2011		2012		2013	
	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)
Groundfish								
4VN	907	1282	790	1631	1002	1862	1131	2752
4VS	4884	5752	2685	4632	4509	6686	1991	5048
4W	10 599	10 747	11 205	13 024	13 280	14 354	12 212	16 436
4X	22 282	31 696	21 023	32 177	21 034	33 976	14 839	29 221
5ZE	19 160	24 902	14 276	22 544	7468	14 917	6242	9057
Total Groundfish	**57 832**	**74 379**	**49 979**	**74 008**	**47 293**	**71 796**	**36 415**	**62 514**
Pelagic								
4VN	13	20	37	2397	185	224	211	154
4VS	126	892	131	908	87	493	145	1257
4W	10 863	9347	12 293	9739	2731	10 773	4105	15 981
4X	58 180	22 787	52 803	22 938	48 106	41 593	54 733	46 781
5ZE	529	4381	307	2427	313	2642	313	2791
Total Pelagic	**69 712**	**145 394**	**65 570**	**38 410**	**51 422**	**55 725**	**59 507**	**66 964**
Invertebrates								
4VN	3721	25 805	4126	36 166	4425	34 913	5673	40 587
4VS	33 043	71 082	32 944	79 621	32, 413	72 918	32 452	64 728
4W	14, 182	62 106	13 476	77 517	13 269	74 222	14 184	62 901
4X	49 642	329 402	58 559	361 654	58, 038	360 782	55 608	418 292
5ZE	44 807	60 957	37 902	60 155	33 926	73 488	42 751	118 461
Total Invertebrates	**145 394**	**549 351**	**147 008**	**615 112**	**142 070**	**616 324**	**150 668**	**704 969**
Other Species (*e.g.*, algae, moss and seaweeds)								
4VN	0	0	0	0	0	0	0	0
4VS	0	0	0	0	0	0	0	0
4W	0	0	0	0	0	0	0	0
4X	41 123	3365	16 989	1355	11 811	793	12 556	746
5ZE	0	0	0	0	0	0	0	0
Total Other	**41 123**	**3365**	**16 989**	**1355**	**11 811**	**793**	**12 556**	**746**
Grand Total	**314 061**	**772 490**	**279 546**	**728 886**	**252 597**	**744 638**	**259 145**	**835 193**

Source: Data courtesy of DFO

Table 5.3.4 Landed Value of Fisheries Harvest within the Project Area (NAFO Unit Areas 4Wf, 4Wg, 4Wj, and 4Wm (2010-2013)

Species	2010		2011		2012		2013	
	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)
Groundfish								
4Wf	2	16	36	49	143	179	9	55
4Wg	138	1041	530	1783	1075	2264	910	2354
4Wj	134	786	998	1818	1253	1975	1334	2889
4Wm	19	32	52	78	24	61	25	27
Total Groundfish	**293**	**1875**	**1616**	**3727**	**2495**	**4479**	**2278**	**5325**
Pelagic								
4Wf	3	30	1	6	1	6	13	105
4Wg	84	628	90	604	17	133	248	1941
4Wj	33	249	83	634	30	235	97	834
4Wm	29	213	41	281	31	258	142	1146
Total Pelagic	**148**	**1119**	**215**	**1526**	**80**	**632**	**500**	**4025**
Invertebrates								
4Wf	997	1841	1002	1186	819	1323	1069	1885
4Wg	140	528	12	64	35	175	18	48
4Wj	72	95	152	248	201	351	504	1377
4Wm	0	0	6	27	6	13	6	15
Total Invertebrates	**1210**	**2464**	**1171**	**1525**	**1061**	**1862**	**1597**	**3324**
Other Species								
4Wf	0	0	0	0	0	0	0	0
4Wg	0	0	0	0	0	0	0	0
4Wj	0	0	0	0	0	0	0	0
4Wm	0	0	0	0	0	0	0	0
Total Other	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Grand Total	**1651**	**5458**	**3002**	**6778**	**3635**	**6973**	**4375**	**12 674**

Source: Data courtesy of DFO

From 2010 to 2013 in NAFO Divisions within the RAA (Table 5.3.3), invertebrates dominated the commercial landing values with between 71% and 84% of the total catch in that period, though it represented a smaller amount of the landing weight (46 to 58%). The invertebrate fishery value and landing weights decrease within the Project Area. From 2010 to 2013 within NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf (Table 5.3.4) the value of the invertebrate fishery represented between 22% and 26% of the total landed values. The value of groundfish landings represented the highest commercial value from 2011 to 2013 with between 42% and 64% of the total landed values.

The majority of the harvest for NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf was landed in Nova Scotia. For the entire NAFO Unit Area 4Xn from 2010 to 2013, the landings were dominated by groundfish. The overall fishery landings and values were dominated by the entire NAFO Unit Area 4X from 2010 to 2013.

The fishing effort in NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf for the years 2008 to 2012 are presented in Figures 5.3.10 and 5.3.11 by type of fishery group; the landing data are geo-referenced by latitude and longitude for all groups in which data were provided. Note that not all of the catch data summarized in Tables 5.3.3 and 5.3.4 include harvest location coordinates; therefore, the commercial fishery figures may not illustrate the same information as portrayed in the tables. Species-specific fisheries data for the years 2008 to 2012 are presented in Figures 1 to 28 of Appendix G.

As evident in Figures 5.3.10 and 5.3.11, there is a marked fishing effort within the northern portion of the Project Area along the Shelf break. As shown in Figures 1 to 28 of Appendix G, harvesting in the Project Area includes Atlantic halibut, Greenland halibut, hagfish, swordfish, shark species, white hake, cusk, monkfish and redfish as well as some flatfish, bluefin tuna, herring, other tuna, red hake and silver hake. Based on Figure 5.3.10 a productive harvest location is just north of the Project Area near Western Bank as well as northwest of the Project Area near Emerald Basin. To the northeast of the Project Area near Middle Bank, there is an active snow crab fishing area. Currently, the snow crab fishery is the second most valuable commercial fishery in Nova Scotia and Atlantic Canada and has been active since the mid-1970s (Cook *et al*. 2014).

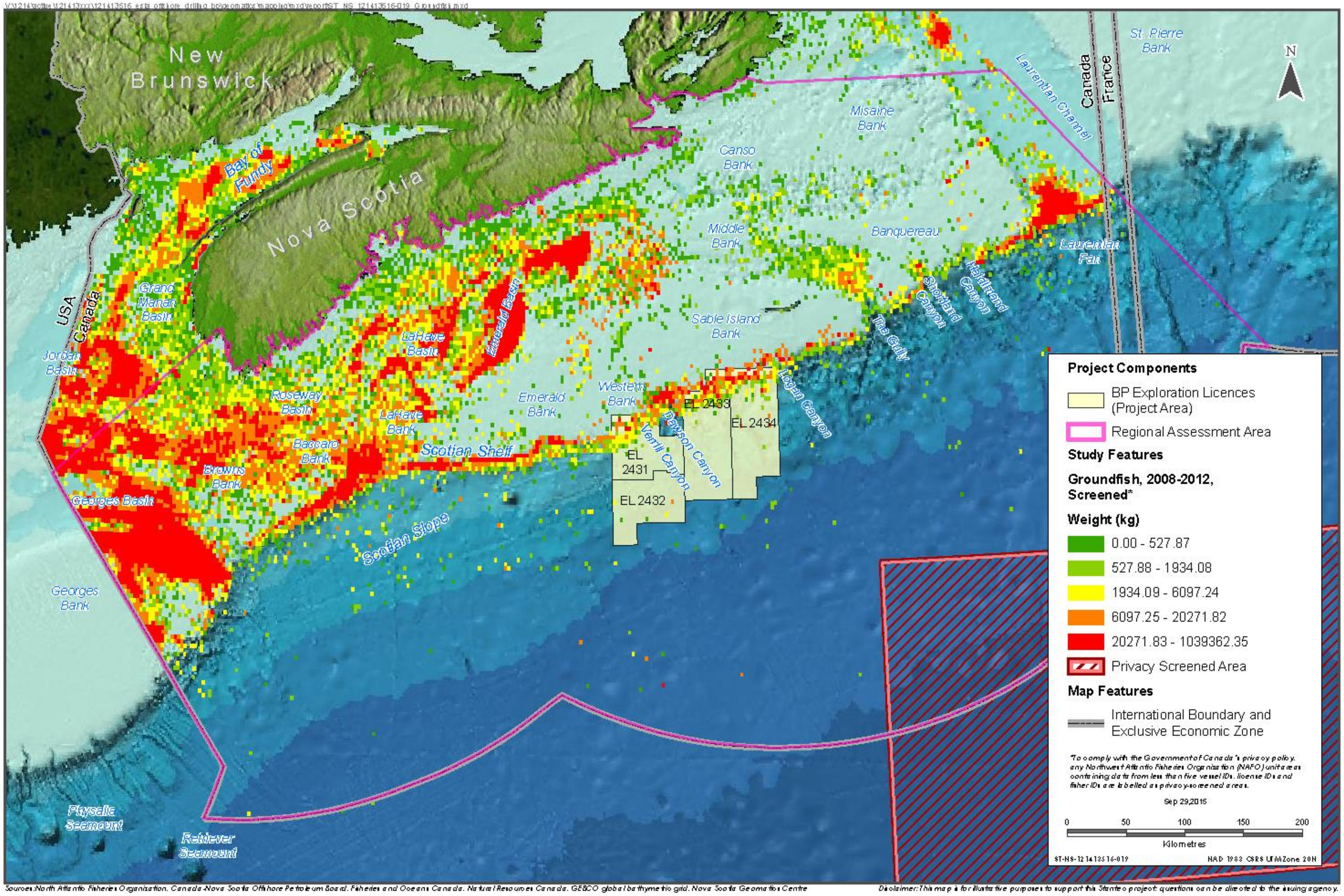


Figure 5.3.10 Groundfish Landings, All Gear Types, 2008-2012

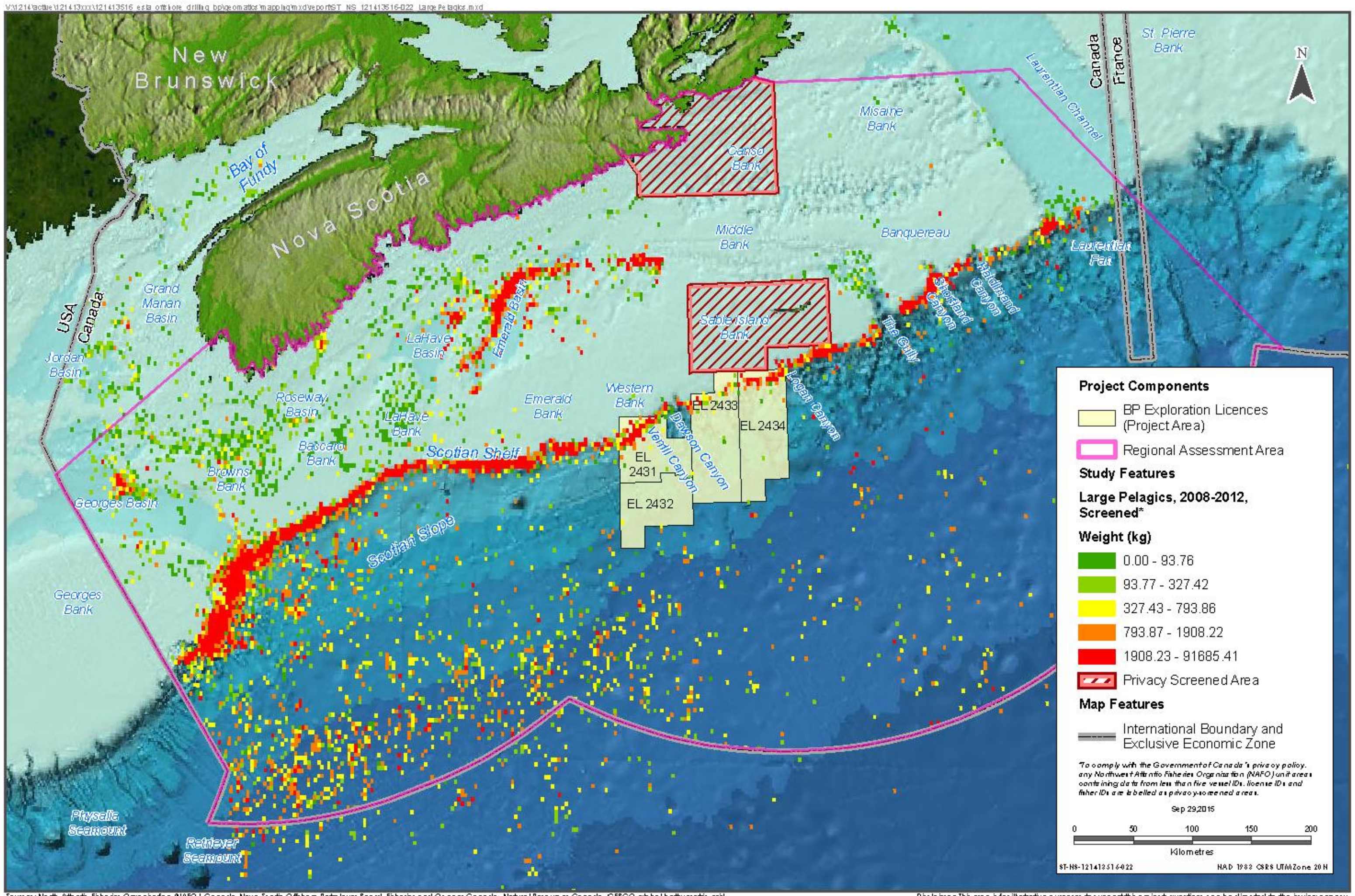


Figure 5.3.11 Large Pelagic Landings, 2008-2012

Key Commercial Fish and Invertebrate Species

Geo-referenced species-specific landings data could not be obtained from DFO due to confidentiality issues and updated policies for releasing fisheries data. However, based on previous data (*e.g.*, as presented in LGL 2014) annual commercial fisheries catch weight from the Project Area averaged about 377 tonnes during April to November 2005 to 2010. The primary commercial species likely harvested in the Project Area by landing weight include: sea scallops (33%), swordfish (~20%), herring (~14%), Atlantic halibut (~10%), silver hake (~8%), cusk (~3%) and white hake (~3%)(LGL 2014). During this six-year period, invertebrates accounted for about 34% of the aggregated catch weight flowed by groundfish species (~28%), large pelagic species (~23%) and small pelagic species (~15%)(LGL 2014). In terms of catch value, large pelagics accounted for about 50% with swordfish accounting for about 45% of landings values and an average landings value of about $1.25 million (LGL 2014). Table 5.3.5 includes the average annual species harvest statistics for the Project Area during April to November, 2005 to 2010.

Table 5.3.5 Average Annual Commercial Harvest by Species within the Project Area, April to November, 2005 to 2010

Species	Quantity (t)	% of Total	Value ($)	% of Total
Sea scallops	126	33.4	165 806	13.3
Swordfish	75	19.9	565 775	45.3
Herring	52	13.7	9838	0.8
Atlantic halibut	37	9.8	385 707	30.9
Silver hake	32	8.4	22 336	1.8
Cusk	10	2.8	9805	0.8
White hake	10	2.5	9443	0.8
Redfish	7	1.8	5106	0.4
Porbeagle shark	5	1.3	5104	0.4
Mackerel	4	1.1	3406	0.3
Mako shark	4	1.0	5528	0.4
Hagfish	3	0.9	3328	0.3
Greenland halibut	2	0.6	3410	0.3
Red hake	2	0.5	829	<0.1
Atlantic wolffish	<0.1	<0.1	<1	<0.1
Total	377	97.7	1 249 506	95.8

Source: Modified from LGL 2014

Species descriptions are provided in Section 5.2.5.

Table 5.3.6 lists key commercial fish species and the fishing seasons in which they are typically fished.

Table 5.3.6 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially within the RAA

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pelagic Species													
Albacore tuna	*Thunnus alalunga*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Bigeye tuna	*Thunnus obesus*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Bluefin tuna	*Thunnus thynnus*	Green	Green	Green	Green	Green	Yellow	Red	Red	Red	Red	Red	Yellow
Herring	*Clupea harengus*	Red	Red	Green	Green	Red	Red	Yellow	Yellow	Green	Green	Red	Red
Mackerel	*Scomber scombrus*	Green	Green	Green	Green	Green	Yellow	Red	Red	Red	Green	Green	Green
Porbeagle shark	*Lamna nasus*	Green	Yellow	Red	Red	Red	Red	Green	Green	Green	Yellow	Yellow	Yellow
Swordfish	*Xiphias gladuis*	Green	Green	Green	Green	Yellow	Red	Red	Red	Red	Red	Red	Yellow
White marlin	*Tetrapturus albidus*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Yellowfin tuna	*Thunnus albacares*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Groundfish Species													
American plaice	*Hippoglossoides platessoides*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Atlantic cod	*Gadus morhua*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Atlantic halibut	*Hippoglossus hippoglossus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Atlantic wolffish	*Anarhichas lupus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Cusk	*Brosme brosme*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Greysole-Witch flounder	*Glyptocephalus cynoglossus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Haddock	*Melanogrammus aeglefinus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Monkfish	*Lophius spp.*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Pollock	*Pollachius virens*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Redfish	*Sebastes mentella /*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow

Table 5.3.6 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially within the RAA

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
(deepwater and Acadian)	*Sebastes fasciatus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Red hake	*Urophycis chuss*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Silver hake	*Merluccius bilinearis*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Turbot – Greenland flounder	*Reinhardtius hippoglossoides*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
White hake	*Urophycis tenuis*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Invertebrate Species													
Lobster[1]	*Homarus americanus*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Scallop	potential for multiple species	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Yellow
Snow crab	*Chionoecetes opilio*				Green	Green	Green	Green	Green	Green			
Red crab	*Chaceon quinquedens*				Green	Green	Green	Green	Green	Green			

Note:
[1]The RAA falls within multiple Lobster Fishing Areas (33, 34, 40, and 41) with different fishing seasons. See below for the various lobster fishing seasons:
LFA 33: Last Monday in November–May 31.
LFA 34: Last Monday in November–May 31.
LFA 40: Closed year-round.
LFA 41: Open year-round.

Green	Open Fishing Season * Note all large pelagic fisheries, all groundfish fisheries and the scallop fishery are open year-round; however, there may be closures if catch rates or yields are low.
White	Closed Fishing Season
Red	High Fishing Activity within the Season
Yellow	Low Fishing Activity within the Season

Sources: Modified from Stantec 2014a and Stantec 2014b

5.3.5.2.1 Groundfish Fisheries

Within Unit Area 4W, which encompasses the Project Area, the groundfish fishery is open year-round with specific months providing better fishing based on the seasonal movement of fish species. The most intensive fishing occurs from July to September, though the central shelf basin provides high yields year-round. Most fishing vessels utilize trawls and longlines, with longlines used predominantly on the shelf edge and deepwater channels (Stantec 2014a).

Groundfish stocks are fished along the Scotian Slope break in the northern portion of the Project. The following describes current conditions of the three principal groundfish species fished within the Project Area.

Atlantic halibut are most abundant at depths of 200 to 500 m in the deep-water channels running between the banks and along the continental shelf (DFO 2015c). The Atlantic halibut fishery was unregulated until 1988 when a total allowable catch (TAC) of 3,200 tonnes was first established which was then reduced to 850 tonnes in 1995 (DFO 2015c). The TAC has increased several times beginning in 1999 and was set at 2,563 tonnes in 2014 (DFO 2015c).

In 2003, cusk was designated as threatened by the Committee on the Status of Endangered Wildlife of Canada (COSEWIC) due to the decline of abundance beginning in the 1970s (DFO 2008b). Canadian cusk landings have ranged from 790 to 1,490 tonnes between 1999 and 2006 in the 4VWX and 5Zc NAFO units with the vast majority of these landings from the groundfish longline fishery in 4X and 5Zc (DFO 2008b). Cusk are also known to be caught as bycatch in some lobster fisheries with mortalities in 2005/2006 lobster fisheries estimated to be a minimum of 226 tonnes in LFA 34 and 22 tonnes in LFA 41 (DFO 2008b).

There has been a directed fishery for hagfish off Nova Scotia since the late 1980s (DFO 2009g). Landings increased to a peak of approximately 1,800 tonnes in 2004, and declined steadily to approximately 1,300 tonnes in 2006 (DFO 2009g). During the early years of the fishery, landings were derived almost exclusively from NAFO Division 4X; however, since 2000, the fishery has expanded eastward and NAFO Division 4W has also become an important source of hagfish landings (DFO 2009g).

Figure 5.3.10 depicts locations of groundfish species catches within and around the Project Area. Refer to Appendix G for more detailed landings maps.

5.3.5.2.2 Pelagic Fisheries

During the period from 1980 to 2000, pelagic species catch has fluctuated from 8% to 15% of the total landed value on the Scotian Shelf (Stantec 2014b). On the Scotian Shelf, bigeye tuna, yellowfin tuna, swordfish and blue shark stocks are considered to be in a healthy state, while bluefin tuna, albacore tuna, shortfin mako, porbeagle, blue marlin, and white marlin stocks are in a critical state as determined by DFO (Stantec 2014b). As indicated in LGL 2014, the dominant commercially caught large pelagics in and around the Project Area include: swordfish, bigeye tuna, yellowfin tuna, bluefin tuna, albacore tuna, unspecified tunas, mako shark (historically), porbeagle shark (historically) and mahi mahi.

Within Unit Area 4W, the pelagic fishery is open year-round with specific months providing better fishing based on the seasonal movement of fish species. The most intensive fishing occurs during the summer and fall, though the main swordfish fishery is from June to November (Stantec 2014b). Most fishing vessels use pelagic (floating) longline, though bluefin tuna and swordfish are also angled or fished with electric harpoons (Stantec 2014b).

Swordfish is one of the main large pelagic fish species frequenting the waters off the Atlantic Ocean during the spring to fall (MacLean *et al.* 2013). Atlantic Canadian catches of swordfish were 1,489 tonnes in 2012, which was one of the highest annual landings since 1988 (ICCAT 2012a). The swordfish population is separated by the International Commission for the Conservation of Atlantic Tunas (ICCAT) into North and South Atlantic stocks with independent TACs. The worldwide TAC for the North Atlantic swordfish fishery is 13,700 tonnes; this has decreased from 2007 to 2009 where the TAC was 14,000 tonnes. Minimum size limits are in place for the North Atlantic swordfish fishery with a 125-cm lower jaw fork length (LJFL) with a 15% tolerance or a 119-cm LJFL with zero tolerance and evaluation of the discards (ICCAT 2012a).

Data provided by ICCAT from the 1988–2012 shows Atlantic Canadian landings of bigeye tuna were highest in 2000 (327 tonnes) decreasing to a low of 103 tonnes in 2010 (ICCAT 2012b). In 2012, Atlantic Canadian catches of bigeye tuna totaled 166 tonnes with total worldwide catches of 70,536 tonnes. The historical TAC was reduced in 2009 from 90,000 tonnes to 85,000 tonnes (ICCAT 2012b).

Atlantic Canadian catches of yellowfin tuna were 93 tonnes in 2012 decreasing from 304 tonnes in 2004 (ICCAT 2012c). Total worldwide catches of yellowfin tuna have declined to 100 000 tonnes in 2007 from 193,000 tonnes in 1990 (ICCAT 2012c.) From 2007 to 2011, catches have increased through only by 10% to 20%. Beginning in 2013, ICCAT proposed a worldwide TAC of 110,000 and time area closures for fishery aggregating devices such as floating longlines. Estimates of fishable biomass trends indicate a recent decline, though a tendency for a slow continued rebuilding was noted (ICCAT 2012c). Figure 5.3.11 illustrates that the pelagic fisheries around the Project Area are concentrated primarily along the shelf break (*e.g.*, swordfish) or in deeper waters off the Scotian Slope (*e.g.*, tuna/shark). Refer to Appendix G for more detailed landings maps.

5.3.5.2.3 Invertebrate Fisheries

Commercial fishing for lobster and crab in and around the Project Area is concentrated on Georges Bank outer shelf, Georges Basin and the upper Scotian Slope (DFO 2013w). The scallop fishery, concentrated on Georges Bank and Browns Bank approximately 300 km west of the Project Area, accounts for approximately 70% to 80% of the annual scallops landed in Canada (Stantec 2014b).

Figures 1 to 4 in Appendix G depict locations of invertebrate landings within and around the Project Area. The fishery is predominantly based along the Scotian Shelf break. The primary commercial species likely harvested in the Project Area include: Atlantic sea scallop, cockles, Iceland scallop, Northern shrimp, propeller clam, quahog, sea cucumbers, snow crab, Stimpson's surf clam, striped shrimp and whelks (LGL 2014).

Within the Project Area the offshore lobster fishery in LFA 41 is open year-round, though it has been subject to a TAC of 720 tonnes per year since 2009 (DFO 2013x). If the TAC weight is not harvested in the previous year, the unused allocation can be then harvested in the subsequent year. Landings for lobster in 2010 and 2011 were 869 tonnes and 752 tonnes, respectively; there were overruns in these two years therefore the allocated TAC in 2012 was reduced to 646 tonnes (Intertek 2012). Lobster is harvested offshore using rectangular wire coated traps (Marine Stewardship Council 2009).

Although not fished within the Project Area, an important snow crab fishery is located to the northeast of the Project Area. The snow crab fishery, existing since the mid-1970s, primarily occurs in the Eastern Scotian Shelf (MacLean *et al*. 2013). In the early 2000s, annual landings rose to above 10,000 tonnes with the majority being from the southern area of the Eastern Scotian Shelf (MacLean *et al*. 2013). Many Crab Fishing Areas (CFAs) and sub-areas were merged in 2005 resulting in three divisions; N-ENS (North-Eastern Nova Scotia, formerly CFAs 20-22), S-ENS (South-Eastern Nova Scotia, CFAs 23, 24), and 4X (DFO 2015n). Landings in 2014 for N-ENS and S-ENS were 778 tonnes and 11,267 tonnes, respectively, and 79 tonnes in 4X for the 2013/2014 season (DFO 2015n). In 2014, the TAC was 783 tonnes, 11,311 tonnes and 80 tonnes in N-ENS, S-ENS and 4X, respectively (DFO 2015n).

5.3.6 Aboriginal Fisheries

In 1990, the Supreme Court of Canada issued the Sparrow Decision which found the Musqueam First Nation had an Aboriginal right to fish for food, social and ceremonial (FSC) purposes. The Court found this FSC right takes priority, after conservation, over other uses of the resource. The decision indicated the importance of consulting with Aboriginal groups when their fishing right may be affected (DFO 2008c). In response to this decision as well as to provide stable fishery management, DFO developed an Aboriginal Fisheries Strategy (AFS). The AFS assists DFO in managing the fishery in a manner consistent with the Supreme Court of Canada's decisions.

The Minister of Fisheries and Oceans issues two types of communal fishing licences to Aboriginal groups, which allow fishing for either FSC or commercial purposes. These licences are held under the name of the Aboriginal community and not under the name of a specific individual.

Aboriginal access to FSC fisheries is through community agreements negotiated under the AFS, imposed licences by the Government of Canada, or community assertion of Aboriginal and Treaty rights with respect to species for which conservation is not a concern (MGS and UINR 2016). In the DFO Maritimes Region, communal FSC licences are held by 16 First Nations and the Native Council of Nova Scotia (NCNS). Eleven of these communal FSC licences are held by groups in Nova Scotia while the remaining five are held by groups in New Brunswick. In the DFO Gulf Region, there are no Aboriginal organizations which hold FSC licences to fish in the RAA.

Following the Supreme Court of Canada's 1999 Marshall Decision, which affirmed a Treaty right to hunt, fish, and gather in pursuit of a moderate livelihood, DFO implemented the Marshall Response Initiative (MRI) from 2000 to 2007 to provide increased Aboriginal access to the commercial fishery through the issuance of communal commercial licences. The Atlantic Integrated Commercial Fisheries Initiative (AICFI) was subsequently created in 2007 to sustain the public investment made to the Aboriginal commercial fishery through the MRI and provide the 34 Mi'kmaq and Wolastoqiyik (Maliseet) First Nations affected by the Marshall decision with capacity-building support for the successful management of Aboriginal communal commercial fisheries and effective Aboriginal participation in fisheries co-management (DFO 2012a, DFO 2012b).

In order to obtain baseline information on Aboriginal fishing activity and licences, and use of species which may be affected by the Project, BP obtained licencing data from DFO, gathered information during engagement activities (refer to Section 4), and commissioned a Traditional Use Study (TUS). The licencing data from DFO indicates permitted fisheries by Aboriginal organization but does not necessarily imply actual fishing activity. BP commissioned Membertou Geomatics Solutions (MGS) and Unama'ki Institute of Natural Resources (UINR) to undertake a TUS to obtain information on the Aboriginal fisheries occurring in and around the Project Area. The TUS scope of work included conducting a background review of commercial licences and FSC agreements, and interviews with elders, fishers and fisheries managers from a representative subset of First Nations in Nova Scotia and New Brunswick, and the Native Council of Nova Scotia (NCNS). The TUS includes information on target species, general fishing areas, and fishing seasons, along with any additional information pertaining to fish or sensitive areas.

5.3.6.1 Communal Commercial Fisheries

There are 22 Aboriginal organizations from the four Atlantic provinces that hold licences issued by the DFO Maritimes Region and 12 Aboriginal organizations that hold licences issued by the DFO Gulf Region that have communal commercial fishing access in or near the Project Area (Table 5.3.7). Licence areas and species fished for each Aboriginal organization are provided in Appendix I. Table 5.38 summarizes this data by Aboriginal organizations licenced by DFO Maritimes Region.

Table 5.3.7 Aboriginal Organizations with Communal Commercial Licences in the Maritimes and Gulf Regions

Maritimes Region	Gulf Region
Acadia First Nation*	Abegweit First Nation
Afton (Paqtnkek) First Nation*	Bouctouche First Nation
Annapolis Valley First Nation	Eel River First Nation
Apaqtukewag Fishery	Elsipogtog First Nation
Bear River First Nation	Esgenoôpetitj First Nation
Chapel Island (Potlotek) Band Council*	Indian Island First Nation
Conne River Band Council	Lennox Island First Nation
Eskasoni First Nation*	Native Council of PEI
Fort Folly First Nation*	NB Aboriginal Peoples Council
Glooscap First Nation*	Pabineau First Nation
Kingsclear First Nation	Pictou Landing First Nation*
Membertou Band Council*	Tobique First Nation
Millbrook First Nation*	
Mime'j Seafoods Ltd. (NCNS)*	
NB Aboriginal Peoples Council	
Oromocto First Nation	
Shubenacadie (Sipekne'katik) Band	
St. Mary's First Nation*	
Tobique First Nation	
Wagmatcook First Nation*	
Waycobah (We'koqma'q) First Nation*	
Woodstock First Nation*	

*Included in the TUS

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
ACADIA FIRST NATION	
Alewives/Gaspereau	
Clams, Unspecified	Clam Harvest Area - 2, 3, 4
Crab, Green	
Crab, Jonah	
Crab, Snow	NAFO Division 4X
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 33, 34
Mackerel	
Marine Worm	Marine Worm Harvest Areas 2, 3
Ocean Quahaug	
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
Tuna, Unspecified	
AFTON FIRST NATION	
Sea Urchins	Guysborough County Indian Harbour
ANNAPOLIS VALLEY FIRST NATION	
Alewives/Gaspereau	Annapolis County
Crab, Green	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas, 34, 35
Marine Worm	Marine Worm Harvest Area 1
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Digby Annapolis Kings County
APAQTUKEWAG FISHERIES	
Crab, Snow	Crab Fishing Area 24
Lobster	Lobster Fishing Area 27
Mackerel	
Sea Urchins	Richmond
Squid, Unspecified	
BEAR RIVER FIRST NATION	
Clams, Unspecified	Clam Harvest Area 2

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Lobster	Lobster Fishing Areas 34, 35
Tuna, Unspecified	
CHAPEL ISLAND BAND COUNCIL	
Alewives/Gaspereau	
Crab, Snow	Crab Fishing Area 24
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Areas 28, 29
Sea Urchins	Richmond
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
CONNE RIVER BAND	
Swordfish	
Tuna, Restricted	
ESKASONI FIRST NATION	
Alewives/Gaspereau	
Crab, Snow	Crab Fishing Area, 23, 24
Eel	
Groundfish, Unspecified	NAFO Division 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 28, 29
Mackerel	
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
FORT FOLLY FIRST NATION	
Alewives/Gaspereau	
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Area 35
Scallop, Sea	Scallop Fishing Areas (Bay of Fundy) 28B, 28C
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
GLOOSCAP FIRST NATION	
Alewives/Gaspereau	
Groundfish, Unspecified	NAFO Divisions 4X, 5Y, 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Area 34
Mackerel	

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Marine Worm	Marine Worm Harvest Area 1
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
Tuna, Unspecified	
KINGSCLEAR FIRST NATION	
Crab, Rock	Lobster Fishing Area 36
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Area 36, 38
Scallop, Sea	Scallop Fishing Area (Bay of Fundy) 28B, 28C
Sea Urchins	Sea Urchin Fishing Areas 36, 38
MEMBERTOU BAND COUNCIL	
Alewives/Gaspereau	
Crab, Rock	Lobster Fishing Area 27
Crab, Snow	Crab Fishing Area 23
Eel	
Groundfish, Unspecified	NAFO Divisions 4T, 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Area 27
Mackerel	
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Cape Breton
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
Tuna, Unspecified	
MILLBROOK FIRST NATION	
Alewives/Gaspereau	
Clams, Unspecified	Clam Harvest Area 5
Crab, Jonah	Lobster Fishing Area 32
Crab, Snow	Crab Fishing Areas 23, 24
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Hagfish (Slime eel)	NAFO Divisions 4VN, 4VS, 4W
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 32, 35
Mackerel	
Sea Urchins	Halifax County East of Pennant Point; Guysborough County East of Port Bickerton

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Seal Skins/Harp/ Rag.Jacket (NO.)	
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
Tuna, Unspecified	
MIME'J SEAFOODS LTD.	
Alewives/Gaspereau	
Clams, Hard Shell	Clam Harvest Area 2
Clams, Unspecified	Clam Harvest Areas 2, 3, 4, 5
Crab, Green	
Crab, Jonah	Lobster Fishing Area 33
Crab, Snow	NAFO Division 4X, Crab Fishing Area 24
Eel	
Groundfish, Unspecified	NAFO Division 4T, 4VN, 4X, 5Y
Herring	Herring Fishing areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas, 27, 29, 33, 34
Mackerel	
Marine Worm	Marine Worm Harvest Area 4
Scallop, Sea	Scallop Fishing Area 29
Shad	
Squid, Unspecified	
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
NB ABORIGINAL PEOPLES COUNCIL	
Clams, Unspecified	Clam Harvest Area 7
Eel	
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Areas 36, 38
Lobster - Grey Zone	Lobster - Grey Zone
Mackerel	
Scallop, Sea	Scallop Fishing Areas (Bay of Fundy) 28B, 28C
OROMOCTO FIRST NATION	
Alewives/Gaspereau	
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Area 36
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Sea Urchins	Sea Urchin Fishing Area 36
Shad	
Smelts	
SHUBENACADIE BAND COUNCIL	
Alewives/Gaspereau	
Clams, Unspecified	Clam Harvest Areas 1, 5
Crab, Snow	Crab Fishing Area 24
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Areas 32, 33, 34, 35
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Halifax County East of Pennant Point
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
ST. MARY'S FIRST NATION	
Alewives/Gaspereau	
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Area 36
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Sea Urchin Fishing Area 36
Shad	
Shrimp, Pandalus Borealis	Shrimp Fishing Areas 4X/5Z - 16
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
TOBIQUE FIRST NATION	
Crab, Jonah	Lobster Fishing Area 38
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Area 38
Lobster - Grey zone	Lobster - Grey Zone
Mackerel	
Ocean Quahaug	
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Sea Urchin Fishing Area 38
WAGMATCOOK FIRST NATION	
Alewives/Gaspereau	
Crab, Snow	Crab Fishing Area 23
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Herring	
Lobster	Lobster Fishing Area 27
Mackerel	
Sea Urchins	Victoria South of Cape North
Seal Skins/Harp/Rag.Jacket (NO.)	
Squid, Unspecified	
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
WAYCOBAH FIRST NATION	
Crab, Snow	Crab Fishing Areas 23, 24
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 27, 29
Mackerel	
Sea Urchins	Victoria South of Cape North
Seal Skins/Harp/Rag.Jacket (NO.)	
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
WOODSTOCK FIRST NATION	
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	
Herring/Mackerel	
Lobster	Lobster Fishing Areas 36, 38
Lobster - Grey Zone	Lobster - Grey Zone
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Sea Urchin Fishing Areas 36, 38
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	

Source: Data courtesy of DFO

There are also several Aboriginal organizations in the DFO Gulf Region with communal commercial licences in the RAA. As shown in Table 5.39, most of these licences for fishing within the Project Area (which falls within NAFO Division 4W) are for tuna.

Table 5.3.9 Communal Commercial Licences Issued by DFO Gulf Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
TOBIQUE FIRST NATION	
Groundfish	NAFO Divisions 4X, 5Y
Lobster	LFA 38
Scallop	SFA 28B, 28C
Herring	Areas 17 and 22
Tuna	NAFO Divisions 4W, 4Vs, 4X, 5
PABINEAU FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs, 4X, 5
ESGENOÔPETITJ FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
ELSIPOGTOG FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
INDIAN ISLAND FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
NB ABORIGINAL PEOPLES COUNCIL	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
BOUCTOUCHE FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
EEL RIVER BAR FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
PICTOU LANDING FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
ABEGWEIT FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
LENNOX ISLAND FIRST NATION	
Groundfish	NAFO Division 4Vn
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
NATIVE COUNCIL OF PEI	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
GLOOSCAP FIRST NATION (MARITIMES REGION)	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
ST. MARY'S FIRST NATION (MARITIMES REGION)	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5

Source: Data courtesy of DFO

As noted in Table 5.3.7 and as reported in the TUS (Appendix B), all 13 Mi'kmaq First Nation communities in Nova Scotia currently have communal commercial fishing licences for various species that may be harvested from the RAA.

As reported in the TUS, which involved a review of licencing data and interviews with several Aboriginal organizations (refer to Table 5.3.7), there are 25 species being fished by Nova Scotia

Mi'kmaq First Nation communities under communal commercial licences within the RAA and 15 species fished within the LAA. Many of these fisheries occur year-round. As reported in the TUS, the following seven species are targeted within the Project Area: Atlantic cod, bluefin tuna, haddock, mahi-mahi, northern shrimp, shark, and swordfish. Cusk, halibut, and silver hake are harvested as by-catch within the Project Area.

As reported in the TUS, the NCNS (Mime'J Seafoods Ltd.) has communal commercial licences which allow them to harvest approximately 19 species (including by-catch species) within the RAA. Nine of these species may also be harvested by NCNS within the LAA. The following seven species may be harvested by NCNS within the Project Area: albacore tuna, bluefin tuna, bigeye tuna, halibut (by-catch), mahi-mahi (by-catch), swordfish, and yellowfin tuna (MGS and UINR 2016).

The TUS indicates that Fort Folly Mi'kmaq First Nation and St. Mary's and Woodstock Wolastoqiyik (Maliseet) First Nations in New Brunswick hold communal commercial fishing licences for various species that may be harvested from the RAA. Under these licences, these communities report fishing 16 species within the RAA, ten of which may also be harvested within the LAA. Silver hake and swordfish are the only species that may also be harvested within the Project Area (MGS and UINR 2016).

5.3.6.2 FSC Fisheries

As noted in Section 5.3.6, DFO also grants licences for FSC fisheries. In the DFO Gulf Region, there are no Aboriginal organizations which hold FSC licences to fish in the RAA. FSC 2015-2016 fishing licence details for the DFO Maritimes Region is provided in Appendix I. This includes 11 Nova Scotia Mi'kmq communities, the NCNS, and five New Bruswick First Nation communities, which hold FSC licences (Appendix I).

According to the TUS, 44 species (34 fish species and 10 invertebrate species) were identified as being harvested for FSC purposes by Mi'kmaq First Nations throughout Nova Scotia. In particular, they reported harvesting seven fish species and three invertebrate species within the RAA, and one invertebrate species (lobster) within the LAA for FSC purposes. None of the species identified are known to be harvested for FSC purposes within the Project Area (MGS and UINR 2016).

Forty-three species (31 fish species and 12 invertebrate species) were identified as being harvested for FSC purposes by the NCNS. FSC fisheries for 22 of these species are known to occur in the RAA, FSC fisheries for five of these species are known to occur in the LAA (*i.e*., Atlantic herring, Atlantic mackerel, Greenland halibut, redfish, and silver hake), and no FSC fisheries are known to occur in the Project Area (MGS and UINR 2016).

Lobster is the only species identified as being harvested for FSC purposes by New Brunswick's Fort Folly, St. Mary's and/or Woodstock First Nations, and it is harvested outside of the RAA, in the Bay of Fundy.

5.3.7 Physical and Cultural Heritage

A consideration of physical and cultural heritage is limited to shipwrecks that may be present in and near the Project Area. Locations of known shipwrecks in the vicinity of the Project Area are shown on Figure 5.3.7. As noted above in Section 5.3.2.6, the Project Area is located 48 km from Sable Island, where more than 350 shipwrecks have been recorded on or around the island since 1583. As noted in Sections 5.2.10 and 5.3.3.4, the history of the island has been shaped by these events, including through the introduction of shipwrecked species (*e.g.*, horses) as early as 1518, and the establishment of a government-run, life-saving station from 1801 to 1958 (Freedman 2014).

6.0 ENVIRONMENTAL EFFECTS ASSESSMENT SCOPE AND METHODS

6.1 SCOPE OF ASSESSMENT

6.1.1 Scope of the Project

The Project under assessment is an offshore exploratory drilling program comprising the drilling, testing and abandonment of up to seven exploration wells within a Project Area encompassing ELs 2431, 2432, 2433, and 2434. The Project Area is located approximately 230 km to 370 km southeast of Halifax on the Scotian Slope (see Figure 2.2.1).

The scope of the Project to be assessed under CEAA, 2012 includes the following Project activities and components (refer to Section 2 for details):

- presence and operation of MODU;
  - establishment of a safety (exclusion) zone, and light and sound emissions associated with MODU presence and operation; and
  - well drilling and testing operations
- waste management;
  - discharge of drill muds and cuttings; and
  - other discharges and emissions (including drilling and well flow testing emissions);
- VSP operations;
- supply and servicing operations;
  - helicopter transportation; and
  - PSV operations (including transit and transfer activities);
- well abandonment.

These activities reflect the scope of the Project as outlined in the EIS Guidelines and represent physical activities that would occur throughout the life of the Project. These activities form the basis of the effects assessment in Section 7. Malfunctions and accidental events, which are unlikely to occur, are assessed separately in Section 8.

6.1.2 Factors to be Considered

Pursuant to section 19 of CEAA, 2012, the federal environmental assessment (EA) of a designated project must take into account the following factors:

> (a) *the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project and any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out;*
>
> (b) *the significance of the effects referred to in paragraph (a);*
>
> (c) *comments from the public – or, with respect to a designated project that requires that a certificate be issued in accordance with an order made under section 54 of the National Energy Board Act, any interested party – that are received in accordance with this Act;*
>
> (d) *mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;*
>
> (e) *the requirements of the follow-up program in respect of the designated project;*
>
> (f) *the purpose of the designated project;*
>
> (g) *alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means;*
>
> (h) *any change to the designated project that may be caused by the environment;*
>
> (i) *the results of any relevant study conducted by a committee established under section 73 or 74 [of CEAA, 2012]; and*
>
> (j) *any other matter relevant to the environmental assessment that the responsible authority, or – if the environmental assessment is referred to a review panel – the Minister, requires to be taken into account.*

The EIS gives full consideration to all of the applicable factors outlined in section 19 of CEAA, 2012.

The scope of the factors to be considered focuses the assessment on the relevant issues and concerns. As per section 5(1) of CEAA, 2012, 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 as defined in section 2 of the* Fisheries Act *and fish habitat as defined in subsection 34(1) of that 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 of [CEAA, 2012];

(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.

Certain additional 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 Act of Parliament other than CEAA, 2012. This is the case for the Project, as BP will require authorizations from the CNSOPB under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* in order for the Project to proceed. Therefore, the following environmental effects have also been considered:

(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.*

These categories of direct and indirect environmental effects have been taken into account in defining the scope of the assessment, including the scope of factors to be considered in the assessment. The EIS Guidelines (CEA Agency 2015a) have also been taken into consideration in determining the scope of the factors to be considered, including the selection of Valued Components (VC) and the identification of spatial and temporal boundaries (refer to Section 6.2.2 and Section 6.2.3.4, respectively).

6.2 ENVIRONMENTAL ASSESSMENT METHODS

6.2.1 Overview of Approach

The method used to conduct the EA for the Project is based on a structured approach that is consistent with international best practices for conducting environmental impact assessments, including the International Association for Impact Assessment's *Principles of Environmental Impact Assessment Best Practice* (IAIA 1999), and with the method used by Stantec for environmental assessments of other major projects assessed by the CEA Agency including the Shelburne Basin Venture Exploration Drilling Project (Stantec 2014a). The assessment method is structured to:

- identify the issues and potential effects that are likely to be important;
- consider key issues raised by Aboriginal peoples, stakeholders, and the public; and
- integrate engineering design and programs for mitigation and follow-up into a comprehensive environmental planning process.

This method is focused on the identification and assessment of potential adverse environmental effects of the Project on VCs. VCs are environmental attributes associated with the Project that are of particular value or interest because they have been identified to be of concern to Aboriginal peoples, regulatory agencies, BP, resource managers, scientists, key stakeholders, and/or the general public.

It is noted that "environment" is defined to include not only ecological systems but also human, social, cultural, and economic conditions that are affected by changes in the biophysical environment. VCs therefore include ecological, social, and economic systems that comprise the environment (refer to Section 6.2.2).

The potential environmental effects of Project activities and components are assessed in Section 7 using a standard framework to facilitate assessment of each VC. Evaluation tables and matrices are used to document the assessment. Residual Project-related environmental effects (*i.e.*, those environmental effects that remain after the planned mitigation measures have been applied) are characterized for each individual VC using specific analysis criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context). The significance of residual Project-related environmental effects is then determined based on pre-defined standards or thresholds (*i.e.*, significance rating criteria) specific to each VC.

The environmental effects associated with potential accidental events as well as the effects of the environment on the Project are considered separately in this EIS (Sections 8 and 9, respectively).

Cumulative environmental effects are assessed in Section 10 and consider whether there is potential for the residual environmental effects of the Project to interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities in the vicinity of the Project. The significance of any identified cumulative environmental effects is also assessed in Section 10.

Figure 6.2.1 illustrates the environmental assessment framework used in this EIS.

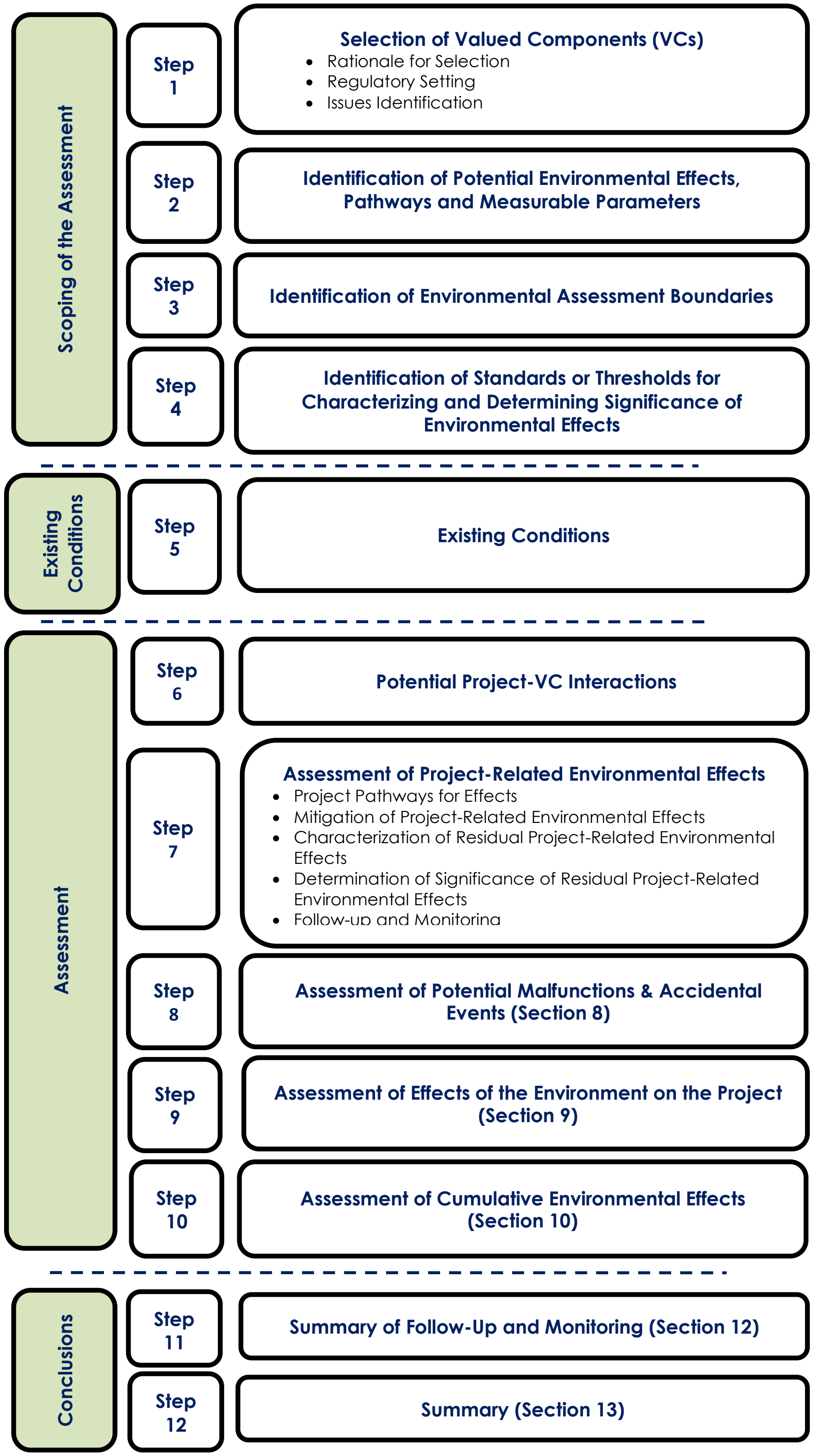


Figure 6.2.1 Overview of Environmental Assessment Process

6.2.2 Selection of Valued Components

The selection of VCs was carried out in consideration of:

- regulatory guidance and requirements, including the Project-specific EIS Guidelines provided by the CEA Agency (CEA Agency 2015a);
- issues raised by regulatory agencies, key stakeholders, and the public (refer to Section 3);
- issues raised by Aboriginal peoples, including traditional ecological knowledge obtained through completion of a TUS for the Project (refer to Section 4 and Appendix B);
- technical aspects of the Project (*i.e.*, the nature and extent of Project components and activities) (refer to Section 2);
- existing environmental conditions in the Project Area and interconnections between the biophysical and socio-economic environment (refer to Section 5);
- experience and lessons learned from similar offshore projects (*e.g.*, Shelburne Basin Venture Exploration Drilling Project) as well as SEAs completed for the Scotian Shelf and Slope; and
- the professional judgment of the EA Study Team.

Section 5 of CEAA, 2012 was also influential in selecting appropriate VCs for the assessment (refer to Section 6.1.2 of this EIS for a discussion of CEAA, 2012 section 5 requirements).

Candidate VCs for consideration were selected from various sections throughout the EIS Guidelines (CEA Agency 2015a) including components listed for baseline conditions (Section 6.1 of EIS Guidelines) and components with predicted changes (Sections 6.2 and 6.3 of the EIS Guidelines). Table 6.2.1 presents the VCs assessed in this EIS and the rationale for their selection or exclusion. Relevant sections of the EIS are referenced where applicable.

The following six VCs were selected to facilitate a focused and effective EA process that complies with government requirements and supports public review:

- Fish and Fish Habitat;
- Marine Mammals and Sea Turtles;
- Migratory Birds;
- Special Areas;
- Commercial Fisheries; and
- Current Aboriginal Use of Lands and Resources for Traditional Purposes.

Specific candidate VCs identified in the EIS Guidelines which were not selected as stand-alone VCs in this EIS include Marine Plants, Federal Species at Risk, Air Quality and Greenhouse Gas Emissions, and Human Environment. Marine plants are addressed, as relevant, in the Fish and Fish Habitat VC. Species at risk and species of conservation concern are considered as part of the

Fish and Fish Habitat VC, the Marine Mammals and Sea Turtles VC, and the Migratory Birds VC rather than as a stand-alone VC to eliminate repetition throughout the EIS.

Some candidate VCs identified in the EIS Guidelines have been addressed throughout the EIS, however because no interactions are predicted, they have not been selected for a focused assessment as stand-alone VCs. For example, air quality and greenhouse gas emissions are addressed in Section 2.8.1 of this EIS. It has been determined that in light of the distance offshore and the lack of any sensitive receptors in close proximity to the Project Area, as well as the limited atmospheric emissions predicted for the Project that the environmental effects on the atmospheric environment and climate do not warrant focussed assessment. Human environment aspects are discussed in Section 5.3, however given the lack of predicted interactions with most aspects of the human environment (as demonstrated in Table 6.2.1), it was not selected as a VC.

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Biophysical Environment			
Atmospheric Environment and Climate (including Air Quality and Greenhouse Gas Emissions)	In consideration of the environmental context and the mitigation referred to in the next column, it has been determined that environmental effects on atmospheric environment and climate do not warrant focused assessment. This component has therefore not been selected as a VC; however, potential changes to the atmospheric environment are addressed elsewhere in the EIS.	• All nearshore and offshore Project-related vessel operations will take place in Canada's portion of the North American ECA, which was established under amendments to the *Dangerous Chemicals Regulations* pursuant to the *Canada Shipping Act* that were adopted in 2013 under Annex VI to MARPOL. New standards have been implemented for the ECA that are designed to reduce allowable emissions of key air pollutants by ships such that, by 2020, emissions of sulphur oxide will be reduced by 96% and nitrogen oxides by 80% (TC 2013). • Given its distance offshore and the limited atmospheric emissions predicted for the Project as described in Section 2.7.2, the Project Area does not contain any receptors that would be sensitive to atmospheric emissions from Project activities and components. • Changes to the atmospheric environment (sound and light) are assessed with respective to potential biological receptors.	• *Section 2.8.1:* Description of project atmospheric emissions • *Sections 2.8.5* and *7.1.1:* Changes related to ambient sound levels • *Section 5.1.2:* Existing conditions regarding the atmospheric environment and climate • *Sections 7.2* and *7.3:* Changes to sound levels and associated effects on fish and fish habitats and marine mammals and sea turtles • *Section 7.4:* Changes in lighting levels and effects on migratory birds • *Section 9:* Effects of the environment on the Project (including the effects of climate change) • *Section 11.1.3:* Summary of changes to the atmospheric environment since the Project requires a federal decision as identified in section 5(2) of CEAA, 2012
Marine Environment	Project activities will result in changes to the marine environment; however these changes are evaluated in the context of other marine VCs (*e.g.*, Fish and Fish Habitat,	• Effects of the Project on the marine environment are evaluated as applicable in the context of all the other VCs in the EIS. • Potential changes to marine water quality and benthic environment are evaluated in the context of the Fish and Fish Habitat VC.	• *Section 5:* Description of biophysical and socio-economic aspects of the marine environment • *Section 7.2:* Fish and Fish Habitat, *Section 7.3:* Marine Mammals and Sea Turtles, *Section 7.4:* Migratory Birds, and

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	Marine Mammals and Sea Turtle) where the analysis of effects and mitigation can be more specific. Marine Environment has therefore not been selected as a VC.	Changes to underwater ambient noise and vibration levels are evaluated in the context of the Fish and Fish Habitat VC, Marine Mammal and Sea Turtles VC, Special Areas VC, Commercial Fisheries VC, and Current Aboriginal Use of Resources for Traditional Purposes VC. • Important and critical habitat for marine species is addressed in the context of the relevant biological VC.	*Section 7.5:* Special Areas • *Section 7.6:* Commercial Fisheries, and *Section 7.7:* Current Aboriginal Use of Resources for Traditional Purposes
Fish and Fish Habitat	Environmental effects on fish (including applicable SAR and SOCC) and fish habitat are assessed within the Fish and Fish Habitat VC. This VC is included in consideration of its ecological importance, the socio-economic importance of fisheries resources (*i.e.*, target fish species), the legislated protection of fish and fish habitat and applicable SAR and SOCC, and the nature of potential Project-VC interactions.	• Several species of fish (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected (including effects on fish habitat) by Project activities and components as well as accidental events associated with the Project. • Project effects on fish and fish habitat has been identified as an issue of concern during Aboriginal and stakeholder engagement (refer to Sections 3 and 4). • Fish and fish habitat are protected under the *Fisheries Act*. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, fish and fish habitat as defined in the *Fisheries Act*).	• *Sections 5.1* and *5.2:* Existing conditions regarding fish and fish habitat • *Section 7.2:* Project-related environmental effects on fish and fish habitat • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Marine Plants	Marine plants are addressed within the Fish and Fish Habitat VC where applicable. Marine Plants has therefore not been selected as a VC.	• Marine plants are not located in the Project Area (given water depth) and routine Project activities are not predicted to interact with marine plants which occur in the nearshore. • Accidental events that could potentially interact with the nearshore environment and therefore potentially affect marine plants, are addressed in the assessment of Fish and Fish Habitat.	• *Section 5.2.3:* Existing conditions regarding marine plants • *Section 7.2:* Project-related environmental effects on marine plants • *Section 8.5:* Environmental effects of potential accidental events
Migratory Birds and their Habitat	Environmental effects on migratory birds (including applicable SAR and SOCC and migratory bird habitat) are assessed within the Migratory Birds VC. This VC is included in consideration of its ecological importance, the legislated protection of migratory birds and other applicable SAR and SOCC, and the nature of potential Project-VC interactions.	• Several species of migratory birds (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Migratory birds are protected under the MBCA. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, migratory birds as defined in the MBCA).	• *Section 5.2.6:* Existing conditions regarding migratory birds • *Section 7.4:* Project-related environmental effects on migratory birds • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)

Species at Risk and Species of Conservation Concern	To reduce redundancy and promote EA efficiency, environmental effects on SAR and SOCC are assessed as part of the Fish and Fish Habitat VC, Marine Mammals and Sea Turtles VC, and the Migratory Birds VC rather than as a stand-alone VC.
	Effects and/or mitigation specific to SAR and SOCC will be highlighted as applicable.
		• SAR and SOCC include the following:
		  ○ Federally protected species listed as “endangered”, “threatened”, or of “special concern” on Schedule 1 of SARA, and their critical habitat
		  ○ species assessed as “endangered”, “threatened”, or of “special concern” by the federal Committee on the Status of Endangered Wildlife of Canada (COSEWIC)
		  ○ species listed as “endangered”, “threatened”, or “vulnerable” under the *Species at Risk Regulations* pursuant to the Nova Scotia *Endangered Species Act* (NS ESA), which are provincially protected
		• Several SAR and SOCC are known to occur in the vicinity of the Project Area, including fish, other aquatic species (*e.g.*, marine mammals, sea turtles) and migratory birds, and have potential to be affected by routine Project activities as well as accidental events associated with the Project.
		• SAR and SOCC can be more vulnerable to changes in their habitat or population levels than secure species and therefore require special consideration. However, in general, evaluation of potential environmental effects and mitigation measures taken to protect SAR and SOCC are also protective of secure
			• *Section 5.2.9:* Summary of marine SAR and SOCC (including applicable species of fish, mammals, turtles, and birds) with potential to be affected by the Project
			• *Section 7.2:* Assessment of project-related environmental effects on fish SAR and SOCC
			• *Section 7.3:* Assessment of project-related environmental effects on marine mammal and sea turtle SAR and SOCC
			• *Section 7.4:* Project-related environmental effects on migratory bird SAR and SOCC
			• *Section 8.5:* Environmental effects of potential accidental events
			• *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		species. • With respect to marine mammals and sea turtles, many of the species found in the area are considered SAR or SOCC; therefore separate VCs to assess secure species and SAR/SOCC would be redundant. SAR/SOCC for these species have therefore been addressed within the Marine Mammals and Sea Turtles VC.	
Marine Mammals	Environmental effects on marine mammals (including applicable SAR and SOCC) are assessed within the Marine Mammals and Sea Turtles VC. This VC is included in consideration of its ecological importance, the legislated protection of applicable SAR, and the nature of potential Project-VC interactions. Marine mammals and sea turtles are considered within the same VC due to the similarities in their potential interactions with the Project.	• Several species of marine mammals (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, aquatic species as defined in SARA).	• *Section 5.2.6:* Existing conditions regarding marine mammals • *Section 7.3:* Project-related environmental effects on marine mammals • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Marine Turtles	Environmental effects on marine turtles (including applicable SAR and SOCC) are assessed within the Marine Mammals and Sea Turtles VC. This VC is included in consideration of its ecological importance, the legislated protection of applicable SAR, and the nature of potential Project-VC interactions. Marine mammals and sea turtles are considered within the same VC due to the similarities in their potential interactions with the Project.	• Marine turtles (including SAR and SOCC) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Section 5(1)(a) of CEAA, 2012 requires consideration of project-related environmental effects associated with a change to a component of the environment within the legislative authority of Parliament (*e.g.*, aquatic species as defined in SARA).	• *Section 5.2.7:* Existing conditions regarding sea turtles • *Section 7.3:* Project-related environmental effects on sea turtles • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects
Special Areas	Environmental effects on Special Areas are assessed within the Special Areas VC. This VC is included in consideration of its ecological and/or socio-economic importance, the legislated protection of applicable Special Areas, and the nature of potential Project-VC interactions.	• Several Special Areas (*i.e.*, areas designated as being of special interest due to their ecological and/or conservation sensitivities, including those protected under federal legislation) are known to occur in the vicinity of the Project Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Special areas provide important (and sometimes "critical") habitat for certain SAR/SOCC.	• *Section 5.2.10:* Existing conditions regarding Special Areas • *Section 7.5:* Project-related environmental effects on Special Areas • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Human Environment			
Aboriginal Peoples	Environmental effects on the current use of lands and resources for traditional purposes by Aboriginal peoples are assessed with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes VC. This VC is included in consideration of its socio-economic, socio-cultural and/or traditional importance; in recognition of potential or established Aboriginal and Treaty rights; and due to the nature of potential Project-VC interactions.	• Aboriginal communal commercial fishing activity is known to occur in the vicinity of the Project Area and has potential to be affected by Project activities and components as well as accidental events associated with the Project. • Aboriginal commercial and traditional fishing activities are also carried out under communal commercial licences and food, social and ceremonial (FSC) licences in the nearshore waters of Nova Scotia. • Project activities can potentially interact with fisheries species harvested offshore or nearshore, particularly migratory species. Section 5(1)(c) of CEAA, 2012 requires consideration of project-related environmental effects, with respect to Aboriginal peoples, associated with a change to the environment on the current use of lands and resources for traditional purposes.	• *Section 4:* Context for Aboriginal organizations (including locations of reserves and communities) • *Section 5.3.5:* Existing conditions regarding the current Aboriginal use of lands and resources for traditional purposes • *Section 7.7:* Project-related environmental effects on the current Aboriginal use of lands and resources for traditional purposes • *Section 8.5:* Environmental effects of potential accidental events • *Section 10.2:* Cumulative environmental effects • *Section 11.2.1:* Effects of Changes to the Environment on Aboriginal People • *Appendix B:* The TUS undertaken in support of the Project
Commercial Fisheries	Environmental effects on commercial fisheries are assessed with respect to the Commercial Fisheries VC. This VC is included in consideration of its economic importance and the potential	• Commercial fishing activity is known to occur in the vicinity of the Project Area and has potential to be affected by Project activities and components as well as accidental events associated with the Project. • Commercial fishing activity in the nearshore waters of Nova Scotia has potential to be affected by accidental events associated	• *Section 5.3.5:* Existing conditions regarding commercial fisheries • *Section 7.6:* Project-related environmental effects on commercial fisheries • *Section 8.5:* Environmental effects of potential accidental events

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	for Project-VC interactions.	with the Project. • Project activities can potentially interact with fisheries species harvested offshore or nearshore, including migratory species. • Environmental effects on Aboriginal fisheries (including communal commercial fisheries) are assessed with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes VC.	• *Section 10.2:* Cumulative environmental effects
Recreational Fisheries and other Areas used for Recreational Activities	In consideration of the environmental context and the mitigation referred to in the next column, the environmental effects on recreational fisheries and other recreation do not warrant focused assessment. This component has therefore not been selected as a VC. Changes to the environment potentially affecting species targeted for recreational fishing are addressed elsewhere in the EIS (*e.g.*, accidental events).	• Recreational fisheries and other forms of recreation are not known to occur in the vicinity of the Project Area. These activities are located closer to the nearshore and therefore are not predicted to interact with routine Project activities. PSVs will use existing shipping routes and are not expected to interfere with nearshore recreational activities. • Recreational activity (including fishing) in the nearshore waters of Nova Scotia has potential to be affected by accidental events associated with the Project. • Mitigation measures for the protection of nearshore commercial fishing activity (and associated target fish species) from Project-related accidental events are also protective of nearshore recreational fishing activity (and associated target fish species). It is therefore anticipated that mitigation proposed for the Fish and Fish Habitat VC and the Commercial	• *Section 5.3.4:* Existing conditions regarding recreational activities • *Section 7.2:* Project-related environmental effects on fish and fish Habitat • *Section 7.6:* Project-related environmental effects on commercial fisheries • *Section 8.5:* Environmental effects of potential accidental events

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		Fisheries VC are sufficient to mitigate similar environmental effects on recreational fisheries.	
Other Ocean Use (*e.g.*, shipping, research, oil and gas, military activities, ocean infrastructure)	In consideration of the environmental context and the mitigation referred to in the next column, environmental effects on other ocean use do not warrant assessment as a VC. This component has therefore not been selected as a VC. However, "other ocean use" is discussed generally in the EIS as indicated.	• Offshore oil and gas exploration in Canadian waters is a highly regulated activity. Standard guidelines and protocols govern nearly every aspect of exploration activities, including avoidance of conflicts with other ocean use such as military activities and scientific research. In particular, Notices to Shipping and Notices to Mariners are issued to notify other ocean users of the presence of potential navigational obstructions posed by exploration activities. • Other ocean users with potential to be affected by the Project will be notified regarding the timing and location of Project activities and components (*e.g.*, through direct communications and/or the issuance of Notices to Shipping) to mitigate potential disruption.	• *Section 5.3.4:* Existing conditions regarding offshore ocean uses and infrastructure • *Section 10:* Potential interactions between residual Project-related environmental effects and the residual environmental effects of projects or activities carried out by other offshore users are considered in the cumulative environmental effects assessment
Human Health, and Socio-economic Conditions	In consideration of the environmental context and the mitigation referred to in the next column, environmental effects on human health and socio-economic conditions do not warrant focused assessment. This component therefore has not been selected as a VC.	• Socio-economic benefits associated with the Project are discussed in Section 1.4. • Given its distance offshore, the Project would be unlikely to affect any receptors that would be sensitive to atmospheric air or noise emissions from routine Project activities and components, or from accidental events. • Project activities and components are not anticipated to result in any changes to the	• *Section 1.4:* Benefits of the Project • *Section 2.7.2:* Routine waste discharges and emissions associated with the Project • *Section 5.3.2:* Existing conditions regarding labor and economy • *Section 5.3.3:* Existing conditions regarding human health

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		environment that would have an effect on human health. Emissions will be discharged in accordance with allowable concentrations stated in the OWTG. • Accidental events (*i.e.*, spills) associated with the Project could result in contamination of fish species commonly harvested for human consumption through commercial, recreational, and/or Aboriginal fisheries. However, fisheries closures would be imposed in the event of such an incident, thereby preventing human exposure to contaminated food sources. Similarly, the imposition of an exclusion zone around the affected area(s) would minimize the potential for human contact with spilled oil.	• *Section 8.4:* Spill response measures • *Section 8.5:* Environmental effects of potential accidental events
Physical and Cultural Heritage (including structures, sites or things of historical, archaeological, paleontological or architectural significance)	In consideration of the environmental context and the mitigation referred to in the next column, the environmental effects on physical and cultural heritage do not warrant focused assessment. This component has therefore not been selected as a VC.	• Project activities and components are not anticipated to result in any changes to the environment that would have an effect on physical and cultural heritage. • BP's imagery based seabed survey will confirm the absence of heritage resources at proposed wellsites. • PSV and helicopter transport activities will not result in any ground/seabed disturbance. Therefore, they will not affect heritage resources.	• *Section 2.2:* Details regarding site surveys to be undertaken in the Project Area in advance of drilling • *Section 5.3.7:* Existing conditions regarding physical and cultural heritage

Table 6.2.1 Selection of Valued Components

Environmental Components Specified in EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Rural and Urban Settings	In consideration of the exclusion of the onshore supply base as part of the Project scope, the environmental effects on rural and urban settings do not warrant focused assessment. This component has therefore not been selected as a VC.	• Routine Project activities are not anticipated to result in any changes to the environment that would have an effect on rural and urban settings. • Accidents and malfunctions that could potentially interact with the mainland Nova Scotia coastline are assessed in terms of ecological and socio-economic receptors and are not expected to result in a change in rural and urban settings.	• *Section 5.3.1:* Existing conditions regarding land use and nearshore ocean use • *Section 8.5:* The environmental effects of potential accidental events

6.2.3 Scoping of the Assessment

The following section describes the approach and organization of the effects assessment undertaken for each VC.

6.2.3.1 Regulatory Setting

The regulatory context is described for each individual VC, including an overview of applicable regulations, policies, or administrative mechanisms. This section helps to establish key aspects of the scope of assessment including relevant definitions under legislation, measureable parameters and significance thresholds, where applicable.

6.2.3.2 The Influence of Engagement on the Assessment

Any VC-specific issues that have been raised during stakeholder and Aboriginal engagement activities are summarized in this section including the extent to which identification and consideration of these issues has influenced the scope of the assessment for the individual VC.

6.2.3.3 Potential Environmental Effects, Pathways and Measurable Parameters

Potential environmental effects arising from interactions between the Project and each selected VC are identified in their respective subsections in Section 7. For each individual VC, potential environmental effects are identified and one or more measurable parameters are selected to facilitate quantitative or qualitative assessment of those effects. Measurable parameters for biophysical VCs include measures of ecosystem health and integrity. Where applicable, measurable parameters also reference regional, provincial and/or national objectives, standards or guidelines.

6.2.3.4 Environmental Assessment Boundaries

Environmental effects are evaluated within spatial and temporal boundaries. The spatial and temporal boundaries may vary among VCs, depending on the nature of potential environmental effects. The spatial boundaries must reflect the geographic range over which the Project's potential environmental effects may occur, recognizing that some environmental effects will extend beyond the Project Area. Temporal boundaries identify when an environmental effect may occur. The temporal boundaries are based on the timing and duration of Project activities and the nature of the interactions with each individual VC. Spatial and temporal boundaries are developed for each VC in consideration of:

- timing/scheduling of Project activities for all Project phases;
- known natural variations of each VC;
- information gathered on current and traditional land and resource use;
- the time required for recovery from an environmental effect; and
- potential for cumulative environmental effects.

The temporal boundaries for the Project to be assessed encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

The spatial boundaries for the Project to be assessed are defined below with respect to Project activities and components.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. As a subset of the Project Area, the wellsite is referenced in the assessment discussion, where relevant, to more appropriately characterize the associated effects. The Project Area is consistent for all VCs and includes ELs 2431, 2432, 2433, and 2434 as depicted on Figure 2.2.1.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects are reasonably expected to occur based on available information including effects thresholds, predictive modelling and professional judgement. The LAA has also been defined to include PSV routes to and from the Project Area. A figure depicting the applicable LAA for each VC is provided in its respective subsection of Section 7.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities. The RAA is 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 western extent of the RAA encompasses the Georges Bank Oil and Gas Moratorium Area and terminates at the international maritime boundary between Canada and the United States. The eastern extent of the RAA extends into the Laurentian Channel to the NAFO division 4S boundary and approaches the Nova Scotia coastline along the boundary of NAFO Unit Area 4VSb. The RAA extends along the Nova Scotia coastline from North Fourchu, Richmond County to Comeaus Hill, Yarmouth County. The RAA is consistent for all VCs and is depicted on Figure 2.2.1. Although the RAA is intended to be much broader than the LAA which focuses on the extent of potential effects associated with routine Project activities for each VC, it is possible that effects from larger scale unplanned events (*e.g.*, blowout) could extend beyond the RAA.

6.2.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

In consideration of the Operational Policy Statement, *Determining Whether a Designated Project is Likely to Cause Significant Environmental Effects under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2015b), criteria or established thresholds for determining the significance of residual adverse environmental effects are identified for each VC and are included in the corresponding sections in the impact assessment chapter (Section 7). These criteria or thresholds are defined using:

- available information on the status and characteristics of each VC;
- scientific literature to assess and qualify significance of an impact (*e.g.*, Southall *et al.* 2007; French-McCay 2009);
- applicable regulatory documents, environmental standards, guidelines, or objectives where available; and
- the professional judgment of the EA Study Team.

These criteria or thresholds establish a level beyond which a residual environmental effect would be considered significant (*i.e.*, an unacceptable change). Where pre-established standards or thresholds do not exist, significance criteria have been defined qualitatively and justifications for the criteria provided.

Additional criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context) are also identified and defined for each VC to support characterization of the nature and extent of residual environmental effects (refer to Section 6.2.5).

6.2.4 Existing Conditions

Existing conditions of the marine physical environment, marine biological environment, and socio-economic environment are described in Section 5 to characterize the setting for the Project, support an understanding of the receiving environment, and provide sufficient context for the effects assessment. A brief overview of existing conditions is also provided for each VC in Section 7, highlighting key information to support the assessment. Inclusion of information on existing conditions is limited to that which is necessary to assess the environmental effects of the Project and support recommendations for mitigation, monitoring and follow-up, as applicable.

6.2.5 Assessment of Project-Related Environmental Effects

The assessment of Project-related environmental effects follows a sequential process whereby potential interactions between each VC and the Project are first identified, and where such interactions may exist, a more detailed assessment of those effects is completed to further characterize the potential effects.

For each VC, a table is used to list Project activities and components, and to identify potential interactions from those Project activities and components with the VC. Interactions are indicated by checkmarks and are discussed in the context of effects pathways, standard and Project-specific mitigation, and residual effects.

- The assessment of potential environmental effects includes: identification of environmental effects pathways (*i.e.*, identification of the means by which the Project could result in an environmental effect on the VC);
- description of the mitigation measures proposed to reduce or eliminate potential environmental effects, including industry standards, best management practices and environmental protection measures that BP will implement;
- identification and characterization of the nature and extent of potential residual environmental effects (*i.e.*, those environmental effects that remain after the proposed mitigation measures have been applied) through application of specific criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context); and
- determination of significance of the residual effects. Where a residual significant effect is predicted, a determination of likelihood based on consideration of probability and uncertainty is given.

The following criteria are used to characterize residual environmental effects on each VC.

- Direction: pertains to whether the effect is predicted to be positive, adverse, or neutral.
- Magnitude: refers to the amount of change in a measurable parameter relative to baseline conditions or other standards, guidelines or objectives. This predicted change may be expressed quantitatively or qualitatively (*i.e.*, negligible, low, moderate, high).
- Geographic Extent: refers to the geographic area or spatial scale over which the residual effect is expected to occur (*i.e.*, within the Project Area, LAA, or RAA).
- Duration: refers to the length of time the residual effect will occur (*i.e.*, short-term, medium-term, long-term, permanent).
- Frequency: refers to how often the residual effect occurs (*i.e.*, single event, multiple irregular events, multiple regular events, continuous).
- Reversibility: pertains to whether or not the residual effect on the VC can be returned to its previous condition once the activity or component causing the disturbance ceases (*i.e.*, reversible or irreversible).
- Context: refers to the current degree of anthropogenic disturbance and/or ecological sensitivity in the area in which the residual effect may occur.

Table 6.2.2 provides an example of generic criteria used to describe residual effects. Refer to Section 7 for VC-specific criteria.

Table 6.2.2 Generic Characterization of Residual Environmental Effects

Characterization	Description	Quantitative Measure of Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial relative to baseline. **Adverse** – an effect that moves measurable parameters in a detrimental direction relative to baseline. **Neutral** – no net change in measureable parameters relative to baseline.
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible** – no measurable change in species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability; will not affect population viability **Moderate** – measurable change but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies how often the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs at not set schedule **Multiple Regular Event** – occurs at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

Following a characterization of the residual effects, a determination of the significance is provided.

The level of confidence is provided for each determination of significance, which is typically based on professional judgment, prior experience, and scope and quality of available information. Where a significant effect is predicted to occur, the likelihood of this significant effect is discussed in the context of probability and certainty.

Following the determination of significance, follow-up and monitoring measures are recommended, where required, to verify environmental effects predictions or to assess the effectiveness of proposed mitigation measures.

6.2.6 Assessment of Accidental Events

Environmental effects associated with potential accidental events are assessed in Section 8. The focus of the assessment is on credible worst-case accidental event scenarios that could result in significant environmental effects. Interactions with VCs are identified for these scenarios, and potential environmental effects are assessed. A description of the planned mitigation and contingency measures is provided, and a conclusion regarding the significance of potential residual environmental effects and their likelihood of occurrence is given. Section 8 provides further details regarding approach to the assessment for the potential accidental events.

6.2.7 Effects of the Environment on the Project

Effects of the environment on the Project are assessed in Section 9. This section considers how local environmental conditions and natural hazards (*e.g.*, extreme weather) could adversely affect the Project and thus result in potential effects on the environment (*e.g.*, accidental events). Section 9.3 defines criteria for what would be considered to be a significant effect on the Project. Potential adverse effects of the environment on a project are typically a function of project design and environmental conditions that could affect the project. These effects are generally mitigated through engineering and environmental design criteria, industry standards, and environmental monitoring.

6.2.8 Assessment of Cumulative Environmental Effects

Cumulative environmental effects are assessed in Section 10 of this EIS in accordance with the CEA Agency's (2013a) Operational Policy Statement (OPS), *Assessing Cumulative Environmental Effects Under the Canadian Environmental Assessment Act, 2012*. Potential cumulative environmental effects are identified in consideration of potential interactions with other physical activities that have been or will be carried out in the vicinity of the Project. These other physical activities include certain or reasonably foreseeable future undertakings. The assessment of cumulative environmental effects is carried out with respect to any Project-related residual environmental effect that is considered likely to overlap with the residual environmental effect of another past, present, or future physical activity.

Where there is potential for cumulative interaction, the residual environmental effects of the Project are assessed in combination with those of other physical activities. The contribution of the Project to the cumulative environmental effects is evaluated, and the significance of residual cumulative environmental effects is determined. Section 10 provides further details regarding the approach to the assessment of cumulative environmental effects.

7.0 ENVIRONMENTAL EFFECTS ASSESSMENT

This section of the EIS identifies and evaluates environmental effects that are likely to result from interactions between Project activities and components and the receiving environment, focusing on the VCs selected in Section 6.

Section 7.1 presents an overview of existing knowledge of potential interactions and effects from past environmental assessment reports (including the Shelburne Basin Venture Exploration Drilling Project EIS [Stantec 2014a], the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey [LGL 2014], and the Environmental Assessment of Exploration Drilling of the Cabot Licence EL 2403 [BP 2003]), SEAs, monitoring programs, and scientific literature with respect to the individual Project activities and components. This information is designed to improve understanding of the potential interactions and resulting environmental effects in order to help facilitate the VC-based analysis of environmental effects that follows in Sections 7.2 to 7.7.

7.1 OVERVIEW OF POTENTIAL INTERACTIONS

This section of the EIS focuses on existing knowledge regarding potential interactions between Project activities and environmental components. Key Project activities and components are addressed within the scope of the EIS, and are summarized from the information presented in Section 2. The selection of VCs is scoped in Section 6. There are several potential interactions between the key Project activities and the VCs that require evaluation for environmental effects. Each of these interactions is noted in Table 7.1.1 and discussed below, in the context of existing scientific knowledge and standard mitigation/best management practices, to facilitate the VC analyses that follow in Sections 7.2 to 7.7.

An overview of the underwater sound propagation and cuttings dispersion assessments carried out in support of this EIS, including modelling work, is also described in this section.

Table 7.1.1 Potential Interactions between the Project and Valued Components

Project Activities and Components	VC					
	Fish and Fish Habitat	Marine Mammals and Sea Turtles	Migratory Birds	Special Areas	Commercial Fisheries	Current Aboriginal use of Lands and Resources for Traditional Purposes
Presence and Operation of the MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓	✓	✓	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓	✓	✓	✓	✓	✓
Vertical Seismic Profiling	✓	✓	✓	✓	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓	✓	✓	✓	✓	✓
Well Abandonment	✓	✓		✓	✓	✓

7.1.1 Presence and Operation of the MODU

As explained in Section 2.3.1, the MODU used to support the Project will be either a semi-submersible rig or drillship. The chosen MODU will be stationed in the Project Area during drilling, testing and abandonment activities and will stay on-site using a dynamic positioning (DP) system, which will result in negligible interaction with the sea floor associated with the anchoring of bottom transponders.

It is anticipated that the presence and operation of the MODU will interact with each of the VCs identified in Section 6, as illustrated in Table 7.1.1. This is a result of:

- the 500-m safety (exclusion) zone required by the *Nova Scotia Offshore Drilling and Production Regulations;*
- underwater sounds generated by the DP system, MODU vibration and the drillstring; and
- light generated by deck lighting (continuous) and well test flaring (short term, intermittent when required).

Further detail of existing knowledge of the environmental effects of MODU presence and operation is provided below.

7.1.1.1 Safety (Exclusion) Zone

In accordance with the *Nova Scotia Offshore Drilling and Production Regulations*, a 500-m safety (exclusion) zone will be established around the MODU within which non-Project vessels (*e.g.*, fishing vessels) will be prohibited entry. As explained in Section 2.4.1, the safety (exclusion) zone is designed to prevent collisions between the MODU and other vessels operating in the area. The safety (exclusion) zone will be monitored by the standby vessel at the MODU at all times. No persons other than Project or CNSOPB personnel will be allowed within the safety (exclusion) zone without the permission of the Offshore Installation Manager. The Offshore Installation Manager has the authority, granted by the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, to enforce exclusion and safety (exclusion) zones. Under the *Nova Scotia Offshore Drilling and Production Regulations*, reasonable measures will be taken to warn persons who are in charge of vessels and aircraft of the safety (exclusion) zone boundaries, of the facilities within the safety (exclusion) zone, and of any related potential hazards. BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notices to Shipping and Notices to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with commercial and Aboriginal fishers. The MODU and standby vessel will be equipped with navigation and communication equipment as specified in regulations. The safety (exclusion) zone will create a relatively small, temporary exclusion area of approximately 0.8 km^2 for fishing on the Scotian Slope, potentially affecting commercial and Aboriginal fishers for the period that the MODU is on location.

7.1.1.2 Underwater Sound

The MODU will generate underwater sounds as a result of the DP system and drilling activities. Further information on these activities is provided in Section 2.8.5.1. The DP system will employ thrusters to keep the MODU on location. These thrusters will generate underwater sound through vibration, and through the creation of low pressure points and bubbles known as cavitation; this is the primary mechanism for sounds produced by propellers and thrusters under higher speeds and loads (Leggat *et al.* 1981). Underwater sound will also be generated in association with drilling activities through mechanical vibration of the MODU and associated machinery located on the vessel. During drilling, the drill string and bit will also emit sound into the marine environment.

Exposure to some anthropogenic sounds can result in adverse effects on marine life. There are two categories of potential effects from sound exposure to marine life:

- injury/mortality (including pathological and physiological effects); and
- behavioural effects.

Each of these categories of potential effects is discussed as applicable in the discussion of Fish and Fish Habitat (Section 7.2), Marine Mammals and Sea Turtles (Section 7.3), and Migratory Birds (Section 7.4). A description of how underwater sound is generated and measured is presented below to help inform these VC-specific analyses of effects of underwater sound. Underwater sound associated with other Project activities (*e.g.*, VSP and PSV operations) are discussed in Sections 7.1.3 and 7.1.4.

Fundamentals of Underwater Acoustics

The basic form of sound is the sound wave, which consists of the alternating compression and rarefactions of molecules within a medium (air, earth, water). This wave can be detected by a receiver as changes in pressure. Structures in the ears of marine mammals, fish, turtles, and marine birds, as well as structures sensitive to vibration (*i.e.*, lateral lines and swim bladders in certain species) are sensitive to these changes in pressure (WDCS 2004). The speed of a sound wave is the rate at which vibrations propagate through an elastic medium, and is characteristic of that medium. In water, the speed of sound is a function of the density of the water, which is dependent on temperature, depth (pressure), and salinity. The frequency of the sound wave is measured in Hertz (Hz), which represents the number of compression / rarefaction cycles per second. The perceived pitch of a sound (*e.g.*, low to high notes on a piano) is how the ear and brain subjectively interpret a sound's frequency (low to high respectively). Sounds that have frequencies within an animal's hearing range are audible if they have higher received amplitudes and/or different characteristics as compared to background (ambient) sound levels.

Underwater sound can be characterized as either impulsive (*e.g.*, from a seismic sound source) or non-impulsive (*e.g*., from drilling, or transiting vessels). Sound levels can also be described using a variety of metrics such as sound pressure levels (SPLs), which represent only the pressure component of sound, and sound exposure levels (SELs), which is a measure of energy (pressure squared) that also takes into account the duration of the signal. SPLs can further be measured by either their root-mean-square (RMS) pressure, which indicates an average SPL over a given amount of time, or by their peak pressure (*i.e*., maximum wave amplitude) or peak-to-peak pressure (*i.e*., maximum negative to maximum positive wave amplitude). There can be large differences between these three ways of characterizing SPLs. While there are numerous factors to consider in selecting a metric, RMS calculations are generally more appropriate for measuring non-impulsive signals, as they are highly dependent on the time window that is applied. Peak SPLs are commonly used for impulsive sounds, as they provide information related to the instantaneous intensity of a sound; however, they do not account for the bandwith or duration of the sound, and are therefore a poor indicator for perceived loudness. Historically, RMS SPLs have also been used to characterize pulsed signals.

Sound level (magnitude) is typically measured on the decibel (dB) scale, with RMS SPLs denoted by dB RMS and peak SPLs denoted by dB Peak. The decibel scale is a logarithmic ratio scale of intensity, and is relative and therefore only meaningful if a reference level is included. In underwater acoustics, a reference pressure of 1 μPa is commonly used to describe SPLs (Richardson *et al.* 1995), whereas a reference pressure of 20 μPa is used for sound in air. The logarithmic nature of the decibel scale means that every 10 dB increase in SPL is a ten-fold increase in acoustic power. However, the way an animal (including humans) perceives the "loudness" of a signal, is not the same as the measured signal strength. While 6 dB represents a doubling of signal strength or intensity, humans perceive a10 dB increase as a doubling of sound "loudness". Unlike SPLs, SELs are a measure of the total energy of one or multiple acoustic events over the duration of the event. Since energy is proportional to squared pressure and the reference time for SELs has been set to one second, SELs are presented in dB re 1 μPa^{2}s. SELs can also be measured cumulatively, measuring the total sound energy at a receiver location over a period of time. Cumulative SELs (SEL_{cum}) capture the overall sound levels experienced by sound receivers as a result of multiple sound events over a period of time (Southall *et al*. 2007).

Terms referred to in underwater acoustics include both source and received levels. The source level usually represents the SPL at a distance of 1 m from the source, referenced to 1 μPa (*e.g.*, 200 dB re 1μPa @ 1m). Source levels are usually derived from received levels obtained during field measurements at some distance from the source, and back-propagated to a distance of 1 m using an acoustic propagation model. This method can overestimate actual near-field source levels for complex sound sources such as seismic arrays, which are made up of multiple source elements; however, these considerations are incorporated into acoustic modelling when predicting sound propagation and transmission loss (see Appendix D). Received levels are usually measured at the receiver's position or predicted through modelling based on estimated source levels, environmental conditions, distance to the receiver, and transmission loss over that distance.

The intensity of sound weakens as it travels through water as a result of spreading and attenuation; this is known as transmission loss. Transmission loss due to spreading can occur in one of two simplistic forms: spherical or geometric spreading loss; or cylindrical spreading loss (Richardson *et al.* 1995). Spherical spreading loss assumes a uniform environment, which is typically found in deep waters (typically >200 m). Cylindrical spreading loss occurs when a water body is non-homogenous such as in shallow coastal waters (<200 m) or in stratified water bodies. Under cylindrical spreading loss, sound is reflected or refracted off the sea surface, seabed, or off water layers of differing densities. As a result, if there are density gradients in the water column, sound can travel much farther than when the water column is mixed and homogeneous (WDCS 2004). In reality, transmission loss falls somewhere between these various forms (see Appendix D for further details of calculations used in the acoustic modelling).

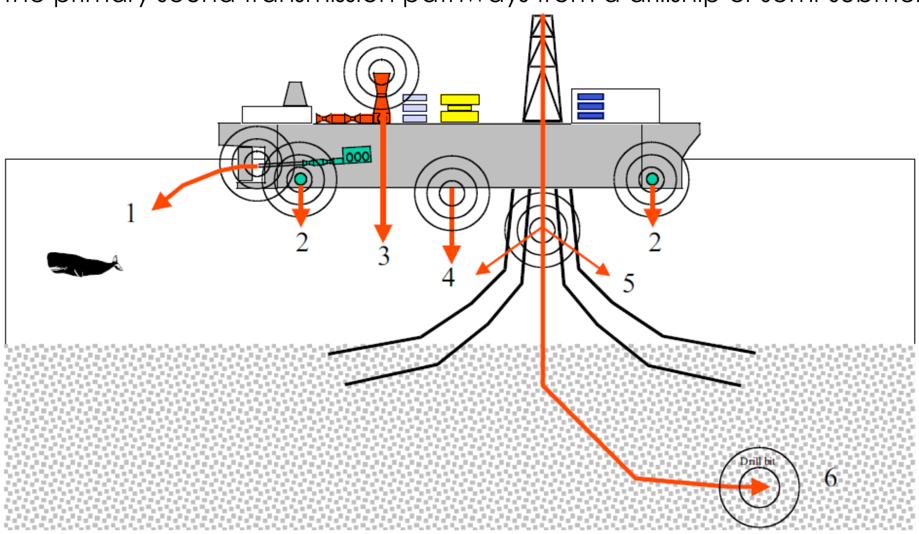
Underwater Acoustic Modelling of Project Activities

JASCO Applied Sciences was engaged to perform acoustic modelling to predict underwater sound levels associated with the MODU, PSV, and VSP (Zykov 2016; Appendix D). As some exact Project details were not available at the time of modelling, two representative wellsites were selected for modelling purposes, and multiple scenarios were modelled at each site to cover different configurations of the acoustic sources (MODU type with/without PSV), as well as potential seasonal variations (winter versus summer). The two representative wellsites were selected within the viable drilling area and included the deepest and shallowest potential locations within the drilling area to demonstrate the potential effect of water depth on the propagation of sound.

MODU source levels were modelled assuming all thrusters operating at their highest operating load (*i.e.*, the highest sustainable revolutions per minute [rpm]) and it was assumed that sound levels from cavitation processes on the thruster propellers dominate all other sources of vessel sound output, including drilling operations. This assumption was validated through comparison of modelled MODU source levels with source levels of similar vessels obtained from direct measurements. Estimated broadband source levels from acoustic modelling and literature values are summarized in the following section. Further details on the acoustic modelling are available in Appendix D. Sound emissions associated with VSP and PSV operations are discussed in Sections 7.1.3 and 7.1.4, respectively.

Sound Levels Associated with the Presence and Operation of the MODU

MODUs vary in form, shape, and size. The MODU design, in combination with the local oceanographic conditions, will affect how much sound is transferred into the water. The presence and operation of the MODU will introduce underwater sound via three primary pathways: mechanical and vibrational sounds from the MODU itself, propeller and thruster cavitation from the DP system, and direct drilling sounds from the drill string and drill bit. Figure 7.1.1 depicts the primary sound transmission pathways from a drillship or semi-submersible drill rig.



Source: WDCS 2004

(1) Cavitation associated with the propeller, (2) Cavitation associated with thrusters, (3) Exhaust ports, (4) Hull vibration associated with machinery, (5) Vibration through drill string casing or risers, and (6) Vibration of the drill bit.

Figure 7.1.1 Sound Transmission Pathways and Sources of Sound Associated with a Drillship or Semi-submersible Drilling Vessel

Mechanical vibration created by the operation of the MODU will result in underwater sounds transferred to the sea via either the ship hull (*i.e.*, in the case of a drillship) or drilling floats. Within the machinery itself, sound and vibrations are created by propulsion equipment, including diesel engines, thrusters, main motors, and reduction gears. Sound can also be created from auxiliary machinery onboard the MODU, including generators, pumps, and HVAC equipment (WDCS 2004).

During operations, the DP thruster system will run continuously, keeping the MODU on station. Each well is estimated to take up to 120 days to drill, with drilling operations occurring 24-hours a day. It is expected that all sources of sound (thrusters, vessel machinery and vibration, drill string) will be operated continuously during drilling. Sound emissions during testing and abandonment activities may be reduced slightly as a result of the removal of the drill string and associated drilling sounds, but the anticipated sound emissions from the operation of the MODU will be similar throughout all Project activities. Under higher propulsion system load (*e.g.*, when thrusters are positioning the vessel) and at higher speeds, the acoustic output from the cavitation processes is expected to dominate over all other sources of sound on the vessel (Leggat *et al.* 1981).

A drillship or a semi-submersible drilling vessel could be used in the Project; therefore, sound levels from both of these scenarios were modelled, along with the presence of a PSV operating alongside the MODU (Appendix D). The estimated broadband source levels for the drillship and semi-submersible drilling vessel were both approximately 197 dB re 1 µPa @ 1 m RMS SPL. Previously reported SPLs produced by operating MODUs range from 130 to 190 dB re 1 µPa @ 1 m RMS SPL (peak frequency 10 to10,000 Hz) (Richardson *et al.* 1995; Hildebrand 2005; OSPAR 2009). Drilling sounds from a rig used in the Beaufort Sea were recorded at approximately 150 dB re 1 µPa @ 1 m RMS SPL at 30 to 40 Hz (OSPAR 2009). Measurements from the drillship *Stena Forth* operating in Baffin Bay in 2010 recorded source levels of 184 dB re 1 µPa @ 1 m RMS SPL (NERI 2011). These example RMS SPLs take into account the combination of all sound sources emitted from the MODU. Based on these previously reported field values, source levels estimated and used in the acoustic modelling (with all thrusters operating at nominal speeds) are higher than those that have been measured and therefore considered conservative for the assessment of potential acoustic effects. Refer to Sections 7.2 Fish and Fish Habitat, and Section 7.3 Marine Mammals and Sea Turtles for a discussion of modelling results and predicted effects on marine life.

7.1.1.3 Lights and Flares

The MODU will emit light. The effects of these light emissions will be strongest above the surface of the water, although some deck lighting is likely to affect areas of the water column down to a certain depth which will be dependent on the strength of the light as well as the various properties of the water itself (factors such as the quality and concentration of suspended particulate matter that affect light attenuation and scattering). Flaring during well testing, if required, will also generate light emissions. However, it is currently anticipated that well testing will not be carried out on the first two wells drilled as part of the Project. If flaring is required, these light emissions will be temporary, short-term and intermittent (*e.g.*, from a few hours up to three days).

Artificial lighting on ships, offshore drilling and production structures, coastal communities, and oceanic island communities regularly attract nocturnally-active seabirds and nocturnally migrating land and waters birds, sometimes in large numbers (Imber 1975; Montevecchi *et al.* 1999; Wiese *et al.* 2001; Gauthreaux and Belser 2006; Montevecchi 2006; Bruinzeel *et al.* 2009; Bruinzeel and van Belle 2010; Ronconi *et al.* 2015), resulting in sublethal and lethal effects. More information on potential interactions between lights and flares and migratory birds is provided in Section 7.4.

Light emitted from the MODU can also affect the light and dark cycle for aquatic species inhabiting the upper layers of the water column, potentially attracting species to the light source and/or interrupting circadian rhythms.

Lighting on the MODU and PSVs will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

7.1.2 Waste Management

As explained in Section 2.8, a number of liquid discharges and solid wastes could be generated from the MODU and associated drilling equipment, and on the PSVs, thereby potentially affecting water, sediment and/or air quality and directly or indirectly affecting the VCs as illustrated in Table 7.1.1. Offshore waste discharges and emissions associated with the Project (*i.e.*, operational discharges and emissions from the MODU and PSVs) will be managed in accordance with relevant regulations and municipal bylaws as applicable, including the Offshore Waste Treatment Guidelines (OWTG) (NEB *et al.*, 2010) and the International Convention for the Prevention of Pollution from Ships (MARPOL), of which Canada has incorporated provisions under various sections of the *Canada Shipping Act*. Waste discharges not meeting legal requirements will not be discharged to the ocean and will be brought to shore for disposal. . Section 2.8 discusses waste discharges and emissions and how they will be managed during Project activities.

Waste management, specifically the discharge of drill muds and cuttings and other drilling and testing emissions is anticipated to have an interaction with each of the six VCs identified in Section 6, as illustrated in Table 7.1.1.

Key waste streams that will be generated by the Project include:

- drilling waste discharges, including cuttings and drilling fluids and cement returns;
- atmospheric emissions from fuel combustion and well test flaring; and
- liquid discharges from the MODU and PSVs, such as produced water, bilge water, ballast water, BOP testing fluids.

Solid waste which will be removed from the MODU and PSVs and sent to shore for disposal in line with regulations and consequently are unlikely to interact with the VCs. Further detail of existing knowledge of the environmental effects of wastes and discharges is provided below.

7.1.2.1 Drill Waste Discharges

As discussed in Section 2.3.2, the drilling of each offshore well is expected to consist of two phases, starting with riserless drilling (*i.e.*, an open system with no direct drill fluid return connection to the MODU) and continuing drilling with a riser (*i.e.*, closed loop system with direct drill fluid return connection to the MODU). During riserless drilling, there is no closed loop (riser) system in place to return drilling fluid back to the MODU; therefore, the drilling fluid (seawater and WBM) will be released directly to the seafloor. During riserless drilling, only WBM will be used. Excess cement from the cementing of the conductor and surface casing string will also be discharged directly to the seafloor during the riserless phase. Once the riser (and BOP) have been installed, the drilling fluids (also referred to as drilling muds) and cuttings generated from the wellbore, as well as any excess cement can be transported back to the MODU for treatment. During this phase of drilling, either WBM or SBM may be used as the drilling fluid.

As explained in Section 2.8.2, once on the MODU, cuttings are separated from the drilling fluid for management and disposal. The recovered drilling mud is reconditioned and reused to the extent practicable. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained "synthetic on cuttings" on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG. It is expected that this SBM treatment will be done using a cuttings dryer, equipment which uses high speed centrifuge technology to separate drilling fluid from the solids. In accordance with OWTG, no excess or spent SBM will be discharged to the sea. Spent or excess SBM that cannot be re-used during drilling operations will be brought back to shore for disposal. More information on drill muds and cuttings, including typical components and predicted discharge volumes is presented in Section 2.8.2. Appendix C presents drill waste dispersion modelling conducted for the Project based on predicted mud types and volumes; results are summarized below.

Drilling Waste Discharges Environmental Stressors

There are several environmental stressors related to drilling discharges including those in the water column (toxic components and suspended particles), and those in the sediment (toxic compounds, change in grain size, oxygen depletion and burial of organisms) (Smit *et al.* 2006). The duration of water column exposure to drill waste can range from minutes to several days. Sediment exposure to drill waste is considered more chronic and can persist for months or years (Smit *et al.* 2006). Studies on the environmental effects of drill waste have primarily focused on effects on the marine benthic environment. Several laboratory studies have focused on the toxicity of drill muds and the sublethal effects of exposure (*e.g.*, Neff *et al.* 1989; Cranford and Gordon 1992; Cranford *et al.* 1999). These studies have linked prolonged exposure of bentonite and barite (found in both WBM and SBM) to sublethal effects affecting shellfish (*e.g.*, scallop) growth and reproduction (Cranford and Gordon 1992; Cranford *et al.* 1999, 2005). However, in many cases, exposure levels were higher than what would be expected in field conditions where WBM and SBM discharges are diluted and dispersed. Field studies have primarily focused on delineating the extent of benthic faunal disturbance through evidence of smothering, elevated contaminants in sediment sampling, and benthic community diversity. Field studies have also examined recovery times for benthic communities.

As reviewed by Neff (2010), most field study experiments and EEM results have shown the following:

- no evidence of ecologically significant bioaccumulation of metals and petroleum hydrocarbons by marine organisms;
- no evidence of toxicity effects associated with WBM constituents;
- no or minimal short-term effects on zooplankton communities; and
- limited effects on benthic macro- and mega-faunal communities restricted to approximately 100-m radius from the well.

These findings are consistent with what has been reported in EEM studies conducted for SOEP and Deep Panuke on the Scotian Shelf (CNSOPB 2011a; McGregor Geoscience Limited 2012).

Measurable adverse environmental effects on the marine benthos from exploration drilling are primarily related to the physical disturbance of the water column and benthic environment, particularly when large amounts of solids accumulate on the seafloor, causing burial and suffocation of benthic species (Neff *et al.* 2004; Neff 2010).

The severity of adverse effects related to burial on species is determined by the following factors: depth of burial; rate of burial; tolerance of species; nature of material (*i.e.*, grain size different from native sediment); and temperature (mortality rate by burial is higher in the summer than the winter) (Smit *et al.* 2006a). In spite of these variables, average burial thresholds have been proposed for consideration in risk assessment studies, ranging from 6.5 mm to 9.6 mm (Neff *et al.* 2004; Smit *et al.* 2006b). It is recognized that drill waste modelling predicts thickness of the deposited layer, which is not necessarily equivalent to depth of burial (*e.g.*, for epifauna attached to the seafloor) (refer to Section 7.2.8 and Appendix C).

Reviews of the environmental effects of offshore drilling in the Norwegian Sea have found that while project-related environmental changes (*i.e.*, chemical footprint, benthic invertebrate effects, metals, total organic carbon) are detectable during the earlier phases of drilling and production, the spatial effects are very localized (*e.g.*, within a 500-m radius of the wellsite) and subside with time (Gates and Jones 2012; Bakke *et al.* 2013). Long-term population and ecosystem effects to benthic communities from drill mud (WBM and SBM) and cuttings discharges are generally low, although recovery time varies with a number of factors including the local environmental conditions (*e.g.*, water depth, currents, temperature) and change in sediment particle size (Gates and Jones 2012).

There has been extensive environmental monitoring in both the Norwegian and UK oil producing regions of the North Sea, with up to 40 years of research. Recovery of sites previously affected by drill cuttings (which included diesel-based muds, as well as WBM and SBM) has been shown to occur in as little as four years (Schaanning and Bakke 1997; Bakke *et al.* 2011) although other studies have shown recovery of deepwater megafaunal assemblages taking longer than this. Jones *et al*. (2012) studied deepwater megafaunal density and diversity in the Faroe-Shetland Channel following deepwater drilling and reported partial megabenthic recovery occurring between three and ten years post-disturbance, with drill cuttings and impacts on epibenthic megafaunal assemblages still evident after a decade. However, these effects were observed only within 10 m of the disturbed area, with the megafaunal community at 10 m distance not readily distinguishable from that found over 100 m from the drilling location (Jones *et al.* 2012).

Bakke *et al.* (1986) capped sediments with 10 mm of WBM and found that fauna recolonization on sediment cuttings differed little in diversity from natural sediment after as little as one year. The results indicated that the recolonizing species were different, which was hypothesized to be related to the fact that the WBM provides a finer sediment type than the natural sediments in the area.

In a review of existing literature and EEM data from exploratory drilling in Canada, Hurley and Ellis (2004) determined that changes in the diversity and abundance of benthic organisms were most common within 50 to 500 m of drill sites and that benthic communities typically returned to baseline conditions within one year after drilling operations ceased. They also found that results of laboratory and field studies reviewed during their assessment suggested a low potential for toxicity or health effects. On the Grand Banks, major indices of benthic community structure (total abundance, total biomass, richness, and diversity) have been largely unaffected by project activity at production fields monitoring such endpoints (Husky Energy 2011; Suncor Energy 2011).

Drill Waste Modelling

Drill waste dispersion modelling has been carried out to demonstrate the expected deposition of cuttings. As with the sound modelling, some Project details were not available at the time of modelling. Consequently, the same two representative wellsites used in the sound modelling were selected for dispersion modelling purposes to illustrate effects at different water depths within the ELs. These wells are referred to as NS1 and NS3.

Table 7.1.2 Drill Waste Dispersion Modelling Locations

Well Reference	Water Depth	Location
NS1	2,104 m	43.046428 N, 60.434610 W
NS3	2,790 m	42.847114 N, 60.297611 W

Appendix C presents the drill waste dispersion modelling report.

The provisional well design illustrated in Section 2.4.2 was used as basis for the modelling work (*i.e.*, a seven-string configuration). It was assumed that SBM would be used once the riser is installed. The modelling accounted for likely discharges from the entire well drilled over a 120 day period, including WBM discharges at seafloor for the initial hole sections [pre-riser], bulk WBM discharges, and treated SBM associated cuttings discharges from the MODU post-riser installation.

Table 7.1.3 summarizes the predicted distances (maximum extent) from the discharge point for various deposition thicknesses associated with sedimentation from drilling discharges for wells at NS1 and NS3. Table 7.1.3 summarizes the predicted areal coverage of sedimentation. These data can be used to predict potential environmental effects on the benthic environment, particularly as it pertains to burial and smothering.

Table 7.1.3 Predicted Maximum Extent of Deposition from the Discharge Point

Deposition Thickness (mm)	Maximum Extent from Discharge Point (m)	
	Well Location NS1	Well Location NS3
0.001	11,213	7,446
0.01	3,684	3,547
0.1	1,367	1,309
1	563	358
2.5	150	251
5	102	167
10	78	116
20	71	93
50	33	62
100	21	30
500	7	15

Table 7.1.4 Predicted Area Extent of Sedimentation from Drilling Discharges

Deposition Thickness (mm)	Well Location NS-1		Well Location NS-3	
	Hectares	m^2	Hectares	m^2
0.001	4,872.7305	48,727,305	5,352.8105	53,528,105
0.01	703.7430	7,037,430	796.2614	7,962,614
0.1	104.7752	1,047,752	116.2959	1,162,959
0.2	58.2847	582,847	66.8110	668,110
0.5	28.1940	281,940	18.7219	187,219
1	9.9089	99,089	4.1702	41,702

Table 7.1.4 Predicted Area Extent of Sedimentation from Drilling Discharges

Deposition Thickness (mm)	Well Location NS-1		Well Location NS-3	
	Hectares	m²	Hectares	m²
2	2.5045	25,045	2.3199	23,199
5	0.9891	9,891	1.0889	10,889
10	0.5388	5,388	0.5356	5,356
20	0.2960	2,960	0.2970	2,970
50	0.1164	1,164	0.1320	1,320
100	0.0658	658	0.0685	685
200	0.0354	354	0.0381	381
500	0.0177	177	0.0102	102

Using a threshold of 9.6 mm (Neff *et al*. 2004) to assume burial of benthic species, it is predicted that these sediment thicknesses could extend up to 116 m from the discharge point, or cover an area of approximately 0.54 ha per well. Refer to Appendix C for more information on modelling methods and results. For more information on the effects of drill waste discharges on the marine environment (focusing on the marine benthos), refer to Section 7.2.8.

7.1.2.2 Other Discharges and Emissions

Section 2.8.1 discusses Project-related air emissions, which are expected to be low and will comply with applicable regulatory requirements. Given the distance of the Project offshore, there will be no predicted effect on air quality of Nova Scotia or public health.

Section 2.8.3 discusses liquid waste and how it will be managed in accordance with applicable regulatory requirements. All liquid wastes generated by the PSVs and MODU will be discharged in accordance with the OWTG and MARPOL. Drilling will require the use of seawater for cooling. The volume of cooling water used will be low and therefore the area of thermal effects will be negligible. Other discharges such as drilling fluids, deck drainage, and bilge waters may have residual hydrocarbon presence, although this would be at allowable levels stated by the OWTG with no measureable adverse effects predicted for marine animals.

Section 2.8.4 discusses solid wastes that may be generated by the Project activities, such as food and domestic waste and packaging. As mentioned in Section 2.8.4, sanitary and food wastes will be macerated to a particle size of 6 mm or less and then discharged overboard. Organic matter will be quickly dispersed by ocean currents and wave activity and will be degraded by bacterial communities. Some birds (*e.g.*, Procellariiforms, such as petrels) use olfactory cues to navigate and may be attracted to the domestic and sanitary waste emissions (Weise *et al.* 2001; Nevitt and Bonadonna 2005). Some fish and marine mammals may also be attracted to emissions, although during active drilling, any attraction would likely be limited due to underwater sound emissions. Further information about potential effects is provided in Section 7.2 for Fish and Fish Habitat and, Section 7.3 for Marine Mammals and Sea Turtles.

7.1.3 Vertical Seismic Profiling (VSP)

As explained in Section 2.4.3.2, VSP may be carried out as part of the well evaluation processes to provide further subsurface information. Where it occurs, VSP would be carried out after drilling has been completed, but before well abandonment and is used to correlate the surface seismic data to well data.

As a result of the sound generated by VSP, potential interaction with each of the six VCs identified in Section 6 is anticipated.

Sound Profiles Associated with VSP

The source of underwater sound during VSP operation is similar to that used in seismic operations (*i.e.*, a seismic sound source array made up of individual source elements), the associated size and overall volume of the source array are much smaller than in a traditional offshore surface seismic survey, and thus VSP operation produce less energy. Exploratory seismic surveys typically produce sound in the frequency range of 5 to 300 Hz and at SPLs of approximately 245 to 260 dB peak re 1 µPa @ 1m in their primary radiation direction (calculated through back-propagation methods that likely typically overestimates actual sound levels in the near-field) (Lee *et al.* 2011). Acoustic modelling for the Project of a representative VSP used by BP in previous Gulf of Mexico surveys produced a broadside source level of 248 dB re 1 µPa @ 1m Peak SPL (SEL of 225 dB re 1 μPa^2s @ 1m), with most energy produced at frequencies below 250 Hz (Zykov 2016; Appendix D).

In addition to utilizing a smaller source array than traditional seismic surveys, VSP operation occurs over substantially shorter time frames (*e.g.*, days instead of months) and is conducted over a much smaller spatial scale (*i.e.*, limited to the wellsite). The VSP that BP is proposing to use for this Project will typically take no more than a day per well to complete and will be located directly above the wellsite. Further description of VSP is provided in Section 2.4.3.

An interpretation of the modelling results relative to potential environmental effects on marine fish, marine mammals and sea turtles is provided in Sections 7.2 and 7.3. Indirect effects on Special Areas, commercial fisheries, and Aboriginal use of lands and resources for traditional purposes are assessed in Sections 7.5, 7.6, and 7.7. Effects of VSP on migratory birds would be limited to diving birds; these interactions are assessed in Section 7.4.

7.1.4 Supply and Servicing Operations

Offshore drilling operations will be supported by logistics arrangements for supply and servicing activity. Such arrangements will allow the movement of equipment and personnel between the MODU and land, and will allow sufficient stocks of equipment and supplies to be maintained for reliable, ongoing drilling operations. Supply and servicing operations will include:

- Helicopter transportation between the MODU and Stanfield International Airport; and
- PSV transit between the MODU and Halifax Harbour.

It is anticipated that supply and servicing operations will interact with each of the VCs as illustrated in Table 7.1.1. Further information is provided below.

7.1.4.1 Helicopter Transportation

As discussed in Section 2.4.5, Project activities will require helicopter support for transfer of crew and light supply. Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m and at a lateral distance of 2 km around active bird colonies when possible. Helicopters will also avoid flying over Sable Island (a 2-km buffer will be recognized) except as needed in the case of an emergency.

The key potential environmental effects associated with helicopter support involve sensory disturbance from helicopter sound. This sensory disturbance can be realized by marine mammals and migratory birds, and can also affect the habitat quality of Special Areas designated as being important for these groups. Helicopter operations can also potentially result in injury or mortality risks to migratory birds through collision during flight. Further information is provided in Section 7.2 and 7.3, for fish and marine mammals and sea turtles. Information about potential effects on migratory birds is provided in Section 7.4.

7.1.4.2 PSV Operations

PSVs will be used for the transport of supplies from the supply base to the MODU and returning waste material for appropriate disposal onshore, as well as providing standby assistance during drilling activities. It is anticipated that two to three PSVs will be required to support the Project with two to three round trips per week being made for transport purposes. One vessel will be required to be on standby (within 20 minutes of the MODU) at all times during drilling operations.

Although the exact routes for the PSVs have not yet been determined, routes are expected to be consistent with existing shipping traffic routes/lanes commonly used by other vessels approaching/leaving Halifax Harbour. Once out in the open sea, the support vessel will select the most direct route for reaching the destination. The PSVs may transit through fishing areas, although this would result in a slight incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Key potential interactions between PSV operations and biological VCs are related to routine emissions, underwater sound, and the risk of collision with marine mammals and sea turtles (refer to Section 7.3). Effects of PSV lights would be similar to those associated with the presence of the MODU (refer to Section 7.1.1) and therefore could have an interaction with migratory birds (refer to Section 7.4 for further information).

7.1.4.3 Underwater Sound

Underwater acoustic modelling for the Project assumed PSV source levels of 188.6 dB re 1 μPa @ 1 m RMS SPL (refer to Zykov 2016; Appendix D). Effects of underwater sound from PSV operation are considered alongside MODU operation, since the highest sound levels are predicted during times when the MODU and PSV are operating simultaneously.

7.1.4.4 Vessel Strikes

The presence and operation of PSVs will result in an increase in marine traffic within the LAA. It is likely that two to three PSVs will be required to support the Project, with one vessel on stand-by at the MODU at all times. It is estimated that the PSVs will make two to three round trips per week between the MODU and the supply base. The increase in vessel traffic from the Project could potentially increase the risk of mortality of marine mammals and sea turtles due to vessel strikes. While there is limited information with respect to the effects of vessel collisions on sea turtles, vessel strikes have been identified as a leading cause of marine mammal injury and mortality (*e.g.,* Vanderlaan and Taggart 2007). Most injuries resulting from animal-vessel interactions are the result of either impact trauma or contact with the propellers (Laist *et al.* 2001). Vessel speed has been positively correlated with the likelihood of a strike, and the likelihood and degree of injury for both marine mammals and sea turtles (Kite-Powell *et al.* 2007; Laist *et al.* 2001; Hazel *et al.* 2007; Vanderlaan and Taggart 2007; Work *et al.* 2010). PSVs will travel at a speed of approximately 12 knots in transit to and from the Project Area, except as needed in the case of an emergency.

7.1.5 Well Abandonment

As discussed in Section 2.4.4, all wells drilled as part of the Project will be abandoned. Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements.

The final well abandonment program has not yet been finalized; however these details will be confirmed to the CNSOPB as planning for the Project continues.

It is possible that the subsea infrastructure could be removed. If this is the case, casing will be cut below the seabed and the wellhead removed. The wellhead will be lifted to the surface and brought to shore using a PSV. No infrastructure will be left on the seafloor after the wellhead has been removed. These details will be confirmed as planning for the Project continues. There will be some underwater noise associated with well abandonment which could be detected by marine fish, marine mammals and sea turtles.

Alternatively, approval may be sought to leave the wellhead in place. Depending on the final details of the abandonment program, there could be some ongoing interaction with the benthic environment, which is evaluated as part of the Fish and Fish Habitat VC (see Section 7.2 for more information).

Both abandonment scenarios (*i.e.*, wellhead removal and wellhead left in place) have been assessed in the EIS.

Regardless of whether the wellhead is removed or kept in place, effects on the benthic environment are expected to be reversible (through colonization) or positive. If the wellhead is not removed, once abandoned it will provide benthic organisms with hard surfaces to colonize and promote benthic biodiversity and productivity, similar to an "artificial reef". Offshore EEM studies from the Deep Panuke Project on the Scotian Shelf report evidence of a "reef effect" with colonization of subsea production structures, including wellheads. Wellhead protection structures associated with the Deep Panuke Project have been colonized by blue mussels, sea cucumbers, sea anemones, and frequented by comb jellies (likely *Pleurobrachia* sp.), cod, Pollock, and cunner (McGregor Geoscience Limited 2012).

Prior to well abandonment, a survey will be completed to confirm the location of the well and details will be submitted to the CNSOPB. The well location will be marked on nautical charts as applicable.

7.2 FISH AND FISH HABITAT

Fish and Fish Habitat was selected as a VC in consideration of the ecological value provided to marine ecosystems, the socio-economic importance of fisheries resources (*i.e.*, target fish species), the EIS Guidelines, and the potential for interactions with Project activities and components. Fish and fish habitat are also regulated under the federal *Fisheries Act*, which includes provisions to protect the productivity of commercial, recreational and Aboriginal (CRA) fisheries. For the purposes of this assessment, Fish and Fish Habitat is assessed according to the following definitions under the *Fisheries Act:*

> "Fish" is defined under section 2 of the *Fisheries Act* and includes: fish, shellfish, crustaceans, and marine animals; any parts of fish, shellfish, crustaceans, and marine animals; and the eggs, sperm, spawn, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals.
>
> "Fish habitat" is defined in the *Fisheries Act* as including spawning, rearing, nursery, food supply, overwintering, migration corridors, and any other area on which fish depend directly or indirectly in order to carry out their life processes.

As indicated in Table 6.2.1 in Section 6, fish habitat includes all aspects of the physical marine environment, including the benthic environment and water quality. Marine plants are not located in the Project Area (given water depth) and routine Project activities are not predicted to interact with marine plants which occur in the nearshore.

Although "fish", as defined under the *Fisheries Act*, is inclusive of marine mammals and sea turtles as marine animals, environmental effects on marine mammals and sea turtles are considered separately in the Marine Mammals and Sea Turtles VC (Section 7.3) due to differences in the nature and extent of potential Project interactions.

Environmental effects on designated Special Areas, including those that provide important habitat for fish species and the prey upon which fish species depend, are assessed with respect to the Special Areas VC (Section 7.5).

Although the assessment in relation to this VC considers potential environmental effects on fisheries resources, potential environmental effects on commercial and Aboriginal fish harvesting are assessed separately in the context of the closely related Fisheries VC (Section 7.6) and Current Aboriginal Use of Lands and Resources for Traditional Purposes VC (Section 7.7), respectively.

7.2.1 Regulatory and Policy Setting

The *Fisheries Act* focuses on protecting the productivity of CRA fisheries including a prohibition against causing serious harm to fish (*i.e.*, the death of fish or any permanent alteration to, or destruction of, fish habitat) that are part of or support a CRA fishery (section 35) (DFO 2013y). Proponents of projects that cause serious harm to fish are required to offset that harm to maintain and enhance the productivity of the fishery (DFO 2013z). Section 36(3) of the *Fisheries Act* prohibits the deposition of a deleterious substance in waters frequented by fish.

Fish Species at Risk (SAR) are protected under the federal *Species at Risk Act* (SARA), which focuses on protecting species and associated habitat whose populations are not secure. For the purposes of this assessment, sections 32, 33 and 58 of SARA are the most relevant sections of the Act that contain provisions to protect species listed on Schedule 1 of SARA and their critical habitat. Critical habitat is defined by SARA as "habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species" (section 2[1]). Critical habitat has not yet been defined for any listed fish species.

Ministerial notification is required under section 79 of SARA if a project is likely to affect a listed wildlife species or its critical habitat. The person required to notify the minister must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them.

The *Canadian Environmental Protection Act*, 1999 (CEPA), and specifically the Disposal at Sea Regulations, also protect marine fish and fish habitat. These regulations (*i.e.*, the Disposal at Sea provisions of Part 7, Division 3 of CEPA, under the authority of Environment Canada; CEPA 1999), stipulate that disposal in the marine environment requires a permit and that sediment or cuttings be screened for potential chemical contaminants.

7.2.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date include general concerns related to potential Project effects (and cumulative effects) on the marine environment including fish species at risk, commercial fish species, and/or fish species that have been identified as having significance to Mi'kmaq and/or Wolastoqiyik (Maliseet) culture. Questions and concerns were raised with respect to effects of routine discharges and spills on fish populations and migration, feeding, and spawning activities that could be occurring in the affected area.

7.2.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have the potential to interact with fish and fish habitat, primarily due to underwater sound emissions from MODU operation, PSV traffic, and VSP surveys. Operational solid and liquid discharges from the MODU and PSVs (*e.g.*, drill muds and cuttings, cooling water, ballast water, bilge and deck water, grey/black water and process water) can interact with fish and fish habitat.

As a result of these considerations, and the policies put in place to protect fish and their habitat outlined in the *Fisheries Act,* SARA, and CEPA, the assessment of Project-related environmental effects on Fish and Fish Habitat is focused on the following potential environmental effects:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

These effects capture *Fisheries Act* prohibitions against causing serious harm to fish (*i.e.*, "the death of fish) or any permanent alteration to, or destruction of, fish habitat") that are part of or support a CRA fishery and also allow for consideration of effects on fish SAR. The measurable parameters used for the assessment of the potential environmental effects identified above, and the rationale for their selection, are provided in Table 7.2.1. Effects of accidental events are assessed separately in Section 8.5.1.

Table 7.2.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Fish and Fish Habitat

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Risk of Mortality or Physical Injury	Direct project effects on fish mortality, injury or health due to direct interactions with individuals (*e.g.*, smothering as a result of deposition of cuttings/drill muds) or indirectly through a change in habitat quality (degradation of habitat quality affecting fish health)	• Mortality,(may be either direct measurement or qualitative) focused on population level changes

Table 7.2.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Fish and Fish Habitat

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Habitat Quality and Use	Change in fish habitat use due to physical disturbance, destruction of benthic habitats or deposition of cuttings/drill muds	• Areal extent of alteration or destruction of fish habitat (ha)
	Change in fish habitat quality due to a change in the chemical composition of sediment and water	• Areal extent (ha) of fish habitat affected by changes in water quality and/or sediment quality
	Increased risk of exposure to underwater sound at levels capable of causing sensory disturbance	• Area of potential behavioural or physiological effects on fish from underwater sound emissions and reported thresholds

7.2.4 Environmental Assessment Boundaries

7.2.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Fish and Fish Habitat are defined below and depicted on Figure 7.2.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and as such represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which potential environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Fish and Fish Habitat are reasonably expected to occur. Based on predicted propagation of sound pressure levels (SPLs) from Project activities and reported thresholds for behavioural effects on fish, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. The LAA has also been defined to include PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

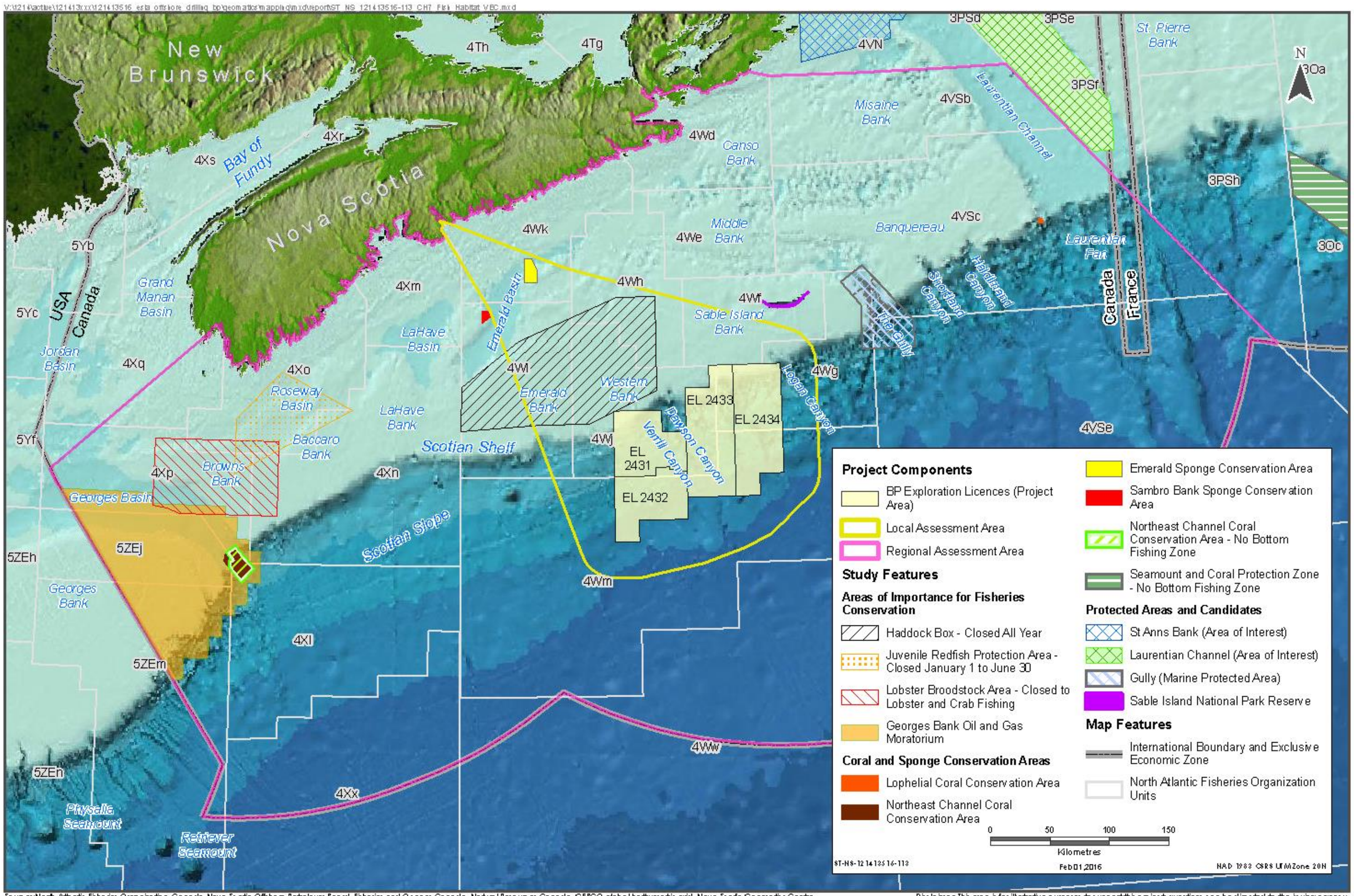


Figure 7.2.1 Assessment Boundaries for Fish and Fish Habitat

7.2.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Fish and Fish Habitat encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round; however, VSP operation (and pulsed sound associated with VSP) is expected to take no more than a day per well.

Fish can be found year-round in and around the Project Area carrying out various life cycle processes. Refer to Section 5.2.5 for specific details regarding specific marine fish species (*i.e.*, SAR and Species of Conservation Concern (SOCC) and species of importance to CRA fisheries) known to occur in the RAA, including their sensitive life stages and their relation to the Project Area.

7.2.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.2.2 defines the descriptors used to characterize residual environmental effects on Fish and Fish Habitat.

Table 7.2.2 Characterization of Residual Environmental Effects on Fish and Fish Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial to Fish and Fish Habitat relative to baseline **Adverse** – an effect that moves measurable parameters in a direction detrimental to Fish and Fish Habitat relative to baseline **Neutral** – no net change in measureable parameters for the Fish and Fish Habitat relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in marine species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability; will not affect population viability **Moderate** – measurable change but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the

Table 7.2.2 Characterization of Residual Environmental Effects on Fish and Fish Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies how often the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at not set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, as well as consideration of requirements under SARA and associated regulations and recovery plans, the following threshold has been established to define a significant adverse residual environmental effect on Fish and Fish Habitat.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Fish and Fish Habitat is defined as a Project-related environmental effect that:

- causes a significant decline in abundance or change in distribution of fish populations within the RAA, such that natural recruitment may not re-establish the population(s) to its original level within one generation;
- jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed species;
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy; or

- results in serious harm to fish as defined by the *Fisheries Act* that is unauthorized, unmitigated, or not compensated through offsetting measures in accordance with DFO's Fisheries Protection Policy Statement (DFO 2013z).

7.2.6 Existing Conditions

The Project Area is located to the south of the Sable Island and Western Banks in an area partly on the Scotian Shelf but primarily on the Scotian Slope. Water depths in the Project Area range from approximately 100 m to over 3,000 m. At water depths of 2,000 to 3,000 m, the slope is more gradual and known as the Continental Rise. Figure 5.1.14 (Section 5.1) illustrates a bathymetric overview of the Project Area and the Scotian Slope. Notable bathymetric features present within or adjacent to the Project Area include the Verrill Canyon, which extends into the Project Area, and Dawson and Logan Canyons that are immediately adjacent to the Project Area (Figure 5.1.14). The eastern Scotian Shelf (east of the Project Area) hosts a series of deepwater canyons, including the Gully and Shortland and Haldimand canyons, which originate on the outer edge of the Scotian Shelf and continue down the slope (Figure 5.1.14).

Several deepsea benthic surveys have been undertaken along the Scotian Slope in 2001 and 2002 in former licence blocks near and overlapping the Scotian Basin Project Area (refer to Section 5.2.2). The areas previously surveyed are within the depth range of the Project Area and the habitat among the adjacent blocks is consistent and provides supporting evidence to suggest that similar habitat is likely to occur within the Project Area (Figure 5.2.4).

Overall, the benthic fauna across the two blocks (former ELs 2381 and 2382) was low in abundance and diversity, and no regions contained substantial coral development (JWEL 2003). BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of habitat-forming corals or species at risk. Refer to Section 5.2.2 for additional information on the habitat of the previously surveyed blocks within and adjacent to the Project Area.

There are 24 fish SAR and SOCC that may be present on the Scotian Shelf or Slope at various times of the year. A complete list of species, their status and presence near the Project is presented in Table 7.2.3. Details on life history characteristics (*i.e.*, mating, spawning and potential times and locations of species' larvae and eggs) are provided in Section 5.2, Table 5.2.3.

Table 7.2.3 Fish Species at Risk and/or of Conservation Concern Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	Low	Year-round
American eel	*Anguilla rostrata*	Not Listed	Threatened	Transient	November -Silver eel out migration from NS March to July - Larvae and glass eels on the Slope and Shelf
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened	Low	Year-round
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered	High	June to October
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered	Low	Year-round
Atlantic cod (Southern population)		Not Listed	Endangered	Low	Winter – Deep water of Browns and LaHave Banks Summer- Southern Northwest Channel, shallow waters of Browns and LaHave Banks
Atlantic salmon (Outer Bay of Fundy population)	*Salmo salar*	Not Listed	Endangered	Transient	March to November
Atlantic salmon (Inner Bay of Fundy population)		Endangered	Endangered	Transient	March to November

Table 7.2.3 Fish Species at Risk and/or of Conservation Concern Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered	Transient	March to November
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered	Transient	March to November
Atlantic sturgeon (Maritimes population)	*Ancipenser oxyrinchus*	Not Listed	Threatened	Low	Year-round
Atlantic wolffish	*Anarhichas lupus*	Special Concern	Special Concern	Low	Year-round
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern	Low to Moderate	Year-round
Blue shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern	Moderate to High	June to October
Cusk	*Brosme brosme*	Not Listed	Endangered	Low to Moderate	Year-round
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened	Low	Year-round
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened	Low	Year-round
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered	High	Year-round
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern	Moderate	Year-round
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered	Moderate to High	Year-round
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened	Moderate	July to October
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern	Moderate	Year-round
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern	High	Year-round

Table 7.2.3 Fish Species at Risk and/or of Conservation Concern Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Spotted wolffish	*Anarhichas minor*	Threatened	Threatened	Low	Year-round
Striped bass (Southern Gulf of St. Lawrence population)	*Morone saxatilis*	Not Listed	Special Concern	Low	June to October
Striped bass (Bay of Fundy population)	*Morone saxatilis*	Not Listed	Endangered	Low	June to October
Thorny skate	*Amblyraja radiate*	Not Listed	Special Concern	Low to Moderate	Year-round
White shark	*Carcharodon Carcharias*	Endangered	Endangered	Low	June to November
White hake	*Urophycis tenuis*	Not Listed	Special	Moderate	Year-round

Note:
[1]Species of conservation concern (SOCC) listed as endangered, threatened, or of special concern by COSEWIC and not listed on Schedule 1 of SARA.
[2]This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.

Source: BIO 2013a; Campana *et al.* 2013; COSWEIC 2006a, 2006b, 2007a, 2008a, 2009b, 2009c, 2010a, 2010b, 2010c, 2010d, 2011b, 2012a, 2012b, 2012c, 2012d, 2012e, DFO 2013e, 2013l, 2013j, 2013k, 2013w; Horseman and Shackell 2009; Maguire and Lester 2012; NOAA2013e; SARA 2015

As noted in Table 7.2.3, five fish species are listed under Schedule 1 and formally protected under SARA. These species include:

- Atlantic salmon (Inner Bay of Fundy population);
- Atlantic wolffish;
- Northern wolffish;
- Spotted wolffish; and
- White shark.

Atlantic salmon are expected to be transient, and individuals from the Inner Bay of Fundy population are not expected to occur in the Project Area. Unlike all other salmon in North America, evidence suggests that inner Bay of Fundy Atlantic Salmon have very limited migration, staying within the Bay of Fundy and the Gulf of Maine for extended periods (SARA 2015).

Atlantic wolffish are typically found inhabiting the seafloor in water depths of 150 to 350 m and have been found as deep as 918 m (COSEWIC 2012b). An examination of wolffish landings in NAFO Division 4X revealed that Atlantic wolffish were concentrated on the western peak of Browns Bank, west of German Bank and in three isolated areas inshore of the 100-m isobath contour line (LGL 2014). Northern wolffish are found in deep water up to 1,500 m and prefer a narrow temperature range of 3 to 5°C; it is believed that temperature is a limiting factor in their distribution (COSEWIC 2012d). Spotted wolffish prefer a broader water temperature range of 2 to 8°C and are often found in shallower water than their Northern counterparts. Both benthic fish species could be found in low numbers on the Scotian Shelf and prefer sand or a mix of sand and shell habitat; the potential occurrence of any of these wolffish species in the Project Area is deemed low based on habitat preferences (COSEWIC 2012d, COSEWIC 2012e).

The white shark is rare in the northwest Atlantic (32 records in 132 years), as it is the northern edge of their range. Recorded sightings near the Project include the Bay of Fundy, Laurentian Channel, and Sable Island Bank. They are predominantly pelagic and can range in water depth from the surface to 1,300 m. These fish are highly mobile and migrate seasonally (COSEWIC 2006b).

Table 5.2.20 summarizes Special Areas in the RAA. Special Areas are often designated to protect SAR and SOCC including fish species. Special Areas of particular relevance to Fish and Fish Habitat include the following:

- Sambro Bank and Emerald Basin *Vazella* Closure Areas - Approximately 130 and 126 km northwest of the Project Area, respectively are habitat for the glass sponge *Vazella pourtalesi* which is known to exist in only three locations worldwide – the Gulf of Mexico, the Azores, and in Canada. The locations on the Scotian Shelf are the only instances where large aggregations have been found and thus are regarded as being globally-unique aggregations.

- Georges Bank – Approximately 300 km southwest from the Project Area, Georges Bank is at the northern edge of southern assemblages of plankton and fish and at the southern edge of northern assemblages. Therefore, biodiversity is very high in this area (of both subpolar and subtropical assemblages), with the Northeast Peak being the most productive part of Georges Bank (NRCan and NSPD 1999).
- Northeast Channel Coral Conservation Area – Approximately 306 km southwest from the Project Area. This conservation area was primarily selected on the basis of having the highest density of large, branching octocorals (gorgonian), *Paragorgia arborea* and *Primnoa resdaeformis* in the Maritimes. These corals provide various ecosystem functions, and coral biomass has been shown to be closely correlated to fish biodiversity (Campbell and Simms 2009).
- Emerald Bank, Western Bank and Sable Bank Complex Ecologically and Biologically Significant Area (EBSA) – Located north of the Project Area. The Emerald Bank, Western Bank and Sable Bank Complex is an area with the highest larval fish density along the Scotian Shelf due to seasonal congregations of spawning fish. This bank complex provides a juvenile nursery area for haddock, cod, monkfish, skates and flounder.
- Haddock Nursery Closure, Emerald and Western Banks (Haddock Box) – Located north of the Project Area in the Emerald Bank, Western Bank and Sable Bank Complex EBSA. The Haddock Box is an important nursery area for juvenile haddock, and is closed year-round by DFO to the commercial groundfish fishery. Scallop fishing continues to occur on the eastern-most part of the closed area (O'Boyle 2011).

Further information about Special Areas is presented in Section 7.5.

As noted above, fish and fish habitat are regulated under the federal *Fisheries Act*, which includes provisions to protect the productivity of CRA fisheries. Within and surrounding the Project Area, the socio-economic setting is dominated by commercial and Aboriginal fisheries activity. Groundfish, pelagic, and invertebrate fisheries occur on the Scotian Shelf and Slope, with large pelagics (*e.g.*, swordfish, tuna, and shark) being the most commonly harvested fish in the Project Area. Following the collapse of the traditional groundfish stocks (*e.g*., cod, flatfish and pollock), shellfish stocks have grown significantly in their contribution to revenue and profitability of the Scotian Shelf fishery. CRA fish species with the potential to occur in the Project Area are listed in Table 7.2.4. The corresponding fisheries data are presented in Section 5.3.5, with the assessment of the interaction of the Project with commercial and Aboriginal fisheries presented in Sections 7.6 and 7.7, respectively.

Table 7.2.4 Fish Species of Commercial, Recreational or Aboriginal Value Found in the RAA

Common Name	Scientific Name	Potential for Occurrence in the Project Area[1]	Timing of Presence
Groundfish Species			
Acadian redfish[2]	*Sebastes fasciatus*	Low	Year-Round
American plaice[2]	*Hippoglossoides platessoides*	Low	Year-Round
Atlantic cod[2]	*Gadus morhua*	Low	Year-Round
Atlantic halibut	*Hippoglossus hippoglossus*	Moderate	Year-Round
Deepwater redfish[2]	*Sebastes mentalla*	Low	Year-Round
Haddock	*Melanogrammus aeglefinus*	Low	Year-Round
Hagfish	*Myxine glutinosa*	Moderate	Year-Round
Monkfish	*Lophius americanus*	Low	Year-Round
Pollock	*Pollachius virens*	Low	Year-Round
Red hake	*Urophycis chuss*	Low	Year-Round
Sand lance	*Ammodytes dubius*	Low	Year-Round
Silver hake	*Merluccius bilinearis*	Low	Year-Round
Turbot – Greenland flounder	*Reinhardtius hippoglossoides*	Moderate to High	Year-Round
White hake[2]	Urophycis tenuis	Moderate	Year-Round
Witch flounder	*Glyptocephalus cynoglossus*	Low	Year-Round
Yellowtail founder	*Limanda ferruginea*	Low	Year-Round
Pelagic Species			
Albacore tuna	*Thunnys alalunga*	Low	July to November
Alewife	*Alosa pseudolarengus and A. aestivalis*	Low	July to February
Atlantic herring	*Clupea harengus*	Low	Year-round
Atlantic mackerel	*Scomber scombrus*	Low	Winter – deep water on the Shelf Spring/Summer – Migrate to shallower coastal zones
Bigeye tuna	*Thunnus obesis*	Low	July to November
Black dogfish	*Centroscyllium fabricii*	Low	Year-round
Bluefin tuna[2]	*Thunnus thynnus*	Low	June to October
Blue shark[2]	*Prionace glauce*	Moderate	June to October
Capelin	*Mallotus villosus*	Low	Year-round
Porbeagle shark[2]	*Lamna nasus*	Moderate	Year-round

Table 7.2.4 Fish Species of Commercial, Recreational or Aboriginal Value Found in the RAA

Common Name	Scientific Name	Potential for Occurrence in the Project Area[1]	Timing of Presence
Shortfin mako shark[2]	*Leurus oxyringus*	Moderate	July to October
Swordfish	*Xiphias gladuis*	Moderate	July to October
White marlin	*Tetrapturus albidus*	Moderate	July to October
Yellowfin tuna	*Thunnus albacares*	Low	July to October
Invertebrates			
American lobster	*Homarus americanus*	Low	Year-round
Jonah crab	*Cancer borealis*	Low	Year-round
Atlantic sea scallop	*Placopecten magellanicus*	Low	Year-round
Clams (Atlantic Surf, Soft-shelled, quahaugs)	*Spisula solidissima, Mya areniaria, Mercenaria mercenaria.*	Low	Year-round
Green sea urchin	*Strongylocentrotus droebachiensis*	Low	Year-round
Northern shrimp	*Pandalus borealis*	Low	October - April – Nearshore May - September-Offshore
Shortfin squid	*Illex illecebrosus*	High	April – November[3]
Snow crab	*Chionoecetes opilio*	Low	Year-round
Red crab	*Chaceon quinquedens*	Low	Year-round

Note:
[1] Based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2] Species at Risk or Species of Conservation Concern.
[3] Based on assumed spawning times.

For more information on baseline conditions for Fish and Fish Habitat, refer to Sections 5.1 (Marine Physical Environment), 5.2 (Marine Biological Environment) and 5.3 (Socioeconomic Environment).

7.2.7 Potential Project-VC Interactions

Table 7.2.5 identifies the physical Project activities that can interact with the Fish and Fish Habitat VC to result in the identified environmental effects. These interactions are indicated by checkmarks and are discussed in Section 7.2.8 in the context of effects pathways, mitigation, and residual effects. A justification is provided below for non-interactions where applicable.

Table 7.2.5 Potential Project-Environment Interactions and Effects on Fish and Fish Habitat

Project Components and Physical Activities	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓	✓
Vertical Seismic Profiling	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	-	✓
Well Abandonment	-	✓
Note: ✓ = Potential interactions that might cause an effect. – = Interaction between the Project and the VC are not expected.		

Supply and Servicing Operations

Helicopter transportation is not predicted to interact with Fish and Fish Habitat to cause a Change in Risk of Mortality or Physical Injury or Change in Habitat Quality and Use due to a lack or very limited interaction with the marine environment (*i.e.*, very weak to no underwater sound transmission and no marine discharges) and associated fish and fish habitat.

The operation of the PSVs (including transit and transfer activities) is not predicted to interact with Fish and Fish Habitat resulting in a Change in Risk of Mortality or Physical Injury because the underwater sound levels associated with PSV traffic is not expected to be at levels that would cause injury or mortality to marine fish species. Fish are anticipated to temporarily avoid the immediate areas subject to PSV traffic, thereby reducing the risk of fish mortality due to vessel strikes or contact with propeller blades. Change in Habitat Quality and Use for fish species has been identified as having potential interactions with PSVs that might cause an environmental effect on Fish and Fish Habitat and is therefore discussed in Section 7.2.8.

Well Abandonment

All wells drilled in the drilling campaign will likely be permanently plugged and abandoned. Wells will be abandoned using a series of cement and mechanical plugs within the wellbore, and will have no interaction with fish and fish habitat outside of the wellsite. Whether the wellhead is removed or kept in place, well abandonment activities are not anticipated to produce underwater sound or discharges that would pose a risk of physical injury or mortality to fish. Well abandonment activities are therefore not predicted to interact with Fish and Fish Habitat resulting in a Change in Risk of Mortality or Physical Injury. Well abandonment may interact with Fish and Fish Habitat potentially resulting in a Change in Habitat Quality and Use; this effect is therefore discussed in Section 7.2.8.

7.2.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Fish and Fish Habitat arising from potential interactions identified in Table 7.2.5. Given the similarities in Project description, proximity of activities on the Scotian Slope, and relevancy of recent data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g*., expansion of geographic scope), scientific updates, and refined EA methods.

7.2.8.1 Project Pathways for Effects

Change in Risk of Mortality or Physical Injury

A Change in Risk of Mortality or Physical Injury for individual marine fish may result from underwater sound associated with the presence and operation of the MODU and VSP. Drilling operations and station-keeping (*i.e.*, use of dynamic positioning thrusters) during MODU operations will generate underwater sound while the MODU is on station, affecting the quality of the underwater acoustic environment for fish species in the Project Area. VSP operation will also result in temporarily (no more than a day per well) increased sounds levels in the marine environment. Sound levels in very close proximity to the VSP sound array may result in physical injury or mortality from acute changes in pressure.

Mortality or physical injury may also occur to benthic species (*e.g*., fish, shellfish, sponges and corals) from smothering or crushing as a result of waste management activities (particularly the discharging of drill muds and cuttings). Routine liquid discharges (cooling water, ballast water, bilge and deck water, grey/black water and small amounts of process water during well testing) will be in accordance with the OWTG, Transport Canada's *Ballast Water Control and Management Regulations* and/or MARPOL as applicable, which are designed to be protective of the marine environment and will not be at levels that would cause mortality or physical injury to fish species.

Change in Habitat Quality and Use

A Change in Habitat Quality and Use for marine fish may occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (light and sound emissions into the water column), waste management (discharge of drill muds and cuttings affecting water and sediment quality), VSP (underwater sound), supply and servicing operations (PSV operations and underwater sound associated with vessel movement), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.2.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effect pathways outlined above, the following mitigation measures and standard practices will be employed to reduce the potential environmental effects of the Project on Fish and Fish Habitat. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

Presence and Operation of MODU

- BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.
- No Project well locations will be located within the Haddock Box.
- Lighting will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

Waste Management

- As described in Section 2.8, offshore waste discharges and emissions associated with the Project (*i.e.*, operational discharges and emissions from the MODU and PSVs) will be managed in accordance with relevant regulations and municipal bylaws as applicable, including the *Offshore Waste Treatment Guidelines* (OWTG) and the *International Convention for the Prevention of Pollution from Ships* (MARPOL), of which Canada has incorporated provisions under various sections of the *Canada Shipping Act*. Waste discharges not meeting legal requirements will not be discharged to the ocean and will be brought to shore for disposal.
- Selection of drilling chemicals will be in accordance with the OCSG that provides a framework for chemical selection to reduce potential for environmental effects. During planning of drilling activities, where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds and cements will be preferentially used. Where feasible, the chemical components of the drilling fluids will be those that have been rated as being least hazardous under the OCNS scheme and as PLONOR by OSPAR.

- Discharges of SBM mud and cuttings will be managed in accordance with the OWTG. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained "synthetic on cuttings" on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG. In accordance with OWTG, no excess or spent SBM will be discharged to the sea. Spent or excess SBM that cannot be re-used during drilling operations will be brought back to shore for disposal.

- Excess cement may be discharged to the seabed during the initial phases of the well, which will be drilled without a riser. Once the riser has been installed, all cement waste will be returned to the MODU. Cement waste will then be transported to shore for disposal in an approved facility.

- Small amounts of produced water may be flared. If volumes of produced water are large, some produced water may be brought onto the MODU for treatment so that it can be discharged in line with the OWTG.

- Deck drainage and bilge water will be discharged according to the OWTG, which state that deck drainage and bilge water can only be discharged if the residual oil concentration of the water does not exceed 15 mg/L.

- Ballast water will be discharged according to IMO *Ballast Water Management Regulations* and Transport Canada's *Ballast Water Control and Management Regulations.* The MODU will carry out ballast tank flushing prior to arriving in Canadian waters.

- Sewage will be macerated prior to discharge. In line with the OWTG and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements, sewage will be macerated so that particles are less than 6 mm in size prior to discharge.

- Cooling water will be discharged in line with the OWTG*, which* states that any biocides used in cooling water are selected in line with a chemical management system developed in line with the OCSG. Cooling water is likely to be warmer than the ambient water temperature upon discharge but will be rapidly dispersed, reaching ambient temperatures.

- BOP fluids and any other discharges from the subsea control equipment will be discharged according to OWTG and OCSG.

- Any hydrocarbons, such as gas, oil or formation water that are brought to surface as part of well test activity will be flared to enable their safe disposal. All flaring will be via one of two horizontal burner booms, to either a high efficiency burner head for liquids, or simple open ended gas flare tips for gases to minimize fall out of un-combusted hydrocarbons. Flaring will be optimized to the amount necessary to characterize the well potential and as necessary for the safety of the operation.

- Liquid wastes, not approved for discharge in OWTG such as waste chemicals, cooking oils or lubricating oils, will be transported onshore for transfer to an approved disposal facility.

- Waste management plans and procedures will be developed and implemented to prevent unauthorized waste discharges and transfers.
- Putrescible solid waste, specifically food waste generated offshore on the MODU and PSVs, will be disposed of according to OWTG and MARPOL requirements. In particular, food waste will be macerated so that particles are less than 6 mm in diameter and then discharged. There will be no discharge of macerated food waste within 3 nm from land. Biomedical waste will be collected onboard by the doctor and stored in special containers before being sent to land for incineration.
- Transfer of hazardous wastes will be conducted according to the *Transportation of Dangerous Goods Act*. Any applicable approvals for the transportation, handling and temporary storage, of these hazardous wastes will be obtained as required.

Vertical Seismic Profiling

- VSP activity will be planned and conducted in consideration of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP; DFO 2007b).
- A ramp-up procedure (*i.e.*, gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before any VSP operation begins.
- BP will use the minimum amount of energy necessary to achieve operational objectives; reduce the energy at frequencies above those necessary for the purpose of the survey; and will reduce the proportion of energy that propagates horizontally.

Well Abandonment

- Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, these details will be confirmed to the CNSOPB as planning for the Project continues.

7.2.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Risk of Mortality or Physical Injury

Presence and Operation of MODU

Underwater sound levels from the MODU were modelled to predict sound level propagation and inform the effects assessment (refer to Appendix D for the acoustic modelling report). It is generally recognized that establishing a single sound exposure criteria for marine fish to predict physical or behavioural changes is very challenging given the variation in sound characteristics from different types of sound sources and interspecific differences in how sound affects different species (generally due to diversity in body type and physiology)(*e.g.,* Popper *et al.* 2014). Most research on sound exposure criteria for marine fish has focused on percussive sounds such as those produced during pile driving activity or seismic surveys.

Although intended as criteria for the onset of effects of impulsive sounds (*e.g.*, pile driving, air guns), in terms of injuries to fish, the US Fisheries Hydroacoustic Working Group proposes the dual criteria of a peak sound pressure level of 206 dB re 1 µPa (peak) and cumulative SEL of 187 dB re 1 $\mu Pa^2 s$ for fish 2 grams or heavier (Fisheries Hydroacoustic Working Group 2008). In consideration of this general criteria and the acoustic modelling conducted for the Project, physical injury effects to individual fish as a result of MODU operation would be very localized. It should also be noted that exposure at these levels would be transient as mobile fish would be expected to react behaviourally at lower thresholds, moving away from these sound levels before injury could occur.

The source levels for the MODU used in the acoustic modelling are 208.7 dB re 1 µPa @1m peak SPL (Zykov 2016), thus just slightly above the 206 dB re 1 µPa peak SPL threshold and therefore have potential to cause physical injury or mortality at very close range (*i.e.,* within 1 to 2 m) to individual fish (refer to Section 4.2.3.2 in Appendix D). Whilst physical effect on small fish may occur if they are in the immediate vicinity of the MODU, mobile fish will likely be startled by vessel movement and activation of the thrusters and are predicted to avoid the area immediately around the thrusters before injury can occur. Aggregations of fish surrounding the thrusters are unlikely as a result of the turbulence generated by the thruster propellers. Given that the majority of mobile fish species are generally expected to avoid underwater sound at lower levels than those at which injury or mortality may occur, physical harm associated with peak SPLs is unlikely to occur therefore any potential impact on fish populations is highly unlikely.

The US Fisheries Hydroacoustic Working Group guidelines also suggest a second threshold criteria of 187 dB re 1 µPa cumulative SEL for fish 2 grams or heavier. Sound modelling of the MODU with PSV suggests a 24-hour cumulative SEL will decrease to below 190 dB re 1 $\mu Pa^2 s$ beyond a maximum distance of 2 km (assuming maximum $R_{95\%}$ value across all seasons and sites). This predicted distance is based on ocean conditions during winter when sound propagation is greater (during summer this distance is reduced to 1 km). These maximum values are based on cumulative sound exposure levels over a period of 24 hours; within this period avoidance behaviour by fish is likely to result by increasing their distance from the source, and therefore an associated exposure to decreased cumulative SELs. Based on the motility of the fish species and their anticipated avoidance behaviour, the risk of mortality or injury from cumulative SELs is expected to be low. Studies by Popper *et al*. (2014) and Normandeau Associates (2012) also indicate that the cumulative SEL criteria established by the Hydroacoustic Working Group may be lower than the actual level of effect for hearing in non-specialist fish. This is substantiated with results by Halvorsen *et al*. (2011a, b) and Casper *et al*. (2011) on hearing generalists.

The Change in Risk of Mortality or Physical Injury as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration and reversible.

Waste Management

As discussed in Section 7.1.2, adverse environmental effects on the marine benthos from exploration drilling are primarily related to the physical disturbance of the water column and benthic environment as a result of the discharge of drill muds and cuttings. In particular, an accumulation of drill solids on the seafloor can cause burial and suffocation of benthic species (Neff *et al.* 2004; Neff 2010).

Effects of smothering can include mortality, reduced growth of some species, reduced larval settlement, and a change in fauna composition (Neff *et al.* 2004). Some organisms may die from the mass of the discharges crushing them, while others may perish because they cannot penetrate through the deposited layer burying them. This effect is localized and short-term and will occur in close proximity to the discharge site and is unlikely to have an effect at the population level.

An average burial depth of 9.6 mm has been calculated to which there will likely be no net adverse effects to benthic organisms attributable to sedimentation (Neff *et al.* 2004). This is an average value and is species-dependent; some species may experience adverse effects at shallower depths (*e.g.*, Smit *et al.* (2006b) references a threshold of 6.5 mm). At thicknesses of approximately 10 mm or more, benthic communities comprised of sedentary or slow moving species may be smothered and the sediment quality will be altered in terms of nutrient enrichment and oxygen depletion (Neff *et al.* 2000; Neff *et al.* 2004).

Drill waste dispersion modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site (refer to Appendix C). The modelling predicts that the thickest drill cuttings deposition (>500 mm) will be confined to an area within 15 m of the discharge point. Considering both the shallowest (NS1) and deepest (NS3) wellsite locations, sediment thicknesses at or above 1 mm will extend up to 563 m from the discharge site and occupy a maximum areal extent of 9.91 ha per well; sediment thicknesses greater than 10 mm will extend up to 116 m, with a maximum footprint of 0.53 ha per well; and sediment thicknesses at or above 100 mm will be confined to a distance of 30 m from the discharge point, with a maximum footprint of 0.07 ha per well.

Environmental changes associated with the discharge of drill muds and cuttings are detectable during the earlier phases of drilling within a localized area (*e.g.*, within 500-m radius) but these effects subside with time (one to four years) (Bakke *et al.* 1986; Hurley and Ellis 2004; Renaud *et al.* 2008; Bakke *et al.* 2011).

In consideration of the predictive drill waste modelling results and mitigation described in Section 7.2.8.2, the Change in Risk of Mortality or Physical Injury as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration and reversible (*i.e.*, low benthic mortality rates are not predicted to result in irreversible changes to local populations).

Vertical Seismic Profiling

Vertical seismic profiling is expected to generate the most intensive underwater sound associated with the Project, although it will be over a relatively short period of time (no more than one day per well). Acoustic modelling conducted for the Project (refer to Appendix D) suggests the maximum sound source level of the VSP array will be 248 dB re 1 μPa @ 1 m peak SPL (broadside).

As discussed for the MODU operation, a threshold of 206 dB re 1 μPa peak and cumulative SELs of 187 dB re 1 μPa^2s has been suggested as a threshold to avoid potential injury to fish species 2 grams or heavier (Fisheries Hydroacoustic Working Group 2008). The results of the acoustic modelling conducted for the Scotian Basin Exploration Drilling Project (Zykov 2016; Appendix H), predicted that sound levels will decrease to below 202 dB re 1 μPa peak SPL at distances greater than 140 m from the VSP source (at wellsite) during VSP surveys (maximum $R_{95\%}$ value across all seasons and sites). This suggests that injury or mortality to fish if they were present (caused by exposure to SPLs ≥ 206 dB re 1 μPa peak) would be restricted to less than 140 m from the VSP sound source.

The results of the modelling were also compared to the Fisheries Hydroacoustic Working Group (2008) cumulative SEL criteria. The modelled cumulative SEL for a 24-hour period was predicted to decrease to below 190 dB re 1 μPa^2s at distances greater than 1.7 km from the VSP source (maximum $R_{95\%}$ value across all seasons and sites). As previously mentioned, application of this criteria is considered to be conservative as more recent studies indicate effects to hearing generalists could occur at sound levels greater than 187 dB re 1 μPa^2s SEL.

Received sound levels are unlikely to result in physical effects to the majority of mobile fish species due to the expectation that they would respond to avoid underwater sound at lower levels than those at which injury or mortality may occur. A ramp-up period for the VSP source will be initiated to further deter mobile fish from the area, thereby reducing their risk of being exposed to harmful levels of sound.

Underwater sound emissions from a seismic source array such as that used in VSP may cause mortality of fish eggs, larvae or fry in very close proximity (*i.e.* <5 m) (Kostyuchenko 1973; Booman *et al.* 1996). Potential mortality associated with sound from the VSP source is not considered to have an effect on recruitment to fish populations (Dalen *et al*. 1996). Sound exposure guidelines for eggs and larvae by Popper *et al*. (2014) were established using dual-criteria similar to those established by the Hydroacoustic Working Group. The sound exposure guidelines suggest that potential mortality or injury to eggs and larvae from seismic sources may result from a cumulative SEL greater than 210 dB re 1 μPa^2s or peak SPLs greater than 207 dB re 1 μPa. Using this dual criteria, potential injury to fish eggs and larvae may occur within 160 m of the source.

The diversity and abundance of fish eggs and larvae in the Project Area and surrounding LAA, with the exception of the Haddock Box, is generally expected to be low. Based on the likely wellsite locations within the Project Area (no Project well locations will be located within the

Haddock Box) and predicted sound propagation, the low likelihood of marine fish eggs and larvae located within a few hundred metres of the sound source while VSP is occurring, and the temporary nature of VSP surveys (no more than one day per well), it is anticipated that the amount of eggs and larvae with the potential to be exposed to sound levels causing physical injury or mortality (even in consideration of proximity to the Haddock Box) would be negligible. Eggs and larvae are only present in the water column during certain periods, thereby reducing temporal opportunities for potential interactions with Project activities and components. The distribution of these species' eggs or larvae extends well beyond the LAA to include most or all of the RAA. Saetre and Ona (1996) concluded that the mortality rates from exposure to a seismic sound source is insignificant as compared to natural mortality. This conclusion is consistent with findings reported in the Environmental Assessment of BP's Tangier 3D Seismic Survey (LGL 2014).

The Change in Risk of Mortality or Physical Injury as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Change in Habitat Quality and Use

Presence and Operation of MODU

Drilling operations as well as dynamic positioning activity of the MODU (*i.e.*, use of thrusters) will generate underwater sound, which may affect the quality of the underwater acoustic environment for marine fish. This activity could occur at any time of the year and would be continuous during the time it takes to drill each well (approximately 120 days per well).

As indicated above, predicting behavioural changes in fish is challenging given the variation in sound characteristics from different types of sources and interspecific differences in how sound is perceived by and may affect different species. Numerous studies have demonstrated avoidance behaviour (*e.g.*, diving, horizontal movements) of fish to approaching vessels, although reactions can vary depending on species, environmental conditions, and the physiological state of the fish (De Robertis and Handegard 2013). Behavioural responses of fish can also vary depending on the context (*e.g.*, the same fish may react differently when exposed to the same sound level while aggregated for spawning versus during foraging or feeding activities) (Hawkins and Popper 2014). Although underwater sound is believed to be the primary stimuli, other factors, including visual stimuli, may also influence behaviour.

During the initial period of drilling, avoidance of some fish species may occur, and startle responses may be elicited in close proximity to the sound source (*e.g.*, DP thrusters) at start-up (Mueller-Blenkle *et al.* 2008; Fewtrel and McCauley 2012). A general behavioral response was noted by McCauley *et al.* (2000a) at sound levels of 156 to 161 dB re 1μPa SPL RMS. Over the course of drilling, it is expected that fish will become habituated to the sound and avoidance and startle responses will cease (Chapman and Hawkins 1969; McCauley *et al.* 2000a, 2000b; Fewtrel and McCauley 2012). Acoustic modelling for the Project (Zykov 2016) predicts sound levels will decrease to below ≤ 150 dB re 1 µPa peak SPL greater than 0.4 km from the MODU and PSV (maximum $R_{95\%}$ value across all seasons and sites, Figure 29, Table 14 in Appendix D).

Lights from the MODU could potentially result in physiological stress in marine fish within the area of influence as artificial light is introduced to the water column. A common reaction of fish groups to the presence of artificial lighting is to school and move towards the light source. Sharp light contrasts created by over-water structures due to shading during the day and artificial lighting at night have the potential to alter the feeding, schooling, predator avoidance, and migratory behaviours of fish (Nightingale and Simenstad 2001; Hanson *et al.* 2003). Fish, especially juveniles and larvae, rely on visual cues for feeding. Shadows can create a light-dark interface, which may increase predation by ambush predators and increase starvation through limited feeding ability (NOAA 2008). The migratory behaviour of some species may favour deeper waters away from shaded areas during the day and lighted areas could affect migratory movements at night, contributing to increased risk of predation.

The Change in Habitat Quality and Use as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, occur within the LAA, continuous throughout the Project, medium-term in duration and reversible.

Waste Management

The discharge of drill muds and cuttings could give rise to a change in sediment quality within a localized area, which may be altered in terms of nutrient enrichment and oxygen depletion which could potentially result in changes in the composition of the benthic macrofauna community. However, few fish species are expected to inhabit the individual wellsites within the Project Area given the depths at which the operations will take place. BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.

Waste and emission discharges with potential for toxicity effects to the marine environment are regulated for compliance under the OWTG. Discharges from the MODU will meet OWTG requirements, which are established to protect the marine environment.

Discharges are expected to be temporary, non-bio-accumulating, non-toxic, and will be subject to high dilution in the open ocean; organic matter will be quickly dispersed and degraded by bacteria. If residual hydrocarbons are present in discharges (*e.g.*, deck drainage, bilge water) they would be at such low volumes and concentrations as they will comply with OWTG and MARPOL requirements.

The Change in Habitat Quality and Use as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration and reversible.

Vertical Seismic Profiling

As noted above for a Change in Risk of Mortality or Physical Injury, this activity is expected to generate the most intense sounds associated with Project activities, with the energy level from a single VSP shot expected to have a frequency of 5 to 2,000 Hz and a SPL of 248.7 dB re 1 μPa @ 1 m (*i.e.*, at source) (Zykov 2016; Appendix D). As noted above, thresholds for behavioural effects can vary, where avoidance behaviour can potentially occur at sound levels of 151 dB re 1 μPa peak SPL (McCauley *et al*. 2000a). Acoustic modelling for the Project (Zykov 2016) predicts sound levels will decrease to below 160 dB re 1 μPa peak SPL at distances greater than 20 km from the VSP sound source (maximum $R_{95\%}$ value across all seasons and sites (Figure 45, Table 26 in Appendix D)).

The Change in Habitat Quality and Use as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

Supply and servicing operations will increase vessel traffic within the Project Area and LAA (two to three PSVs making two to three round trips per week between the MODU and the supply base) and may therefore locally affect Fish Habitat Quality and Use around the PSV due to increased vessel sound. At an estimated sound source level of 188 dB re 1 μPa @ 1 m RMS SPL (Zykov 2016; Appendix D), underwater sound associated with PSV traffic will introduce additional underwater sound to the acoustic environment, although given the relatively small increment in vessel traffic as a result of the Project, this increase will be very low. Reactions of fish to vessels can vary by species and can also be influenced by environmental conditions and physiological state of the fish at the time of the interaction (De Robertis and Handegard 2013). However, the likely reaction to vessel sound is either temporary displacement or avoidance of the area in which the disturbing sound level is occurring. Any change to habitat quality would represent a small increment over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

The Change in Habitat Quality and Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, continuous throughout the Project, medium-term in duration and reversible.

Well Abandonment

Well abandonment is likely only to give rise to a localized disturbance, and therefore it is expected that fish would avoid the immediate area where the mechanical separation activities are taking place. Following abandonment of the drill site, it is anticipated that the wellhead (if left in place), will provide hard substrate suitable for recolonization by benthic communities.

The Change in Habitat Quality and Use as a result of well abandonment is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project may result in adverse effects that cause a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for Fish and Fish Habitat. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g*., compliance with OWTG, *Canadian Practice with Respect to the Mitigation of Sound in the Marine Environment*), the residual effect of a Change in Risk of Mortality or Physical Injury for various Project components and activities is considered to be low in magnitude. Residual project environmental effects for a Change in Risk of Mortality or Physical Injury will be restricted primarily to the Project Area but could extend into parts of the LAA during VSP surveys. The duration of effects will vary from short-term events (*i.e.,* no more than one day per well for VSP) to medium-term, continuous or regular events such as the presence and operation of the MODU and waste management. These environmental effects may occur within a disturbed ecological and socio-economic context (associated with ongoing harvesting of fish species and underwater sound and waste discharge associated with marine shipping in the RAA). Similarly, changes to Habitat Quality and Use for Fish and Fish Habitat are predicted to be low in magnitude, occur within the Project Area or parts of the LAA, be short to medium-term in duration, be reversible at the completion of the Project, and occur within a relatively undisturbed ecological and socio-economic context. No permanent alteration to, or destruction of, fish habitat is predicted to occur as a result of Project activities.

Table 7.2.6 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Fish and Fish Habitat that were identified in Table 7.2.6.

Table 7.2.6 Summary of Project Residual Environmental Effects on Fish and Fish Habitat

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L	PA	MT	C	R	D
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	A	L	PA	MT	R	R	D
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	D
Change in Habitat Quality and Use							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sounds)	A	L	LAA	MT	C	R	D
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	A	L	PA	MT	R	R	D
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	D
Supply and Servicing Operations (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	D

KEY:
See Table 7.2.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.2.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Risk of Mortality of Physical Injury and Change in Habitat Quality on Fish and Fish Habitat from Project activities and components are predicted to be not significant. This conclusion has been determined with a moderate to high level of confidence based on a good understanding of the general effects of exploration drilling and VSP operation on Fish and Fish Habitat and the effectiveness of mitigation measures discussed in Section 7.2.8.2. Taking a conservative approach, the confidence level has been reduced to moderate in some cases to account for the dearth of research around appropriate effects thresholds for continuous sounds on marine fish.

7.2.10 Follow-up and Monitoring

BP will conduct a visual survey (using an ROV) of the seafloor during and after drilling activities to assess the extent of sediment dispersion.

BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the drilling program to collect field measurements of underwater sound in order to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and the CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.

7.3 MARINE MAMMALS AND SEA TURTLES

Marine Mammals and Sea Turtles was selected as a VC in recognition of the ecological value they provide to marine ecosystems, specific regulatory requirements of the *Fisheries Act* and SARA, requirements of the EIS Guidelines, and potential interactions with the Project. This VC considers secure species as well as species of marine mammals and sea turtles listed under SARA (*i.e.,* SAR) or considered at risk by COSEWIC (*i.e.,* SOCC). The marine mammals component includes consideration of baleen whales (mysticetes), toothed whales (odontocetes), and seals (phocids). Due to similarities in habitat use and the nature of interactions with the Project, sea turtles are assessed together with marine mammals, with differences noted as applicable.

The Project Area is located within the Scotian Slope offshore region, which is known to support a diversity of marine mammals and sea turtles and to contain important foraging areas and migratory routes for these species (refer to Section 5.2). This VC is related to the Special Areas VC, considered separately in Section 7.5, as Special Areas are often designated to protect SAR and SOCC, including applicable species of marine mammals and sea turtles.

7.3.1 Regulatory and Policy Setting

Marine mammals and sea turtles are "marine animals" and therefore included within the definition of "fish" under the *Fisheries Act*. As noted in Section 7.2, the federal *Fisheries Act* includes provisions that prohibit serious harm to fish (*i.e.*, the death of fish or any permanent alteration to, or destruction of, fish habitat) that are part of a commercial, recreational, or Aboriginal (CRA) fishery. It also prohibits the deposition of a deleterious substance in waters frequented by fish.

The federal SARA focuses on protecting species and their associated habitat whose populations are not secure. SARA seeks to prevent species from being extirpated (*i.e.*, locally extinct) or becoming extinct; to provide for the recovery of species that are extirpated, endangered or threatened as a result of human activity; and to manage species of special concern to prevent them from becoming endangered or threatened. For the purposes of this assessment, sections 32, 33 and 58 of SARA are the most relevant sections of the Act and contain provisions to protect species listed on Schedule 1 of SARA and their critical habitat. Critical habitat is defined under SARA as "habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or action plan for the species" (section 2[1]). Critical habitat has not yet been defined for all listed species.

Under section 79 of SARA, Ministerial notification is required if a project "is likely to affect a listed wildlife species or its critical habitat". This notification must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, measures that will be taken to avoid or lessen those effects, along with monitoring commitments.

DFO has not yet set regulatory thresholds for levels of underwater sound to be avoided to reduce potential for injury or behavioural disturbance effects to marine mammals. In the absence of formal Canadian thresholds, published literature reviews and US regulatory and draft regulatory thresholds for reducing risk of potential impacts to marine mammals and fish have been used to inform this assessment of potential physical injury in the form of permanent threshold shifts (PTS). Various thresholds have been established using peak sound pressure level (SPL), root-mean-square (RMS) SPL, and sound exposure (energy) level (SEL) metrics.

Threshold criteria are commonly used to assess potential PTS; however, behavioural responses of marine mammals to underwater sound are generally more variable, context-dependent and less predictable than potential physical effects (Southall *et al*. 2007). Therefore, use of available sound thresholds to predict behavioural response are considered as a guide to informing the assessment of potential effects of sound on marine mammals rather than as an absolute measure of such effects occurring.

The determination of threshold criteria for sound levels believed to have the potential to injure or disturb marine mammals is currently an active and complex research topic. Since 2007, several expert groups have investigated various assessment approaches and a number of key studies and papers have been undertaken on the topic. In the US, NOAA has recently released for public comment, a third version (NOAA 2016a) of their draft guidelines - *Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (NOAA 2015b). While the most recent 2016 version updates were not available for review and incorporation at the time acoustic modelling was undertaken for this Project, the 2015 draft guidelines were considered and predictions based on those thresholds are presented in this report. The draft NOAA guidelines provide the most current guidance on the threshold levels of underwater sound that are thought to cause temporary or permanent changes in marine mammal hearing sensitivity (*i.e.,* temporary threshold shifts (TTS) and PTS). It is important to recognize that these draft guidelines remain under review by the scientific community and are subject to change. Much of the basis for these guidelines comes from the recommendations previously put forward by Southall *et al*. (2007), whose criteria have and continue to be commonly used for assessing potential effects from sounds associated with offshore activities around the world. NOAA's new guidelines also incorporate more recent auditory data acquired since 2007. Since the NOAA 2015b thresholds remain in draft form, have already undergone and will continue to be subject to further revision, and have not yet been formally accepted by either NOAA or the scientific community, the thresholds put forward by Southall *et al.* (2007) have been used as the primary source of acoustic criteria for this assessment with additional context provided by exploring the draft 2015 NOAA Guidelines. Thresholds for onset of PTS in marine mammals proposed by NOAA (2015) and Southall *et al.* (2007) are summarized in Table 1 of Appendix D and are discussed as applicable in the subsections below. NOAA (2015b) and Southall *et al.* (2007) both present dual metrics (*i.e.,* they provide threshold values in both peak and cumulative sound exposure level (SEL) decibel levels), and recommend that proponents draw conclusions based on whichever metric is exceeded first. It is noted that disagreement persists in the scientific community with respect to many aspects of the establishment of appropriate exposure criteria for marine mammals (see for example Wright 2015, Tougaard *et al.* 2015, Finneran 2015).

Both the NOAA (2015b) and Southall *et al.* (2007) criteria were developed specifically for use with marine mammals. NOAA has stated that they intend to establish similar acoustic injury thresholds for other species of conservation concern, such as sea turtles and marine fish, as soon as more data become available (NOAA 2015b). Under the ANSI-Accredited Standards Committee S3/SC 1, a Working Group (WG) on Animal Bioacoustics has established sound exposure guidelines for sea turtles that adopt some of Southall *et al.* (2007)'s approaches for marine mammals. However, the WG acknowledges that it is very difficult to establish guidelines for sea turtles because very little is known about their hearing and the role of sound in their lives (Popper *et al.* 2014). The WG has therefore only developed numeric thresholds for potential sea turtle mortality and mortal injury in relation to explosions, seismic airguns, and pile driving, at this time. The recommended thresholds for seismic airguns are considered in the assessment of potential effects on sea turtles from VSP.

NOAA's interim guidelines (NOAA n.d.) for marine mammals provide threshold levels for broadband underwater RMS SPLs to avoid risk of behavioural disruption. NOAA's most recent 2015 draft guidelines do not address behavioural disruption or update the interim guidelines, which is widely recognized as being a complex and challenging subject which is an area of ongoing investigation and analysis. Until this updated guidance is developed, and in the absence of formal Canadian thresholds, NOAA's interim root mean square (RMS) SPLs (NOAA n.d.) sound level thresholds have been used to inform the assessment of potential behavioural effects of sound on marine mammals with additional context provided based on outcomes of various available research study and review publications . These sound level threshold values, which have been historically applied generically to both cetaceans and pinnipeds, are 120 dB RMS re 1 µPa for continuous sounds (*e.g.*, shipping and drilling) and 160 dB RMS re 1 µPa for pulse sounds (*e.g.*, seismic surveys and VSP). These sound levels have commonly been used in environmental assessments of seismic programs in Atlantic Canada (as well as Pacific Canada, Arctic Canada, and the US) for assessing behavioural effects of anthropogenic underwater sound on marine mammals. See for example: BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014); the Shelburne Basin Venture Exploration Drilling Project (Stantec 2014a; the Strategic Environmental Assessment for Offshore Petroleum Exploration Activities - Western Scotian Slope (Phase 3B) (Stantec 2014b); the SEA for Offshore Petroleum Activities - Eastern Scotian Slope (Phase 1B) (Stantec 2012b). This approach is also consistent with that taken in the acoustic assessment framework put forward by DFO in which an SPL of 120 dB re 1 µPa RMS is applied as the received threshold sound levels at which negative responses by cetaceans to underwater continuous sound are "presumed to begin" (Lawson and Lesage 2013). However, similar to criteria developed for auditory injury, it is noted that there exists much scientific disagreement and debate concerning the validity and relevance of assigning singular value sensory disturbance thresholds across species, particularly considering evidence highlighting the importance of context at the time of exposure. While there has been suggestion that the 120 and 160 dB values over-extrapolate results from too few studies and species (Green 1994), recent studies have also shown responses at lower levels (*e.g.*, bowhead whales showed decreases in call rates in response to a received seismic pulse SPL of 116 dB RMS re 1 µPa [Blackwell *et al.* 2013]).

7.3.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date include concerns about potential effects of drilling sounds on marine mammals, and the proximity of Project activities to important habitat for marine mammals and sea turtles, including the endangered North Atlantic right whale, northern bottlenose whale, and leatherback sea turtle. Whales were also identified as being spiritually important to the Mi'kmaq.

7.3.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have the potential to interact with marine mammals and sea turtles as well as their habitat. These interactions could result from underwater sound emissions produced by operation of the MODU, PSV, and helicopter, as well as during VSP surveys. PSV traffic presents a risk of collision with marine mammals and seas turtles, potentially resulting in physical injury or mortality to individuals. The Project could also result in changes in availability, distribution, or quality of prey items and habitat for marine mammals and sea turtles as a result of underwater sound or operation discharges (refer to Section 7.2. for an assessment of effects on prey species).

In consideration of these potential interactions, the assessment of Project-related environmental effects on Marine Mammals and Sea Turtles is focused on the following potential environmental effects:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

The measurable parameters used for the assessment of these environmental effects, and the rationale for selection, are provided in Table 7.3.1. Effects of accidental events are assessed separately in Section 8.5.2.

Table 7.3.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Marine Mammals and Sea Turtles

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Risk of Mortality or Physical Injury	• Increased risk of exposure to underwater sound at levels capable of causing auditory injury (*i.e.*, PTS) • Increased risk of vessel collision	• Species injury or mortality (qualitative likelihood of species injury or mortality) • Extent (km from sound source) of underwater sound potentially injuring marine mammals and sea turtles
Change in Habitat Quality and Use	• Increased risk of exposure to marine contaminants • Increased risk of exposure to underwater sound at levels capable of causing sensory disturbance	• Change in chemical composition of water (unit depends on the contaminant) • Extent (km from sound source) of underwater sound potentially affecting marine mammal and sea turtle behaviour

Determining if and at what distance an animal can hear a sound is important in assessing effects from introduced underwater sound (Richardson *et al.* 1995; Popper 2003). This EIS uses expected species presence in the study area along with the results of acoustic modelling (Section 7.1.1.2 and Appendix D) to compare predicted Project-related sound levels to commonly used sound level thresholds to assess the ranges from the source at which potential injury or behavioural disturbance may occur. Distances of threshold exceedance presented in this EIS are the $R_{95\%}$ values, which are based on the predicted range that encompasses at least 95% of the area (in the horizontal plane) that would be exposed to sound at or above that threshold level.

7.3.4 Environmental Assessment Boundaries

7.3.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Marine Mammals and Sea Turtles are defined below and depicted on Figure 7.3.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Marine Mammals and Sea Turtles are reasonably expected to occur if they are present within this area. Based on predicted propagation of sound from Project Activities and reported thresholds for behavioural and physical effects on cetaceans, the recognition of critical habitat for SAR in the RAA and migratory activity of marine mammals and sea turtles in the RAA, and the PSV routes to and from the Project Area, the LAA has been extended to include the entire RAA.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

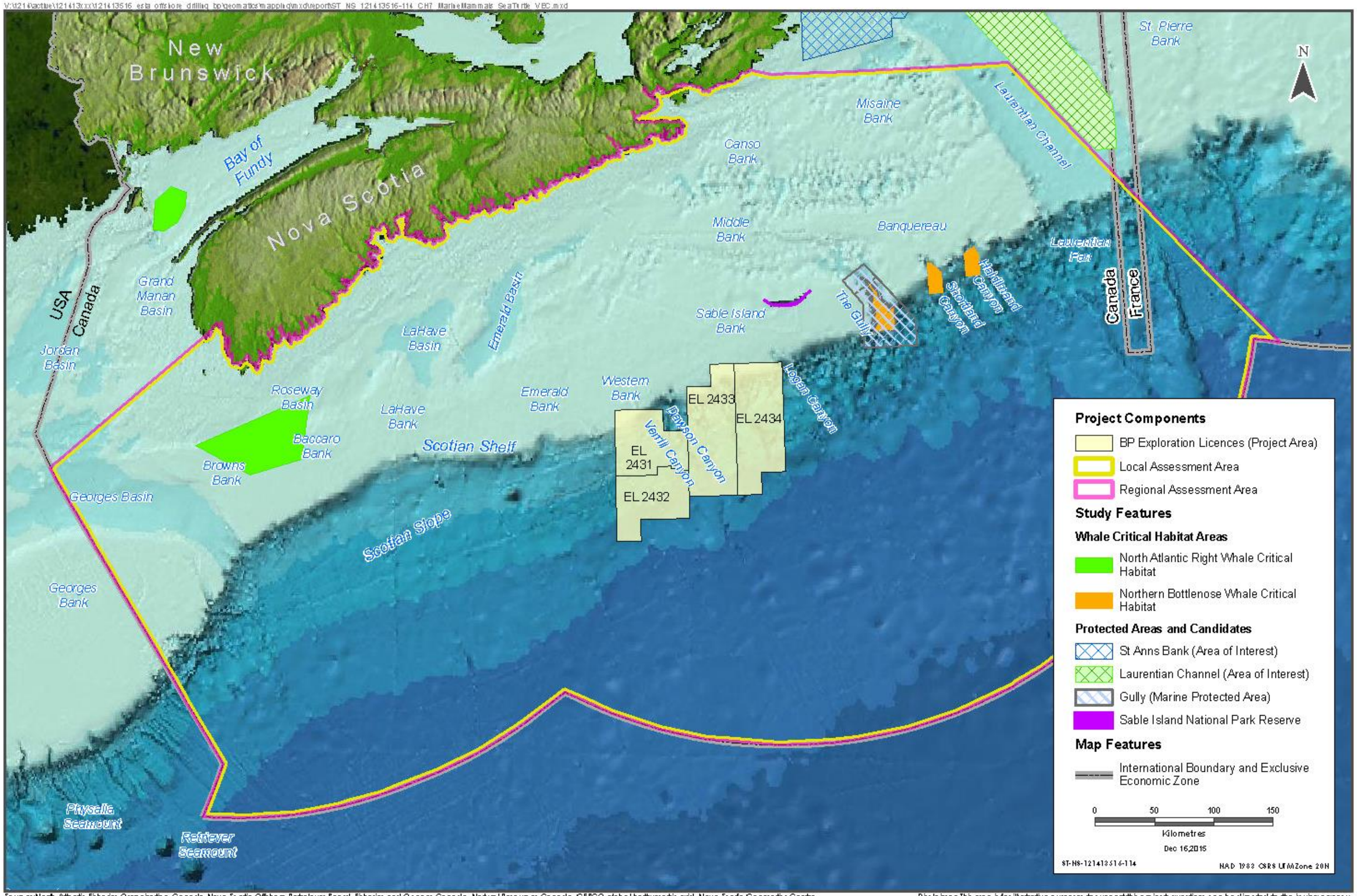


Figure 7.3.1 Assessment Boundaries for Marine Mammals and Sea Turtles

7.3.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Marine Mammals and Sea Turtles encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking up to a maximum of 120 days to drill. VSP operations are typically short duration, normally taking no more than a day per well to complete the profiling. It is assumed that Project activities could occur year-round.

Marine mammals and sea turtles can be found year-round in and around the Project Area carrying out various life cycle processes. Refer to Section 5.2 for details regarding the specific marine mammal and sea turtle species known to occur in the RAA, including their sensitive life stages in relation to the Project Area.

7.3.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.3.2 defines the descriptors that are used to characterize residual environmental effects on Marine Mammals and Sea Turtles.

Table 7.3.2 Characterization of Residual Environmental Effects on Marine Mammals and Sea Turtles

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial to Marine Mammals and Sea Turtles relative to baseline **Adverse** – an effect that moves measurable parameters in a direction detrimental to Marine Mammals and Sea Turtles relative to baseline **Neutral** – no net change in measureable parameters for the Marine Mammals and Sea Turtles relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in marine species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability; will not affect population viability **Moderate** – measurable change outside the range of natural variability but not posing a risk to population viability

Table 7.3.2 Characterization of Residual Environmental Effects on Marine Mammals and Sea Turtles

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		High – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to a portion of the LAA/RAA **Regional Assessment Area** – effects could extend widely throughout the LAA/RAA
Frequency	Identifies when the residual effect occurs and how often during the Project or in a specific phase	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once with no set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continues after well abandonment
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, the following threshold has been established to define a significant adverse residual environmental effect on Marine Mammals and Sea Turtles.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Marine Mammals and Sea Turtles is defined as a Project-related environmental effect that:

- causes a decline in abundance or change in distribution of marine mammal or sea turtle populations within the RAA, such that natural recruitment may not re-establish the population(s) to its original level within one generation;
- jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed SARA species; or
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy.

7.3.6 Existing Conditions

7.3.6.1 Overview of Marine Mammal and Sea Turtle Species Presence

Marine mammals and sea turtles found on the Scotian Shelf and Slope include six species of mysticetes (baleen whales), eleven species of odontocetes (toothed whales), five species of phocids (seals), and four species of sea turtles (see Tables 5.2.9 and 5.2.12). Of these, ten species are designated at risk by SARA or COSEWIC (three species of mysticetes, four species of odontocetes, and two species of sea turtles; see Table 7.3.3). No phocid populations on the Scotian Shelf are listed as SOCC.

Most species of baleen whale are migratory, and are present on the Scotian Shelf and Slope from late spring through fall. Only the fin whale is present year-round. While odontocetes are also present in greatest diversity during the spring through fall months, their timing is more variable, with multiple species present in the winter or year-round. Table 5.2.10 presents information on presence and timing of marine mammals known to occur in the vicinity of the Project Area based on a review of existing literature incorporated within the SEA for the Scotian Slope (Phase 1B and 3B) (Stantec 2012b, 2014b). Critical habitat for the endangered North Atlantic right whale has been identified in Roseway Basin on the Scotian Shelf within the RAA (Brown *et al.* 2009). Critical habitat for the endangered northern bottlenose whale has been designated in the Gully and in the Shortland and Haldimand Canyons on the east of the Scotian Shelf and Slope (DFO 2010b).

In the waters off Nova Scotia, seals are most commonly found over the Scotian Shelf, particularly north of the Project Area, in the nearshore waters around Sable Island. They are less common in the open waters over the Scotian Slope, where the Project Area is located. For example, during the 2014 Tangier 3D Seismic Survey, only three harbour seals were observed in the Project Area (see Table 5.2.11; LGL 2014). Sable Island is an important area for phocids as it hosts breeding populations of harbour seals (*Phoca vitulina*), and the world's largest breeding colony of grey seals (*Halichoerus grypus*; DFO 2011a; Freedman 2014). Smaller breeding colonies have also been found on coastal islands along southwestern Nova Scotia at Flat, Mud, Noddy, and Round Islands (Bowen *et al.* 2011). Grey seals pup from mid-December to late January, while harbour seals are year-round residents that pup from mid-May to mid-June. Other species of phocids known to forage on the Scotian Shelf include harp (*Pagophilus groenlandica*), hooded (*Cystophora cristata*) and ringed (*Pusa hipsida*) seals. Generally, these species have only occasionally been observed foraging offshore Nova Scotia and are considered to be infrequent visitors to these waters; however, for a few hours or days during the winter and early spring, hundreds of harp and hooded seals and one or two ringed seals come ashore on Sable Island (DFO 2011a). Seal observations recorded on the Scotian Shelf and Slope between 1911 and 2013 are presented in Figure 5.2.18.

Four species of sea turtle can be found migrating and foraging on the Scotian Shelf and Slope waters. Of these, the leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) sea turtles are the most likely to occur, and both species are listed as endangered by COSEWIC (only the leatherback sea turtle is currently designated under SARA). Leatherback and loggerhead sea turtles, and a few green sea turtles (*Chelonia mydas*) were observed over the course of BP's 2014 Tangier 3D Seismic Survey (RPS 2014), and Shell's 2013 Shelburne Basin 3D Seismic Survey (see Figures 5.2.19-5.2.20 for reported sea turtle sightings). The presence of Kemp's ridley sea turtle (*Lepidochelys kempii*) in the Project Area is considered unlikely.

Critical habitat was not identified in the 2006 Recovery Strategy for the leatherback sea turtle; however, DFO has been using satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada for the purpose of identifying critical habitat for designation under SARA (DFO 2011b). Research has identified three important areas for leatherback turtle foraging in Atlantic Canadian water (DFO 2013c) and it is expected that these areas will be included as critical habitat in an amended Recovery Strategy, once finalized.

Table 7.3.3 Marine Mammal and Sea Turtle Species at Risk and Species of Conservation Concern Found in the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area[1]	Timing of Presence
Mysticetes (Toothless or Baleen Whales)					
Blue whale (Atlantic population)	*Balaenoptera musculus*	Endangered	Endangered	Moderate	Summer to Fall
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Special Concern	High	Year- round (highest concentrations in Summer)
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered	Low	Summer
Odontocetes (Toothed Whales)					
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Not Listed	Special Concern	Low	Summer to Fall
Killer whale	*Orcinus orca*	Not Listed	Special Concern	Low to Moderate	Summer

Table 7.3.3 Marine Mammal and Sea Turtle Species at Risk and Species of Conservation Concern Found in the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area[1]	Timing of Presence
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Endangered	Endangered	Low	Year-round
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Special Concern	Low	Year-round
Sea Turtles					
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered	High	April to December
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered	High	April to December

Note:
[1]This is based on the analysis of habitat preferences during various life history stages, distribution mapping, and sightings data for each species within the Project Area.

Source: Modified from Stantec 2012b and 2014bb

7.3.6.2 Marine Mammals and Underwater Sounds

Marine mammals rely heavily on their ability to hear and use underwater sounds to communicate, locate prey, avoid predators, and gather other information about their surroundings (Richardson *et al.* 1995; Gordon *et al.* 2004; Nowacek *et al.* 2007; Tyack 2008). Research to date (based on both direct measurements and predictions resulting from morphology, behaviour, vocalizations, and taxonomy) indicates that not all marine mammal individuals or species have equal hearing capabilities in terms of absolute hearing sensitivity or the frequency at which they are able to detect sound (Southall 2007; NOAA 2015b). The hearing abilities of some marine mammals species have been directly measured (*i.e.*, some odontocetes, pinnipeds), while for other species (*i.e.*, mysticetes) hearing abilities have been determined from behavioural and anatomical evidence alone, as limitations exist to make such measurements (*e.g.*, it is difficult to keep baleen whales in captivity) (Houser *et al.* 2001; Parks *et al.* 2007; Dahlheim and Ljungbald 1990; Reichmuth 2007). The ability to hear sounds varies across a species' functional hearing range, with most marine mammal audiograms depicting a "U-shape", where frequencies at the bottom of the "U" are those to which the animal is the most sensitive and for which they have the best hearing ability (Southall 2007; NOAA 2015b). To reflect this higher sensitivity to particular frequencies, received sound levels are often weighted using species-specific (or functional hearing group-specific) audiograms. Weighting functions have been proposed for marine mammals, specifically when associated with TTS and PTS acoustic threshold levels expressed as cSEL. The functional hearing ranges of marine mammals (according to Southall *et al.* 2007) are listed in Table 7.3.4.

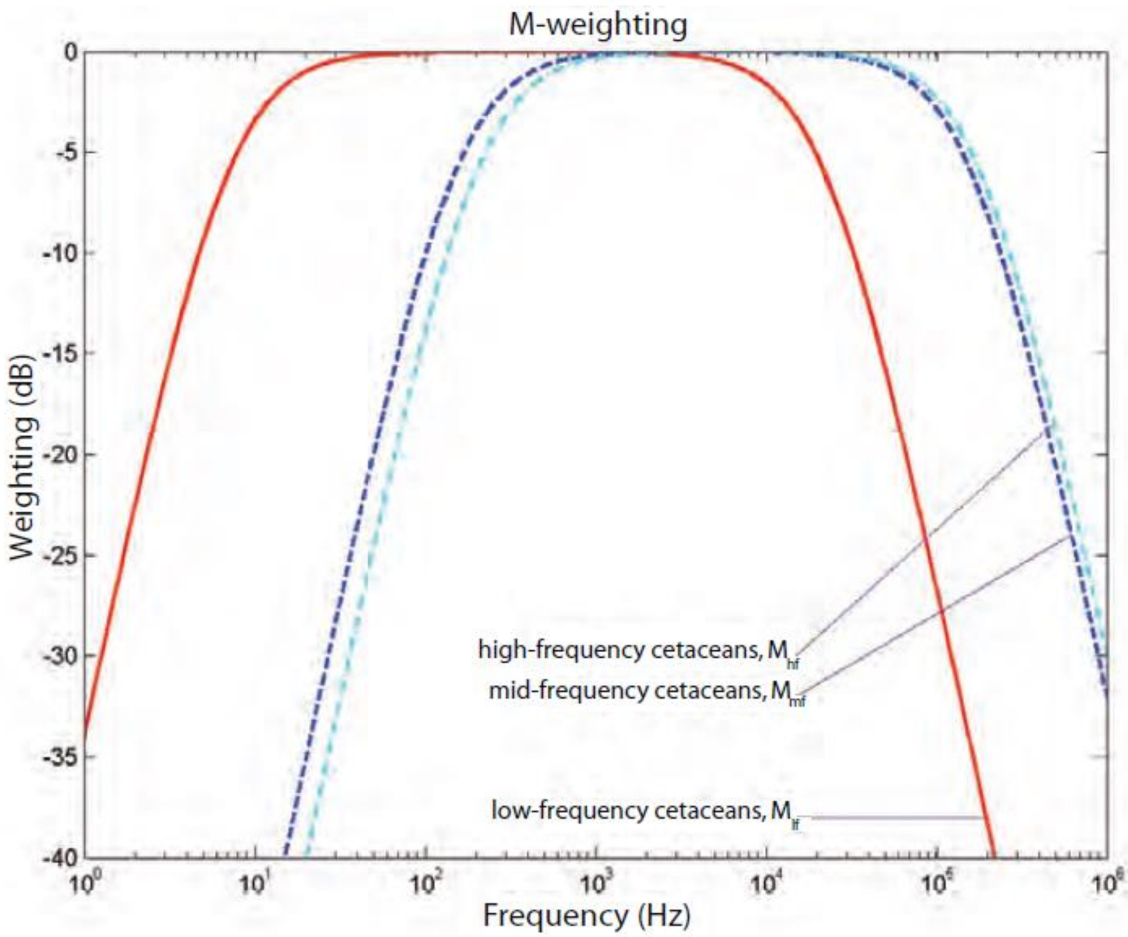
Table 7.3.4 Functional Hearing Range of Marine Mammals.

Functional Hearing Group	Functional Hearing Range	Frequency- Weighting Network
Low-Frequency (LF) Cetaceans[1] (Mysticetes)	7 Hz to 22 kHz	M_{lf} (lf: low-frequency cetacean)
Mid-Frequency (MF) Cetaceans (Most Odontocetes)	150 Hz to 160 kHz	M_{mf} (mf:mid-frequency cetacean)
High- Frequency (HF) Cetaceans (*e.g.,* Harbour Porpoise)	200 Hz to 180 kHz	M_{hf} (hf:high-frequency cetacean)
Pinnipeds in Water	75 Hz to 75 kHz	M_{pw} (pw:pinnipeds in water)
Pinnipeds in Air	75 Hz to 30 kHz	M_{pa} (pa:pinnipeds in air)

[1]Estimated hearing and frequency range for low-frequency cetaceans is based on behavioural studies, recorded vocalizations, and inner ear morphology measurements. No direct measurements of hearing ability have been successfully completed.

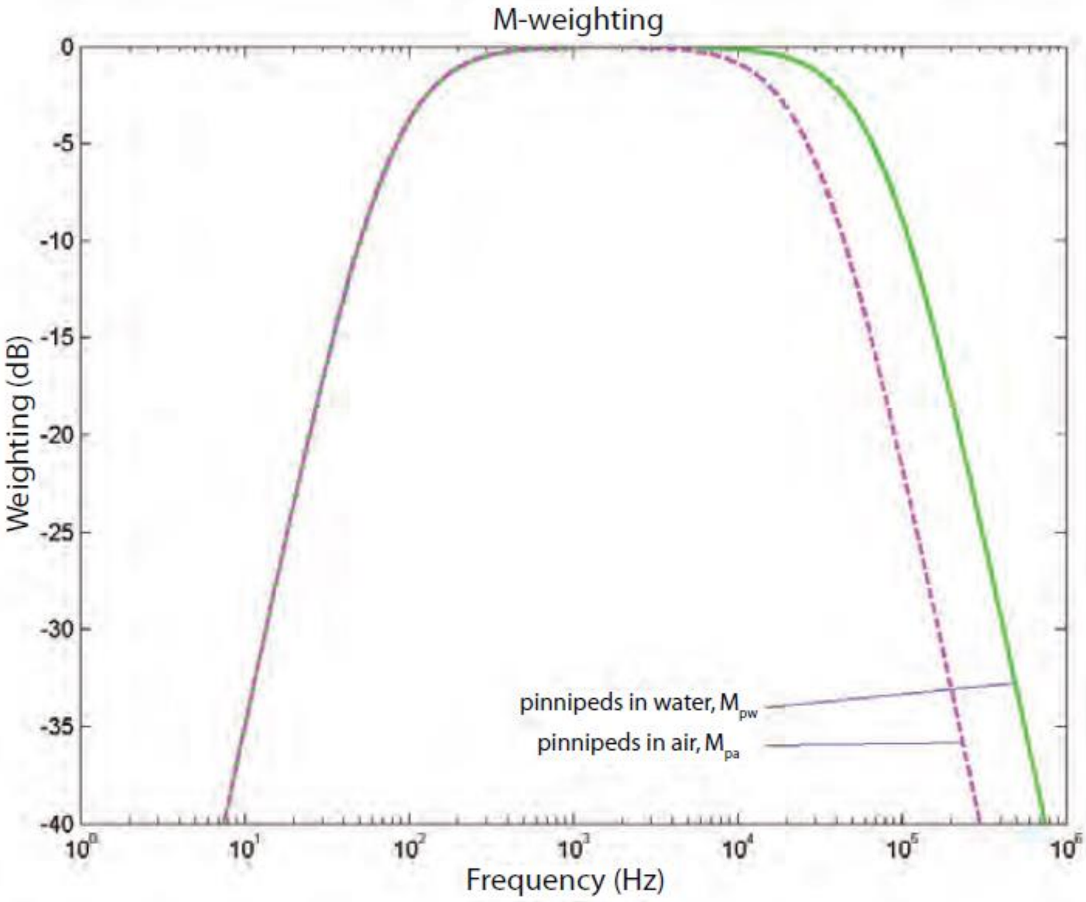
Source: Southall *et al.* 2007

Southall *et al.* (2007) proposed standard frequency weighted functions (referred to as M-weighted functions) for marine mammals. These functions can be viewed in Figures 7.3.2 and 7.3.3 (taken from Southall *et al.* 2007). The weighted function accounts for a "discount" to sound frequencies outside of the peak hearing frequency for a mammal. An animal's ability to hear or detect sound levels outside the range of a functional hearing group's prime hearing sensitivity (*i.e*., where the weighted function amplitude is equal to 0) is reduced. The farther a sound source's frequency is away from the range of best sensitivity, the lower the animal's ability to detect or hear that sound.



Source: Southall *et al.* 2007

Figure 7.3.2 High-frequency, Mid-frequency, and Low-frequency Cetacean Auditory Weighting Functions



Source: Southall *et al.* 2007

Figure 7.3.3 Pinniped Auditory Weighting Function

The addition of anthropogenic underwater sounds to the marine environment has the potential to result in adverse effects on marine life. Potential effects are highly variable and may include injury/mortality (both pathological and physiological effects), behavioural effects, and effects on habitat (*e.g*., communication masking). The actual reactions of marine mammals are difficult to predict and depend on many variables including the type, magnitude and duration of the sound, the species and its distance from the source, and the activity state of the animal at the time (Popper and Hawkins 2012; Richardson *et al.* 1995).

7.3.6.2.1 Physiological Effects

One of the more common potential physiological effects of increased anthropogenic sound levels is a threshold shift caused by hair cell fatigue or damage within the ear, or nerve degeneration resulting in a loss of hearing sensitivity. The result of a threshold shift is a reduction in hearing sensitivity and an upward shift in the auditory threshold (*i.e.,* reduction in the ability to hear certain sound levels). The auditory threshold is the level of the quietest sound audible, and is estimated by either behavioural or electrophysiological responses over a specified percent of trials (Southall *et al.* 2007). A threshold shift may occur due to exposure to a sound level, which is species-dependent; once this occurs, the threshold of hearing increases, resulting in decreased sensitivity to sound. If marine animals are exposed to sounds of sufficient intensity, they may experience a noise-induced threshold shift – an increased hearing threshold (decrease in hearing sensitivity)(Southall *et al.* 2007). These shifts can either be temporary (TTS) for some duration following exposure or, in the event of prolonged exposure and/or sufficiently intense sound levels, permanent (PTS).

Southall *et al.* (2007) have suggested that marine mammals below the surface can likely tolerate (before the onset of permanent hearing damage) exposure to about 17 dB higher received acoustic energy level if the sound is non-impulsive as opposed to impulsive. Thresholds for onset of PTS in marine mammals proposed by Southall *et al*. (2007) and NOAA (2015) are summarized in Table 1 of Appendix D.

7.3.6.2.2 Behavioural Effects

Potential behavioural disturbance effects can be difficult to measure and depend on a wide variety of factors such as the physical characteristics of the sound source, the behavioural and motivational state of the receiver, its age, sex, social status, *etc.* (OSPAR 2009). Behavioural reactions can range from very subtle changes in behaviour to overt avoidance reactions. Increased levels of underwater sound have been shown to cause stress (Wright and Kuczaj 2007; Wysocki *et al*. 2006; Hastings and Popper 2005; Rolland *et al.* 2012), which could theoretically lead to lowered immune response and diminished reproductive effort (Southall *et al.* 2007; Wright *et al.* 2007a, 2007b, 2009, 2011). Behavioural effects can also take the form of changes in vocal activity (Clark *et al.* 2009; Popper and Hawkins 2012; Richardson *et al.* 1995; Risch *et al.* 2012; Southall *et al.* 2007; Williams *et al.* 2013) or through the triggering of avoidance behaviours, with potential effects on migration (*e.g*., van Opzeeland and Slabbekoorn 2012) and foraging patterns (*e.g.*, Slotte *et al.* 2004; Sundermeyer *et al.* 2012; Tougaard *et al.* 2012). Information on the reactions of marine mammals to anthropogenic sound is available through a number of studies (see for example the Behavioural Response of Australian Humpback whales to Seismic Surveys [BRAHSS] program), although this information is limited in terms of species and situations (Richardson *et al.*1995; Gordon *et al.* 2004; Nowacek *et al.* 2007; Southall *et al.* 2007; BRAHSS 2015). The majority of this research has focused on the response to seismic sound, and not specifically on drilling sounds.

Examples of observed behavioural responses from mysticetes in relation to seismic activity include deviation from their migration routes, altered feeding patterns, and avoidance behaviour (Malme *et al.*1984, 1985, 1988; Richardson *et al.* 1986, 1995; Richardson and Malme 1993; Ljungbald and Miller 1988; McCauley *et al.* 1998, 2000a, 2000b; Gordon *et al.* 2004; Miller *et al.* 2005; Moulton and Miller 2005; Stone and Tasker 2006; Johnson *et al.* 2007; Nowacek *et al.* 2007; Weir 2008). Other examples of mysticete responses to sound are changes in respiration and dive patterns, breaching, and tail slapping (Nowacek *et al.* 2007; Southall *et al.* 2007). There is less information regarding odontocete responses to increased underwater sound, as much research has focused on mysticetes; however, some odontocetes such as harbour porpoises have been shown to move away from areas of intense sound. Due to the lower magnitude of sound emitted during drilling, effects are expected to be considerably less than those observed in response to seismic source.

7.3.6.2.3 Masking

Masking is considered to occur when a sound interferes with the way in which an animal receives an acoustic signal. The occurrence and degree of masking depend on a large number of factors, including the source level and spectral characteristics of the signal, the distance between the source and receiver, habitat characteristics affecting sound absorption, reflection, refraction, scattering and spreading loss, and ambient sound levels (biotic, abiotic, and anthropogenic). Some marine animals have been shown to alter their communications (*i.e*., frequency, duration, or intensity) in response to the presence of a masking sound (*e.g*., Clark *et al*. 2009; Popper and Hawkins 2012; Risch *et al*. 2012; Williams *et al*. 2013). Masking is of potential concern when it interferes with an animal's ability to detect biologically important signals, including communication sounds, echolocation clicks, social calls and songs during mating and reproduction, and passive detection cues that are used to navigate and find prey (OSPAR 2009; Clark 1990; Erbe 2002; Southall *et al*. 2007; Wright 2008; Erbe *et al*. 2016). Some species use areas of thousands of square kilometres to communicate and masking may shrink the distance over which these communications can be detected (OSPAR 2009). A recent study on the west coast of Canada conducted by Williams *et al.* (2013) has illustrated that the presence of anthropogenic sounds can heavily reduce the possible range of cetacean communication. The largest effects were observed for low- and mid-frequency communications. Under natural, ambient ocean conditions (*i.e.,* from natural sound sources including wind and surf), fin whales lose less than 1% of their communication space. In contrast, under the "noisiest conditions" humpback whales can lose 80 to 94% of their communication space within the 71 to 708 Hz communication range; under "typical" (median) conditions, they lose 35 to 52% (Williams *et al.* 2013). In another study, killer whales in British Columbia were shown to lose up to 97% of their communication space in the mid-frequency range (1.5 to 3.5 kHz), compared to the quietest natural conditions.

7.3.6.3 Sea Turtles and Underwater Sounds

Available information indicates that turtles hear at low frequency ranges (*e.g.*, 100 to 900 Hz), with measureable age and species variations in response to underwater sound (Office of Naval Research 2002; Environment Australia 2003; Ketten and Bartol 2005). Ketten and Bartol (2005) observed a size/age difference in hearing range for loggerhead and green sea turtles, with smaller, younger individuals having a greater hearing range than larger, older individuals. Martin *et al.* (2012) demonstrated that loggerhead sea turtles have low frequency hearing, with the best sensitivity between 100 and 400 Hz. Juvenile green sea turtles responded to underwater stimuli between 50 to 1,600 Hz and have optimal hearing below 1,000 Hz (Dow Piniak *et al.* 2012a). Dow Piniak *et al.* (2012b) determined that leatherback sea turtle hearing sensitivity overlaps with frequencies and source levels that are produced by low-frequency anthropogenic sources including seismic source arrays, offshore drilling, and vessel traffic. There remains a lack of research on the acoustic sensitivity of sea turtles and on the relative importance of their acoustic environment. There is little evidence to suggest that sea turtles would be more sensitive to drilling sounds than cetaceans or fish. In the absence of established hearing impairment thresholds for sea turtles, the thresholds for PTS or TTS onset in cetaceans have frequently been applied to sea turtles (LGL 2013), based on the fact that sea turtles and mysticetes both have best sensitivity to low frequencies. To date, however, there are no known studies demonstrating sea turtle TTS or PTS (Finneran and Jenkins 2012) and the sea turtle WG has concluded that comparing sea turtles to fish has higher merit than the comparison to marine mammals, based on hearing ranges and ear anatomy (Popper *et al.* 2014). Numeric underwater sound thresholds for sea turtles do not exist for activities associated with the Project.

7.3.7 Potential Project-VC Interactions

Table 7.3.5 identifies the physical Project activities that might interact with the VC to result in the identified environmental effects. These interactions are indicated by checkmarks, and are discussed in Section 7.3.8 in the context of effects pathways, mitigation, and residual effects. A justification is also provided below for non-interactions (no checkmarks).

Table 7.3.5 Potential Project-Environment Interactions and Effects on Marine Mammals and Sea Turtles

Project Components and Physical Activities	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	-	✓
Vertical Seismic Profiling	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓	✓
Well Abandonment	-	✓
Note: ✓ = Potential interactions that might cause an effect. – = Interaction between the Project and the VC are not expected.		

Waste Management

Discharge of drill muds and cuttings as well as other routine discharges are not predicted to interact with Marine Mammals and Sea Turtles to cause a Change in Risk of Mortality or Physical Injury; these discharges will be in accordance with the OWTG, which are designed to mitigate potential effects from discharges. Wastes that do not meet OWTG requirements will not be discharged to the ocean, but brought to shore for disposal. Discharges made in accordance with OWTG requirements will result in a temporary and localized reduction in water and sediment quality; however, they are highly unlikely to cause mortality or physical injury to marine mammals or sea turtles. Potential effects of these discharges on marine mammal and sea turtle food sources (*e.g.*, plankton, fish) are discussed in Section 7.3.8 in the context of Change in Habitat Quality and Use.

Supply and Servicing (Helicopter Transportation)

Helicopter transportation is not predicted to interact with Marine Mammals and Sea Turtles to cause a Change in Risk of Mortality or Physical Injury. While helicopter presence, and associated in-air and underwater sound levels may result in localized behavioural disturbance, sound levels will not reach thresholds predicted to cause injury or mortality to marine mammals and sea turtles. The potential for helicopter transportation to result in a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles is discussed in Section 7.3.8.

Well Abandonment

Well abandonment is not predicted to interact with Marine Mammals and Sea Turtles to cause a Change in Risk of Mortality or Physical Injury. All wells drilled in the drilling campaign will be permanently plugged and abandoned (P&A), which involves setting a series of cement and mechanical plugs within the wellbore. If the wellhead is removed, it will be accomplished by using mechanical means; explosives will not be used. This activity will have no interaction with marine mammals and sea turtles outside of the wellsite. Well abandonment activities are not anticipated to produce sound or discharges that would pose a risk of physical injury or mortality to marine mammals or sea turtles. Well abandonment activities that could potentially result in a Change in Habitat Quality and Use are discussed in Section 7.3.8.

7.3.8 Assessment of Project-Related Environmental Effects

The following section assesses the potential environmental effects on Marine Mammals and Sea Turtles identified as arising from interactions in Table 7.3.5. Given the similarities in Project description, proximity of activities on the Scotian Slope, and relevancy of recent data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g*., expansion of geographic scope), scientific updates, and refined EA methods.

7.3.8.1 Project Pathways for Effects

Change in Risk of Mortality or Physical Injury

A Change in Risk of Mortality or Physical Injury as a result of underwater sound levels may occur for Marine mammals and Sea Turtles in close proximity during VSP operations, or for individuals that remained in close proximity to the MODU and PSV (*i.e.*, during the use of dynamic positioning thrusters during station keeping and drilling). Exposure to underwater sound of sufficient intensity may result in hearing loss, whether temporary or permanent (*i.e.,* TTS or PTS)

(Richardson *et al.* 1995; Nowacek *et al.* 2007; Southall *et al.* 2007). There is also the potential for vessel collisions with marine mammals and sea turtles during PSV operations.

Change in Habitat Quality and Use

Underwater sounds introduced by the presence and operation of the MODU and VSP, helicopter transportation, and PSV traffic activities may affect the quality of the underwater acoustic environment for marine mammals and sea turtles. Biological effects on marine organisms may occur when introduced anthropogenic sounds overlap in sound signal characteristics and frequency with the hearing range of species present in the area of sound exposure. A sound is considered audible if the receiver is able to detect it over background sound (existing ambient sounds on the Scotian Shelf and Slope are discussed in Section 5.1.3.6). Possible marine mammal or sea turtle responses to increased underwater sound levels include: avoidance, communication masking, discomfort, and behavioural disturbance (*e.g.*, changes in diving/breathing rate or foraging efficiency).

Potential changes in the chemical composition of water may also result from the discharge of drill muds and cuttings and other discharges and emissions. Change in Habitat Quality and Use as a result of physical disturbance may also occur during well abandonment.

7.3.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effect pathways outlined above, the following mitigation measures and standard practices will be used to reduce the potential environmental effects of the Project on Marine Mammals and Sea Turtles.

MODU

- PSV and MODU contractors will have a Maintenance Management System designed to ensure that the vessels and MODU, and all equipment, are well maintained and operated efficiently. This will reduce the possibility of generating excess noise, for example from vessel engines or propellers.

Waste Management

- Refer to the waste management mitigation measures identified in the Fish and Fish Habitat VC (Section 7.2.8.2).

Vertical Seismic Profiling

In March 2014, the Canadian Science Advisory Secretariat (CSAS) held a national peer review process to examine mitigation and monitoring measures for seismic survey activities in and near habitat for cetacean species at risk (*e.g.*, northern bottlenose whale, North Atlantic right whale, Atlantic blue whale), using the Maritimes Region as a case study (DFO 2015a). The CSAS review focused on sound exposure criteria and additional mitigation and monitoring measures that should be considered to avoid or reduce adverse effects on cetacean species at risk.

- BP will consult with DFO regarding relevant findings from the 2014 CSAS review (DFO 2015a), including additional recommended mitigation that would be appropriate for implementation during VSP prior to Project commencement.

- VSP activity will be planned and conducted in consideration of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP; DFO 2007b).

The following mitigation measures, recommended in the SOCP (DFO 2007b), will be implemented during Project VSP activities:

- Marine Mammal Observers (MMOs) will be used to monitor and report on marine mammal and sea turtle sightings during VSP surveys to enable shutdown or delay actions to be implemented in the presence of a marine mammal or sea turtle species listed on Schedule 1 of SARA, as well as all other baleen whales and sea turtles (see also Section 7.3.10).

- A ramp-up procedure (*i.e.*, gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before any VSP activity begins. This measure is aimed at reducing the potential for auditory injury to marine animals in close proximity to the source at the onset of the activity. It is based on the assumption that the gradual increase in emitted sound levels will provide an opportunity for marine animals to move away from the sound source before potentially injurious sound levels are achieved close to the source.

- Shutdown procedures (*i.e.*, shutdown of source array) will be implemented if a marine mammal or sea turtle species listed on Schedule 1 of SARA, as well as all other baleen whales (*i.e.*, mysticetes) and sea turtles are observed within 650 m of the wellsite. This is larger than the minimum distance (500 m) specified in the SOCP in recognition of the potential for SARA and SOCC to be foraging or migrating through the RAA and in consideration of species sensitivities to operating frequencies of the VSP sound source as well as acoustic modelling completed for this Project (Appendix D).

- Passive acoustic monitoring (PAM) will be used to detect vocalizing marine mammals during conditions of low visibility (*e.g.*, fog and darkness). The technical specifications and operational deployment configuration of the PAM system will be optimized within the bounds of operational and safety constraints in order to maximize the likelihood of detecting cetacean species anticipated in the area.

Supply and Servicing

- Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities). Helicopters will also avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency.

- To reduce the risk of marine mammal vessel strikes, Project PSVs will avoid currently-identified critical habitat for the North Atlantic right whale (Roseway Basin) and northern bottlenose whale (the Gully, and Shortland and Haldimand canyons), during transiting activities within the LAA and outside the Project Area, except as needed in the case of an emergency.

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency. In order to reduce the potential for vessel collisions during transiting activities outside the Project Area, vessels will reduce speed in the event that a marine mammal or sea turtle is noted in proximity to the vessel.

- Should critical habitat be formally designated for leatherback sea turtle or other SAR within the RAA over the term of the exploration licences, BP will comply with applicable restrictions or mitigations developed for the marine shipping industry to reduce the risks of vessel strikes in these areas.

Well Abandonment

- Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues.

7.3.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Risk of Mortality or Physical Injury

Presence and Operation of the MODU

Underwater sounds from the presence and operation of the MODU may result in a Change in Risk of Mortality or Physical Injury to Marine Mammals and Sea Turtles in the Project Area if they are in and remain within close proximity of the operation. Underwater acoustic modelling (Zykov 2016) results for the operation of the MODU with PSV, suggest cumulative SELs over 24 hours will decrease to below threshold values associated with potential injury for cetaceans at distances between less than 100 m and 470 m from the operation, (depending on species group and scenario) using both the Southall *et al.* (2007) and NOAA (2015b) criteria (Appendix D). Calculation of these values assumes that all of the thrusters of the vessels (MODU and PSV as applicable) are performing at nominal output power (*i.e.*, the highest sustainable revolutions per minute [rpm]), and that the receiver (*i.e.,* marine mammal or sea turtle) is exposed to this level continuously over a 24-hour period. This scenario is precautionary and highly unlikely to manifest, as marine mammals are not expected to remain within 470 m of the MODU and PSV over the course of 24 hours. Peak SPLs based on both the Southall *et al.* (2007) and NOAA (2015b) criteria are predicted to decrease to below threshold values associated with potential auditory injury at distances beyond 10 m from the source. All values presented are maximum $R_{95\%}$ values across seasons and sites modelled.

Although responses of marine mammals to increased sound levels are highly variable and depend on several internal and external factors (NRC 2005), some studies have documented avoidance of intense sound sources by marine mammals (Stone and Tasker 2006; Moulton and Holst 2010), particularly if the marine mammals are exposed to multiple simultaneous sound sources (Richardson *et al.* 1995; Richardson and Wursig 1995). Based on the most conservative thresholds and modelled results, cumulative SEL over 24 hours, high-frequency cetaceans (*e.g.,* harbour porpoise) would have to remain within approximately 470 m of the MODU, seals would have to remain within 210 m, and low- and mid-frequency cetaceans (including blue, fin, North Atlantic right, and northern bottlenose whale, Sowerby's beaked whale, and killer whale) would have to remain within 140 m of the MODU and PSV for sound levels to be greater than threshold level associated with potential auditory injury. These are not likely to be credible scenarios.

Less is known about the responses of sea turtles to underwater sound; studies to date have focused on seismic sound sources that are far more intense than the sounds emitted from drilling activities. It is assumed that similar to marine mammals, sea turtles will tend to avoid intense sources of sound, and therefore may not approach close enough to the MODU, or remain in the vicinity long enough to be exposed to sound levels capable of causing auditory injury.

The Change in Risk of Mortality or Physical Injury as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration, and reversible.

Vertical Seismic Profiling

There have been no documented cases of marine mammal or sea turtle mortality stemming from exposure to sound from exploration seismic surveys. However, it has been suggested that the typical monitoring programs implemented for mitigation purposes during offshore activities may not detect sub-lethal or longer-term effects that could have occurred (DFO 2004). Underwater sounds emitted during VSP operation are expected to be the most intense sounds generated by the Project and therefore may result in a Change in Risk of Mortality or Physical Injury to Marine Mammals and Sea Turtles. Although VSP sound sources typically use similar equipment that is used in seismic operations (*i.e*., an array of compressed air source elements), VSPs typically use substantially smaller source array volumes than those used in exploration seismic surveys. A typical source array for VSP uses between three and six sound source elements, each with a volume size of 150 to 250 cubic inches; however, larger source arrays may be used depending on the geophysical objectives. These sound sources are generally positioned at 5 to 10 m water depth. For the purposes of acoustic modelling, a larger source array, the Schlumberger Dual Magnum 2,400 in^3 airgun, which has been used by BP in other geographic regions, was modelled as the VSP sound source for the Project at an assumed depth of 4.5 m (Appendix D). Literature values suggest that the energy level from a single VSP pulse is expected to produce a source level of 220 to 245 dB re 1 μPa @ 1 m, at frequencies of 5 to 300 Hz (Lee *et al*. 2011). Source level specifications for the airgun source array used in the acoustic modelling were 248 dB re 1 μPa @ 1 m (peak SPL) in the broadside firing direction (Appendix D).

Based on the results of underwater acoustic modelling (Zykov 2016) (Appendix D) sound levels are expected to decrease to below peak SPL threshold values associated with potential permanent auditory injury (*i.e.,* 230 dB, 218 dB, and 202 dB re 1 μPa) at distances greater than 40 m for mid- and low-frequency cetaceans and pinnipeds (Southall *et al.* 2007 and NOAA 2015b), and >140 m for high-frequency cetaceans (NOAA 2015b).

Sound levels (maximum $R_{95\%}$ values across all seasons and sites) are expected to be below cumulative SEL levels associated with permanent auditory injury (198 dB re 1 μPa^2s for cetaceans and 186 dB re 1 μPa^2s for pinnipeds) (Southall *et al*. 2007) beyond maximum distances of approximately 620 m, 240 m 170 m, and 1.6 km for low, mid and high-frequency cetacean hearing groups and pinnipeds, respectively. Calculation of cumulative SEL values assumes that the VSP source array is activated 2,040 times in a 24-hour period during the VSP survey and that the receiver (*i.e.,* marine mammal or sea turtle) is exposed to this level continuously over this period. VSP surveys are expected to take up to one day at each well; therefore, based on the most conservative distance estimate considered, a marine mammal would have to remain within 1.6 km of the VSP sound source over the duration of the survey for cumulative sound levels to be greater than threshold values associated with potential auditory injury. This scenario is considered unlikely. Sound levels are expected to be below the NOAA 2015b cumulative SEL threshold levels for all cetacean hearing groups and pinnipeds at shorter distances from the sound source than those predicted using the Southall *et al.* (2007) thresholds. For example, for low-frequency cetaceans (including fin and blue whales) and mid-frequency cetaceans (including the northern bottlenose whale, Sowerby's beaked whale, and killer whale) this distance is expected to be less than 240 m and 20 m, respectively, from the sound source (compared to 620 m and 240 m, Southall *et al.* [2007]). For seals, this distance is predicted to be approximately 370 m compared to 1.6 km. Likewise, peak SPLs are expected to decrease below the Southall *et al.* 2007 and NOAA 2005 thresholds for all cetacean hearing groups and pinnipeds at shorter distances from the sound source than those discussed above.

Although less is known about sound levels that may cause auditory injury to sea turtles, it is assumed that these values would not exceed those for cetaceans (LGL 2014). While they acknowledge that few data exist on the effects of seismic airguns on sea turtles, Popper *et al.* (2014) proposed guidelines for threshold levels capable of causing mortality and potential mortal injury from seismic airguns of 210 dB cumulative SEL and 207 dB peak SPL. These values are consistent with those proposed for fish species whose swim bladder is not involved in hearing (Popper *et al.* 2014). Based on acoustic modelling (Zykov 2016), sound levels from VSP operations are predicted to be below these levels at distances greater than approximately 160 m and

100 m respectively. It is also possible that sea turtles are highly protected from potential effects from impulsive sound by their rigid external anatomy (Popper *et al.* 2014). Thresholds for non-mortal injury of sea turtles have not been identified, but the relative risk has been described as 'high' in the 'near' field (*i.e.,* in the tens of metres from the source), and 'low' at both intermediate (*i.e.,* hundreds of metres) and far (*i.e.,* thousands of metres) distances (Popper *et al.* 2014).

Marine mammals and sea turtles are generally expected to temporarily avoid localized areas subject to sound from seismic sources (LGL 2014) and are therefore considered unlikely to approach (or remain) close enough to the VSP sound source to be exposed to sound levels capable of causing auditory injury. A number of mitigation measures will also be implemented to further reduce the effects to marine mammals and sea turtles from VSP operation (see Section 7.3.8.2 above).

The Change in Risk of Mortality or Physical Injury as a result of VSP operation is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

PSV Operations

The presence and operation of PSVs will increase marine traffic within the LAA (two to three PSVs making two to three round trips per week between the MODU and the supply base). This represents a very small increase over existing shipping levels in the RAA (refer to Figure 5.3.4 for a visualization of shipping traffic in the RAA). PSVs are not expected to produce sound levels above those associated with potential permanent auditory injury; however, the Project could produce a Change in Risk of Mortality or Physical Injury due to potential for PSV collision with marine mammals and sea turtles during transit. In general, odontocetes and pinnipeds are less likely to be struck by vessels, while mysticetes (*e.g.*, North Atlantic right whales) are known to be more vulnerable (Laist *et al.* 2001; Jensen and Silber 2003; Vanderlaan and Taggart 2007). Vanderlaan and Taggart (2007) examined historical vessel strike data from 1885 to 2002 and determined that the species of whales most frequently affected by vessel strikes are North Atlantic right whales, fin whales, humpback whales, and grey whales. The North Atlantic right whale is the species most affected by vessel strikes, with mortalities two orders of magnitude more frequent than any other whale species on a per capita basis (Vanderlaan and Taggart 2007). Right whales tend to be easily injured because they are slow moving and have a low profile in the water. Results have shown that reducing vessel speed reduces the number of deaths and severe injuries by vessel impact (Vanderlaan and Taggart 2007; Vanderlaan *et al.* 2008, 2009; van der Hoop *et al.* 2012). Lethal strikes to whales have been noted to be infrequent at vessel speeds less than 25.9 km/hour (14 knots) and rare at speeds less than 18.5 km/hour (10 knots) (Laist *et al.* 2001). As discussed in Section 7.3.8.2, during transit between Halifax Harbour and the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots) except as needed in the case of an emergency.

There is limited information with respect to the frequency of vessel collisions and sea turtles. Sea turtles have been observed avoiding vessels (Hazel *et al.* 2007), but speed plays a key role in this as turtles can only swim at certain speeds. In an Australian field study examining behavioural effects of vessel speed on green sea turtles, Hazel *et al.* (2007) demonstrated that the proportion of turtles that moved away to avoid the vessel decreased significantly as vessel speed increased. Turtles that moved away from "moderate" (11 km/hour; 6 knots) and "fast" approaches (19 km/hour; 10 knots) did so at significantly shorter distances from the vessel compared to "slow" (4 km/hour; 2 knots) approaches. This research suggests that vessel operators cannot rely on green sea turtles to actively avoid being struck by the vessel if speeds exceed 4 km/hour (2 knots) (Hazel *et al.* 2007). However, reduced (mitigated) speeds within the Project Area are still considered of benefit in reducing the overall likelihood of vessel strikes. Animals are likely to be more susceptible to strikes while foraging. Should critical habitat be formally designated for leatherback sea turtle or other SAR over the term of the exploration licences, BP will comply with applicable restrictions or mitigations developed for the marine shipping industry to reduce the risks of vessel strikes in these areas.

The Change in Risk of Mortality or Physical Injury as a result of PSV operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Change in Habitat Quality and Use

Presence and Operation of the MODU

As indicated in Section 5.1.3.6, the Scotian Shelf is an active economic area with anthropogenic sound stemming from a number of sources (*i.e.,* shipping, commercial fishing, oil and gas, defence, construction, marine research, and tourism)(Walmsley and Theriault 2011), though shipping is considered to be the major and consistent contributor to low-frequency ambient sound. Effects of underwater sound generated by the presence and operation of the MODU may result in a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. The operation of the MODU, and in particular, the dynamic positioning activity (*i.e.*, use of DP thrusters), will generate underwater sound, thereby affecting the quality of the underwater acoustic environment for marine mammals and sea turtles. This activity could occur at any time of the year and would be continuous during the time it takes to drill each well (*i.e.,* approximately 120 days per well).

Threshold criteria are commonly used to assess potential PTS; however, behavioural responses of marine mammals to underwater sound are generally more variable, context-dependent and less predictable than potential physical effects (Southall *et al*. 2007). Therefore, use of available sound thresholds to predict behavioural response are considered as a guide to informing the assessment of potential effects of sound on marine mammals rather than as an absolute measure of such effects occurring.

In the US, NOAA (n.d.) has used 120 dB re 1 µPa RMS SPL as a behavioural threshold value for marine mammals exposed to continuous sounds (*e.g.*, shipping and drilling). At received sound levels above this, marine mammals may exhibit a variety of behavioural responses. These may include, for example, changes in vocalizations and call length, diving rates, foraging or travelling patterns, breeding and/or migration routes, and in some cases of intense source levels, avoidance of the area of increased sound (refer to Section 7.3.6.2 for additional information on potential behavioural effects of introduced underwater sound).

Based on the results of underwater acoustic modelling (Zykov 2016), sound levels are predicted to decrease to below 120 dB re 1 µPa RMS SPL at distances >150 km from the MODU during operations in winter (*i.e.,* when sound propagates furthest due to environment conditions). For the most conservative summer scenario (*i.e*., drillship with PSV at Site A), the distance is predicted to be one-third of the winter distance, approximately 50 km. This large variation in distance is due to the strong surface channel produced by the sound speed profile in February, which was selected as an average worst case scenario to represent the winter period, although in reality the temperature and salinity varies on a daily basis. The predicted February surface channel acts to trap acoustic energy at the surface, reducing potential transmission loss (see Appendix D). Sound attenuates rapidly with distance, particularly in deepwater environments, and sound levels greater than 120 dB re 1 µPa RMS SPL are predicted to occur at much closer distances to the source. While onset of marine mammal behavioural responses to continuous sound may occur at SPLs of 120 dB re 1 µPa RMS (NOAA n.d.), the potential magnitude and ecological relevance of a response is expected to vary dependent on a number of factors, such as the intensity of underwater sound, degree of overlap in frequency between a sound and the marine mammal species' hearing sensitivity, as well as the animal's activity state at the time of exposure. More extreme behavioural responses (*e.g.*, long-term displacement from an area) may become generally more likely at received sound levels higher than 120 dB re 1 µPa RMS SPL. Therefore, the distances over which such overt responses may occur will also be less than those predicted for the 120 dB re 1 µPa isopleth. Thompson *et al.* (2016) observed short-term avoidance movements (10 km) and decreased densities of harbour porpoise in response to underwater noise from commercial two-dimensional seismic surveys in the North Sea (peak-to-peak source SPLs of 242 to 253 dB re 1 µPa at 1 m), but most harbour porpoise returned to the area within a few hours following seismic activity (Thompson *et al.* 2013). Some species of marine mammals, such as fin and right whales, have been found to be less responsive to stationary sources of sound than moving sources (Watkins 1986).

The greatest potential for masking exists for marine mammals that produce and perceive sounds within the range of frequencies produced by vessels. Baleen whales vocalize primarily in the lower frequencies (7 Hz to 22 kHz) and are therefore likely to be the most susceptible species (Clark 1990; Erbe 2002) to potential masking associated with the increased ambient sound levels as a result of the MODU or PSV traffic, especially over greater distances. In contrast, odontocete communication frequency ranges from 2 to over 100 kHz (Au and Hastings 2008), which would only partially be overlapped by the low frequency range of drilling sounds (10 Hz to 10 kHz). This suggests that effects of masking may be of lesser concern than for baleen whales, though recent studies suggest odontocetes may still react to low levels of the high frequency components of vessel noise (*e.g.*, Dyndo *et al.* 2015; Veirs *et al.* 2016). Studies on North Atlantic right whales indicate that this species will adjust its vocalizations in the presence of vessel sound; however, as noted by Wright 2008, such alterations "can be presumed to be costly to survival and/or reproductive success" (Wright 2008). Most species of baleen whales known to occur in the RAA are present primarily in the summer months; thus individuals that frequent the area are less likely to be present at the time of year when sound levels will extend to the greater distances due to the sound propagation characteristics in winter. Some species of toothed whale are present in the RAA year-round (see Table 5.2.9). Most of these species are mid-frequency cetaceans, and thus communicate at frequency ranges that only partially overlap with the low-frequency range of MODU operation sounds; however, at ranges less than 3 km, sound levels received from ships also extends to frequencies used by odontocetes (*i.e*., 10 to 96 kHz)(Veirs *et al.* 2016). The marine mammal SAR and SOCC that are most likely to be in the RAA during the winter months are fin whale (SAR Special Concern), northern bottlenose whale (SAR Endangered), and Sowerby's beaked whale (SAR Special Concern). During the winter months, when the strong surface channel propagates sound from the MODU and PSV over the greatest distances, sound levels above 120 dB re 1 µPa RMS SPL may extend to portions of northern bottlenose whale critical habitat: the Gully, Shortland Canyon, and Haldimand Canyon approximately 81 km, 139 km and 171 km respectively from the Project Area. Uncertainty around acoustic disturbances and the effect on species using the Gully remains in spite of numerous scientific reviews undertaken to address this issue (*e.g.,* Lawson *et al*. 2000; Lee *et al*. 2005) (see Section 7.5 – Special Areas).

At this time, there are no data on the effects of shipping sounds (or other continuous sources such as drilling or dynamic positioning) on sea turtles, and no numeric thresholds have been proposed for which to compare to acoustic modelling results (Popper *et al.* 2014). None of the four species of sea turtles known to occur in the vicinity of the Project Area are expected to be present in February, when underwater sounds from MODU operations are expected to extend the furthest. Leatherback and loggerhead sea turtles may still be in the area in December, but Kemp's ridley and green sea turtles are expected only during the summer months. Studies have suggested that sea turtles (including these four species) have greatest hearing sensitivity to low-frequency sounds (Office of Naval Research 2002; Environment Australia 2003; Ketten and Bartol 2005). While there is a general lack of research or scientific data on the effects of sound on sea turtles or the relative importance of their acoustic environment, there is also little to suggest that they would be more sensitive to underwater sounds than marine mammals (Popper *et al.* 2014). The same categories of potential effects discussed above for marine mammals (*i.e.,* behavioural effects and communication masking) are generally expected to encompass the range of potential effects on sea turtles.

The Change in Habitat Quality and Use as a result of the presence and operation of the MODU is predicted to be adverse, moderate in magnitude, occur within the RAA, continuous throughout the Project, short-term in duration, and reversible.

Waste Management

The routine discharge of wastes and emissions (including drill waste discharges) could potentially result in a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. Routine discharges from the MODU will meet OWTG requirements, which have been established to protect the marine environment. The routine discharge of wastes and emissions is regulated for compliance against these requirements; these discharges therefore have a low potential for toxicity effects to the marine environment and low risk of affecting any marine species. Discharges will not be bio-accumulating or toxic, and will be subject to high dilution in the open ocean. Organic matter associated with any discharge will be quickly degraded by bacteria.

Discharges of mud and cuttings will be in accordance with the OWTG, which allows discharge of WBM cuttings without treatment and SBM cuttings treated prior to release to achieve 6.9% or less synthetic oil on cuttings. Screening of chemicals will be done in accordance with the OCSG to assess the viability of using lower toxicity chemicals. Localized smothering and mortality of sedentary or slow moving benthic species is expected to occur due to the deposition of discharged drill muds and cuttings at thicknesses of ≥10 mm; this is predicted to extend up to 116 m from the wellsite (refer to Appendix C). Benthic species do not represent primary prey for marine mammals and sea turtles. Baleen whales feed primarily on plankton and small schooling fish from the water column. Toothed whales and dolphins feed primarily on fish and squid, some of which may be demersal species. Sea turtles feed primarily on pelagic invertebrates such as jellyfish. Although some of these prey species may be exposed to drill cuttings and other discharges in the water column and in localized areas around the wellsites within the Project Area, they will not be affected to an extent that would result in a change in the quantity or quality of the food source of marine mammals and sea turtles.

The Change in Habitat Quality and Use as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, medium-term in duration, and reversible.

VSP

Acoustic modelling conducted for the Project (Zykov 2016) predicts that sound from the VSP source will decrease to below 160 dB re 1 μPa RMS SPL (NOAA's interim threshold for sensory disturbance from an impulsive source) at distances greater than approximately 3.2 km from the sound source.

Mysticetes generally avoid active air source arrays, although the radius of avoidance can vary (Richardson *et al.*1995; Gordon *et al.* 2004). Numerous studies have been conducted and mysticetes exposed to strong pulses from air source arrays typically respond by avoiding the sound source, which can result in deviation from their normal migration route and/or disruption to 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). Avoidance responses may occur at distances beyond the monitoring range of vessel-based observers and as a result, behavioural observations from vessels can be biased (LGL 2014).

Studies of migrating grey, bowhead, and humpback whales have shown that received SPLs of pulses in the 160 to 170 dB re 1 µPa RMS range elicit avoidance behaviour in a substantial number of animals exposed to the sound (Richardson *et al.* 1995). Migrating bowhead whales have shown avoidance behaviour to sound levels as low as 120 to 130 dB re 1 µPa RMS (over pulse duration) (Miller *et al.* 1999; Manly *et al.* 2007). At the same time, some mysticetes have shown limited response to sound from full-air source arrays with only localized avoidance and minor changes in behaviour (LGL 2014). Additionally, grey whales have continued to migrate annually along the west coast of North America regardless of seismic exploration or shipping traffic in the area (Malme *et al.* 1984; Richardson *et al.* 1995). As a result of these varying findings, it is not known to what extent impulsive sounds affect the distribution and habitat use of cetaceans. The overall trend seems to show that over the history of seismic surveys co-existing with mysticetes, brief exposure to pulsed sounds from a single seismic survey are not likely to result in prolonged disturbance (LGL 2014).

The overall response of odontocetes to seismic pulsed sound is variable (LGL 2014). Data suggest that some odontocete species such as belugas and harbour porpoises are more responsive to low-frequency sound than once thought (LGL 2014). Reactions at larger distances may occur when environmental sound propagation conditions are conducive to transmission of the higher-frequency components of the pulsed sound (DeRuiter *et al*. 2006; Tyack *et al.* 2006; Potter *et al.* 2007). There is a lack of specific data on responses of beaked whales to seismic surveys, but it is believed that they would exhibit strong avoidance patterns. Most beaked whales avoid approaching vessels in general (Würsig *et al.* 1998) and may also dive for extended periods of time when approached by a vessel (Kasuya 1986). As a result, it is likely that beaked whales would show avoidance to seismic vessels and activity, although this behaviour has not been specifically studied or documented to date.

For some odontocetes such as delphinids, data suggest that a sound level of >170 dB re 1 µPa RMS may result in avoidance behaviour (LGL 2014). Seismic operators and marine mammal observers on seismic vessels regularly observe dolphins and other small toothed whales in close proximity to operating air source arrays, but there is a general tendency for most delphinids to show some avoidance to operating seismic air source arrays (Stone and Tasker 2006; Weir 2008; Richardson *et al.* 2009; Moulton and Holst 2010). Harbour porpoises have been shown to exhibit behavioural responses to operating seismic air source arrays at levels <145 dB re 1 µPa RMS (Bain and Williams 2006). Lee *et al.* (2005) reported that northern bottlenose whales in the Gully were not displaced by received sound levels of 145 dB re 1 µPa RMS SPL generated by a seismic survey >20 km away that had been operating for a number of weeks. For VSP surveys, sound levels are expected to dissipate below 150 dB re 1 µPa RMS approximately >20 km from the source, and potential for exposure would be limited to a single day for each well.

Visual monitoring from seismic vessels has shown little to no avoidance of air source arrays by pinnipeds, with only a few observed changes in behaviour. Studies have shown that pinnipeds do not avoid the area within a few hundred metres around the air source array (Harris *et al.* 2001; Moulton and Lawson 2002; Miller *et al.* 2005); however, the opposite has been shown with larger sample sizes and observations from a separate observation vessel (LGL 2014). Southall *et al.* 2007 found that, though limited data exist for pinnipeds exposed to multiple pulses (primarily ringed seals), received levels of greater than 190 dB re 1 µPa RMS are likely to elicit a response.

Masking could potentially occur during VSP, although the sound emitted during the survey would be of very short duration (*i.e.*, one day), with periods of silence between pulses, resulting in a limited masking effect.

Studies to date indicate that seismic surveys can have short-term effects on sea turtles such as a change in hearing sensitivity and behavioural effects (*e.g.*, increased and erratic swimming behaviour; McCauley *et al.* 2000a), and physiological responses. Certain levels of exposure to low-frequency sound may cause temporary displacement from areas near the sound source and increased surfacing behaviour. This exposure could potentially lead to displacement from preferred foraging areas (Atlantic Leatherback Turtle Recovery Team 2006). Weir (2007) reported a decrease in the number of sea turtles (of several species) during periods when seismic sources were active, although sea turtles at the surface exhibited no obvious behavioural avoidance, and it is not possible to distinguish whether the decrease in numbers was in relation to the presence of the ship and towing equipment, or to the airgun sounds themselves. DeRuiter and Doukara (2012) also reported avoidance responses (diving behaviour) by loggerhead sea turtles at ranges of up to 839 m, in response to active seismic sources at estimated exposure levels between 175 and 191 dB re 1 µPa peak SPL. In studies of penned animals, McCauley *et al.* (2000) reported behavioural responses (including surfacing and changes in swim patterns) in sea turtles exposed to received levels of 166 dB re 1 µPa RMS SPL, and Moein *et al.* (1994) (cited in Popper *et al.* 2014) reported avoidance of penned loggerhead turtles exposed to active airguns at source levels of 175 to 179 dB re 1 µPa at 1 m (though this behaviour occurred only upon first exposure). Sea turtle dive probability has been shown to decline with increasing minimum range to a seismic source array (DeRuiter and Doukara 2012). No critical habitat for any species of sea turtle in the Atlantic Ocean has yet been defined under SARA; however, a draft Recovery Strategy for the Leatherback Sea Turtle Atlantic population identified three areas of critical habitat (DFO 2015o). The closest of these areas to the Project Area is located south and southeast of Georges Bank and extending to the southwest boundary of the Canadian EEZ on the southwestern Scotian Slope (DFO 2015o); this area is well beyond (more than 200 km) the extent over which behavioural responses to sound from VSP operation may be expected, and any potential disturbance effects in the near field would be short-lived.

The Change in Habitat Quality and Use as a result of VSP operation is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, short-term in duration, and reversible.

Supply and Servicing

Helicopter transportation has the potential to interact with marine mammals or sea turtles via sensory disturbance resulting from visual cues and helicopter sounds (while the animal is either at the surface or submerged). For aircraft with propellers, sound is primarily related to rotor and propeller blade revolutions per minute, with frequencies concentrated below 500 Hz (Richardson *et al.* 1995). The amount of helicopter sound that enters the marine environment depends primarily on the aircraft's altitude as well as the sea surface conditions (Richardson *et al.* 1995), but sounds will be strongest just below the surface and directly underneath the aircraft. Underwater sound from a passing aircraft is generally brief in duration and will become undetectable underwater far faster than it would in air (Richardson *et al.* 1995).

The most common response of cetaceans to aircraft sounds is diving; however, other reactions include breaching, short surfacing, and changes in behavioural state (Luksenburg and Parsons 2009). Cetaceans have shown varying degrees of sensitivity to aircraft sounds; this may depend on their activity and behavioural state at the time of exposure (*e.g*., resting, socializing, foraging or travelling), with individuals in a resting state appearing to be the most sensitive to disturbance (Würsig *et al*. 1998; Luksenburg and Parsons 2009). In a study in the Beaufort Sea, observers recorded beluga and bowhead whale reactions to a Bell 212 helicopter, and reported that the majority of responses occurred when the helicopter was flying at altitudes less than 150 m, and at lateral distances of less than 250 m (Patenaude *et al.* 2002).

Flights to and from the MODU will be short-term and regular. Except as needed in the case of an emergency, helicopters will also avoid flying over Sable Island, which will reduce the likelihood of effects on seals; this is the standard protocol for other oil and gas operators working offshore Nova Scotia. Helicopter transportation is therefore not predicted to affect seals that could be feeding, breeding or pupping on Sable Island. Any behavioural responses of cetaceans near the surface during a helicopter overflight are expected to be infrequent and temporary.

Underwater sound associated with PSV traffic (*i.e.*, during transiting and operations) has the potential to adversely affect the quality of the acoustic environment and therefore result in a Change in Habitat Quality and Use by marine mammals and sea turtles. The combined effects of underwater sound levels produced by the PSV while alongside the operating MODU are addressed above; however, PSVs will also produce sound during transit to and from the MODU. PSVs are predicted to have nominal operating source sound levels of 170 to 180 dB re 1 μPa @ 1 m RMS SPL (Hurley and Ellis 2004). Sound levels produced by PSVs are not expected to be high enough to cause direct physical harm; however, similar to any other vessels, they could result in changes to swimming, foraging, or vocal behaviours and contribute to masking, as previously discussed (Richardson *et al.* 1995; Clark *et al.* 2009; Nowacek *et al.* 2007; Sundermeyer *et al.* 2012; Tougaard *et al.* 2012; Parks *et al.* 2012). Studies have shown that at frequencies dominated by shipping sound (10 to 100 Hz), ambient spectral sound levels in the RAA are up to 40 dB re 1 μPa higher than sound levels generated by high winds (Walmsley and Theriault 2011).

The Change in Habitat Quality and Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

The well abandonment program has not yet been finalized. If approval is sought and granted to keep the wellhead in place, benthic communities may begin to colonize the hard surface of the wellhead; however, this change in habitat is expected to have a negligible effect on marine mammal and sea turtle populations. If the wellhead is removed, it will be done via mechanical separation, which will also result in limited interaction with marine mammals and sea turtles. The mechanical separation of the wellhead from the seabed will not produce excess sound or discharge, but it is likely that this physical disturbance may result in marine mammals and sea turtles temporarily avoiding the immediate area around the wellhead during this activity (which may take 7 to 10 days per well).

The Change in Habitat Quality and Use as a result of well abandonment is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project may result in adverse effects that cause a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect of a Change in Risk of Mortality or Physical Injury for various Project components and activities is considered to be low in magnitude. Effects will be restricted primarily to the Project Area but will extend into the LAA for Supply and Servicing, and will be short- to medium-term in duration, continuous or irregular, reversible, and occur within a disturbed ecological and socio-economic context (stemming from current sources of ambient noise (primarily shipping) in the RAA). Similarly, Changes to Habitat Quality and Use for Marine Mammals and Sea Turtles are predicted to be low to moderate in magnitude, occur within the Project Area or RAA, be short- to medium-term in duration, continuous or irregular, reversible, and occur within a disturbed context.

Summary of Residual Effects

Table 7.3.6 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from interactions between the Project and Marine Mammals and Sea Turtles that were identified in Table 7.3.5.

Table 7.3.6 Summary of Project Residual Environmental Effects on Marine Mammals and Sea Turtles

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L	PA	MT	C	R	D
Vertical Seismic Profiling	A	L	PA	ST	IR	R	D
Supply and Servicing (PSV Operations)	A	L	LAA	MT	R	R	D
Change in Habitat Quality and Use							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	M	RAA	MT	C	R	D
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	A	L	PA	MT	IR	R	D
Vertical Seismic Profiling	A	L	PA	ST	IR	R	D
Supply and Servicing (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	D

KEY:
See Table 7.3.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

N/A: Not Applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.3.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use on Marine Mammals and Sea Turtles from Project activities and components are predicted to be not significant. This conclusion has been determined with a moderate level of confidence based on the low likelihood of animals being present and remaining within close proximity of the operations and the duration of the Project activities. Confidence is reduced from high due to scientific uncertainty of potential effects of introduced underwater sound on sea turtles and marine mammals (particularly with respect to species-specific behavioural effects). There are also inherent uncertainties in the acoustic model, as well as scientific disagreement about the appropriateness of the various thresholds. There is, however a reasonable understanding of the general effects of exploration drilling and VSP operation on marine mammals and the effectiveness of mitigation measures, including those discussed in Section 7.3.8.2.

7.3.10 Follow-up and Monitoring

BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the first phase of the drilling program to collect field measurements to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.

MMOs will be employed to monitor and report on sightings of marine mammals and sea turtles during VSP surveys (see Section 7.3.8.2). Monitoring will include visual observations and the use of PAM to inform decisions related to mitigation actions required during VSP operations when baleen whales, sea turtles, or any marine mammal listed on Schedule 1 of SARA are detected within a minimum 650 m predetermined exclusion zone.

MMO duties will include watching for and identifying marine mammals and sea turtles; recording their numbers, distances and behaviour relative to the VSP survey; initiating mitigation measures when appropriate (*e.g.*, shutdown); and reporting results. Following the program, copies of the marine mammal and sea turtle observer reports will be provided to DFO and the CNSOPB.

PAM will be used to detect marine mammals during periods of low visibility (*e.g.*, fog and darkness) for the VSP surveys. The technical specifications and operational deployment configuration of the PAM system will be optimized within the bounds of operational and safety constraints in order to maximize the likelihood of detecting cetacean species anticipated to be in the area.

Following the program, recorded PAM data will be provided to DFO so that this information can be used to help inform understanding of marine mammals in the area.

BP will also consult with DFO regarding relevant findings from the 2014 CSAS review that examined mitigation and monitoring measures for seismic survey activities in and near habitat for cetacean species at risk (DFO 2015a).

In the event that a vessel collision with a marine mammal or sea turtle occurs, BP will contact the Marine Animal Response Society or the Canadian Coast Guard to relay incident information.

7.4 MIGRATORY BIRDS

Migratory Birds was selected as a VC due to their ecological value to marine and coastal ecosystems, potential interaction with Project activities and components, regulatory considerations, and requirements in the EIS Guidelines. The Migratory Birds VC includes pelagic (*i.e.*, offshore) and neritic (*i.e.*, inshore) seabirds, waterfowl, and shorebirds that are protected under the *Migratory Birds Convention Act* (MBCA) and additional marine-related birds not protected under the Act (*e.g.*, cormorants). This VC also considers all migratory birds listed under Schedule 1 of SARA, COSEWIC, and/or the NS ESA.

This VC is related to the Fish and Fish Habitat VC (Section 7.2) in recognition of prey species on which migratory birds may rely. This VC is also related to the Special Areas VC (Section 7.5), as Special Areas are often designated to protect SAR and SOCC, including applicable species of migratory birds. As defined in Section 5.2, SAR include all species listed under Schedule 1 of the federal SARA as *endangered*, *threatened*, or of *special concern*; or listed under the Nova Scotia *Endangered Species Act* (NS ESA) as *endangered*, *threatened*, or *vulnerable*. SOCC include those that are listed as *endangered*, *threatened*, or of *special concern* by COSEWIC, but not yet listed in Schedule 1 of SARA.

7.4.1 Regulatory and Policy Setting

Migratory birds are protected federally under the MBCA, which is administered by Environment Canada. The MBCA and associated regulations provide protection to all birds listed in the Canadian Wildlife Service (CWS) *Occasional Paper No. 1, Birds Protected in Canada* under the MBCA. Migratory birds protected by the Act generally include all seabirds, except cormorants and pelicans, all waterfowl, all shorebirds, and most landbirds (birds with principally terrestrial life cycles). The Act and associated regulations state that no person may disturb, destroy, or take/have in their possession a migratory bird (alive or dead), or its nest or eggs, except under authority of a permit. Section 5.1 of the MBCA describes prohibitions related to depositing substances harmful to migratory birds: "No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area". Other bird species (and other wildlife) not protected under the federal act, such as cormorants, are protected under the provincial *Wildlife Act.*

Both federal and provincial legislation protect SAR and SOCC, including migratory birds. SARA and the NS ESA generally protect species listed as being *extirpated*, *endangered*, *threatened*, or *vulnerable*, as well as important habitat for these species.

Wildlife species that are protected federally under SARA are listed in Schedule 1 of the Act. SARA seeks to prevent species from being extirpated or becoming extinct; to provide for the recovery of species that are *extirpated*, *endangered* or *threatened* as a result of human activity; and to manage species of *special concern* to prevent them from becoming *endangered* or *threatened*. Sections 32, 33 and 58 of SARA contain provisions to protect species listed on Schedule 1 of SARA, and their critical habitat. Under section 79 of SARA, Ministerial notification is required if a project is likely to affect a listed wildlife species or its critical habitat. This notification must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, measures that will be taken to avoid or lessen those effects, along with monitoring commitments.

The NS ESA provides protection to species listed as *endangered*, *threatened*, or *vulnerable* under the Act, as well as their core habitat. The conservation and recovery of species assessed and listed under the NS ESA is coordinated by the Wildlife Division of the NSDNR.

7.4.2 The Influence of Engagement on the Assessment

Birds have traditionally played and continue to play an important role in Mi'kmaq culture, providing cues for traditional harvesting activities along the coast and also providing a food source. Accordingly, potential effects on migratory birds (primarily as a result of a spill) have been raised as an issue during Aboriginal engagement.

7.4.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have potential to interact with migratory birds and their associated habitat due to attraction to the lights and flares of the MODU, operational discharges during well drilling and testing operations, underwater sound emissions from VSP operations, and interactions with PSV and helicopter activities during supply and servicing.

As a result of these considerations, the assessment of Project-related environmental effects on Migratory Birds is focused on the following potential environmental effects:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

The measurable parameters used for the assessment of the environmental effects presented above, and the rationale for their selection, are provided in Table 7.4.1. Effects of accidental events are assessed separately in Section 8.5.3.

Table 7.4.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Migratory Birds

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Risk of Mortality or Physical Injury	Interactions between the extent, duration, or timing of Project activities and the environment that result in direct (*e.g.*, collisions, oiling) effects to the health or condition of migratory birds	• Species injury or mortality (qualitative likelihood of species injury or mortality) • Increase in predator species (qualitative likelihood of predator species attraction)
Change in Habitat Quality and Use	Interactions between the extent, duration, or timing of Project activities and the environment that result in chemical, physical, or sensory changes to migratory bird habitat	• Change in area of habitat (qualitative) used for feeding, breeding, resting, or travelling

7.4.4 Environmental Assessment Boundaries

7.4.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Migratory Birds are defined below and depicted on Figure 7.4.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and as such represents the area within which direct physical disturbance to the marine benthic environment may occur as a result of the Project. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Migratory Birds are reasonably expected to occur. In consideration of potential effects on prey (fish), an approximate 30 km buffer around the Project Area boundaries has been established to represent the LAA. The LAA has also been defined to include PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.4.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Migratory Birds encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

Migratory birds can be found in and around the Project Area year-round carrying out various life cycle processes. Refer to Section 5.2.7 for details regarding the specific migratory bird SAR and SOCC known to occur in the RAA, including their sensitive periods and relation to the Project Area. An overview is also provided below in Section 7.4.6.

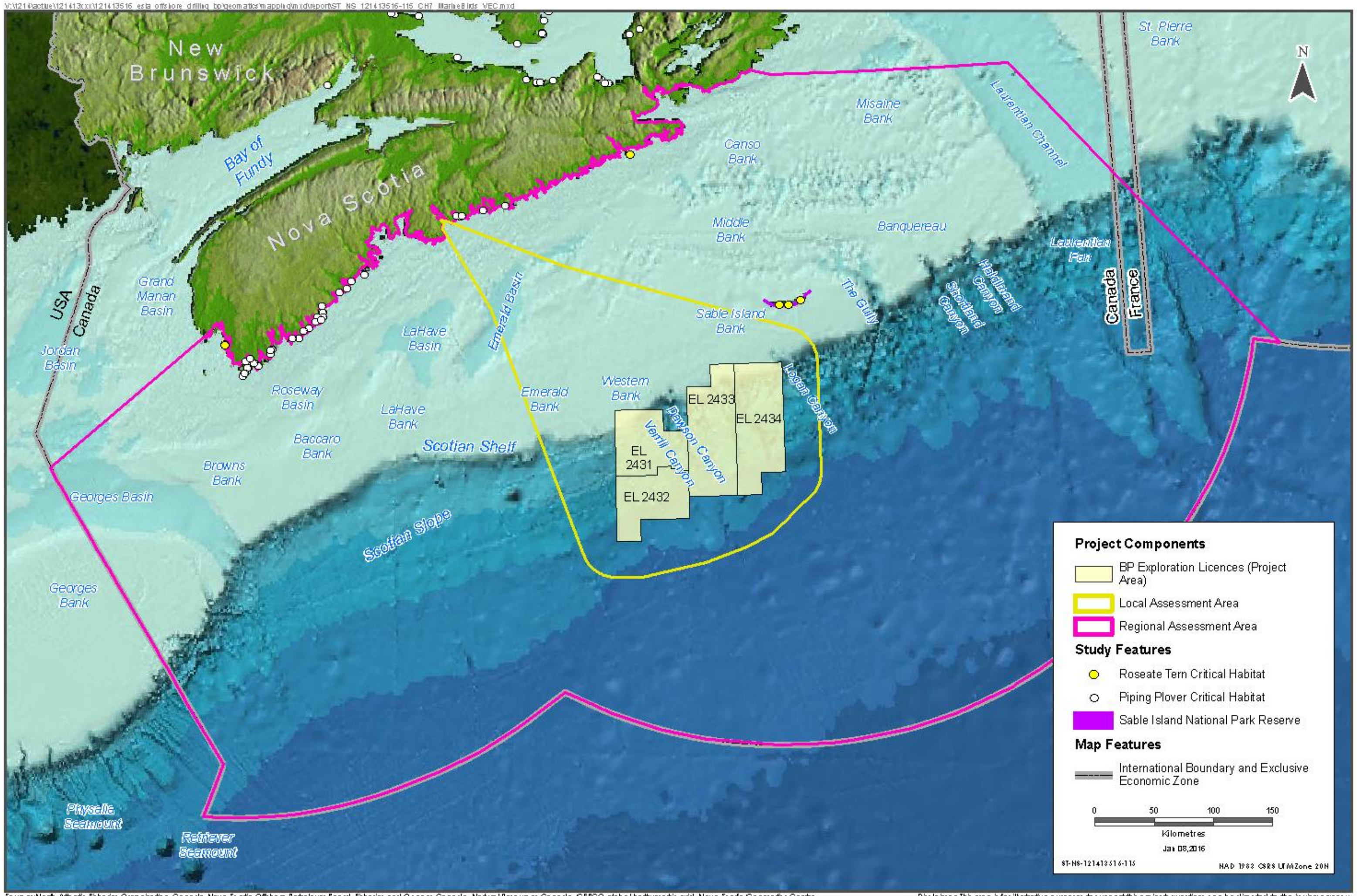


Figure 7.4.1 Spatial Assessment Boundaries for Migratory Birds

7.4.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.4.2 defines the descriptors used to characterize residual environmental effects on Migratory Birds.

Table 7.4.2 Characterization of Residual Environmental Effects on Migratory Birds

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – a residual effect that moves measurable parameters in a direction beneficial to Migratory Birds relative to baseline **Adverse** – a residual effect that moves measurable parameters in a direction detrimental to Migratory Birds relative to baseline **Neutral** – no net change in measureable parameters for the Migratory Birds relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in migratory species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability (change in population levels consistent with baseline levels); will not affect population viability **Moderate** – measurable change outside the range of natural variability but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** –effects are restricted to the Project Area **Local Assessment Area** –effects are restricted to the LAA **Regional Assessment Area** –effects are restricted to the RAA
Frequency	Identifies how often the effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at no set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously

Table 7.4.2 Characterization of Residual Environmental Effects on Migratory Birds

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time required until the measurable parameter returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter of the VC can return to its existing condition after the Project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, as well as consideration of requirements under SARA and associated regulations and recovery plans, the following threshold has been established to define a significant adverse residual environmental effect on Migratory Birds.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Migratory Birds is defined as a Project-related environmental effect that:

- causes a decline in abundance or change in distribution of migratory birds within the RAA, such that natural recruitment may not re-establish the population(s) to its original level within one generation;
- jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed (SAR) species; or
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy for a listed (SAR) species.

7.4.6 Existing Conditions

Waters off the Scotian Shelf are nutrient rich and highly productive due to the complex oceanographic conditions of the area with an estimated 30 million seabirds using the eastern Canadian waters each year (Fifield *et al.* 2009). Large numbers of breeding marine birds and millions of migrating birds from the southern hemisphere and northeastern Atlantic can be found using the area throughout the year (Gjerdrum *et al*. 2008, 2012). Species diversity peaks during the summer months, when northern hemisphere breeders have returned to their breeding grounds and southern hemisphere breeders have returned from their winter breeding season to spend the summer in more northern waters (Fifield *et al.* 2009). The combination of northern hemisphere birds and southern hemisphere migrating birds results in a diversity peak during spring months (Fifield *et al.* 2009). Significant numbers of overwintering alcids, gulls, and northern fulmars can be found in Atlantic Canadian waters during the fall and winter (Brown 1986), whereas species assemblages are dominated by shearwaters, storm-petrels, northern fulmars, and gulls in summer (Fifield *et al.* 2009).

The waters of the RAA are known to support approximately 19 species of pelagic seabirds, 14 species of neritic seabirds, 18 species of waterfowl and loons, and 22 shorebird species (Table 7.4.3), with more occurring in the area as rare vagrants or incidentals. However, many of these species have a coastal affinity and would therefore not be expected to regularly occur in waters of the Project Area. Seven migratory bird SAR/SOCC are known to occur in waters of the Scotian Shelf and Slope and could occur within the RAA: Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, Red-necked Phalarope, and Barrow's Goldeneye. A number of breeding, migrant, and vagrant landbirds also occur in association with the RAA, including two SAR/SOCC that have coastal affinities: Peregrine Falcon and Savannah Sparrow (*Ipswich* subspecies).

Table 7.4.3 Migratory Birds Found in the RAA[1]

Common Name	Species Name
Pelagic Seabirds	
Northern Fulmar	*Fulmarus glacialis*
Cory's Shearwater	*Calonectris diomedea borealis*
Great Shearwater	*Puffinus gravis*
Sooty Shearwater	*Puffinus griseus*
Manx Shearwater	*Puffinus puffinus*
Wilson's Storm-Petrel	*Oceanites oceanicus*
Leach's Storm-Petrel	*Oceanodroma leucorhoa*
Northern Gannet	*Morus bassanus*
Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Great Skua	*Stercorarius skua*
South Polar Skua	*Stercorarius maccormicki*
Black-legged Kittiwake	*Rissa tridactyla*
Dovekie	*Alle alle*
Common Murre	*Uria aalge*
Thick-Billed Murre	*Uria lomvia*
Razorbill	*Alca torda*
Atlantic Puffin	*Fratercula arctica*

Table 7.4.3 Migratory Birds Found in the RAA[1]

Common Name	Species Name
Neritic Seabirds	
Great Cormorant	*Phalacrocorax carbo*
Double-Crested Cormorant	*Phalacrocorax auritus*
Black-headed Gull	*Larus ridibundus*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Iceland Gull	*Larus glaucoides*
Glaucous Gull	*Larus hyperboreus*
Great Black-backed Gull	*Larus marinus*
Ivory Gull[2]	*Pagophila eburnea*
Roseate Tern[3]	*Sterna dougallii*
Common Tern	*Sterna hirundo*
Arctic Tern	*Sterna paradisaea*
Black Guillemot	*Cepphus grylle*
Waterfowl and Loons	
Red-throated Loon	*Gavia stellata*
Common Loon	*Gavia immer*
Canada Goose	*Branta Canadensis*
American Green-winged Teal	*Anas crecca*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Eider	*Somateria mollissima*
Harlequin Duck[4]	*Histrionicus histrionicus*
Long-tailed Duck	*Clangula hyemalis*
Black Scoter	*Melanitta nigra*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Common Goldeneye	*Bucephala clangula*
Barrows Goldeneye[5]	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
Red-breasted Merganser	*Mergus serrator*
Shorebirds	
Black-bellied Plover	*Pluvialis squatarola*

Table 7.4.3 Migratory Birds Found in the RAA[1]

Common Name	Species Name
American Golden-Plover	*Pluvialis dominica*
Semipalmated Plover	*Charadrius semipalmatus*
Piping Plover (melodus subspecies)[6]	*Charadrius melodus melodus*
Killdeer	*Charadrius vociferus*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Willet	*Tringa semipalmata*
Spotted Sandpiper	*Actitis macularius*
Whimbrel	*Numenius phaeopus*
Ruddy Turnstone	*Arenaria interpres*
Red Knot rufa ssp[7]	*Calidris canutus rufa*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Pectoral Sandpiper	*Calidris melanotos*
Purple Sandpiper	*Calidris maritima*
Dunlin	*Calidris alpina*
Short-billed Dowitcher	*Limnodromus griseus*
Red-necked Phalarope[8]	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicarius*
Terrestrial (Land) Birds	
Peregrine Falcon[9]	*Falco perigrinus anatum/tundrius*
Savannah Sparrow (*princeps* subspecies)[10]	*Passerculus sandwichensis*

Note:
[1]Excludes rare transients / vagrants, except for species at risk which are known to occasionally occur (*e.g.*, Ivory Gull).
[2]Ivory Gull is designated as *endangered* under SARA (Schedule 1) and by COSEWIC.
[3]Roseate Tern is designated as *endangered* under SARA (Schedule 1), the NS ESA, and by COSEWIC.
[4]Harlequin Duck is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC; and is listed as *endangered* under the NS ESA.
[5]Barrows Goldeneye is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC.
[6]Piping Plover (melodus subspecies) is designated as *endangered* under SARA (Schedule 1), the NS ESA, and by COSEWIC.
[7]Red Knot rufa ssp is designated as *endangered* under SARA (Schedule 1), the NS ESA, and by COSEWIC.
[8]Red-necked Phalarope is designated as a species of *special concern* by COSEWIC.
[9]Peregrine Falcon is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC; and is listed as *vulnerable* under the NS ESA.
[10]Savannah Sparrow (*princeps* subspecies) is designated as a species of *special concern* under SARA (Schedule 1) and by COSEWIC.

Source: Modified from Stantec 2014a

During summer months, the coastline of the RAA supports over two hundred colonies of nesting migratory birds, ranging in size from a few individuals to thousands of breeding pairs. In general, nesting colonies are distributed all along the coast of Nova Scotia. Areas of dense aggregation include the area between Cape Sable and Yarmouth, the Eastern Shore islands along the southeast coast, and near Country Harbour and Tor Bay. These colonies are known to support Atlantic Puffins, Black-legged Kittiwakes, Common Eiders, Cormorants, Leach's Storm-petrels, Great Black-backed Gulls, Herring Gulls, Razorbills, and terns. Leach's Storm-petrel is the most numerous breeding seabird in the RAA, the vast majority of breeding birds being found on Bon Portage Island near Cape Sable Island. Sable Island is also an important breeding area for colonial marine birds, including gulls, terns, cormorants, as well as other migratory birds.

Fourteen coastal Important Bird Areas (IBAs), including Sable Island, are present within the RAA, as shown in Figures 5.2.25 and 5.2.26. The IBAs are scattered throughout the RAA but many are located in the southeastern portion of Nova Scotia, between Halifax and Cape Breton Island. These areas have been designated as IBAs for a variety of reasons including the presence of breeding habitat for SAR, important shorebird migration habitat, important coastal waterfowl habitat, and/or the occurrence of regionally significant colonial water bird colonies.

7.4.7 Potential Project-VC Interactions

Table 7.4.4 identifies the physical Project activities that might interact with the VC to result in the identified environmental effects. These interactions are indicated by checkmarks, and are discussed in Section 7.4.8 in the context of effects pathways, mitigation, and residual effects. A justification is also provided below for non-interactions (no checkmarks).

Table 7.4.4 Potential Project-Environment Interactions and Effects on Migratory Birds

Project Components and Physical Activities	Potential Environmental Effects	
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓	✓
Vertical Seismic Profiling	✓	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓	✓
Well Abandonment	-	-
Note: ✓ = Potential interactions that might cause an effect. – = Interaction between the Project and the VC are not expected.		

Well Abandonment

Well abandonment will occur underwater at sufficient depths to prevent interaction with migratory birds, including diving species. Of the migratory birds which are likely to occur in the vicinity of the Project regularly, alcids would spend the most amount of time underwater and are among the deepest divers. The maximum diving depth has been estimated to be approximately 50 m for black guillemots and 60 m for Atlantic puffins; razorbills are known to dive to depths of at least 120 m, and common murres to 180 m or deeper (Piatt and Nettleship 1985). Water depths range from 100 to more than 3,000 m in the Project Area but drilling and well abandonment will take place beyond the depth of diving seabirds (*e.g*., 180 m or shallower) found in the area and is therefore not predicted to interact with Migratory Birds, including diving seabirds.

7.4.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Migratory Birds identified as arising from potential interactions in Table 7.4.4. Given the similarities in Project description, proximity of activities on the Scotian Slope, and currency of data, the EA for the Tangier 3D Seismic Survey (LGL 2014) and the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) have been drawn on for this analysis, with updates incorporated as applicable due to Project and geographic differences, scientific updates, and refined EA methods.

7.4.8.1 Project Pathways for Effects

Change in Risk of Mortality or Physical Injury

The presence and operation of the MODU and PSVs has the greatest potential to result in Changes to Risk of Mortality or Physical Injury for Migratory Birds because they are known to aggregate around drilling features as a result of night lighting, food, and other visual cues, potentially making them subject to increased risk of mortality due to physical impacts with structures, predation by other marine bird species, and incineration from flares (Wiese *et al.* 2001; Ronconi *et al*. 2015). In addition to direct (*e.g*., collisions) and indirect interactions with the MODU and PSVs, the Project has potential to result in a Change in Risk of Mortality or Physical Injury of Migratory Birds through exposure to residual hydrocarbons associated with drill muds, cuttings, and other discharges and emissions through exposure to underwater sound caused by VSP operations and disturbance from and collisions with transiting helicopters.

Change in Habitat Quality and Use

A Change in Habitat Quality and Use for Migratory Birds could potentially occur as a result of Project activities; particularly the influence of sound, lights, and flaring from the MODU and PSVs on habitat conditions, the presence of hydrocarbons and TSS within the water column from the discharge of drill muds and cuttings; the release of other discharges and emissions (including cooling water, ballast water, bilge and deck water, grey/black water and small quantities of process water); through exposure of migratory birds to underwater sound from VSP operations; and disturbance from helicopter transportation.

7.4.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices will be employed to reduce the potential environmental effects of the Project on Migratory Birds. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

Presence and Operation of MODU

- Lighting will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

- Routine checks for stranded birds will be conducted on the MODU and appropriate procedures for release will be implemented. If stranded birds are found during routine inspections, they will be handled using the protocol outlined in *The Leach's Storm Petrel: General Information and Handling Instructions* (Williams and Chardine 1999), including obtaining the associated permit from CWS. Activities will comply with the requirements for documenting and reporting any stranded birds (or bird mortalities) to CWS during the drilling program.

Waste Management

- Refer to the waste management mitigation measures identified in the Fish and Fish Habitat VC (Section 7.2.8.2).

Vertical Seismic Profiling

- A ramp-up procedure (*i.e.*, gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before any VSP activity begins.

Supply and Servicing Operations

- Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities) and at a lateral distance of 2 km around active colonies when possible. Helicopters will avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency.

- Lighting on PSVs will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency. PSVs will maintain a 2 km avoidance buffer around Sable Island and associated bird colonies in that area except as needed in the case of an emergency.
- Routine checks for stranded birds will be conducted on the PSVs and appropriate procedures for release will be implemented. If stranded birds are found during routine inspections, they will be handled using the protocol outlined in *The Leach's Storm Petrel: General Information and Handling Instructions* (Williams and Chardine 1999), including obtaining the associated permit from CWS. Activities will comply with the requirements for documenting and reporting any stranded birds (or bird mortalities) to CWS during the drilling program.

7.4.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Risk of Mortality or Physical Injury

Presence and Operation of the MODU

Many migratory birds navigate by sight, and lights can be a visual cue (Wiese *et al.* 2001). Artificial lighting in the offshore and coastal environments regularly attract nocturnally-active seabirds and migrating land and waters birds, sometimes in large numbers (Imber 1975; Montevecchi *et al*. 1999; Wiese *et al.* 2001; Gauthreaux and Belser 2006; Montevecchi 2006; Bruinzeel *et al*. 2009; Bruinzeel and van Belle 2010; Ronconi *et al*. 2015). Attraction to artificial lighting is widespread among procellariiform sea birds (*e.g*., shearwaters and storm-petrels), because they feed on bioluminescent prey and are naturally attracted to light (Imber 1975). During migration, small songbirds are also commonly attracted to artificial lighting on offshore ships and installations (Gauthreaux and Belser 2006; Poot *et al.* 2008). Artificial lighting associated with the MODU and PSVs has potential to result in strandings, collisions, increased opportunities for predation, and exposure to other vessel-based threats.

Migratory birds that are attracted to offshore installations may experience mortality through direct collision with the MODU or may become disoriented by lights and become stranded. Short-duration flaring by the MODU during testing may attract migratory birds and result in increased mortality risk. In addition to incineration, seabirds have been observed to circle flares for days, eventually dying of starvation (Bourne 1979). However, studies have shown most bird mortality on offshore platforms or lighthouses to be related to collision injuries rather than energy reserve depletion (Bruinzeel and van Belle 2010). Storm petrels are the most common species to be stranded on vessels in Atlantic Canada (Environment Canada 2015), but Greater Shearwater and Sooty Shearwater have also been observed to commonly strand themselves in Nova Scotia (LGL 2014). Predation is an additional potential problem for certain species such as storm petrels. For example, during shipboard studies conducted in 1999, Leach's Storm-petrels were observed being attacked by Great Black-backed Gulls after they became confused by the lights of vessels and platforms (Wiese and Montevecchi 2000). Additionally, birds that spend the nighttime circling the platform may need to prolong their migratory journeys during the day, potentially increasing predation risks (Bruinzeel and van Belle 2010).

A number of factors influence the potential severity of marine bird interactions with flares, including the time of year, location, height, light and cross-sectional areas of the obstacle and weather conditions (Weir 1976; Wiese *et al.* 2001). The extent of attraction from artificial lights on drilling vessels and flares can vary based on meteorological conditions (rain, visibility), season, age of the birds, the lunar phase, and light composition (*e.g*., wavelength, intensity). Assuming a typical offshore platform scenario of 30 kW of artificial lighting, birds may be attracted from distances up to 5 km from the source (Poot *et al.* 2008). Bruinzeel and van Belle (2010) calculate that the threshold for disorientation ranges from 200 m (dense fog), 1000 m (fog) 1,250 m (mist), 1,400 m light rain, and 1,650 m (heavy rain), with the most dramatic scenario being one with perfect ground visibility (*e.g*., 10,000 m) with no celestial cues due to overhead clouds, where disorientation can occur up to 4,500 m from the illuminated platform. During conditions of drizzle and fog, moisture droplets in the air refract light and greatly increase the illuminated area, thus enhancing attraction. Mortality can also increase during migration when large numbers of birds fly relatively low as a result of unfavorable weather conditions (Wiese *et al.* 2001). Mortality risk with flares and other lighted structures may also be higher in the latter part of the night as most nocturnal migrants climb to their migrating height soon after takeoff and then undertake a gradual descent shortly after midnight (Weir 1976).

Recent studies have examined the effects of lighting composition (*e.g*., wavelength, intensity), with most studies showing that longer wavelengths are more likely to cause disorientation to migrating birds. Steady burning red-coloured lights were shown to result in the majority of bird casualties (Gautreaux and Belser 2006; Gehring *et al*. 2009; Marquenie *et al*. 2014). A 2000 field experiment at an offshore oil platform in the North Sea demonstrated a high correlation between lighting intensity and bird attraction (Marquenie and van der Laar 2004). When platform lighting was reduced from full illumination to only beacon and obstruction lights, the number of birds observed circling the platform was significantly reduced (Marquenie and van der Laar 2004). The type and intensity of lighting are therefore expected to be important factors in determining the magnitude of adverse effects on migratory birds.

Seabird monitoring conducted as part of the SOEP and Deep Panuke EEM programs has shown little to no effect of flaring on birds transiting to and from Sable Island or the Scotian Slope (CNSOPB 2011; McGregor Geoscience Limited 2012). In 2012, only a single stranding (Leach's Storm-petrel) was recorded during the Deep Panuke bird monitoring program, with the bird released unharmed (McGregor Geoscience Limited 2012).

While conducting daily vessel searches during BP's Tangier 3D seismic survey, the MMOs and vessel crews on the six seismic vessels encountered 19 stranded birds and 26 dead birds over the course of the survey (May to September 2014). Stranded birds consisted of 18 storm petrel species and one warbler species; the majority of dead birds were passerines (RPS 2014).

In general, bird morality rates recorded from offshore platforms are believed to be underreported most likely due to the birds falling into the sea and/or being consumed by scavengers before being detected by observers (Bruinzeel *et al.* 2009). As such, it is likely that some unknown proportion of individuals entering into contact with flares or otherwise negatively affected by flaring would not be recovered during monitoring.

In consideration of mitigation, including efforts to reduce flaring and exposure to artificial lighting, the Change in Risk of Mortality or Physical Injury as a result of the presence and operation of the MODU is predicted to be adverse, low to moderate in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration, and reversible.

Waste Management

Although there are several types of discharges that migratory birds may interact with during drilling of the well and operation of the PSVs, all will be in compliance with the OWTG and in adherence to MARPOL, both of which have been established to protect the marine environment. As well, discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean.

Drill cuttings associated with SBM use will be discharged via a caisson below the sea surface, potentially affecting water quality within a localized area as the discharges migrate through the water column (refer to Appendix C for drill waste dispersion modelling). The discharge of cuttings has potential to result in small sheens to form under certain conditions (*i.e*., calm winds and small waves) during routine operation, which could affect migratory birds. Although data on the relationship between sheen thickness and lethality to marine birds are lacking (Hartung 1995), a laboratory study demonstrated that it only requires a small amount of oil (*e.g*., 10 ml) to affect the feather structure of Common Murre (*Uria aalge*) and Dovekie (*Alle alle*) (O'Hara and Morandin 2010). However, there are no data on threshold number of affected feathers before an individual bird would begin to be affected by exposure to oil sheen (O'Hara and Morandin 2010).

The potential for sheen formation as a result of the discharge of cuttings and SBM use is low because activity will be carried out in adherence to the OWTG and drill muds will be selected in accordance with OCSG. The SBM itself has a fraction of oil or synthetic oil as a component and the cuttings are cleaned and have only a very small fraction of the SBM adhered to them when discharged. The amount of SBM on cuttings would be in the single percentages of the total volume. Discharging the cuttings at depth further mitigates the potential for sheen formation. Furthermore, if the wind and wave conditions were such that a sheen formed in association with an SBM cuttings discharge for this Project, the sheen would be temporary and limited in size, such that only birds in the immediate area of the spill would likely be affected. While the risk of mortality for individual birds that came in contact with the sheen would be increased, the limited nature of this sheen and the likely number of birds affected are such that potential effects are minor. Additionally, WBM and cuttings released at the seafloor will not interact with surface waters such that migratory birds or their prey would be affected.

Deck drainage and bilge waters have potential to negatively affect marine bird health because of the presence of residual hydrocarbons. However, residual hydrocarbons in discharges are generally not associated with the formation of a slick and are therefore unlikely to have a measurable effect on migratory birds. Sea water used for cooling purposes aboard the MODU will be treated through an oil-water separator before being disposed of at sea. Discharges of sanitary and domestic waste may attract birds and/or prey to the MODU and PSVs, but food and sewage waste will be macerated to maximum particle size (6 mm) prior to disposal. This waste is expected to be quickly degraded by bacteria and other biological activity after release. However, even if discharges are non-toxic, gray water discharge will attract gulls and other species to the vicinity of the MODU and PSVs, which may slightly increase Risk of Mortality or Physical Injury of marine bird species, particularly if they interact with a flare or become stranded on the MODU. No food or sewage waste will be discharged within 3 nm of the coast consistent with MARPOL.

The Change in Risk of Mortality or Physical Injury as a result of waste management is predicted to be adverse, negligible in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

There is a scarcity of data on the effects of underwater sound on marine birds and the few studies that have been done regarding seismic testing have observed little behavioural effect (Stemp 1985; Turnpenny and Nedwell 1994; Lacroix *et al.* 2003). For example, shearwaters have been observed with their heads underwater within 30 m of seismic vessels and no response was noted (Stemp 1985). Environmental observers found the same lack of response by guillemots, fulmars, and kittiwakes during seismic testing in the North Sea (Turnpenny and Nedwell 1994). A study of Long-tailed Ducks in the Beaufort Sea also found no effects from seismic testing (Lacroix *et al*. 2003).

Although birds are generally considered to have good hearing abilities, information on their underwater hearing abilities is largely lacking (Wiese *et al.* 2001; OSPAR 2009; Dooling and Therrien 2012). Audiograms of over 50 species of birds indicate that they hear best, on average, between 2 and 5 kHz in air (Dooling and Therrien 2012). The effects of anthropogenic sound in air include auditory system damage, and behavioural responses. For birds in air, continuous sound exposure levels above 110 dB(A) SPL or blast noise above 140 dB SPL can result in PTS (Dooling and Therrien 2012). Continuous sound exposure levels above 90 to 95 dB SPL, has been shown to cause TTS (in air). Taking into consideration changes in human hearing underwater and the protective effect against acoustic overexposure in birds from changes in middle ear pressure, it has been suggested that diving birds may not hear well underwater. It is also thought that the frequency for optimal hearing may shift below 2 to 4 kHz (Dooling and Therrien 2012).

In consideration of the short term nature of VSP operation (lasting for no more than one day per well), the lack of documented behavioral and physiological effects of seismic testing on diving birds, and use of a ramp-up procedure, the Change in Risk of Mortality or Physical Injury as a result of VSP operation is predicted to be adverse, negligible in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

Studies have shown that marine birds react mostly to low-level helicopter flights and the effects of these responses are short in duration (Stantec 2013b). Helicopter flights at 300 m failed to elicit responses in moulting sea ducks in the North Sea, while flights occurring at 100 m created a short-term avoidance response (Ward and Sharp 1974). Marine birds tend to habituate to helicopter transportation over time. One of the greatest effects due to helicopter transportation can occur over large nesting colonies. Aircraft passing over nesting colonies can cause birds to panic, leaving eggs and young-of-the-year unprotected from predators and inclement weather, and also result in the use of valuable energy reserves for defence instead of caring for their young (Environment Canada 2013f).

As outlined in Section 7.4.8.2, helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities) and at a lateral distance of 2 km around active colonies when possible; thus reducing disturbance to migratory birds and potential for collisions.

Residual effects of PSV operations are expected to be similar to that described above in the context of lighting effects from the MODU, although the lighting will not be stationary and the extent of residual effects could extend beyond the Project and into the LAA to account for PSV transit to and from the supply base.

In consideration of proposed mitigation, the Change in Risk of Mortality or Physical Injury as a result of supply and servicing is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Change in Habitat Quality and Use

Presence and Operation of the MODU

Underwater and atmospheric sound from the MODU may result in sensory disturbance to migratory birds, leading to behavioural responses such as temporary habitat avoidance or changes in activity state (*e.g.*, feeding, resting, or travelling). However, because the MODU will remain on-site at the drilling location during Project activities, the spatial extent of changes to habitat quality for migratory birds as a result of the presence and operation of the MODU would be minimal. Furthermore, mitigation measures to limit flaring and exposure of migratory birds to artificial lighting will reduce potential effects.

The Change in Habitat Quality and Use as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, restricted to the Project Area, continuous throughout the Project, medium-term in duration, and reversible.

Waste Management

There are several types of discharges during drilling of the well and from PSV operations that may interact with migratory bird habitat and use (Section 2.8). However, all of these discharges will be in compliance with the OWTG and in adherence to MARPOL. As well, discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean. Residual hydrocarbons in discharges are generally not associated with the formation of a slick and are therefore unlikely to have a measurable effect on the quality of migratory bird habitat.

The discharge of mud and cuttings could potentially result in a Change in Habitat Quality for Migratory Birds. However, WBM and cuttings released at the seafloor will not interact with surface waters such that migratory birds or their prey would be affected. Furthermore, drill cuttings associated with SBM use will be treated in accordance with the OWTG prior to discharged via a caisson below the sea surface. Discharged drill cuttings will settle rapidly to the seabed and have a negligible interaction with migratory birds. Extremely small volumes and fine particle sizes of SBM adhered to treated drill cuttings will remain suspended in the upper water column, contributing to increased levels of TSS before dispersing (refer to Appendix C for drill waste dispersion modelling). As such, temporary elevated TSS levels in the water column could result in temporary avoidance of a localized area of the Project Area by migratory birds during discharge of SBM cuttings at the surface.

As outlined in Section 7.4.8.2, seawater used for cooling purposes aboard the MODU will be treated through an oil-water separator before being disposed of at sea. Discharges of sanitary and domestic waste may attract birds and/or prey to the MODU and PSVs, but food and sewage waste will be macerated to maximum particle size (6 mm) prior to discharge. This waste is expected to be quickly degraded by bacteria and other biological activity after release.

The Change in Habitat Quality and Use as a result of waste management is predicted to be adverse, negligible in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Sound from VSP operations is expected to be the most intense sound generated by the Project. However, the VSP operations is only expected to be generated for approximately one day per well and studies have failed to document a strong response of migratory birds to seismic testing (Stemp 1985; Turnpenny and Nedwell 1994; Lacroix *et al*. 2003). Furthermore, many species of seabirds that may be present in the Project Area spend less than one minute underwater during a foraging dive, resulting in a short temporal overlap with VSP operations. Of the migratory birds that may be found within the Project Area, alcids (*e.g.*, Dovekie, Common Murre, Thick-billed Murre, Atlantic Puffin) spend relatively high amounts of time underwater during forage dives. However, it is unlikely that these birds will feed underwater when the seismic source is activated as a ramp-up period will be initiated which would deter migratory birds from the area and reduce their exposure to harmful underwater sound waves.

The Change in Habitat Quality and Use as a result of VSP operations is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration and reversible.

Supply and Servicing Operations

Migratory birds can react to low-level helicopter flights although their reactions are often temporary in nature. However, as outlined in Section 7.4.8.2, helicopters transiting to and from the MODU will fly at altitudes greater than 300 m and at a lateral distance of 2 km around active colonies when possible. Helicopters will also avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency, as is the standard protocol for other oil and gas operators working offshore Nova Scotia (see Section 7.5). Although migratory birds near the MODU may be disturbed during take-off and landing, they are likely to become habituated to the activity.

The presence of an approaching PSV may alert birds and flush some species from the area. The potential for PSVs to disturb bird colonies will be minor as the only colonies in the vicinity of the travel routes are in Halifax Harbour, where nesting birds are currently habituated to relatively high shipping activity. PSVs will not come in close proximity to any critical habitat for marine birds (*i.e.*, piping plover or roseate tern), or IBAs. Additionally, PSV activities are expected to be minimal compared to ongoing ship activity within the LAA; two or three PSVs will be required for the transport of materials and equipment to the MODU and will make between two to three round trips per week. One PSV must also be present on-site at all times as a standby vessel, as required by BP's operating standards and under the CNSOPB regulations. PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore and travel at approximately 22 km/hour (12 knots), except as needed in the case of an emergency.

The Change in Habitat Quality and Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration and reversible.

Summary of Residual Effects

In summary, the Project will result in adverse effects to a Change in Risk of Mortality or Physical Injury and a change in Habitat Quality and Use for Migratory Birds. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Risk or Mortality or Physical Injury is considered to vary from negligible to moderate in magnitude for various Project components and activities; primarily restricted to the Project Area but extend into the LAA for PSV operations and helicopter traffic; are short to medium-term in duration, reversible, and primarily occur within an undisturbed ecological and socio-economic context (with the exception of helicopter and PSV activity in the nearshore environment). Similarly, changes to Habitat Quality and Use for Migratory Birds are predicted to be negligible to low in magnitude, restricted to the Project Area or LAA, short to medium-term in duration, reversible, and to primarily occur within an undisturbed context. Table 7.4.5 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Migratory Birds that were identified in Table 7.4.4.

Table 7.4.5 Summary of Project Residual Environmental Effects on Migratory Birds

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Change in Risk of Mortality or Physical Injury							
Presence and Operation of MODU (including drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L-M	PA	MT	C	R	U
Waste Management	A	N	PA	MT	R	R	U
Vertical Seismic Profiling	A	N	PA	ST	IR	R	U
Supply and Servicing Operations	A	L	LAA	MT	R	R	U-D
Change in Habitat and Use							
Presence and Operation of MODU (including drilling and testing operations and associated lights, safety (exclusion) zone and underwater sound)	A	L	PA	MT	C	R	U
Waste Management	A	N	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	PA	ST	IR	R	U
Supply and Servicing Operations (including helicopter transportation PSV operations)	A	N-L	LAA	MT	R	R	U-D

KEY:
See Table 7.4.2 for detailed definitions
N/A: Not Applicable

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Frequency:
S: Single event
IR: Irregular event
R: Regular event

Table 7.4.5 Summary of Project Residual Environmental Effects on Migratory Birds

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.4.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effect of a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use on Migratory Birds during routine Project activities is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general effects of routine exploration drilling and the effectiveness of mitigation measures. The greatest risk to migratory birds from routine Project activities and components was identified as a potential Change in Risk of Mortality or Physical Injury as a result of the presence of the MODU and the transiting PSVs (See Table 7.4.5).

7.4.10 Follow-up and Monitoring

Follow-up and monitoring will include routine checks for stranded birds on the MODU and PSVs (with handling as per the Williams and Chardine 1999 protocol) and compliance with the requirements for documenting and reporting any stranded birds (or bird mortalities) to the CWS during the drilling program. To differentiate between Wilson's storm-petrel (*Oceanites oceanicus*) and Leach's storm-petrel, photographs depicting their differences will be provided to crew members trained to check for and handle stranded birds.

7.5 SPECIAL AREAS

Special Areas has been selected as a VC due to ecological and/or socio-economic importance, stakeholder and regulatory interests, and potential Project interactions. Special Areas provide important habitat that may be relatively more vulnerable to Project-related effects than other areas. Adverse environmental effects on Special Areas could degrade the ecological integrity of a Special Area such that it is not capable of providing the same biological or ecological function for which it was designated (*e.g.*, protection of sensitive or commercially important species). Special Areas are often designated to protect SAR and SOCC; therefore the assessment of Special Areas is closely linked to the other VCs (including associated SAR and SOCC) considered in this assessment including Fish and Fish Habitat (Section 7.2), Marine Mammals and Sea Turtles (Section 7.3) and Migratory Birds (Section 7.4).

Special Areas includes consideration of areas noted for their biological and ecological significance including, but not limited to, protected areas and Ecologically and Biologically Significant Areas (EBSAs). Although EBSAs do not have the same regulatory status as protected areas, they have been recognized by DFO as warranting consideration for conservation given their ecological and biological significance. In many cases, EBSAs overlap with other designated Special Areas that may already receive regulatory protection under federal legislation (*e.g.*, Emerald-Western-Sable Island Bank Complex EBSA and the Haddock Box). In these circumstances, the VC analysis focuses on the designated protected area, rather than the EBSA itself. The Scotian Slope EBSA extends through the Project Area. Therefore, this VC focuses on designated protected areas and the Scotian Slope EBSA.

7.5.1 Regulatory and Policy Setting

Many of the Special Areas (shown in Figure 7.5.1) considered in this assessment are under regulatory protection to protect the biological and ecological integrity of the Special Area and associated resources.

Petroleum exploration is prohibited on Sable Island National Park Reserve (approximately 48 km northeast of the Project Area) and in the Gully MPA (approximately 71 km northeast of the Project Area). Sable Island became officially designated as a National Park Reserve under the *Canada National Parks Act* in 2013. In response to this designation, the *Canada–Nova Scotia Offshore Petroleum Resources Accord Implementation Act* was amended to prohibit drilling for petroleum on Sable Island and within a one-nautical-mile exclusion zone around it. As an MPA under the *Oceans Act*, the Gully is protected from any activity within or near the MPA that disturbs, damages, destroys or removes any living marine organism or any part of its habitat within the MPA as per the *Gully Marine Protected Area Regulations*.

Closures have been established in accordance with the *Fisheries Act* and *Oceans Act*, restricting bottom fisheries activities on the eastern Scotian Shelf (Sambro Bank and Emerald Basin) to protect *Vazella Pourtalesi* (Russian hat glass sponges). Although petroleum exploration is not specifically prohibited, the designations protect high densities of intact octocorals and glass sponges from benthic disturbance which effectively negates drilling activity in these areas.

DFO has designated a Whale Sanctuary for the northern bottlenose whales. The Recovery Strategy for northern bottlenose whale identifies the entirety of Zone 1 of the Gully MPA and areas with water depths of more than 500 m in Haldimand Canyon and Shortland Canyon as Critical Habitat under SARA for the Scotian Shelf population (DFO 2009j). The Gully, Shortland Canyon and Haldimand Canyon are approximately 81 km, 139 km and 171 km respectively from the Project Area.

Critical habitat has also been designated under SARA for the endangered North Atlantic right whale, in the Roseway Basin (refer to Section 7.3.1 for further information on SARA). This area is also recognized by Transport Canada (TC) and IMO as a seasonal area to be avoided by ships 300 gross tonnage and above in transit during the period of June 1 to December 31. The Roseway Basin Critical Habitat/Area to be Avoided is located approximately 264 km northwest of the Project Area.

The federal *Species at Risk Act* (SARA) focuses on protecting species and their associated habitat whose populations are not secure. Sections 32, 33 and 58 of SARA contain provisions to protect species listed on Schedule 1 of SARA and their critical habitat. Critical habitat is defined under SARA as "habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or action plan for the species" (section 2[1]).

Under section 79 of SARA, Ministerial notification is required if a project "is likely to affect a listed wildlife species or its critical habitat". This notification must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, measures that will be taken to avoid or lessen those effects, along with monitoring commitments.

Other than the Scotian Slope EBSA, which extends across the RAA, including through the Project Area, the Special Areas located in closest proximity to the Project Area are fisheries closure areas that have been designated under the *Fisheries Act* to protect spawning and nursery areas and/or juvenile species. Although there are no specific regulatory considerations relevant to exploration drilling, these designations are relevant from a biological, ecological and socio-economic perspective. The closest closure area for the Project is the Haddock Box of which approximately 153 ha is located within the Project Area.

7.5.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date include concerns about possible effects on species at risk and their habitat such as the potential effects of underwater sound on marine life. Concerns were raised regarding the proximity of the Project to Sable Island, the Gully and northern bottlenose whale critical habitat. Through Aboriginal engagement, concern for sensitive and protected areas was noted and additional information regarding potential effects on these areas was requested.

7.5.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components could potentially interact with Special Areas, which could affect the ability of the Special Area to continue to provide important biological and ecological functions on which marine species and/or fisheries depend. These potential interactions most closely relate to concerns with the changes to the existing quality and use of natural habitats within these Special Areas.

As a result of these considerations, the assessment of Project-related environmental effects on Special Areas is focused on the following potential environmental effect:

- Change in Habitat Quality.

The effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 7.5.1. Effects of accidental events are assessed separately in Section 8.5.4.

Table 7.5.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Special Areas

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Habitat Quality	Interactions between the extent, duration, or timing of Project activities that result in direct loss or alteration of habitat	• Area of habitat permanently affected (m^2) • Change in chemical composition of sediment and water (unit depends on the contaminant) • Sound level (dB) and extent (km from sound source) of underwater sound affecting marine fish, marine mammals, and/or sea turtles

7.5.4 Environmental Assessment Boundaries

7.5.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Special Areas are defined below and depicted on Figure 7.5.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Special Areas are reasonably expected to occur and considers LAAs defined for other marine wildlife VCs. In recognition of the broad LAA delineation for Marine Mammals and Sea Turtles extending to include the RAA, the LAA for Special Areas has also been defined to reflect the RAA including PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e*., certain or reasonably foreseeable) physical activities, and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.5.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Special Areas encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. VSP operations are typically short duration, normally taking no more than a day to complete the profiling. It is assumed that Project activities could occur year-round.

Special Areas provide important habitat year-round, although some areas are more sensitive or commonly used by species during specific times of the year (*e.g.*, adult haddock aggregate to spawn in the Haddock Box from March to June). The Scotian Slope EBSA, which transects the Project Area, provides various functions for a diversity of species at different times of the year (*e.g.*, migratory route and foraging area for leatherback turtles in the spring, summer and fall; overwintering area for several fish (including benthic invertebrates) and bird species; and year-round habitat for several marine species). Refer to Section 5.2.10 for information on species use of Special Areas.

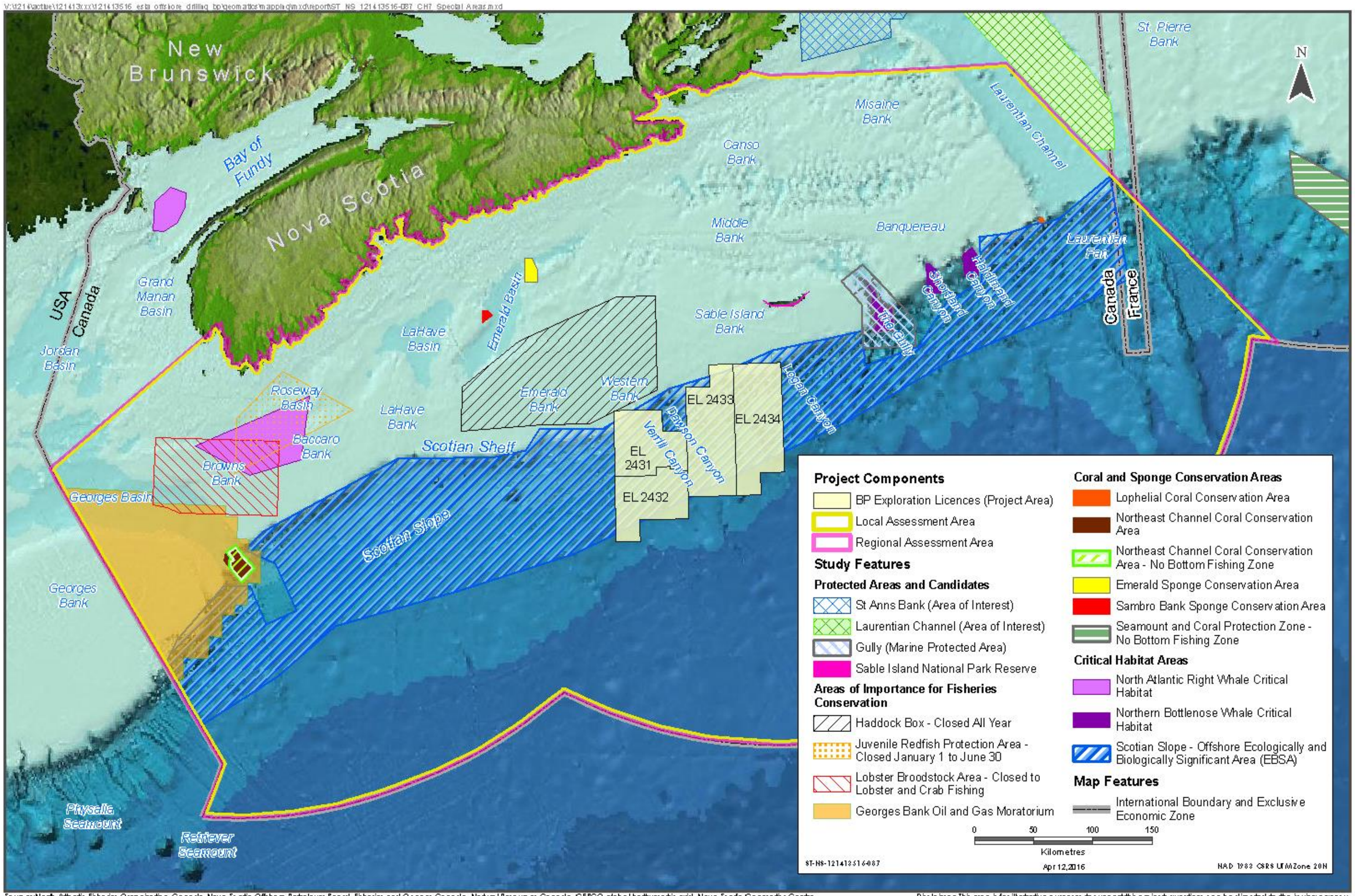


Figure 7.5.1 Assessment Boundaries for Special Areas

7.5.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.5.2 defines descriptors that are used to characterize residual environmental effects on Special Areas.

Table 7.5.2 Characterization of Residual Environmental Effects on Special Areas

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – a residual effect that moves measurable parameters in a direction beneficial to Special Areas relative to baseline **Adverse** – a residual effect that moves measurable parameters in a direction detrimental to Special Areas relative to baseline **Neutral** – no net change in measureable parameters for the Special Areas relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change in marine species populations, habitat quality or quantity **Low** – a measurable change but within the range of natural variability (change in population levels consistent with baseline levels); will not affect population viability **Moderate** – measurable change outside the range of natural variability but not posing a risk to population viability **High** – measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to a portion of the LAA/RAA **Regional Assessment Area** – effects extend throughout the LAA/RAA
Frequency	Identifies when the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at no set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities

Table 7.5.2 Characterization of Residual Environmental Effects on Special Areas

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
	existing condition, or the effect can no longer be measured or otherwise perceived	**Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment
Reversibility	Pertains to whether a measurable parameter of the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the descriptors listed above, the following threshold has been established to define a significant adverse residual environmental effect on Special Areas.

A **significant adverse residual environmental effect** on Special Areas is defined as a Project-related environmental effect that:

- alters the valued habitat physically, chemically or biologically, in quality or extent, to such a degree that there is a decline in abundance lasting more than one generation of key species (for which the Special Area was designated) or a change in community structure, beyond which natural recruitment (reproduction and immigration from unaffected areas) would not sustain the population or community in the Special Area and would not return to its original level within one generation; or
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy.

7.5.6 Existing Conditions

Section 5.2.9 describes the Special Areas in the RAA. Both the Scotian Slope EBSA and Haddock Box are partially located within the Project Area. The Scotian Slope EBSA is recognized for: high primary productivity; species diversity and richness; unique and sensitive benthic communities; migratory routes; overwintering habitat; foraging area for leatherback sea turtles; and habitat for Greenland sharks (Doherty and Horsman 2007; DFO 2014b). Approximately 87% of the Project Area falls within the Scotian Slope EBSA. However, the EBSA is very large (approximately 72,568 km^2); the Project Area constitutes only about 17% of the total area of the EBSA.

The Haddock Box is an important nursery area for the protection of juvenile haddock, and is closed year-round by DFO to the commercial groundfish fishery. Scallop fishing continues to occur on the eastern-most part of the closed area (O'Boyle 2011). Approximately 153 ha of the Haddock Box is within the Project Area (representing 0.01% of the Haddock Box area). The LAA for the PSV route crosses through the Haddock Box and encompasses the Sambro Bank Sponge Conservation Area and Emerald Sponge Conservation Area located 130 km and 126 km, respectively, from the Project Area.

Table 7.5.3 lists the Special Areas in the RAA and the approximate distance (in order of proximity) to the Project Area at the closest point.

Table 7.5.3 Proximity of Special Areas to the Project Area

Special Area	Distance from Project Area
Scotian Slope EBSA	0 km
Haddock Nursery Closure, Emerald/Western Bank (Haddock Box)	0 km
Sable Island National Park Reserve	48 km
The Gully Marine Protected Area	71 km
Northern Bottlenose Whale Critical Habitat (Sanctuaries): the Gully, Shortland Canyon, Haldimand Canyon	81 km, 139 km, 171 km
Sambro Bank and Emerald Basin Sponge Conservation Areas	130 km, 126 km
Redfish Nursery Closure Area (Bowtie)	221 km
Lophelia Conservation Area (LCA)	248 km
North Atlantic Right Whale Critical "Habitat/Area to be Avoided"	264 km
Lobster Fishing Area 40 (Georges Bank)	284 km
Georges Bank Oil and Gas Moratorium Area	300 km
Northeast Channel Coral Conservation Area	306 km
Hell Hole (Northeast Channel)	336 km

Given the relative distance of most of the identified Special Areas from the Project Area, the consideration of potential Project-VC interactions (and resulting environmental effects) focuses primarily on the Scotian Slope EBSA, the Haddock Box, and the Gully MPA. PSV transit activities could potentially cross the Emerald Basin Sponge Conservation Area, and to a lesser likely extent, the Sambro Bank Sponge Conservation Area. Although Sable Island National Park Reserve is closer than some Special Areas, the extent of potential effects from routine Project activities are not predicted to interact with this Special Area. Effects on migratory birds using Sable Island are assessed in Section 7.4.

7.5.7 Potential Project-VC Interactions

Table 7.5.4 identifies the physical Project activities that might interact with the Special Areas VC to result in the identified environmental effect. These interactions are indicated by checkmarks, and are discussed in Section 7.5.8 in the context of effects pathways, mitigation, and residual effects.

Table 7.5.4 Potential Project-Environment Interactions and Effects on Special Areas

Project Components and Physical Activities	Potential Environmental Effects
	Change in Habitat Quality
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓
Vertical Seismic Profiling	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓
Well Abandonment	✓
Note: ✓ = Potential interactions that might cause an effect. – = Interaction between the Project and the VC are not expected.	

7.5.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Special Areas arising from potential interactions in Table 7.5.4. Effects on species that could occur within the Special Areas are assessed within their respective VCs including: Section 7.2 (Fish and Fish Habitat); Section 7.3 (Marine Mammals and Sea Turtles); and Section 7.4 (Migratory Birds). Given the similarities in Project description, proximity of activities on the Scotian Slope, and relevancy of recent data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g.*, expansion of geographic scope), scientific updates, and refined EA methods.

7.5.8.1 Project Pathways for Effects

Change in Habitat Quality

A Change in Habitat Quality for Special Areas could potentially occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (light and sound emissions affecting underwater environment), discharge of drill muds and cuttings (reduction of water and sediment quality), other emissions and discharges (effects on water quality), VSP (underwater sound), helicopter transportation (sound emissions), PSV operations (underwater sound associated with vessel movement), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.5.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices, in addition to mitigation measures identified for the Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Migratory Birds VCs, will be employed to reduce the potential environmental effects of the Project on special areas. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

Presence and Operation of MODU

- BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.
- No Project well locations will be located within the Haddock Box.

Waste Management

- Refer to the waste management mitigation measures identified in the Fish and Fish Habitat VC (Section 7.2.8.2).

Vertical Seismic Profiling

- Refer to the VSP mitigation measures identified in the Marine Mammals and Sea Turtles VC (Section 7.3.8.2).

Supply and Servicing Operations

- To reduce the risk of marine mammal vessel strikes, Project PSVs will avoid currently-identified critical habitat for the North Atlantic right whale (Roseway Basin) and northern bottlenose whale (the Gully, and Shortland and Haldimand canyons), during transiting activities within the LAA and outside the Project Area, except as needed in the case of an emergency.
- Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities) and at a lateral distance of 2 km around active colonies when possible. Helicopters will avoid flying over Sable Island (a 2 km buffer

will be recognized) except as needed in the case of an emergency. These restrictions will also apply to other active coastal colonies (refer to Figures 5.2.25 and 5.2.26).

Well Abandonment

- Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues.

7.5.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Habitat Quality

Presence and Operation of the MODU

The Scotian Slope EBSA, Haddock Box, the Gully, and Shortland Canyon could potentially experience effects from the presence and operation of the MODU. Drilling operations and dynamic positioning of the MODU will generate underwater sound, which may affect the quality of the underwater acoustic environment and potentially result in temporary avoidance of habitat by marine fish, marine mammals and sea turtles. Sections 7.2 and 7.3 assess the effects of MODU underwater sound on fish and fish habitat, and marine mammals and sea turtles, respectively. Sections 7.2.7 and 7.3.8 discuss the results of the acoustic modelling and predicted effects on marine fish, and marine mammals and sea turtles, respectively. Based on predicted propagation of MODU and PSV underwater sound emissions, a Change in Habitat Quality for marine fish could potentially occur in areas of the Scotian Slope EBSA and Haddock Box that are situated closer to the Project Area.

While threshold criteria are commonly used to assess potential permanent auditory injury, behavioural responses of marine mammals to underwater sound are generally more variable, context dependent and less predictable than potential physical impacts (Southall *et al*. 2007). Therefore, the use of sound thresholds to predict behavioural response is limited and considered as a guide to informing the assessment of potential effects of sound on marine mammals rather than an absolute measure. In the US, NOAA (n.d.) has used 120 dB re 1 µPa RMS SPL in some offshore regions as a behavioural threshold value for marine mammals and continuous sounds (*e.g.*, shipping and drilling). However, as noted in Section 7.3, there exists much scientific disagreement and debate concerning the validity and relevance of assigning singular value sensory disturbance thresholds across species, particularly considering evidence highlighting the importance of context at the time of exposure. Based on acoustic modelling conducted for the Project (refer to Appendix D), these sound levels may extend into the Gully MPA, and Shortland Canyon under certain environmental conditions (winter season). These canyons, along with the Haldimand Canyon, provide important habitat for many marine species including primary year-round habitat for all life stages of the endangered northern bottlenose whale (Whitehead and Wimmer 2002; DFO 2009j).

Uncertainty around acoustic disturbances and the effect on species using the Gully remains in spite of numerous scientific reviews undertaken to address this issue (e.g., Lawson *et al.* 2000; Hooker and Whitehead 2002; Lee *et al.* 2005). However, to be conservative, it is assumed that a Change in Habitat Quality could therefore potentially occur in the Gully MPA and Shorland Canyon during the winter season when sound propagates furthest due to environmental conditions. However, this change would be temporary and is not predicted to result in permanent or irreversible loss of critical habitat.

Lights from the MODU will affect a portion of the visual environment of the EBSA and Haddock Box within the LAA and may attract fish and migratory birds; however, these effects are expected to be of negligible to low magnitude, continuous, medium-term and reversible. These effects are not likely to affect viability of populations using the EBSA and Haddock Box. At a distance of 48 km, the MODU will not affect the night-time light levels of Sable Island National Park Reserve; therefore the presence and operation of the MODU is not predicted to result in a Change in Habitat Quality of Sable Island.

Given the large extent of the EBSA relative to the area potentially affected by elevated SPLs from MODU presence and operation, a predicted Change in Habitat Quality of the Haddock Box and Scotian Slope EBSA are expected to be adverse, low in magnitude, continuous throughout the Project, medium-term in duration, and reversible. Effects on Habitat Quality in the Gully and Shortland and Haldimand Canyons are predicted to be adverse, moderate in magnitude, regular (potentially occurring in the winter season), short-term in duration (effect is predicted only during a seasonal portion of the drilling program), and reversible (baseline conditions are expected to return once the drilling program is complete).

Waste Management

The discharge of drill muds and cuttings as well as other discharges and emissions from the MODU and PSVs has the potential to cause a change in water and sediment quality within the portion of the Scotian Slope EBSA that falls within the Project Area. As discussed in Section 7.1.2, benthic communities comprised of sedentary or slow moving species may be smothered in the immediate vicinity of the wellsite by drill waste and the sediment quality will be altered in terms of nutrient enrichment and oxygen depletion (Neff *et al.* 2000; Neff *et al.* 2004). These effects could potentially result in changes in the composition of the benthic macrofauna community, although studies have shown recorded effects on benthic macrofauna are most often confined to within a 250-m radius and seldom detected beyond 500 m (Bakke *et al.* 2013). Drill waste modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site (refer to Appendix C).Using a threshold of 9.6 mm to assume burial of benthic species, it is predicted that these sediment thicknesses could extend approximately 116 m from the discharge point, or cover an area of approximately 0.54 ha per well.

Available benthic habitat mapping in the vicinity of the Project Area (refer to Figure 5.2.4) suggests the presence of a low-energy, Holocene mud and clay benthos with ophuroids, burrowing anemones and sea urchins as typical benthic fauna likely to be encountered with some corals also potentially present. BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This confirms confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling.

Other discharges and emissions will be released on a regular basis during the drilling program, potentially affecting water quality within the LAA. Marine fish and birds could be attracted to certain discharges from the MODU and PSVs (*e.g.*, sanitary and organic wastes). These discharges will have a negligible effect on water quality and species use of the EBSA or Haddock Box will not be affected at a population level. No other Special Areas are predicted to be affected by waste management.

The Change in Habitat Quality as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Physiological and biological effects of underwater sound from VSP operation on marine fish and marine mammals and sea turtles are discussed in Section 7.2.8 and 7.3.8 respectively.

As discussed in Section 7.2.8, thresholds for behavioral effects of marine fish can vary, with avoidance behavior potentially occurring at sound levels of 151 dB re 1 µPa peak SPL (McCauley *et al.* 2000a). Acoustic modelling for the Project predicts sound levels will decrease to below ≤160 dB re 1 µPa peak SPL up to 20 km from the VSP sound source (Zykov 2016; Table 26 in Appendix D). Depending on the proximity of the wellsite to the Haddock Box (there will be no drilling within the Haddock Box), there could potentially be elevated SPLs within the Haddock Box that could result in a temporary Change in Habitat Quality for marine fish species. VSP operation will occur over a relatively short period of time (up to one day per well) and there is a low likelihood of a VSP survey occurring within 20 km of the Haddock Box, and/or coinciding with spawning activities in the Haddock Box. VSP operation will be carried out in consideration of the mitigation commitments stated in Section 7.5.8.2.

As discussed in Section 7.3.8.3, acoustic modelling conducted for the Project predicts that sound from the VSP source will decrease to below 160 dB re 1 µPa RMS SPL (NOAA's interim threshold for sensory disturbance from an impulsive sound source) at distances greater than approximately 3 km from the sound source (details presented in Appendix D). Higher SPLs occur only in close proximity to the source, with 180 dB re 1 µPa RMS SPL expected within 280 m of the source. Based on the extent of these predicted effects on marine mammals, and the distance of the Project Area to other Special Areas, it is assumed that a Change in Habitat Quality as a result of VSP operation would be restricted to the Scotian Slope EBSA. No other Special Areas are expected to be affected by VSP operation.

The Change in Habitat Quality as a result of VSP operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

Although PSVs may transit through or in close proximity to the Sambro Bank and Emerald Bank Sponge Closure Areas, this interaction is not predicted to result in any change that would affect the biological or ecological integrity of these Special Areas.

Helicopter transportation and PSV traffic could affect habitat quality of Special Areas as a result of sound disturbance, particularly in the vicinity of migratory bird colonies. As noted in Section 7.4.8.2 and 7.5.8.2, helicopters will avoid flying at altitudes less than 300 m (with the exception of approach and landing activities) and a lateral distance of 2 km around active bird colonies when possible. Helicopters will avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency. These restrictions will also apply to other active coastal colonies (refer to Figures 5.2.25 and 5.2.26).

Sound disturbance effects on marine mammals and sea turtles are discussed in Section 7.3 and above in the context of MODU presence and operation. Collision risk associated with PSV transit, which will be mitigated in part by avoidance of the Roseway Basin, the Gully and Shortland and Haldimand Canyons, is discussed with respect to a Change in Risk of Mortality or Physical Injury for Marine Mammals and Sea Turtles in Section 7.3 and is not considered in the context of this VC.

The Change in Habitat Quality as a result of supply and servicing operations are predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

As discussed in Section 2.4.4, all wells drilled as part of the Project will be abandoned. Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements.

The final well abandonment program has not yet been finalized; however, these details will be confirmed to CNSOPB as planning for the Project continues. It is possible that the subsea infrastructure could be removed after the cement plugs are set within the well. If this is the case, casing would be cut below the seabed and the wellhead removed. The wellhead would be lifted to the surface and brought to shore using a PSV. No infrastructure would be left on the seafloor after the wellhead has been removed. These details will be confirmed as planning for the Project continues. If the wellhead is removed mechanically, well abandonment is expected to have little interaction with the Scotian Slope EBSA and the Haddock Box outside the immediate vicinity of the wellhead. This activity will not produce excess sound or discharge.

Alternatively, approval may be sought to leave the wellhead in place. If this is the case, there will be a hard substrate suitable for recolonization by benthic communities.

The Change in Habitat Quality as a result of well abandonment are predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project is expected to result in adverse effects to a Change in Habitat Quality for Special Areas including the Scotian Slope EBSA, the Haddock Box, the Gully, and the Shortland and Haldimand Canyons (critical habitat for the northern bottlenose whale). In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Habitat Quality is considered to be low in magnitude for most Project components and activities; are short- to medium-term in duration; reversible; and primarily occur within an undisturbed ecological and socio-economic context (with the exception of helicopter and PSV activity in the nearshore environment). Underwater sound associated with MODU presence and operation could result in a moderate magnitude effect based on predicted sound propagation to the Gully and other designated critical habitat for the northern bottlenose whale in the winter season (refer to Section 7.3.8). This effect is predicted to be short-term in duration and reversible and will not result in permanent and irreversible loss of critical habitat. Table 7.5.5 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Special Areas that were identified in Table 7.5.4.

Table 7.5.5 Summary of Project Residual Environmental Effects on Special Areas

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Habitat Quality							
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	A	L-M	LAA	ST-MT	C	R	D
Waste Management	A	L	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	D
Supply and Servicing Operations (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	U

KEY:
See Table 7.5.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.5.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Habitat Quality of Special Areas from Project activities and components are predicted to be not significant. This conclusion has been determined with a moderate level of confidence based on the conservative assumptions used in underwater sound modelling and application of a conservative threshold to predict potential change in behavior for marine mammals. The level of confidence is reduced from high due to uncertainties regarding the scientific information on behavioural changes for cetaceans to underwater sound in the Gully and Haldimand and Shortland Canyons regarding potential Change in Habitat Quality.

7.5.10 Follow-up and Monitoring

BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the first phase of the drilling program to collect field measurements to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.

7.6 COMMERCIAL FISHERIES

Commercial Fisheries is included as a VC because of the commercial and cultural importance of commercial fisheries to the region, regulatory protection of fish and fish habitat under the *Fisheries Act*, requirements of the EIS Guidelines, and the potential for Project activities and components to interact with fisheries. This VC addresses potential effects on non-Aboriginal commercial fisheries, focusing on those interactions that could have an effect on the success of commercial fisheries.

Effects on Aboriginal fisheries (including Aboriginal commercial fisheries) are discussed in Section 7.7 (Current Aboriginal Use of Lands and Resources for Traditional Purposes). Effects on targeted fishery species could potentially affect the success of commercial fisheries; therefore, this VC is also closely related to the Fish and Fish Habitat VC (Section 7.2). The Commercial Fisheries VC is also related to the Special Areas VC (Section 7.5) as some Special Areas are designated for the protection of important spawning areas (*i.e.*, the Haddock Box).

7.6.1 Regulatory and Policy Setting

The Project Area is located within NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf, Scallop Fishing Area (SFA) 25 and CFA 24 (refer to Figure 5.3.1). The *Fisheries Act* focuses on protecting the productivity of CRA fisheries including a prohibition against causing serious harm to fish that are part of or support a CRA fishery without authorization (Section 35).

The *Maritime Provinces Fishery Regulations* (MPFR) governs fishing activity in inland and adjacent tidal waters of the provinces of Nova Scotia, New Brunswick and Prince Edward Island. The *Atlantic Fishery Regulations, 1985* provide for the management and allocation of fishery resources off the Atlantic coast of Canada. MPFR prohibits any person from fishing, including catching and retaining fish, unless: (a) the person is authorized to do so under the authority of a MPFR issued licence, the *Fishery (General) Regulations,* or the *Aboriginal Communal Fishing Licences Regulations;* (b) holds a fisher's registration card; or (c) where a vessel is used in fishing, a vessel registration card has been issued in respect of the vessel. The administration of aquaculture, sea plant harvesting, seafood processing and recreational fisheries in the province is provided by the provincial *Fisheries and Coastal Resources Act*.

Fishery resources are protected from uncontrolled fishing activity through various measures such as area closures, fishing quotas, fishing seasons, and gear and vessel restrictions. Closures have been established in accordance with the *Fisheries Act* and *Oceans Act*, restricting bottom fisheries activities on the eastern Scotian Shelf (Sambro Bank and Emerald Basin) to protect *Vazella Pourtalesi* (Russian hat glass sponges). Other broad mechanisms for the protection of marine resources are provided in the federal *Oceans Act* (*e.g.*, authority to establish MPAs).

7.6.2 The Influence of Engagement on the Assessment

Key issues raised during stakeholder and Aboriginal engagement for the Project to date consists of concerns related to potential Project effects on the marine environment including commercially fished species and the possible effects to the fishing industry. Aboriginal engagement identified concern of possible obstruction of Mi'kmaq and Wolastoqiyik (Maliseet) fishing areas as a result of the Project as well as potential effects on nearshore and inshore resources as a result of a spill (refer to Section 7.7 for an assessment of effects on Aboriginal fishing). Questions and concerns were raised with respect to effects of routine discharges and spills on fish populations and migration, feeding, and spawning activities that could be occurring in the affected area.

7.6.3 Potential Environmental Effects, Pathways and Measurable Parameters

Routine Project activities and components have potential to interact with fisheries resources by direct or indirect effects on commercially fished species and/or effects on fishing activity from displacement from fishing areas, gear loss or damage that may result in a demonstrated financial loss to commercial fishing interests.

As a result of these considerations, the assessment of Project-related environmental effects on Commercial Fisheries is focused on the following potential environmental effect:

- Change in Availability of Fisheries Resources.

The measurable parameters used for the assessment of the environmental effect presented above, and the rationale for selection, are provided in Table 7.6.1. Effects of accidental events are assessed separately in Section 8.5.5.

Table 7.6.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Commercial Fisheries

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Availability of Fisheries Resources	Interactions between the extent, duration, or timing of Project activities that result in direct or indirect loss in availability of fisheries resources	• Change in access to area used for commercial fisheries (ha) • Change in catch rates (qualitative) • Area of fish habitat permanently affected (m^2) • Mortality of commercially important species • (qualitative) • Damage to fishing gear

7.6.4 Environmental Assessment Boundaries

7.6.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment for Commercial Fisheries are defined below and depicted on Figure 7.6.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur, and represents the area within which direct physical disturbance to the marine benthic environment may occur. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from routine Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Commercial Fisheries are reasonably expected to occur. Based on predicted propagation of SPLs from drilling and VSP, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. The LAA has also been defined to include PSV routes to and from the Project Area. In the context of Commercial Fisheries, the LAA, (including the PSV route) falls within NAFO Unit Areas 4Wk, 4Wl, 4Wh, 4Wf, 4Wg, 4Wj, and 4Wm.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the effects assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.6.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Commercial Fisheries encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

Commercial fisheries could interact with the Project year-round although it is understood that the majority of fishing near the Project Area occurs between February and October with peak fishing efforts for pelagic and groundfish species occurring from July to September. Refer to Section 5.3.5 for a description of the fisheries conducted in 4W.

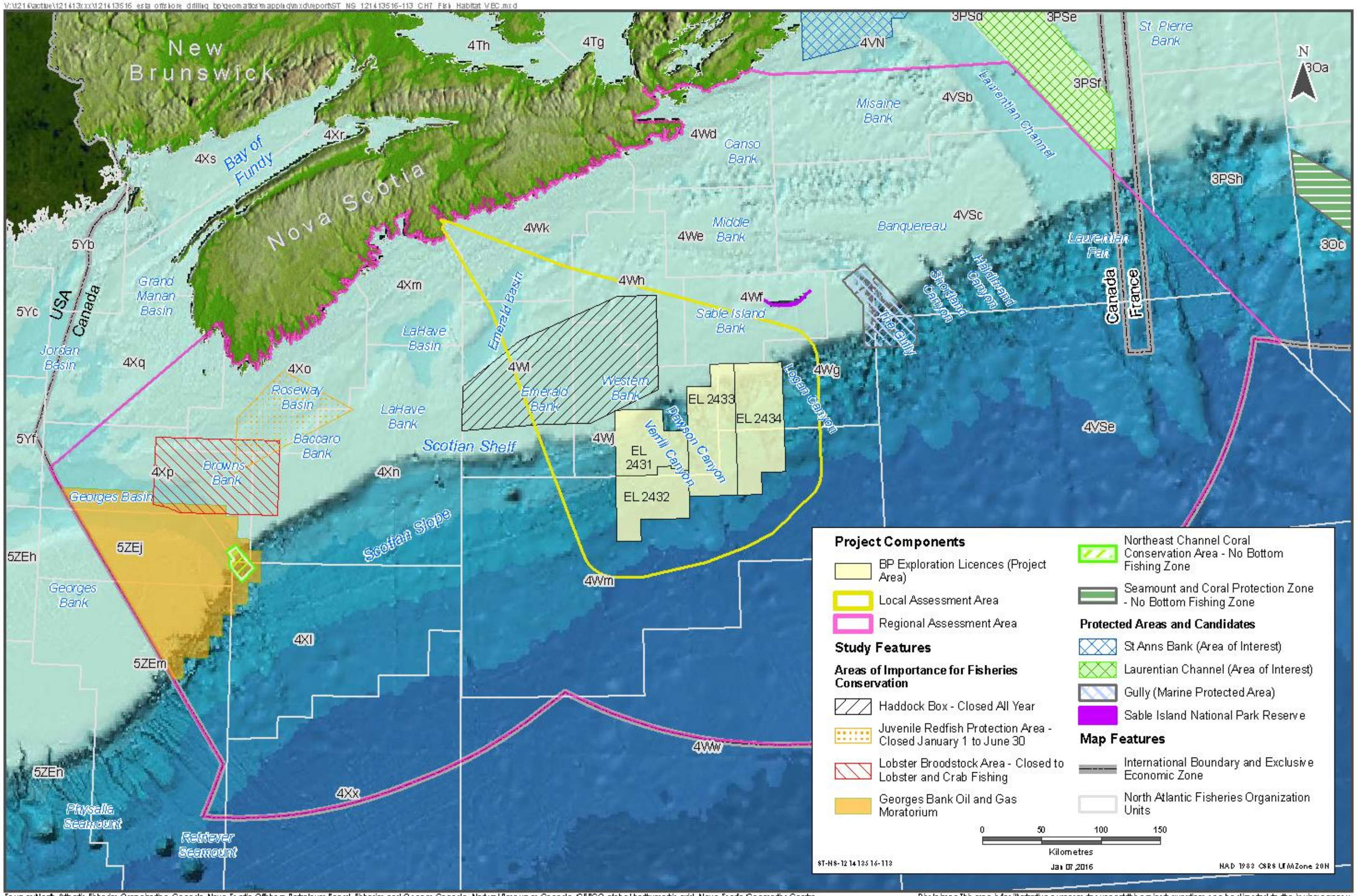


Figure 7.6.1 Assessment Boundaries for Commercial Fisheries

7.6.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.6.2 defines the descriptors used to characterize residual environmental effects on Commercial Fisheries.

Table 7.6.2 Characterization of Residual Environmental Effects on Commercial Fisheries

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – a residual effect that moves measurable parameters in a direction beneficial to Commercial Fisheries relative to baseline **Adverse** – a residual effect that moves measurable parameters in a direction detrimental to Commercial Fisheries relative to baseline **Neutral** – no net change in measureable parameters for the Commercial Fisheries relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change to commercial fisheries **Low** – very small detectable change to commercial fisheries in low-use areas **Moderate** – measurable change to commercial fisheries in moderate-use areas **High** – measurable change to commercial fisheries in high-use areas
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies how often the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at not set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire duration of Project activities **Long-term** – effects extend beyond the duration of Project activities and continue after well abandonment

Table 7.6.2 Characterization of Residual Environmental Effects on Commercial Fisheries

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially disturbed by previous human development or human development is still present

In consideration of the residual effects descriptors listed in Table 7.6.2, the following threshold has been established to define a significant adverse residual environmental effect on Commercial Fisheries.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Commercial Fisheries is defined as a Project-related environmental effect that results in one or more of the following outcomes:

- local fishers being displaced or unable to use substantial portions of the areas currently fished for all or most of a fishing season;
- local fishers experiencing a change in the availability of fisheries resources (*e.g.* fish mortality and/or dispersion of stocks) such that resources cannot continue to be used at current levels within the RAA for more than one fishing season; or
- unmitigated damage to fishing gear.

7.6.6 Existing Conditions

Within and surrounding the Project Area, the socio-economic setting is dominated by commercial fisheries activity. Groundfish, pelagic, and invertebrate fisheries occur on the Scotian Shelf and Slope, with large pelagics (*e.g.*, swordfish, tuna, and shark) as the most commonly harvested fish in the Project Area. The Project Area is located within Commercial Fisheries Management Areas for lobster, shrimp, scallop and crab (Figure 5.3.7), and within NAFO Unit Area 4Wm, 4Wj, 4Wg and 4Wf (Figure 7.6.1).

As evident in Figures 5.3.9 and 5.3.10, there is notable fishing effort within the northern portion of the Project Area along the Shelf break including the harvesting of Atlantic halibut, Greenland halibut, hagfish, swordfish, shark species, white hake, cusk, monkfish and redfish as well as some flatfish, bluefin tuna, herring, other tuna, red hake and silver hake. Based on previous data (*e.g.*, as presented in LGL 2014) it can be surmised that the primary commercial species likely harvested in the Project Area by landing weight include sea scallops (33%), swordfish (~20%), herring (~14%), Atlantic halibut (~10%), silver hake (~8%), cusk (~3%) and white hake (~3%) (LGL 2014). As presented in Table 5.3.4, in terms of catch value, large pelagics accounted for about 50% with swordfish accounting for about 45% of landings values and an average landings value of about $1.25 million (LGL 2014).

Based on Figure 5.3.9, productive groundfish harvesting occurs north of the Project Area near Western Bank and northwest of the Project Area near Emerald Basin. There is an active snow crab fishing area to the northeast of the Project Area, near Middle Bank.

Commercial fisheries can occur year-round for most species, although it is understood that the majority of fishing near the Project Area occurs between February and October with peak fishing efforts for pelagic and groundfish species occurring from July to September (refer to Table 5.3.5).

7.6.7 Potential Project-VC Interactions

Table 7.6.3 identifies the physical Project activities that might interact with the VC to result in the identified environmental effect. These interactions are indicated by checkmarks, and are discussed in Section 7.6.8 in the context of effects pathways, mitigation, and residual effects.

Table 7.6.3 Potential Project-Environment Interactions and Effects on Commercial Fisheries

Project Components and Physical Activities	Potential Environmental Effects
	Change in Availability of Fisheries Resources
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓
Vertical Seismic Profiling	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓
Well Abandonment	✓

Note:
✓ = Potential interactions that might cause an effect.
– = Interaction between the Project and the VC are not expected.

7.6.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on fisheries resources arising from potential interactions in Table 7.6.3. Given the similarities in Project description, proximity of activities on the Scotian Slope, and currency of data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a), and the Environmental Assessment of BP Exploration

(Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) has been extensively referenced for this analysis. This information has been updated, as applicable, due to Project and geographic differences (*e.g.*, expansion of geographic scope), scientific updates, and refined EA methods.

7.6.8.1 Project Pathways for Effects

Change in Availability of Fisheries Resources

A Change in Availability of Fisheries Resources for commercial fisheries could potentially occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (fisheries exclusions and underwater sound effects on fisheries species), discharge of drill muds and cuttings (effects on water and sediment quality on fisheries species), other discharges and emissions (effects on water quality), VSP (underwater sound), PSV operations (underwater sound associated with vessel movement potentially causing behavioural effects on fisheries species), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.6.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices, as well as mitigation measures identified for the Fish and Fish Habitat VC (refer to Section 7.2.8.2), will be employed to reduce the potential environmental effects of the Project on fisheries resources. Refer to Table 13.2.1 for a complete list of Project mitigation measures.

General

- BP will continue to engage commercial fishers to share Project details as applicable and facilitate coordination of information sharing. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers.

- BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notices to Shipping and Notices to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with commercial fishers.

- Project-related damage to fishing gear, if any, will be compensated in accordance with the *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).

Supply and Servicing

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency.
- To maintain navigational safety at all times during the Project, obstruction lights, navigation lights and foghorns will be kept in working condition on board the MODU and PSVs. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

7.6.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Availability of Fisheries Resources

Presence and Operation of MODU

There is potential for a disruption of commercial fishing activities if drilling activities displace fishing in the areas around drill sites. A 500-m radius safety (exclusion) zone will be established around the MODU, in accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, within which fisheries activities will be excluded while the MODU is in operation. This will result in localized fisheries exclusion within an area of approximately 0.8 km^2 (80 ha) for a maximum of 120 days for each well to be drilled. Although fishing effort may be disrupted within this safety (exclusion) zone, it is anticipated to be a temporary and localized fishing exclusion and is not likely to have a substantial effect on fishing activities and fisheries resources. The LAA does not include any unique fishing grounds or concentrated fishing effort that occurs exclusively within the LAA; similar alternative sites are readily available within the immediate area.

Fish can be affected by underwater sound emissions from the MODU. Sound generation from the MODU may cause fisheries species to avoid the area around the MODU, particularly during start-up of drilling. This avoidance behavior is expected to be temporary as fish become habituated to the continuous sound levels from the MODU and startle responses cease (Chapman and Hawkins 1969; McCauley *et al*. 2000a, 2000b; Fewtrel and McCauley 2012). Given the temporary and localized nature of this effect, it is not expected to affect commercial fisheries species so that fishers would be adversely affected. Refer to Section 7.2 for additional information on Project effects on Fish and Fish Habitat.

The Change in Availability of Fisheries Resources as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, occur within the LAA, continuous throughout the Project, medium-term in duration, and reversible (*e.g.*, avoidance behavior exhibited by fisheries species, as well as the establishment of the safety (exclusion) zone associated with the presence of the MODU will not have a permanent, irreversible effect on fisheries).

Waste Management

The discharge of drill muds and cuttings and other discharges and emissions from the MODU and PSVs can give rise to a change in sedimentation and water quality. As noted in Section 7.2, these effects are expected to be low in magnitude and localized to the Project Area. Adherence to the OCSG and OWTG, which have been developed to be protective of the marine environment, will reduce adverse effects on fisheries species.

Drill waste modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site. As presented in Appendix C and discussed in Section 7.2.8, sediment thicknesses at or above 1 mm will extend up to 563 m from the discharge site and occupy a maximum areal extent of 9.91 ha per well; sediment thicknesses greater than 10 mm will extend up to 116 m, with a maximum footprint of 0.53 ha per well; and sediment thicknesses at or above 100 mm will be confined to a distance of 30 m from the discharge point, with a maximum footprint of 0.07 ha per well.

Results of environmental effects monitoring programs undertaken for various drilling programs in the Atlantic Canada (Hurley and Ellis 2004) concluded that there are negligible effects on fish health and fish habitat from these activities; therefore the availability of fisheries resources are not expected to be affected by waste management.

Other discharges and emissions such as drilling and testing emissions will result in temporary and localized effects on water quality. Discharges, however, will be in accordance with the OWTG, which is designed to mitigate potential effects from discharges and therefore they are not predicted to adversely affect fisheries species in the Project Area or the LAA. Discharges may include organic matter, substances containing minor amounts of chemicals or residual hydrocarbons. These discharges are expected to disperse quickly and will be degraded by bacterial communities.

Benthic prey species for commercially fished species are widespread within the LAA and available outside any localized areas at the wellsite that could be affected by drill mud and cuttings discharges and other discharges and emissions.

The Change in Availability of Fisheries Resources as a result of waste management are predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Section 7.2.8 discusses potential startle and alarm responses of marine fish as a result of VSP surveys and references acoustic modelling conducted for the Project. The Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) provides a comprehensive literature review on the effects of seismic sound on fish and fisheries, concluding that behavioral effects (which can be quite variable between and within species) are localized and temporary but can result in short-term effects of catch rates. VSP operations are typically of short duration, normally taking no more than a day per well, which is much shorter than a typical 2D or 3D seismic exploration program. Therefore, any behavioral changes in fisheries species as a result of VSP surveys would be expected to be low.

The Change in Availability of Fisheries Resources as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

The operation of PSVs will increase vessel traffic within the Project Area and LAA. Two to three PSVs will be required for re-supply to the drilling vessel making two to three round trips per week between the MODU and the supply base. This increase in vessel traffic has the potential to interfere with fishing gear and may restrict fishing vessel navigation. PSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour, where applicable, and will adhere to standard navigation procedures, thereby reducing potential conflicts with commercial fisheries. Potential environmental effects on fish attributable to PSV traffic and operations would also represent only a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Helicopter transportation is predicted to have negligible effect on fisheries given the limited frequency of trips associated with the exploration program and lack of interaction with the marine environment (including fish).

The Change in Availability of Fisheries Resources as a result of supply and servicing operations are predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues.

It is expected that plugging and abandonment activities would take approximately 7 to 10 days. It is likely that the casing will be cut below the seabed, and the wellhead removed which would mean that no infrastructure would be left on the seabed. In the event that the wellhead is left in place, there could potentially be an interaction with commercial fishing activity in the Project Area through a change in fish habitat (*i.e.*, small structure remaining above seabed). Prior to well abandonment, a survey will be completed to confirm the location of the well and details will be submitted to the CNSOPB. The well location will be marked on nautical charts as applicable.

Well abandonment is not expected to interact with commercial fishing activities given the temporary nature of the abandonment operation, the localized effects around the wellsite, and the water depths in the Project Area. Following abandonment of the drill site, it is anticipated that the wellhead (if kept in place) will provide hard substrate suitable for recolonization by benthic communities.

The Change in Availability of Fisheries Resources as a result of well abandonment is predicted to be adverse, low in magnitude, within the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project will result in adverse effects to a Change in Availability of Fisheries Resources for Commercial Fisheries. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Availability of Fisheries Resources is considered low in magnitude for various Project components and activities; occur within the LAA; be of short to medium-term in duration, be reversible; and primarily occur within an undisturbed ecological and socio-economic context. Table 7.6.4 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Commercial Fisheries that were identified in Table 7.6.3.

Table 7.6.4 Summary of Project Residual Environmental Effects on Commercial Fisheries

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Change in Availability of Fisheries Resources							
Presence and Operation of MODU (including well drilling and testing operations and associate lights, safety [exclusion] zone and underwater noise)	A	L	LAA	MT	C	R	U
Waste Management	A	L	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	U

Table 7.6.4 Summary of Project Residual Environmental Effects on Commercial Fisheries

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Supply and Servicing Operations (including helicopter transportation and PSV operation)	A	L	LAA	MT	R	R	U
Well Abandonment	A	L	PA	ST	IR	R	U

KEY:
See Table 7.6.2 for detailed definitions
N/A: Not Applicable

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.6.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Availability of Fisheries Resources on Commercial Fisheries from Project activities and components are predicted to be not significant. This conclusion has been determined with a high level of confidence based on a good understanding of the general effects on commercial species inhabiting the LAA and the effectiveness of mitigation measures including those discussed in Sections 7.6.8.2.

7.6.10 Follow-up and Monitoring

Given the high level of confidence around a prediction of no significant adverse environmental effects on Commercial Fisheries, and the implementation of standard mitigation, no follow-up and monitoring is proposed to be implemented for routine Project activities.

7.7 CURRENT ABORIGINAL USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES

Current Aboriginal Use of Lands and Resources for Traditional Purposes refers to communal commercial, as well as food, social and ceremonial (FSC) fishing activities by Aboriginal peoples that could potentially interact with the Project. It is included as a VC in recognition of the cultural and economic importance of marine life and fishing to Aboriginal peoples and in recognition of potential or established Aboriginal and Treaty rights. This VC is closely linked to the Fish and Fish Habitat VC (Section 7.2), the Special Areas VC (Section 7.5) and the Commercial Fisheries VC (Section 7.6). This VC is also closed linked to the Traditional Use Study (TUS) which has been conducted to obtain information about Aboriginal use of resources in the RAA (MGS and UINR 2016; refer to Appendix B).

7.7.1 Regulatory and Policy Setting

The Project Area is located within NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf. These boundaries include SFA 25 and CFA 24 (refer to Figure 5.3.8). The *Fisheries Act* focuses on protecting the productivity of commercial, recreational or Aboriginal (CRA) fisheries including a prohibition against causing serious harm to fish that are part of or support a CRA fishery without authorization. As indicated in Section 5.3.6, DFO manages Aboriginal fishing in accordance with the Aboriginal Fishing Strategy, which recognizes Aboriginal and Treaty rights and places priority on Aboriginal rights to fish for FSC purposes. Treaty rights in Nova Scotia to hunt, fish, and gather in pursuit of a moderate livelihood have been recognized through Supreme Court of Canada decisions. DFO also issues communal licences pursuant to the *Aboriginal Communal Fishing Licences Regulation* to provide for the harvest of fish for FSC purposes.

There are two key guidelines that have influenced the EA process including the scoping and assessment of this VC: *Proponent's Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia* (NSOAA 2012) and the *Mi'kmaq Ecological Knowledge Study Protocol* (Assembly of Nova Scotia Mi'kmaq Chiefs 2007). Another relevant guideline with respect to Aboriginal engagement is the *Aboriginal Consultation and Accommodation – Updated Guidelines for Federal Officials to Fulfill the Duty to Consult* (AANDC 2011).

7.7.2 The Influence of Engagement on the Assessment

Aboriginal engagement identified concern of possible obstruction of Mi'kmaq and Wolastoqiyik (Maliseet) fishing areas as a result of the Project as well as potential effects on nearshore and inshore resources as a result of a spill. In particular, concerns were raised by Aboriginal organizations around potential adverse effects from planned Project activities or accidental events on fish identified as being traditionally or commercially significant to the Mi'kmaq and/or Wolastoqiyik (Maliseet) including American eel, Atlantic sturgeon, bluefin tuna, swordfish, herring, gaspereau (alewife), lobster, crab and shrimp. Concern was raised with regards to a potential spill affecting migration, spawning and/or feeding grounds of species of significance to

Mi'kmaq culture. Section 4 provides additional information on issues and concerns raised during Aboriginal engagement.

7.7.3 Potential Environmental Effects, Pathways and Measurable Parameters

The selection of environmental effects for this VC reflects the variations in fishing locations by Aboriginal Groups, which include nearshore areas and offshore areas. It also reflects the multiple purposes for the use of marine resources, which includes communal commercial fisheries and FSC fisheries and the economic or cultural aspects of each fishery. Similar to Commercial Fisheries (refer to Section 7.6), the Project could have an effect on fisheries resources by direct or indirect effects on fished species and/or effects on fishing activity from displacement from fishing areas, gear loss or damage.

The assessment of Project-related environmental effects on the Current Aboriginal Use of Lands and Resources for Traditional Purposes is therefore focused on the following potential environmental effect:

- Change in Traditional Use.

The effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 7.7.1.

Table 7.7.1 Potential Environmental Effects, Effects Pathways and Measurable Parameters for Current Aboriginal Use of Lands and Resources for Traditional Purposes

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Traditional Use	Direct or indirect loss in availability of fisheries resources arising from Project activities	• Change in access to area used for communal commercial or FSC fisheries (ha) • Change in catch rates (qualitative) • Area of fish habitat permanently affected (ha)

7.7.4 Environmental Assessment Boundaries

7.7.4.1 Spatial Boundaries

The spatial boundaries for the environmental effects assessment with respect to Current Aboriginal Use of Lands and Resources for Traditional Purposes are defined below and shown on Figure 7.7.1. Effects of accidental events are assessed separately in Section 8.5.1.

Project Area: The Project Area encompasses the immediate area in which Project activities and components may occur and as such represents the area within which direct physical disturbance to the marine benthic environment may occur as a result of the Project. Well locations have not yet been identified, but will occur within the Project Area and represent the actual Project footprint. The Project Area includes ELs 2431, 2432, 2433, and 2434.

Local Assessment Area (LAA): The LAA is the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the Project Area and adjacent areas where Project-related environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes are reasonably expected to occur. Based on predicted propagation of SPLs from drilling and VSP operation and minimum thresholds for behavioural effects on fish, a buffer of 30 km around the Project Area boundaries has been established to represent the LAA. Sound from VSP operation is expected to represent the maximum area within which environmental effects from Project activities and components would occur. The LAA has also been defined to include PSV routes to and from the Project Area.

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities, and to provide regional context for the assessment. The RAA is restricted to the 200 nautical mile limit of Canada's EEZ, including offshore marine waters of the Scotian Shelf and Slope within Canadian jurisdiction.

7.7.4.2 Temporal Boundaries

The temporal boundaries for the assessment of potential Project-related environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes encompass all Project phases, including well drilling, testing and abandonment. Up to seven exploration wells will be drilled over the term of the ELs, with Project activities at each well taking approximately 120 days to drill. It is assumed that Project activities could occur year-round.

As indicated in Section 4 of the TUS (refer to Appendix B), Aboriginal fishing activities can occur year-round.

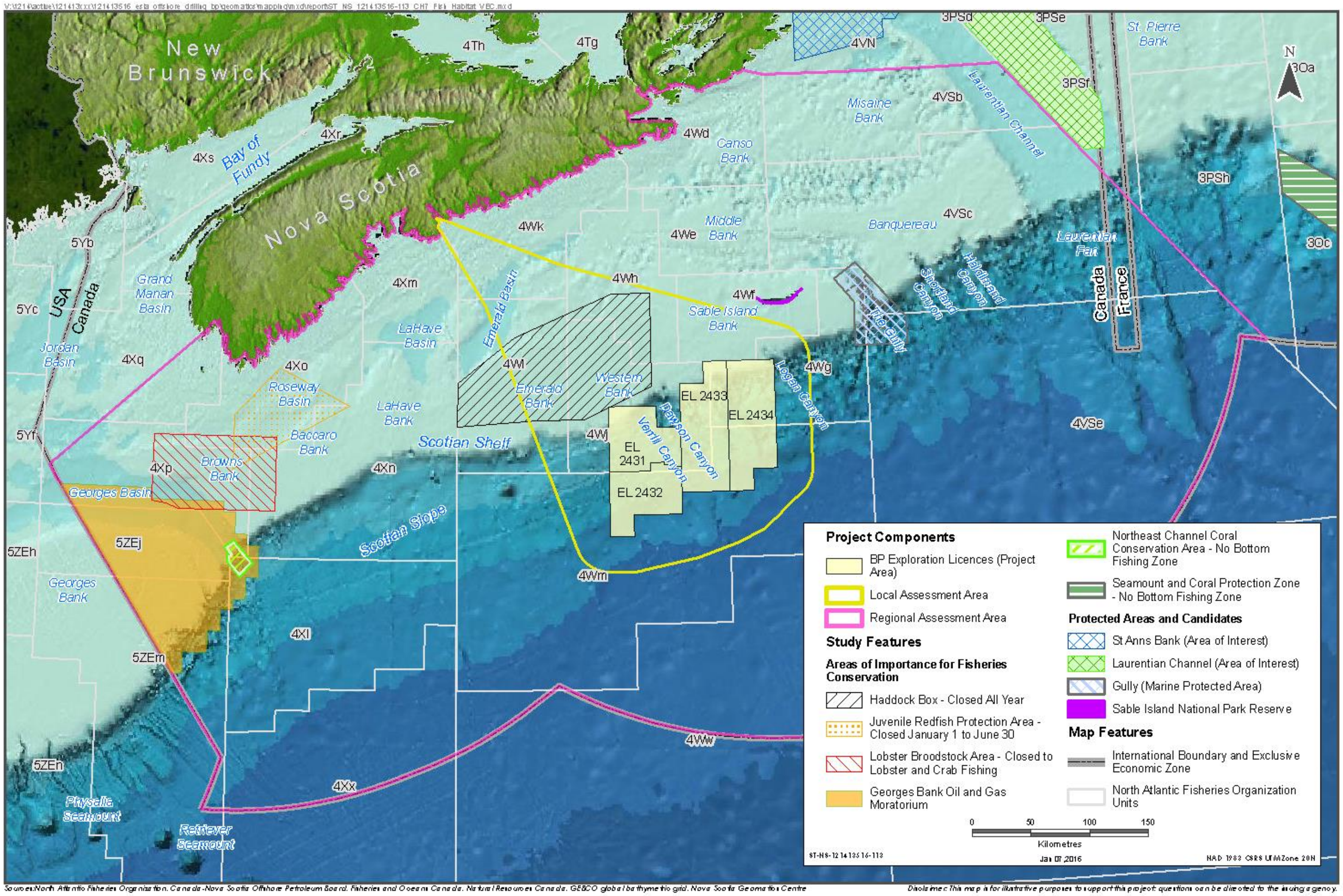


Figure 7.7.1 Assessment Boundaries for Current Aboriginal Use of Lands and Resources for Traditional Purposes

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7.7.5 Criteria for Characterizing Residual Environmental Effects and Determining Significance

Table 7.7.2 defines various descriptors that may be used to characterize residual environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes.

Table 7.7.2 Characterization of Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – an effect that moves measurable parameters in a direction beneficial to Current Aboriginal Use of Lands and Resources for Traditional Purposes relative to baseline **Adverse** – an effect that moves measurable parameters in a direction detrimental Current Aboriginal Use of Lands and Resources for Traditional Purposes relative to baseline **Neutral** – no net change in measureable parameters for the Current Aboriginal Use of Lands and Resources for Traditional Purposes relative to baseline
Magnitude	The amount of change in measurable parameters of the VC relative to existing conditions	**Negligible** – no measurable change from baseline **Low** – very small detectable change from baseline **Moderate** – varies from baseline and may result in noticeable changes to traditional practices, traditional knowledge or community perceptions of traditional territory, practices or knowledge **High** – varies from baseline to a high degree, has serious implication for the continuance of traditional practices and traditional knowledge
Geographic Extent	The geographic area in which an environmental effect occurs	**Project Area** – effects are restricted to the Project Area **Local Assessment Area** – effects are restricted to the LAA **Regional Assessment Area** – effects are restricted to the RAA
Frequency	Identifies when the residual effect occurs	**Single Event** – effect occurs once **Multiple Irregular Event** – occurs more than once at not set schedule **Multiple Regular Event** – occurs more than once at regular intervals **Continuous** – occurs continuously
Duration	The period of time required until the measurable parameter of the VC returns to its	**Short-term** – effect extends for a portion of the duration of Project activities **Medium-term** – effect extends through the entire

Table 7.7.2 Characterization of Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
	existing condition, or the effect can no longer be measured or otherwise perceived	duration of Project activities **Long-term** – effects extend beyond the duration of Project activities, after well abandonment
Reversibility	Pertains to whether a measurable parameter of the VC can return to its existing condition after the project activity ceases	**Reversible** – will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** – area is relatively undisturbed or not adversely affected by human activity **Disturbed** – area has been substantially previously disturbed by human development or human development is still present

In consideration of the descriptors listed above, the following threshold has been established to define a significant adverse residual environmental effect on Current Aboriginal Use of Lands and Resources for Traditional Purposes.

For the purposes of this effects assessment, a **significant adverse residual environmental effect** on Current Aboriginal Use of Lands and Resources for Traditional Purposes is defined as a residual Project-related environmental effect that results in one or more of the following outcomes:

- Aboriginal communal commercial fisheries or FSC fisheries being displaced or unable to use the areas traditionally or currently fished for all or most of a fishing season;
- a change in the availability of fisheries resources (*e.g.*, fish mortality and/or dispersion of stocks) such that resources cannot continue to be used at current levels within the RAA for more than one fishing season; and
- unmitigated damage to fishing gear.

7.7.6 Existing Conditions

Section 4.1 describes the Aboriginal groups in Nova Scotia and New Brunswick which could potentially be affected by the Project. In the DFO Maritimes Region, communal FSC licences are held by 16 First Nations and the Native Council of Nova Scotia (NCNS). Eleven of these communal FSC licences are held by groups in Nova Scotia while the remaining five are held by groups in New Brunswick. There are 22 Aboriginal organizations who hold licences issued by the DFO Maritimes Region and 12 Aboriginal organizations who hold licences issued by the DFO Gulf

Region that have communal commercial fishing access in the RAA including in or near the Project Area (refer to Section 5.3.6.1).

BP commissioned Membertou Geomatics Solutions (MGS) and Unama'ki Institute of Natural Resources (UINR) to undertake a TUS to obtain information from the Aboriginal fisheries occurring in and around the Project Area. The TUS scope of work included conducting a background review of commercial licences and FSC agreements, and interviews with elders, fishers and fisheries managers from a representative subset of First Nations in Nova Scotia and New Brunswick, and the NCNS. The TUS includes information on target species, general fishing areas, and fishing seasons, along with any additional information pertaining to fish or sensitive areas.

As reported in the TUS (Appendix B), all 13 Mi'kmaq First Nation communities in Nova Scotia currently have communal commercial fishing licences for various species that may be harvested from the RAA. There are 25 species being fished by Mi'kmaq First Nation communities under commercial communal fisheries access within the RAA and 15 species fished within the LAA. Many of these fisheries occur year-round. The following eight species are targeted within the Project Area: Atlantic cod, bluefin tuna, haddock, mahi-mahi, northern shrimp, shark, snow crab and swordfish. Cusk, halibut, and silver hake are harvested as by-catch within the Project Area.

The NCNS has a communal commercial licence granting access to 19 species (including by-catch species) within the RAA. Nine of these species may also be harvested by NCNS within the LAA. The following seven species may be harvested by NCNS within the Project Area: albacore tuna, bluefin tuna, bigeye tuna, halibut (by-catch), mahi-mahi (by-catch), swordfish, and yellowfin tuna (MGS and UINR 2016).

The TUS (Appendix B) includes tables identifying all of the species that are accessible within the RAA, LAA and Project Area under these communal commercial licences, as well as the timing of fishing activity for each species.

The TUS (Appendix B) indicates that Fort Folly Mi'kmaq First Nation and St. Mary's and Woodstock Wolastoqiyik (Maliseet) First Nations in New Brunswick hold communal commercial fishing licences for various species that may be harvested from the RAA. Under these licences, these communities report fishing 16 species within the RAA, ten of which may also be harvested within the LAA. Silver hake and swordfish are the only species that may also be harvested within the Project Area (MGS and UINR 2016). The TUS (Appendix B) includes a table identifying all of the species that that are accessible within the RAA, LAA and Project Area under these communal commercial licences, as well as the timing of fishing activity for each species.

According to the TUS, 44 species (34 fish species and 10 invertebrate species) were identified as being harvested for FSC purposes by Mi'kmaq First Nations throughout Nova Scotia. In particular, they reported harvesting seven fish species and three invertebrate species within the RAA, and one invertebrate species (lobster) within the LAA for FSC purposes. None of the species identified are known to be harvested for FSC purposes within the Project Area (MGS and UINR 2016).

Forty-three species (31 fish species and 12 invertebrate species) were identified as being harvested for FSC purposes by the NCNS. FSC fisheries for 22 of these species are known to occur in the RAA, FSC fisheries for five of these species are known to occur in the LAA (*i.e.*, Atlantic herring, Atlantic mackerel, Greenland halibut, redfish, and silver hake), and no FSC fisheries are known to occur in the Project Area (MGS and UINR 2016).

The TUS (Appendix B) includes tables identifying all of the species that may be harvested for FSC purposes within the RAA and LAA, as well as the timing of FSC fishing activity for each species.

Lobster is the only species identified as being harvested for FSC purposes by New Brunswick's Fort Folly and Woodstock First Nations, and it is harvested outside of the RAA, in the Bay of Fundy.

7.7.7 Potential Project-VC Interactions

Table 7.7.3 identifies the physical Project activities that might interact with the VC to result in the identified environmental effect. These interactions are indicated by checkmarks, and are discussed in Section 7.7.8 in the context of effects pathways, mitigation, and residual effects.

Table 7.7.3 Potential Project-Environment Interactions and Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Project Components and Physical Activities	Potential Environmental Effects
	Change in Traditional Use
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓
Vertical Seismic Profiling	✓
Supply and Servicing Operations (including helicopter transportation and PSV operations)	✓
Well Abandonment	✓

Note:
✓ = Potential interactions that might cause an effect.
– = Interaction between the Project and the VC are not expected.

7.7.8 Assessment of Project-Related Environmental Effects

The following section assesses the environmental effects on Aboriginal fisheries resources arising from potential interactions in Table 7.7.3. Given the similarities in Project description, proximity of activities on the Scotian Slope, and currency of data, the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) have been referenced extensively for this analysis, with updates incorporated as applicable due to Project and geographic differences (*e.g.*, expansion of geographic scope), scientific updates, and refined EA methods.

7.7.8.1 Project Pathways for Effects

Change in Traditional Use

A Change in Traditional Use for Current Aboriginal Use of Lands and Resources for Traditional Purposes could potentially occur as a result of Project activities affecting the marine environment including the presence and operation of the MODU (fisheries exclusions and underwater sound effects on fisheries species), discharge of drill muds and cuttings (effects on water and sediment quality on fisheries species), other discharges and emissions (effects on water quality), VSP operations (underwater sound), PSV operations (underwater sound associated with vessel movement causing fisheries species to avoid the area), and well abandonment (potential underwater sound associated with removal of wellhead infrastructure and/or a change in benthic habitat associated with leaving the wellhead in place).

7.7.8.2 Mitigation of Project-Related Environmental Effects

In consideration of the environmental effects pathways outlined above, the following mitigation measures and standard practices, as well as mitigation measures identified for the Fish and Fish Habitat VC (refer to Section 7.2.8.2) will be employed to reduce the potential environmental effects of the Project on Aboriginal fisheries resources. These mitigation measures are consistent with measures proposed to reduce potential environmental effects on Commercial Fisheries (refer to Section 7.6.8.2). Refer to Table 13.2.1 for a complete list of Project mitigation measures.

General

- BP will continue to engage Aboriginal fishers to share Project details as applicable and facilitate coordination of information sharing. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers.
- BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notices to Shipping and Notices to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with Aboriginal commercial fishers.
- Project-related damage to fishing gear, if any, will be compensated in accordance with the *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).

Supply and Servicing

- PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots), except as needed in the case of an emergency.

- To maintain navigational safety at all times during the Project, obstruction lights, navigation lights and foghorns will be kept in working condition on board the MODU and PSVs. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

7.7.8.3 Characterization of Residual Project-Related Environmental Effects

Change in Traditional Use

Presence and Operation of MODU

There is potential for a disruption of Aboriginal fishing activities if drilling activities displace fishing in the areas around drill sites. A 500-m radius safety (exclusion) zone will be established around the MODU, in accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, within which Aboriginal fishing activities will be excluded while the MODU is in operation. This will result in localized Aboriginal fisheries exclusion within an area of approximately 0.8 km^2 (80 ha) for a maximum of 120 days for each well to be drilled. Although fishing effort may be disrupted within this safety (exclusion) zone, it is anticipated to be a temporary and localized fishing exclusion and is not likely to have a substantial effect on Aboriginal fishing activities and fisheries resources. The LAA does not include any unique fishing grounds or concentrated fishing effort that occurs exclusively within the LAA; similar alternative sites are readily available within the immediate area.

Fish can be affected by underwater sound emissions from the MODU. Sound generation from the MODU may cause fisheries species to avoid the area around the MODU, particularly during start-up of drilling. This avoidance behavior is expected to be temporary as fish become habituated to the continuous sound levels from the MODU and startle responses cease (Chapman and Hawkins 1969; McCauley *et al*. 2000a, 2000b; Fewtrel and McCauley 2012). Given the temporary and localized nature of this effect, it is not expected to affect fisheries species so that Aboriginal fishers would be adversely affected. Refer to Section 7.2 for additional information on Project effects on Fish and Fish Habitat.

The Change in Traditional Use as a result of the presence and operation of the MODU is predicted to be adverse, low in magnitude, within the LAA, continuous throughout the Project, medium-term in duration, and reversible (*e.g.*, avoidance behavior exhibited by fisheries species, as well as the establishment of the safety [exclusion] zone associated with the presence of the MODU will not have a permanent, irreversible effect on Traditional Use).

Waste Management

The discharge of drill muds and cuttings has the potential to interact with commercial and FSC fisheries species within a localized area from sedimentation and localized changes in water quality. As noted in Section 7.2, these effects are expected to be low in magnitude and localized to the Project Area. The Project will adhere to the OCSG and OWTG, which have been developed to protect the marine environment, will limit adverse effects on fisheries species.

Drill waste modelling conducted for this Project considered the extent of various thicknesses of the deposition of drill cuttings on the seafloor in a radius from the discharge site. As presented in Appendix C and discussed in Section 7.2.8, sediment thicknesses at or above 1 mm will extend up to 563 m from the discharge site and occupy a maximum areal extent of 9.91 ha per well; sediment thicknesses greater than 10 mm will extend up to 116 m, with a maximum footprint of 0.53 ha per well; and sediment thicknesses at or above 100 mm will be confined to a distance of 30 m from the discharge point, with a maximum footprint of 0.07 ha per well.

Results of environmental effects monitoring programs undertaken for various drilling programs in the Atlantic Canada (Hurley and Ellis 2004) concluded that there are negligible effects on fish health and fish habitat from these activities; therefore the availability of traditional fisheries resources are not expected to be affected by waste management.

Other discharges and emissions such as drilling and testing emissions will result in temporary and localized effects on water quality. Discharges, however, will be in accordance with the OWTG, which is designed to mitigate potential effects from discharges; therefore, Aboriginal fisheries species in the Project Area or the LAA are not expected to be adversely affected. Discharges may include organic matter, substances containing minor amounts of chemicals or residual hydrocarbons. These discharges are expected to disperse quickly and will be degraded by bacterial communities.

Benthic prey species for commercially or FSC fished species are widespread within the LAA and available outside any localized areas at the wellsite that could be affected by drill mud and cuttings discharges and other discharges and emissions.

The Change in Traditional Use as a result of waste management is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at regular intervals, medium-term in duration, and reversible.

Vertical Seismic Profiling

Sound levels associated with VSP surveys can interact with commercially or FSC fished species. Section 7.2.8 discusses potential startle and alarm responses of marine fish resulting from VSP surveys. The Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) provides a comprehensive literature review on the effects of seismic sound on fish and fisheries, concluding that behavioral effects (which can be quite variable between and within species) are localized and temporary but can result in short-term effects of catch rates. VSP operations are typically of short duration, and normally taking no more than a day, which is much shorter than a typical 2D or 3D seismic exploration program. Therefore, any behavioral changes in Aboriginal fisheries species resulting from VSP surveys would be expected to be low.

The Change in Traditional Use as a result of VSP operation is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at irregular intervals, short-term in duration, and reversible.

Supply and Servicing Operations

The operation of PSVs will increase vessel traffic within the Project Area and LAA, and may therefore locally affect commercially or FSC fished species habitat quality and use around the PSV. Two to three PSVs will be required for re-supply to the drilling vessel making two to three round trips per week between the MODU and the supply base. The increase in vessel traffic has the potential to interfere with fishing gear and may restrict fishing vessel navigation. PSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour, where applicable, and will adhere to standard navigation procedures, thereby reducing potential conflicts with Aboriginal fisheries. Potential environmental effects on fish attributable to PSV traffic and operations would also represent only a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Helicopter transportation is predicted to have a negligible effect on fisheries given the limited frequency of trips associated with the exploration program and lack of interaction with the marine environment (including fish). Except as needed in the case of an emergency, helicopters will also avoid flying over Sable Island, therefore helicopter transportation is not predicted to interact with seals (identified as a traditional FSC species) which could be feeding, breeding or pupping on the island (refer to Section 7.3 for an assessment of Project effects on marine mammals).

The Change in Traditional Use as a result of supply and servicing operations is predicted to be adverse, low in magnitude, occur within the LAA, occurring more than once at regular intervals, medium-term in duration, and reversible.

Well Abandonment

Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, details will be confirmed to the CNSOPB as planning for the Project continues. It is expected that plugging and abandonment activities would take approximately 7 to 10 days. It is likely that the casing will be cut below the seabed, and the wellhead removed which would mean that no infrastructure would be left on the seabed. Should the wellhead be kept in place, the abandonment of wells could potentially interact with commercial or FSC fishing activity in the Project Area through a change in fish habitat (*i.e.*, small structure above the seabed). Prior to well abandonment, a survey will be completed to confirm the location of the well and details will be submitted to the CNSOPB. The well location will be marked on nautical charts as applicable.

Well abandonment is not expected to interact with Aboriginal fishing activities given the temporary nature of the abandonment operation, the localized effects around the wellsite, and the water depths in the Project Area. Following abandonment of the drill site, it is anticipated that the wellhead (if kept in place) will provide hard substrate suitable for recolonization by benthic communities.

The Change in Traditional Use as a result of well abandonment is predicted to be adverse, low in magnitude, restricted to the Project Area, occurring more than once at irregular intervals, short-term in duration, and reversible.

Summary of Residual Effects

In summary, the Project will result in adverse effects to a Change in Traditional Use for Current Aboriginal Use of Lands and Resources for Traditional Purposes. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (*e.g.*, compliance with OWTG), the residual effect on a Change in Traditional Use is considered low in magnitude for various Project components and activities; occur within the LAA; be of short to medium-term in duration, be reversible; and primarily occur within an undisturbed ecological and socio-economic context. Table 7.7.4 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from those interactions between the Project and Current Aboriginal Use of Lands and Resources for Traditional Purposes that were identified in Table 7.7.3.

Table 7.7.4 Summary of Project Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Change in Traditional Use							
Presence and Operation of MODU (including well drilling and testing operations and associate lights, safety [exclusion] zone and underwater sound)	A	L	LAA	MT	C	R	U
Waste Management	A	L	PA	MT	R	R	U
Vertical Seismic Profiling	A	L	LAA	ST	IR	R	U

Table 7.7.4 Summary of Project Residual Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Content
Supply and Servicing Operations (including helicopter transportation and PSV operations)	A	L	LAA	MT	R	R	U
Well Abandonment	A	L	PA	ST	IR	R	U

KEY:
N/A: Not Applicable
See Table 7.7.2 for detailed definitions

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

7.7.9 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a Change in Traditional Use on Current Aboriginal Use of Lands and Resources for Traditional Purposes from Project activities and components are predicted to be not significant. This conclusion has been determined with a high level of confidence based on a good understanding of the general effects on commercial species inhabiting the LAA and the effectiveness of mitigation measures including those discussed in Sections 7.7.8.2.

7.7.10 Follow-up and Monitoring

Given the high level of confidence around a prediction of no significant adverse environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes, and the implementation of standard mitigation, no follow-up and monitoring is proposed to be implemented for routine Project activities.

8.0 ACCIDENTAL EVENTS

BP uses a systematic process to identify and manage potential accidental events that could occur during its project activities. This chapter presents potential accidental events that could arise during Project operations, with a focus on those that could result in a release of hydrocarbons to the marine environment. An assessment of potential environmental effects of accidental spills is presented, which has been informed, in part, by oil spill fate and behavior modelling that has been undertaken for the Project (refer to Section 8.4 and Appendix H). The assessment is also undertaken in consideration of BP's approach to crisis and continuity management, (including spill response and planning) and lessons learned following the 2010 Deepwater Horizon (DWH) incident and other industry incidents.

Detailed information about reasonably foreseeable events which could impact worker safety will be presented in the Safety Plan and Incident Management Plan (IMP) (and associated Spill Response Plan (SRP)). Additionally, an emergency response plan for the MODU will be provided. Details about environmental management measures which will be put in place will be submitted in the Environmental Protection Plan (EPP). The Safety Plan, IMP, SRP and EPP will be submitted to the CNSOPB as part of the Operations Authorization (OA) process.

8.1 POTENTIAL ACCIDENTAL EVENTS

8.1.1 Risk Management within BP

BP manages, monitors, and reports on the principal risks and uncertainties that could potentially arise during their global activities, to ensure safe, compliant and reliable operations. BP uses management systems, organizational structures, processes, standards, behaviours and its code of conduct to form a system of internal control to govern the way in which BP operates and manages its risks.

There are a number of tiers to BP's risk management philosophy to ensure a holistic approach to risk management across the company:

- **Day-to-day risk management:**

  Management and staff at individual facilities and assets identify and manage risk, promoting safe, compliant and reliable operations. The operating management system (OMS) integrates BP requirements on health, safety, security, environment, social responsibility, regulatory compliance, operational reliability and related issues.

- **Business and strategic risk management:**

  BP's businesses and functions integrate risk into key business processes such as strategy, planning, performance management and resource and capital allocation. This is done using a standard process for collating risk data, assessing risk management activities, making further improvements and planning new activities.

- **Oversight and governance:**

  Functional leadership, the executive team, the board and relevant committees provide oversight to identify, understand and endorse management of significant risks to BP. They also put in place systems of risk management, compliance and control to mitigate these risks. Executive committees set policies and procedures and oversee the management of significant risks, and dedicated board committees review and monitor certain risks throughout the year.

BP has dedicated organizations within the company to ensure a consistent approach to risk management, to support individual assets and teams in the identification and management of risk and to manage the checks and controls around risk management to provide assurance regarding the assessment and delivery of risk management strategies within the company.

- The operating businesses identify and manage the risks, as described above in day-to-day risk management. They are also required to carry out self-verification, and are subject to independent scrutiny and assurance.
- BP's safety and operational risk (S&OR) team works alongside operating businesses to set clear requirements; maintain an independent view of operating risk; examine how risks are being assessed, prioritized and managed; and intervene when appropriate to bring about corrective action.
- Members of BP's group audit team visit sites across the globe to evaluate how they are managing risks.

8.1.2 Barrier Philosophy

One of the key tools that BP uses to manage risk is the barrier philosophy, illustrated in Figure 8.1.1.

A risk is the measure of the likelihood of occurrence of an undesirable event (*i.e.*, an incident) and of the potentially adverse consequences that this event may have upon people, the environment or economic resources (IAGC-OGP 1999). An undesirable event can occur as a consequence of a hazard, which is a situation with the potential to cause adverse effects. An example of a hazard includes pressure within the wellbore, which can give rise to a loss of well control. The barrier philosophy for risk management uses a combination of equipment, processes and procedures carried out by competent personnel as barriers to prevent conditions from arising that could allow a hazard to become an undesirable event. If an undesirable event does occur, further barriers will be put in place to mitigate and minimize the negative consequences associated with the event.

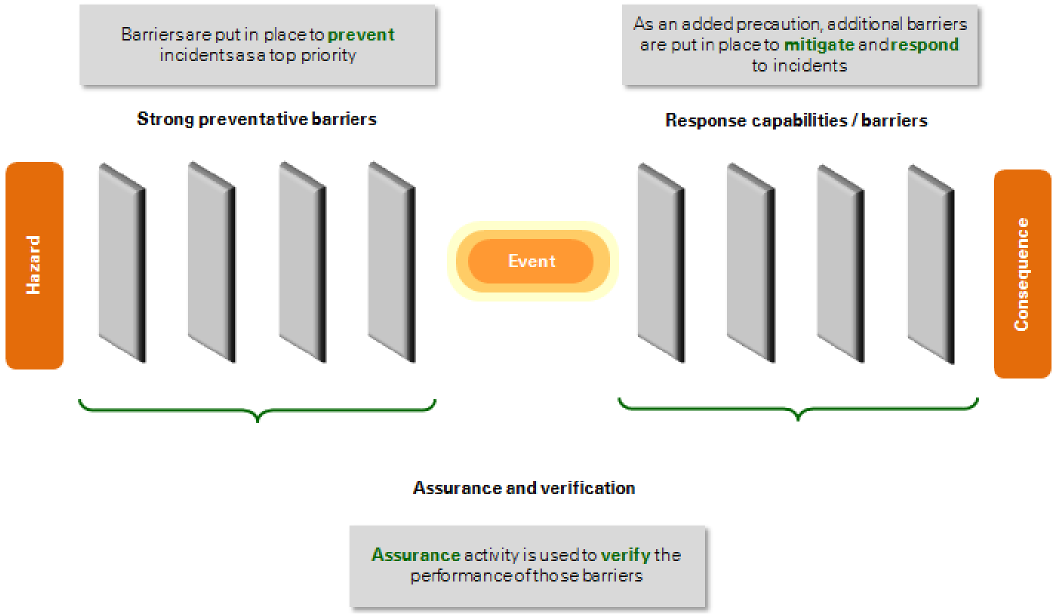


Figure 8.1.1 Risk Barrier Philosophy

Multiple preventative and response barriers are put in place to manage the risk, both in terms of the incident arising in the first place, and to mitigate and respond to incidents to manage the potential consequences. This is illustrated in Figure 8.1.1.

BP has assessed the risks associated with the Project and has identified barriers that will be in place to prevent and mitigate the identified risks. In order to be effective, each of these barriers needs to be robust. The performance of the barriers will be monitored and tested through self-verification, assurance, and audit.

BP has worked, along with industry partners, to improve the strength of the barriers used in deepwater drilling risk prevention and management. These improvements are built on the lessons learned as a result of the Deepwater Horizon (DWH) incident and response in 2010. Standardized global requirements for well design and construction are used by BP to reduce risk of a major accident. Additional and strengthened preventative and response barriers to manage risk have been embedded in the following key areas as described below.

People

BP has a single, centralized global wells organization (GWO) which is responsible for embedding standardization and a consistent approach to the delivery of wells-related activity across the company.

BP processes verify that individuals and teams have the competencies to deliver safe operations. Only highly trained and competent personnel are authorized to supervise operations. BP uses industry and company training for wells personnel examination and accreditation, and conducts specific competency assessments for well site leaders. BP emphasizes the development and management of key competencies within the company, particularly around cementing, well control and blowout preventer (BOP) reliability. Personnel undergo consistent and structured well control competency training to assure competency in key capability areas. BP's training facilities have received accreditation by the International Association of Drilling Contractors (IADC) and the International Well Control Forum (IWCF) to teach, test and provide certification to those attending its drilling well control courses.

BP also works closely with contractors to deliver safe, compliant and reliable performance. BP uses well simulators to bring together well crews, to train and practice using scenarios from actual wells that they will drill. This includes BP, rig contractor, and well service company employees.

Bridging documents align BP and contractor requirements during operations. Additionally, BP conducts formal oversight of performance against the contractor's safety and environmental management systems. Since 2012, BP has held annual safety workshops and quarterly check-ins with senior executives from drilling contractors and service providers to continuously improve safety performance across its operations worldwide.

Procedures

There is a continual focus on procedural discipline and on self-verification, assurance and audit. All drilling activity is carried out in line with a well operations program, which includes measures to prevent loss of well control. Additionally, rig contactor procedures are in place to prevent and mitigate potential effects from bulk, operational and maintenance spills.

BP uses its global wells engineering practices, which embed standardization and consistent implementation of well design and planning. These practices include current industry standards.

Leadership, including well site leaders and supervisors, conduct regular safety inspections. BP uses a standardized tool with checklists on tablet computers to support leaders across its global drilling operations to self-verify safety standards and preventative well barriers.

Process and Equipment

BP carries out a number of equipment and process checks for equipment used during drilling operations. This includes regular checks on the BOP and well control equipment before and during drilling operations. Additionally, the mobile offshore drilling unit (MODU) that will be used for drilling operations will be subject to a rig intake process. The rig intake process provides the means to identify and effectively manage risks for rig start-ups and verify that contracted rigs conform to specified BP practices and industry standards.

Technological innovation has further enabled safe and reliable operations. BP uses advanced technology to remotely monitor conditions in their wells, enhance operational safety and improve drilling efficiency. For its exploration wells in offshore Nova Scotia, BP will use a real-time monitoring center in Houston to provide an additional level of monitoring to identify potential well control situations. This acts as an additional resource to manage well integrity, reducing both the occurrence and likely severity of potential well control events.

BP shares expertise with industry peers and works to promote common standards across the industry. For example in 2015, BP worked with the Center for Offshore Safety, Oil and Gas UK and the International Association of Oil & Gas Producers (IOGP) to publish global definitions of well control incidents, providing a common way to report and share lessons learned. BP also works with the American Petroleum Institute to develop industry standards.

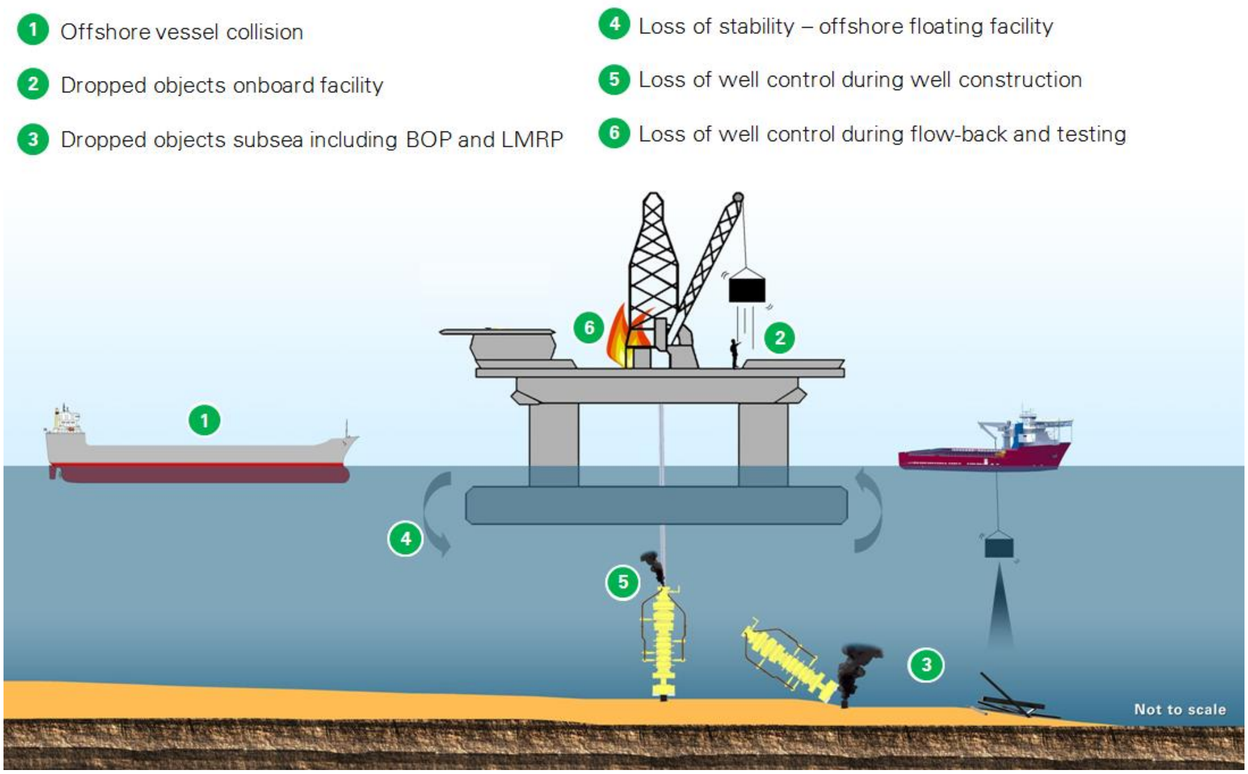
8.1.3 Potential Accidental Risk Scenarios

A number of potential accidental risk events that could occur during drilling activity have been identified. A summary of these events and the associated preventative and response barriers is presented below. It is possible that additional accidental risk scenarios other than those presented below could occur.

Risk management is a dynamic process. The risk events are regularly evaluated and BP continually seeks to refine its understanding of the preventative and response barriers to ensure a robust risk management strategy.

The accidental risk events that have been identified for the Project and described here have been identified by specialist safety and operational risk personnel within BP. They have been assessed based on historic industry trends and events and the proposed drilling program which is described in detail in the Project Description, Section 2.

Accidental risk events that could occur during Project operations are illustrated in Figure 8.1.2. The accidental events are further described below in terms of their potential causes and consequences, and the barriers that are in place to help manage these risks. Further information about accidental risks that could occur during Project operations will be described in the Safety Plan, which will be submitted for regulatory approval as part of the OA process.



Note: BOP = blowout preventer; LMRP = lower marine riser package

Figure 8.1.2 Exploration Drilling Accidental Risks

8.1.3.1 Offshore Vessel Collision

As described in Section 5.2.3.2, several established shipping routes are used for international and domestic commercial shipping in Canadian waters. Additionally, platform supply vessels (PSVs) will be used to support the drilling operations. One of the PSVs will remain on standby outside the MODU's 500-m safety (exclusion) zone at all times in the event that operational assistance or emergency response support is required, while the other PSVs will be used to deliver equipment and supplies to the MODU and collect waste for return to shore.

It is possible that there could be a collision between the MODU and one of the vessels encountered in the Project Area (*i.e.*, one of the Project PSVs or one of the other domestic or international vessels passing through the Project Area). A collision could also arise if the MODU moves from its designated position or in the event of extreme weather, such as an intense storm, which may cause either a vessel or the MODU to lose position.

As detailed in Section 2.4.1, a 500-m safety (exclusion) zone is maintained at all times around the MODU, within which non-Project vessels are prohibited. The safety (exclusion) zone will be monitored by the standby vessel at the MODU. The boundaries of the safety (exclusion) zone will be communicated formally through a Notice to Mariners and a Notice to Shipping.

Additionally, robust positioning systems and certified watch-keepers on the MODU and PSVs, navigation aids, weather radars and alarms will be used to keep the rig and vessels on position and to highlight the presence of other vessels and changing weather conditions. The strength of these preventative barriers will be tested as part of the rig and vessel inspection processes such as the rig intake process and marine assurance reviews described in the Project Description, Section 2. Robust vessel and MODU operator procedures will be used, defining a process for collision assessment, communication protocols and procedures for the use of navigation equipment and alarms, which will be used by competent personnel.

The Project will use weather and natural hazard preparedness processes to monitor for and respond to extreme weather events. These processes will identify conditions when precautionary riser unlatching or rig evacuations are required.

Some consequences of a marine collision could include personnel injury or fatalities, or a loss of primary containment of hydrocarbons, which could result in adverse effects to the receiving environment. Additionally, a marine collision could cause other accident risk events, such as a loss of stability of the MODU, or a loss of well control. Response barriers are in place to reduce the possibility of these consequences arising, such as fire and explosion suppression and protection systems, evacuation and escape protocols, and emergency unlatching protocols. Additionally, emergency response containment and recovery operations will reduce adverse consequences resulting from a spill event.

8.1.3.2 Dropped Objects

Dropped objects refers to items accidentally falling either onboard the MODU structure, (*i.e.*, from a crane on to the decking below) or subsea (*i.e.*, from a PSV or MODU on to the seafloor or subsea infrastructure). These are both illustrated in Figure 8.1.2 above. Subsea infrastructure could refer to non-Project equipment, such as third party pipelines, or project equipment, such as the BOP and the lower part of the riser which connects to the BOP, often referred to as the lower marine riser package (LMRP). There is no third-party subsea infrastructure, including pipelines, in the exploration licences (ELs) as illustrated in Section 5.3.4.

Large objects dropped from height pose a health and safety risk as personnel could be injured or killed, and there is also potential for dropped objects to damage the MODU. Damage to the MODU could result in the loss of primary containment and the release of hydrocarbons into marine waters.

An object could be dropped as a result of a failure of the PSV or MODU lifting equipment (*e.g.*, cranes, winches, lines or connections). This risk is managed through the use of tested and certified lifting equipment and ropes, clear specifications for equipment limits, and the use of agreed and controlled lifting plans. An object could fall from the MODU during extreme weather events. As described in Section 2.3.1.1 and 9.2, potential meteorological conditions are considered during the MODU selection process to confirm that the MODU is capable of operating in harsh, deepwater environments. The Project will use weather forecasting to monitor and prepare for a response to extreme weather.

On March 5, 2016, Shell Canada Limited advised the CNSOPB that it had successfully disconnected the rig drilling its Cheshire exploration well 225 km offshore Nova Scotia from the well in advance of severe weather. It also reported that "shortly after the rig moved away from the well location, high waves and heave caused the riser tensioner system to release, resulting in the riser and lower marine riser package, which connect the rig to the well during drilling, to fall to the seabed." There were no injuries and no drilling fluid was released during the incident (CNSOPB 2016). When results of the investigation are available, BP will work with regulators to apply lessons learned from the incident.

There is a low potential for response barriers to fail, resulting in a release of hydrocarbons and adverse effects to the receiving environment. Released hydrocarbons present a fire or explosion risk, particularly in the presence of a source of ignition, and a fire or explosion on the rig could cause injuries and/or fatalities. A number of response barriers are in place to prevent harmful consequences from arising. These include active and passive fire and explosion prevention and suppression equipment and systems and procedures to prevent ignition of any released hydrocarbons. Additionally, evacuation and escape procedures would be used to move the workforce to safe areas. Response barriers to mitigate adverse environmental effects associated with released hydrocarbons include emergency response containment and recovery operations and well intervention plans. Further information about these response barriers is provided below.

8.1.3.3 Loss of MODU Stability or Structural Integrity

As described in Section 2.3.1, the Project is likely to use a semi-submersible drilling rig or a drillship as the MODU for the Project. MODU stability is managed by controlling the distribution of weight both across the rig, as well as below and above the waterline. One way in which this is managed is by using ballast. A loss of stability or structural integrity could cause the MODU to list, capsize, or even sink.

A loss of stability or structural integrity could be caused by a design or operation error of the MODU, specifically its ballast system, or by an extreme weather event. Other accidental risk events could also result in the loss of the MODU's stability or integrity, (*e.g.*, a vessel collision, or a fire or explosion during a loss of well control event).

Some of the key barriers that are in place to prevent a loss of stability or structural integrity include the use of positioning and control systems, alarms, and operator interventions to ensure that the MODU is operated correctly, including careful control of variable deck load by competent personnel. Robust MODU design, including the use of inherently safe design systems, is tested through the rig intake and marine assurance process. Maintenance and inspection processes are designed to test and regularly check equipment to confirm that it is still operating. As identified in Section 8.1.2, competent personnel are of primary importance in the correct implementation of procedures. As stated previously, the Project will use weather and natural hazard preparedness processes, such as weather forecasting tools as defined in Section 9. If the rig loses position, an emergency disconnect protocol is in place that will allow the well to be shut in and the rig to move off location.

A loss of stability could also result in personnel injury, fatalities, or a loss of primary containment on the MODU, which could result in adverse environmental consequences. There is also a possibility that a loss of MODU stability could cause a loss of well control.

8.1.3.4 Loss of Well Control during Well Construction and Well Testing

A number of well control measures are put in place as part of drilling operations to maintain control of wellbore fluid pressures. Should well control barriers fail there could be an uncontrolled flow of formation fluids, which could result in a blowout incident. This could occur during any phase of the well, including the type of activity planned for the Project, such as well construction (*i.e.*, drilling operations), and well testing, (which is not planned for the first two wells associated with the program).

An influx of hydrocarbons into the wellbore could occur during the drilling program. Blowout incidents are prevented in the first instance using primary well control measures. This includes predicting and monitoring the formation pressure and controlling the density of the drilling fluid accordingly. During the drilling of the well, the drilling crew will use equipment and procedures to maintain hydrostatic overbalance (*i.e.*, a wellbore pressure that is greater than the formation fluid pressure) to prevent an influx of hydrocarbons into the wellbore. The density (*i.e.,* weight per given volume) of the drilling fluid is controlled to maintain an overbalance of pressure against the formation, which keeps the wellbore stable. Drilling and geologic properties are monitored during operations and the density of the drilling fluid is increased or decreased accordingly to maintain an overbalance, which keeps the wellbore stable.

As described previously, only highly trained and competent personnel are authorized to supervise operations, and BP has a number of programs in place to assure that personnel undergo consistent and structured competency training and assessment for well control. In addition to the requirement that key personnel have industry-accredited well control training certification, well control is practiced on simulators in the scenario-based enhanced crew competency development programs. Agreed shut in procedures define what the rig crew must do in the event of a "kick" (*i.e.*, a sudden influx of formation fluids into the wellbore). The crew on the rig will be supported with an additional level of monitoring for well control situations from BP's monitoring center in Houston.

BP uses standardized planning and design procedures and all drilling operations are carried out in line with a well operations program. Engineering procedures are designed to deliver consistent implementation of well design and planning. These procedures include current industry practices and standards. Additionally, BP works with experienced, qualified drilling contractors and uses assurance processes, such as the rig intake process to confirm that the equipment is fit for purpose and satisfies BP, contractor and regulatory standards. BP uses bridging documents to define roles and responsibilities for personnel and the verification and oversight program provides BP with assurance that contractors are delivering against their management systems.

There could be a loss of well control in the event that a shallow gas pocket is encountered during initial drilling. As explained in Section 2.2, the well location will have been selected to avoid potential shallow gas pockets following the outcome of the geohazard review, carried out using reprocessed seismic data from the BP Tangier 3D WATS survey, geotechnical cores and offset wells. The well operations program will highlight if there are any areas in which shallow gas could be encountered and will detail responsibilities for crew members in the event that shallow gas is encountered to enable a swift and effective response.

The MODU will be equipped with secondary well control equipment in the unlikely event that the primary well control measures fail. The secondary well control equipment enables an emergency shut-down that would allow the well to be shut in. An American Petroleum Institute (API) Standard 53 compliant 15,000 pounds per square inch (psi) working pressure BOP will be used, equipped with hydraulically-operated valves and sealing mechanisms including blind shear rams. Further information about the BOPs that will be used is included in Section 2.5.

An unmitigated loss of well control, followed by a gas or fluid release, could result in fatalities and environmental damage. Procedures and equipment will be in place to manage the release of any hydrocarbons if it were to occur. This includes systems to keep personnel safe, such as ignition prevention, fire suppression and explosion protection and H_2S monitoring equipment. Evacuation and escape procedures for personnel will be in place. Additionally, emergency response plans will be in place that will define emergency response procedures and measures for the containment, recovery and control of released hydrocarbons.

Further information about well control is provided Section 2.5. Information about spills associated with a loss of well control, specifically a blowout incident, is provided in Section 8.2.3. Additionally, response measures to a blowout incident are detailed in Section 8.3.

8.2 POTENTIAL SPILL SCENARIOS

Some of the potential accidental risk events described above could result in a release of hydrocarbons, chemicals or emissions, resulting in adverse environmental effects. Additionally, there are some potential operational spill events that could result from anywhere that hydrocarbons or chemicals are stored or transferred on the MODU or PSVs.

Key categories of potential spill events that could occur on the MODU and/or PSVs are described in Sections 8.2.1 to 8.2.3.

In addition to the potential spills from oil and gas activity, offshore oil spills could occur from a number of anthropogenic sources in the region. For example, tankers transport 82 million tonnes of petroleum products in and out of 23 ports in Atlantic Canada, and there are approximately 3,890 tanker movements along the east coast per year (Transport Canada 2015). Significant tanker spills have occurred in waters in and near Nova Scotia, including the *SS Arrow* which ran aground in February 1970 releasing over 10,000 tonnes of oil. Additionally, urban run-off and onshore industrial facilities can contribute to spilled hydrocarbons. Furthermore, natural seeps of hydrocarbons from the sea floor are present in the region; however, there is no quantification of volumes that are released into waters around Nova Scotia.

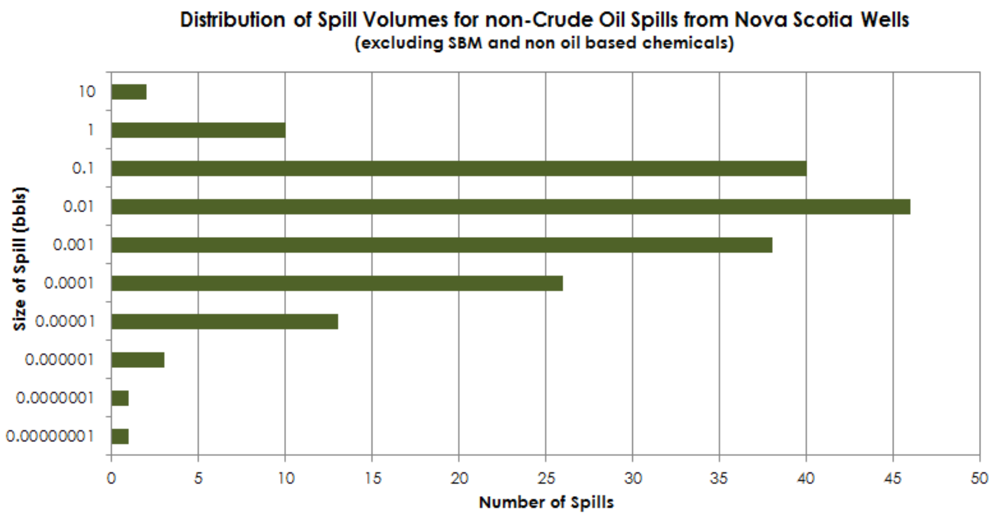
Historic industry data, including data from the CNSOPB, has been used to provide information about trends of accidental spill events from oil and gas activity in Nova Scotia and other regions. Analysis shows that the probability of a well blowout incident or other release is very low. Well-related spills occur infrequently during offshore operations. Of the spills that do occur, most spills involve releases of less than 100 barrels (bbl) over the course of less than one day. Large-scale exploratory well blowout incidents are very rare events (ERC 2014; Appendix F of Stantec 2014a).

Credible spill event scenarios considered in this effects assessment are described below. Further information is provided in Sections 8.4 and 8.5.

8.2.1 Spills during Operations and Maintenance

Spills which could occur during operations and maintenance activity are likely to be small volume, instantaneous release events which could arise where hydrocarbons, such as diesel, lubricants, or drilling fluids are spilled during handling, storage or transfers.

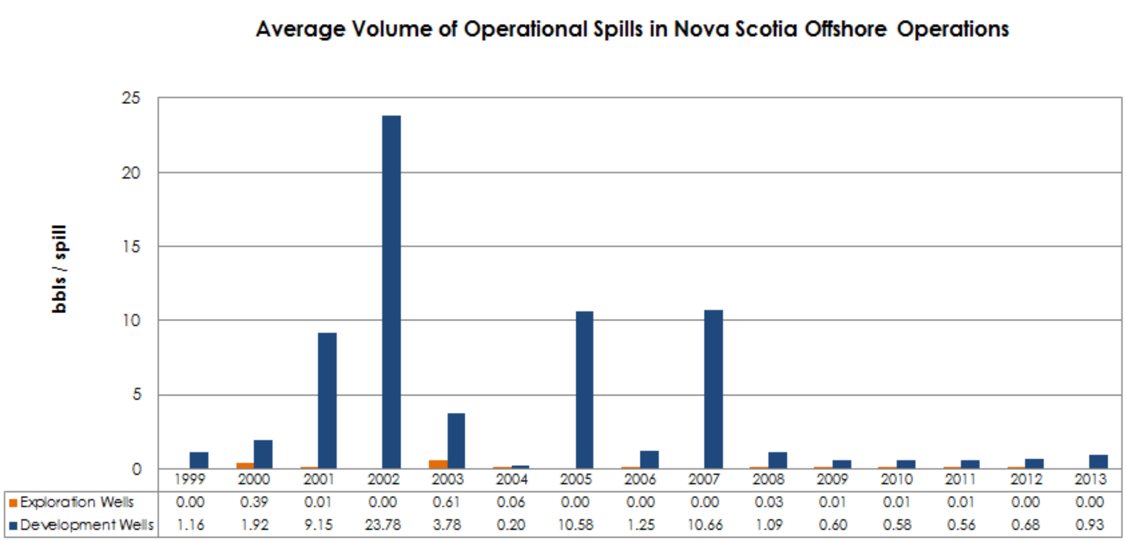
Small operational and maintenance spills are the most probable spill events that could occur during drilling operations. Historical data for spills of this type at wells in Nova Scotia (sourced from CNSOPB for the period 1999 to 2010) are provided in Figure 8.2.1. During this time, 53 exploration and development wells were drilled. The vast majority of non-crude, oil based chemicals (*e.g.*, diesel or kerosene) spills that have occurred in Nova Scotia, and have been reported to CNSOPB are less than 1 bbl in volume. Very small spills (*i.e.*, those under 20 ml) may not have been detected; consequently, spills of this magnitude may be underreported in this data.



Source: Modified from ERC 2014

Figure 8.2.1 Distribution of Non-Crude Spill Volumes for Nova Scotia

Figure 8.2.2 shows the frequency and average volume of small to medium spills from both exploration and development wells drilled in Nova Scotia between 1999 and 2013. These data do not show crude spills or synthetic-based mud (SBM) spills. Over this time, a total of 88 bbl of refined products were spilled over 189 different spill events. The data show that on average, non-crude and non-SBM spills between 1999 and 2013 were small in nature; the average spill volume was 0.4 bbl.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Exploration Wells	0.00	0.39	0.01	0.00	0.61	0.06	0.00	0.00	0.00	0.03	0.01	0.01	0.01	0.00	0.00
Development Wells	1.16	1.92	9.15	23.78	3.78	0.20	10.58	1.25	10.66	1.09	0.60	0.58	0.56	0.68	0.93

Source: Modified from ERC 2014

Figure 8.2.2 Average Volume of Operational Spills in Offshore Nova Scotia

Possible causes of these small to medium non-crude oil spills include leaks from pipes, hoses, connections, flanges or valves. These spills could occur during loading, discharging and bunkering operations and tend to be higher frequency events with less severe consequences. Such spills are most likely to occur onboard drilling rigs or vessels, where they may be more easily contained and have a lower probability of reaching the marine environment.

Secondary containment systems are used where bulk or drummed chemicals and hydrocarbon based products are stored. Additionally, oil spill response kits will be available in relevant locations around the MODU and PSVs. These oil spill response kits will be used in the event of diesel, utility oil or SBM spills onboard the MODU or PSVs. The MODU will be equipped with labelled drainage systems for both hazardous and non-hazardous materials so that all surface and drainage water is disposed of in accordance with the Offshore Waste Treatment Guidelines (OWTG). Personnel will be trained in chemical handling procedures and the use of spill kits to reduce the probability and consequence of operational and maintenance spills.

An operational diesel spill of 10 bbl from the MODU has been modelled as part of the spill fate and behaviour modelling work, further described in Section 8.4.3. A summary of results is provided in Section 8.4.9, and effects of this spill scenario are assessed in Section 8.5.

8.2.2 Bulk Spills

Bulk spills, which can occur on the MODU or PSVs, involve the accidental release of different types of hydrocarbons, including diesel, aviation fuel, and drilling fluids such as SBM. The bulk spill category includes a number of small to medium size releases from a variety of potential incidents.

Further to the information on potential accidental risk scenarios provided in Section 8.1.3, a number of potential bulk spill accidental risk scenarios have been identified. These scenarios include a tank rupture as a result of a vessel collision, and a riser unlatching as a result of a loss of position through dynamic positioning (DP) failure or bad weather before which fluids are removed. Additionally, a hose or tank failure during bunkering operations on the PSV or MODU could result in a release of hydrocarbons.

Bulk spills refer to a range of spill events and consequently, the preventative and response measures employed to reduce the probability and consequences of such a spill are broad ranging. Competent personnel, well maintained and robustly designed equipment and process, and procedures are all used to reduce the probability and potential severity of a bulk spill incident. Oil spill response kits will be available in relevant locations around the MODU and PSVs and will be used in the event of diesel, utility oil or SBM spills on board these vessels.

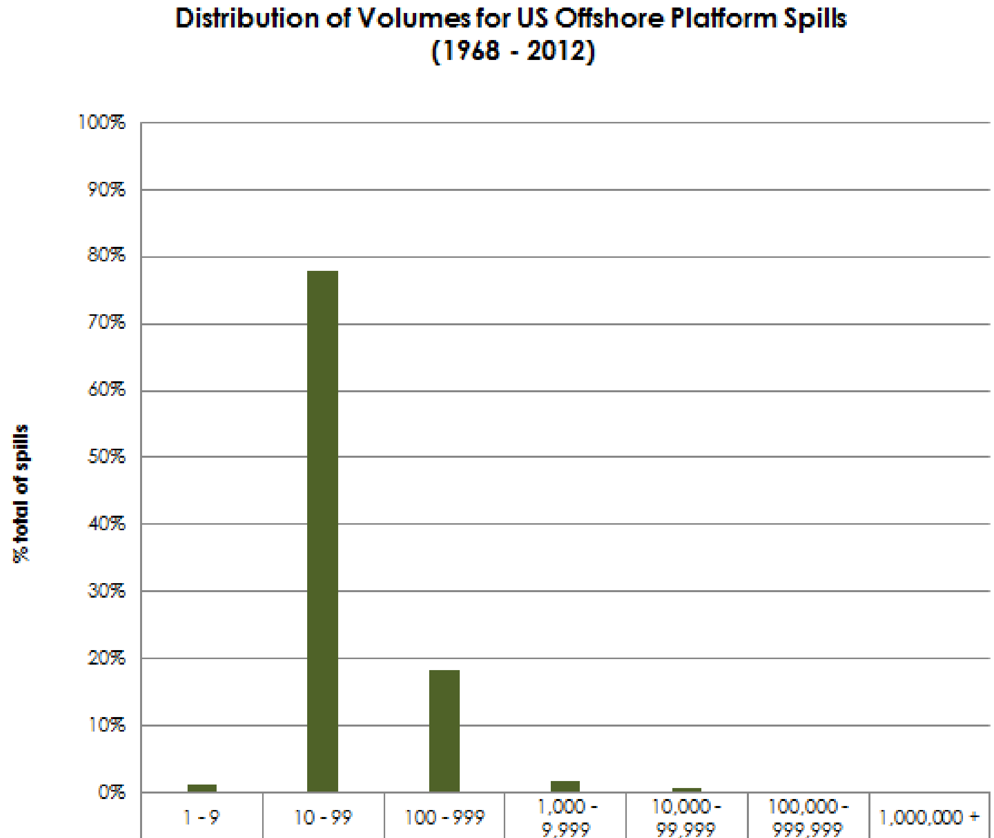
Bunkering transfer procedures will be used to define roles and responsibilities for personnel involved in transfer operations. Transfers will not be undertaken without completing a risk assessment process through the permit to work process. Dry-break hose couplings will be used to minimize the risk of a spill and hose floats will be used so that hose leaks are quickly and easily identifiable. Transfer hoses will be regularly inspected.

As described in 8.1.3.1, the risk of vessel collisions will be reduced by maintaining a 500-m safety (exclusion) zone around the MODU. The MODU and vessels will use weather forecasting tools and radar to plan operations to avoid or prepare for extreme weather events. Navigation and communication equipment, and the implementation of vessel operator procedures will help to reduce the risk of a vessel collision.

The riser used in drilling, that will circulate drilling fluid and cuttings between the MODU and the wellbore, will be confirmed to have been designed to withstand the meteorological and oceanographic (metocean) conditions likely to be encountered in the area. In the approach of an extreme weather event, the riser may be unlatched to prevent damaging the MODU, the BOP or the riser, and to avoid risk of uncontrolled loss of cuttings or fluid. The riser would be emptied as part of the unlatching process. Procedures will be in place to minimize the risk of an unintentional unlatching (refer to Section 8.1.3.2 for a discussion of dropped objects and the recent riser incident during the Shelburne Basin Venture Exploration Drilling Project where no drilling fluid loss occurred).

Bulk spills have occurred historically in Nova Scotia. For example, in 2004, a 2,226 bbl spill of SBM drilling fluid occurred as a result of an equipment failure at an exploration well (CNSOPB 2004). SBM is a heavy, dense fluid used during drilling operations to lubricate the drill pipe and balance formation pressure. SBM could be accidentally released from a surface tank discharge, riser flex joint failure or a BOP disconnect.

Industry trends show that bulk spills are less frequent than small operational and maintenance spills. Figure 8.2.3 illustrates the higher prevalence of medium size spills (10 to 99 bbl and 100 to 999 bbl) relative to other sizes of spills from offshore exploration and production platforms in the United States (US) over 45 years from 1968 to 2012.

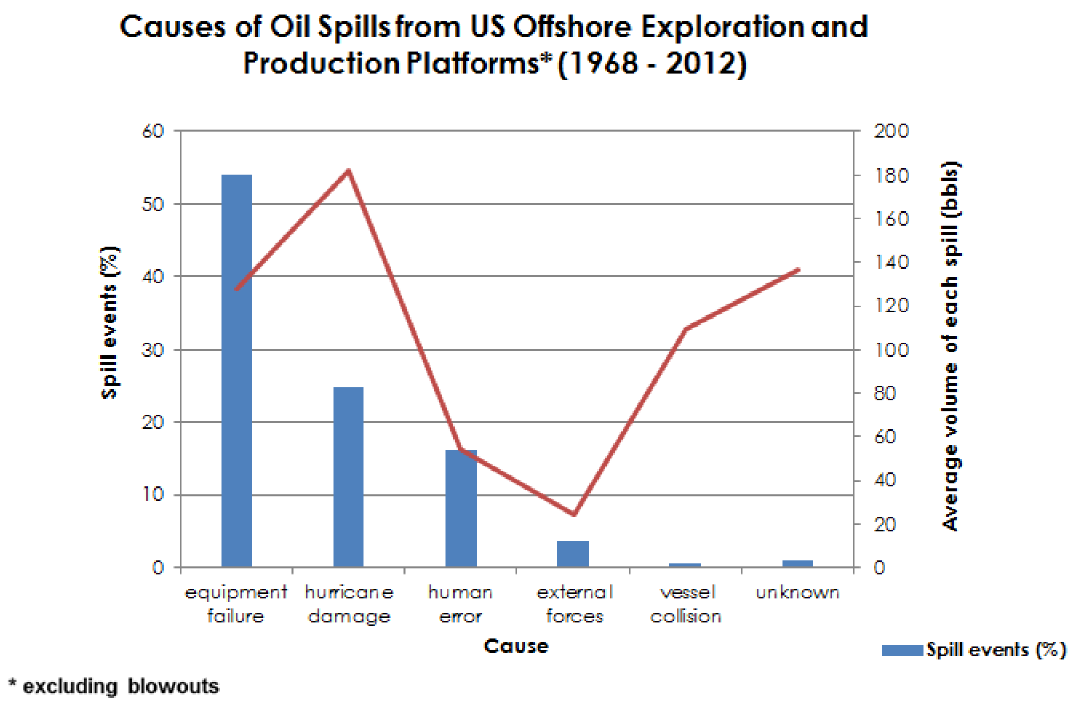


	1 - 9	10 - 99	100 - 999	1,000 - 9,999	10,000 - 99,999	100,000 - 999,999	1,000,000 +
Percentage of Spills	1.25%	77.87%	18.37%	1.67%	0.63%	0.00%	0.21%

Source: Modified from ERC 2014

Figure 8.2.3 Distribution of Volumes of Spills from US Offshore Platforms

The same data set, taken from offshore exploration and production facilities in the US between 1968 and 2012, shows the majority of spills are caused by equipment failure. Extreme weather events also play a substantial contributing role, accounting for nearly 25% of all spill events. Much of the data available for US offshore platform would have been derived from platforms in the Gulf of Mexico. The Gulf of Mexico is a hurricane prone area; therefore, these data are likely to include a higher percentage of hurricane related spills than may be expected in other regions, such as the North Atlantic.



Source: Modified from ERC 2014

Figure 8.2.4 Causes of Oil Spills from US Offshore Exploration and Production Platforms (1968-2012)

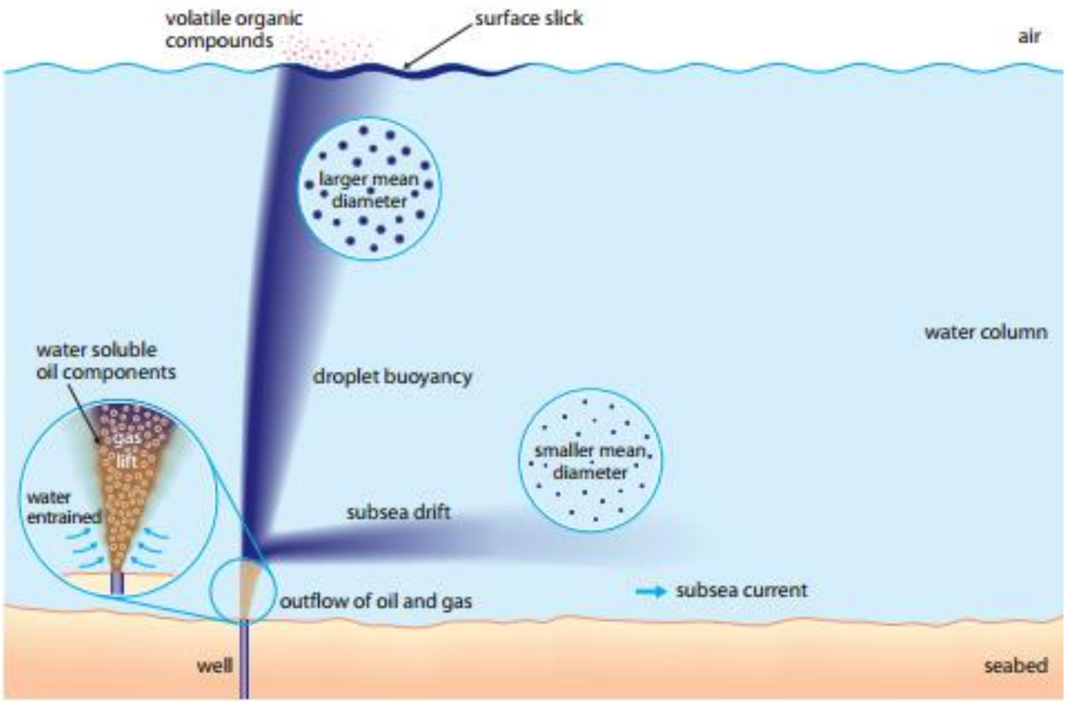
A bulk spill of 100 bbl of diesel from the MODU has been modelled as part of the spill fate and behaviour modelling work as explained in Section 8.4.3. A summary of results is provided in Section 8.4.9; effects are assessed in Section 8.5. Additionally, the effects of a bulk diesel release from a PSV (*e.g.*, 10 bbls in the nearshore environment) have been considered in the effects assessment in Section 8.5.

Project-specific modelling was not conducted for a SBM spill scenario. Instead, modelling conducted for the Shelburne Basin Venture Exploration Drilling Project EIS was consulted to inform the assessment (refer to Appendix C in Stantec 2014a). A summary of SBM spill modelling results is provided in Section 8.4.10; effects are assessed in Section 8.5.

8.2.3 Well Blowout Incident

As previously described in Section 8.1.3.4, a blowout incident is an uncontrolled release from the wellbore that can occur following a loss of well control. Formation fluids that can be released during a blowout include brine, water, gas or oil. A blowout incident occurs when the formation pressure exceeds the pressure exerted from the drilling fluid, and well control measures fail. When the pressure encountered in the formation increases rapidly, it is referred to as a kick. The severity of the kick depends on the reaction time of the drill crew, the porosity and the permeability of the formation (*i.e.*, how it allows fluid to flow through it), and the difference between the formation pressure and the hydrostatic pressure of the drilling fluid. Information about primary and secondary well control measures, which are employed to prevent a well blowout incident, is included in Section 8.1.3.4.

In the extremely unlikely event where primary and secondary well control measures have failed, hydrocarbons would be released from the BOP into the ocean. A subsea well blowout incident is described below and illustrated in Figure 8.2.5 (IPIECA-OGP 2015).



Source: IPIECA-OGP 2015

Figure 8.2.5 Blowout Incident Schematic

- High-velocity jets of oil and methane gas released subsea in deep water will be broken up by the intense turbulence of the release conditions into small oil droplets and gas bubbles. This is often referred to as "mechanically" dispersed oil to distinguish it from oil dispersed by chemical dispersant use.
- The plume of small oil droplets, gas bubbles and entrained water will initially rise rapidly in the form of a buoyant plume, with the gas providing the dominant source of lift and buoyancy. Close to the point of release, this plume will behave like a single-phase plume.
- As the plume of oil droplets and gas bubbles rise through the deep water (where water depths are greater than 500 m in depth), the methane gas will dissolve into the ocean (due

to its solubility at high pressure); this reduces the buoyancy of the plume, thereby slowing its ascent through the water.

- Stratification in the water column and currents will then separate the oil droplets and gas bubbles (if not already dissolved) from the plume of entrained water.
- The larger oil droplets will then continue to rise slowly to the sea surface under their own buoyancy, which is a function of size, while the smaller oil droplets will be carried horizontally under the influence of ocean currents and remain suspended in the water column as they dilute and biodegrade.

A blowout incident has occurred in offshore Nova Scotia. The Uniacke G-72 incident occurred on February 22, 1984. The incident occurred at a gas well that was being drilled 150 nautical miles from Halifax by the semisubmersible drilling vessel, *Vinland*, under contract to Shell Canada Resources. The initial flow rate of gas and condensate was estimated to be approximately 300 bbl per day. The incident lasted for 10 days and approximately 1,500 bbl of gas condensate was released in total. Between 1.11 to 1.83 million m^3 / day of natural gas was released. The well was declared static 10 days after the initial release after a team of specialists boarded the Vinland and pumped mud down the choke line (Gill *et al.* 1985).

Historical data indicates that the probability of a blowout incident is extremely low. It is estimated that for wells with a subsea BOP installed, including shear rams and following the two-barrier principle, the frequency of a blowout incident is 3.1×10^{-4} (0.00031, or 0.031%) per exploration well drilled (OGP 2010 and DNV 2011). This probability estimate is based on data from the Gulf of Mexico, United Kingdom (UK) and Norway between 1980 and 2004. These data are relevant to a period prior to the implementation of additional controls and mitigation measures that will be used for well control. The following controls and mitigation measures are based on industry advancements and the lessons learned following the DWH incident:

- enhanced industry and BP training and competency assessment for individuals and crews with accountability for well control and other wells operations;
- additional shear rams on the BOP – BP uses three shear rams on the BOP. In addition, there are two variable pipe rams and one fixed diameter ram;
- regular system and pressure testing of BOP;
- third-party verification of BOP testing and maintenance; and
- onshore remote monitoring to support well operations.

Detailed information on emergency preparedness and response is presented in Section 8.3, including specific lessons learned following the DWH incident.

Spill fate and behaviour modelling has been conducted for a well blowout incident in two potential locations within the ELs. Assumptions and background information about the modelling work are provided in Section 8.4; effects are assessed in Section 8.5.

8.3 EMERGENCY RESPONSE AND SPILL MANAGEMENT

BP prioritizes activities and takes measures to reduce the probability of incidents, including oil spills, from occurring through the use of prevention barriers. Additionally, as a precaution, BP prepares response barriers to mitigate adverse consequences should an incident occur.

Response barriers used by BP include standardized practices for the preparation and response to crises and emergency events that have the potential to cause harm to BP employees and contractors, the environment, company assets and neighbouring communities, environmental damage and interruption to business operations. These practices form the foundation of the response management strategy for the Project, which will be based upon the principles of preparedness, response and recovery. Response management strategies will incorporate lessons learned from within BP and the wider industry.

This section provides detail about the emergency response measures that will be used by BP as part of the exploration program, with specific focus on spill management.

8.3.1 Incident Management Plan and Spill Response Plan

The Project will operate under an IMP to define the response to incidents. The IMP will be a comprehensive document including practices and procedures for responding to an emergency event. The IMP will include, or reference, a number of specific contingency plans for responding to specific emergency events, including potential spill or well control events.

The IMP and supporting specific contingency plans, such as the SRP will be aligned with applicable regulations, industry practice and BP standards and will include response scenarios, strategies and capabilities. These plans will be submitted to CNSOPB prior to the start of any drilling activity as part of the OA process. The SRP will be finalized in consultation with applicable regulatory authorities.

To ensure readiness, emergency exercises and drills will be conducted to test the plans. Bridging documents will be prepared to link the safety management systems of BP and the contractors that it works with, which will include the IMP and SRP (or equivalent documents as defined by the contractor).

The IMP will describe the overarching response measures to respond to an emergency event, irrespective of the size, complexity or type of incident. Specifically, it will define the response organization and roles and responsibilities, and will include notification and reporting procedures. It will be designed to ensure an efficient and timely response.

As part of the IMP, BP will prepare an SRP. The SRP will satisfy BP's planning requirements and will be designed to fulfil all of the information required as part of the OA process. The SRP will include a risk assessment and detailed description of how BP's preventative measures reduce the likelihood of spills occurring. It will also include response information for a variety of potential spill scenarios, the response organization structure, roles and responsibilities, and the procedures for notification and reporting. The SRP will describe the mobilization and deployment of equipment and personnel and will include information about how to monitor and predict spill movement to facilitate an effective response. Information about source control will be included as part of the IMP and SRP documentation, describing how resources will be deployed to respond to a loss of well control incident. Information about environmental and socio-economic sensitivities and potentially affected Aboriginal groups and stakeholders will also be included in the plans.

BP will include tactical response measures within the SRP to clarify procedures and strategies for safely responding to different spill scenarios. The plan will include information about how oiled wildlife and recovered oil waste will be managed and how a sampling and monitoring program will be established if necessary.

The Project will adopt a tiered approach for spill response and preparedness, as per International Petroleum Industry Environmental Conservation Association (IPIECA) guidelines, for planning the response to oil spills. The tiered response definitions are as below in Table 8.3.1.

Table 8.3.1 Tiered Level Response Description (from IPIECA 2015)

Response Tier	Description
Tier 1	**Resources necessary to handle a local spill and / or provide an initial response** Tier 1 has been conventionally defined by the response capability required to deal immediately with operational spills. However, it is important to recognize that all spills, regardless of cause or consequence, have a Tier 1 component. Tier 1 is therefore the foundation of preparedness and response for all spills, which may or may not ultimately escalate beyond the scope of Tier 1 initial actions and capabilities.
Tier 2	**Shared resources necessary to supplement a Tier 1 response** Tier 2 capability includes a wider selection of equipment suited to a range of strategic response options. More importantly, Tier 2 delivers more people, and a greater range of specialism. While Tier 1 responders may be appropriately trained and knowledgeable, their response duties are invariably subordinate to their operational role. Tier 2 service providers come with appropriate professional training and have knowledge of national legislation and domestic practices in the countries/regions in which they work. In the context of the wider incident, Tier 2 contractors can also provide access to expertise for specific elements of spill response (*e.g.*, aircraft, communication systems, marine logistics and other emergency-related services), the absence of which may delay or hinder a response.
Tier 3	**Global resources necessary for spills that require a substantial external response due to incident scale, complexity and / or consequence potential** Tier 3 capability tends to be predetermined, with well-established industry-controlled equipment stockpiles and response personnel at key strategic locations and with defined geographical remits. It is through contracts and agreements that industry and governments can have access to the cooperatively held resources therein. Physical response times to any given risk location can be ascertained, and agreements are in place which guarantee specified response services and time frames to provide added security.

The tiered response approach provides a full range of response tools and strategies that can be mobilized and demobilized, and implemented efficiently and appropriately. The tiered response approach will be adhered to in BP's IMP, SRP and the well control plan described above.

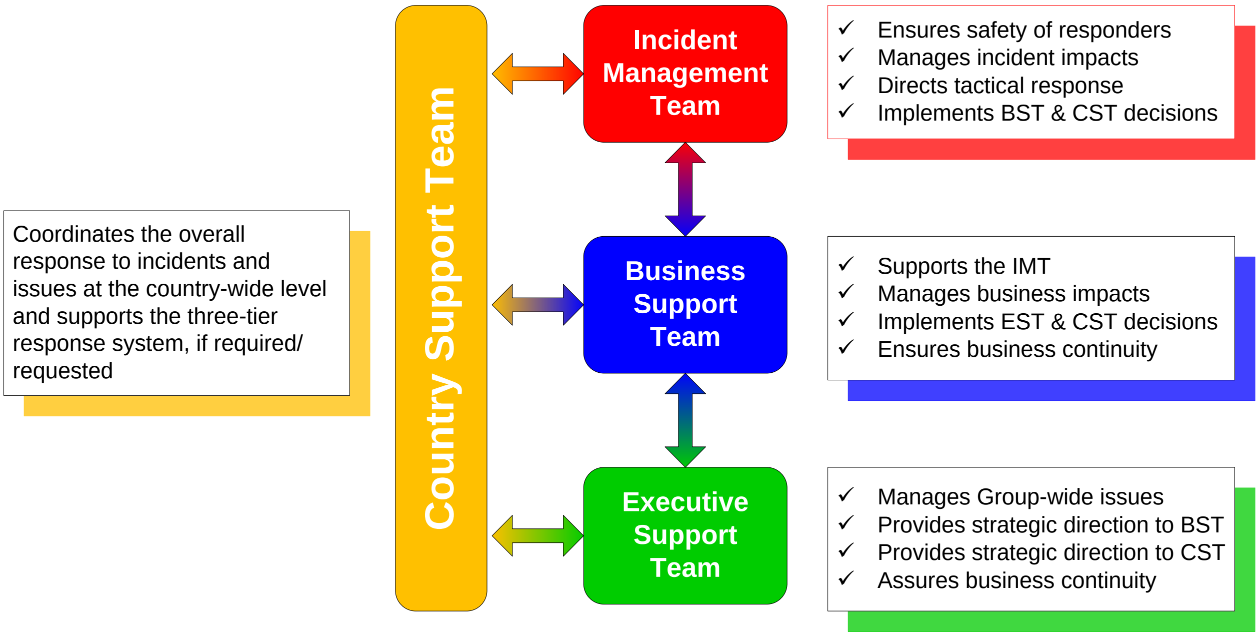
The selection of appropriate response methods and equipment will be determined by the specific nature of the incident and the environmental conditions at the time of the incident; however, indicative strategies that may be applied during response to an oil spill are described in Section 8.3.3 below.

8.3.2 Response Co-ordination and Management

BP's incident management organization is based upon a scalable system illustrated in Figure 8.3.1. This structure is designed to co-ordinate an efficient, timely and effective response using teams based at the worksite, BP Canada offices in Halifax and Calgary, and BP head offices in Houston and London where appropriate. The Incident Management Team has access to a global network of expertise to support response efforts.

Throughout BP's incident management organization, BP adopts the incident command system (ICS) as the foundation for the response management system. The ICS structure will be described in the IMP and SRP. ICS is a standardized emergency response system that provides a systematic response capability and an integrated organization structure that provides clear lines of communication and defined roles and responsibilities. It is a system that can be deployed in any emergency scenario.

BP will have personnel in their Halifax office who will co-ordinate the incident management team. Additional personnel will be called from supporting offices, as required, to provide technical or specialist support.



Note: BST=Business Support Team; CST = Country Support Team; IMT = Incident Management Team; EST = Executive Support Team

Figure 8.3.1 BP Incident Management Organization

BP will work with a number of local and federal government bodies in the event of a spill event. Agencies that would be notified of a spill event, engaged to support response efforts and provide regulatory oversight, as required, include the CNSOPB, the Canadian Coast Guard (CCG), the Joint Rescue Coordination Centre (JRCC), the Nova Scotia Emergency Management Office (NSEMO), DFO, and Environment and Climate Change Canada (ECCC).

BP has access to support organizations and agencies that can provide resources to support a spill response effort. Different organizations and resources are in place within the region and may be mobilized depending on the extent and scale of a spill to support a response. Further information about these organizations will be provided in the SRP.

One of these organizations is Oil Spill Response Limited (OSRL). OSRL is an international, industry owned organization that provides resources and expertise for oil spill response and clean up. BP is a member of OSRL and as such is able to access and use specialist equipment, call on and deploy specialist incident management experts and technical advisors. OSRL's expertise and resources are strategically located across the world to facilitate effective and efficient response to oil spill incidents.

OSRL has a dedicated subsea division, the Subsea Well Intervention Services (SWIS), which provides OSRL members with the opportunity to access subsea intervention capabilities, including subsea dispersant equipment, and capping and containment equipment. This complements the response services described above that OSRL membership provides. BP is a signatory to SWIS and worked as part of the Subsea Well Response Project to create the SWIS. OSRL will be notified of upcoming wells drilled as part of the Project to ensure that they are covered under the SWIS and other OSRL services. Specific information about the capping stack equipment, which BP can access as part of SWIS, is presented in Section 8.3.3.

8.3.3 Response Strategies

Response strategies to a spill will vary depending on the spill scenario and will be defined by the IMP and SRP described above.

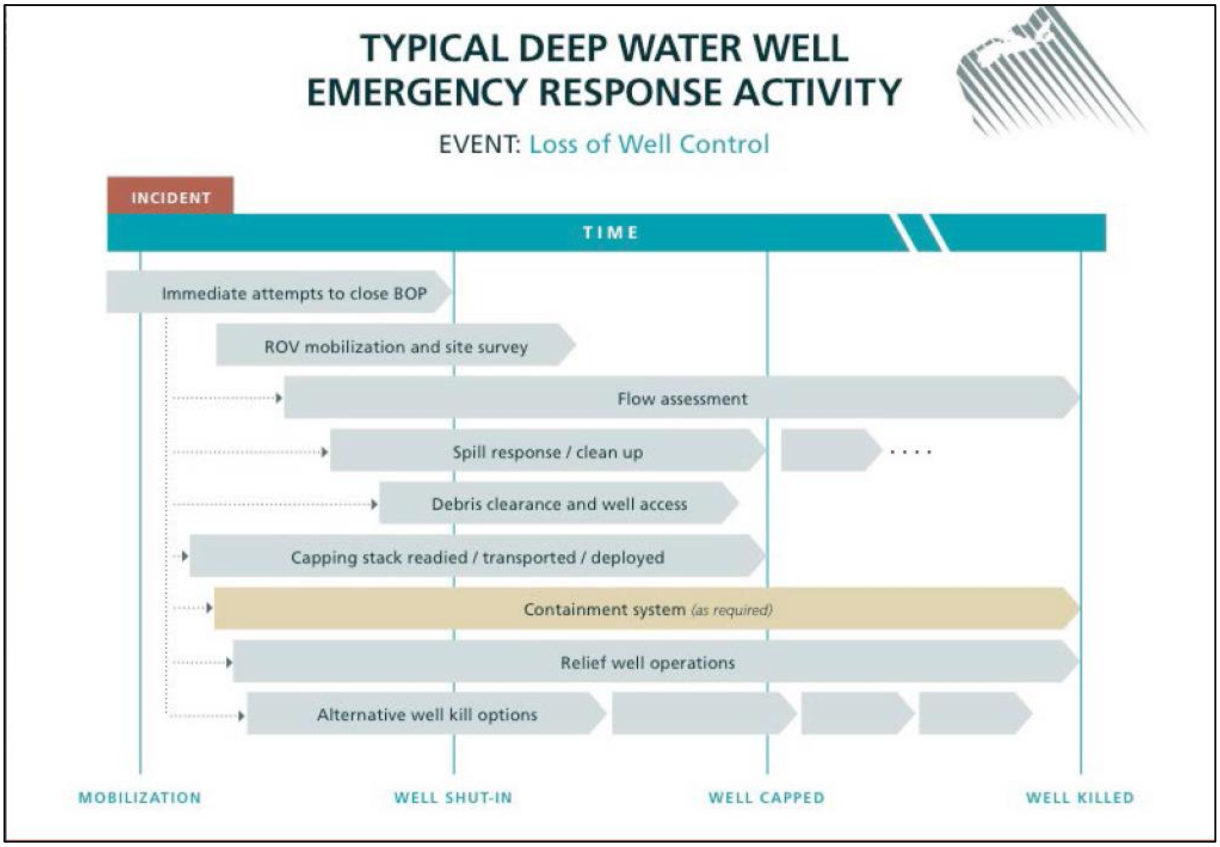
The most significant spill event, in terms of potential adverse effects on Valued Components (VCs), which could occur during Project activities, is a major release of formation fluids from a loss of well control (*i.e.*, a blowout) event. The majority of this section therefore refers to response strategies that would be implemented following a major release of formation fluids.

The IMP and SRP will include information about well control response strategies to set out measures to stop the flow of oil, and spill response tactics to manage any released oil.

8.3.3.1 Well Control Response Strategies

In the event that all of the preventative measures described in earlier sections have failed and an uncontrolled well event has occurred, BP will have plans in place to launch multiple simultaneous activities to stop the flow of hydrocarbons.

Figure 8.3.2 outlines the typical sequence of events that will be implemented in the event of a loss of well control and subsequent blowout incident. The figure illustrates the BOP intervention, and capping and containment measures that would be conducted to stop the flow of hydrocarbons, and indicates the timing of spill response efforts to manage, contain and recover spilled hydrocarbons.



Source: CNSOPB n.d. (c).

Figure 8.3.2 Well Control Response Strategies

A suite of response measures will be activated in response to any uncontrolled well control event as soon as practicable and when safe to do so. Many of these measures will be deployed simultaneously to provide a comprehensive response. This approach also provides a level of contingency so that if initial response measures are unsuccessful, additional measures will be available to be deployed as back up.

Well control response effort will comprise well intervention (*i.e.*, source control) strategies including direct BOP intervention, mobilization and installation of a capping stack, and drilling of a relief well if required. Additional spill response options including containment and recovery of oil and in-situ burning may be implemented as appropriate. Dispersants may be mobilized, depending on the outcome of BP's net environmental benefit analysis (NEBA) and regulatory approval to help reduce surface or shoreline oiling (refer to Section 8.3.3.3 for information on BP's plan for dispersant use).

The incident management team will assess the situation as it evolves throughout any response effort to ensure that the response strategy is appropriate for the specific conditions.

8.3.3.2 Well Intervention Response

BOP Intervention

BP's first response would be to attempt direct intervention measures intended to close in the original BOP. The BOP will be equipped with multiple shear rams to provide additional options to close the BOP.

BP will maintain equipment and capability to perform external intervention on the BOP within the Nova Scotia region. This will include specialist equipment and ROVs which can be deployed from a PSV or the MODU to provide hydraulic power to the BOP in order to close the rams directly.

A BOP intervention response is estimated to take between 2 and 5 days.

ROV Mobilisation, Site Survey and Debris Clearance

In parallel with the attempted BOP intervention activities, an ROV based site survey will be carried out to assess the extent of debris on the seafloor following the blowout incident. Debris on the seafloor, potentially including formation debris blown out of the wellbore, can impede additional response efforts. If large debris that could limit access for response equipment is detected, subsea cranes and ROVs with debris removal tools will be used to clear the area around the well site.

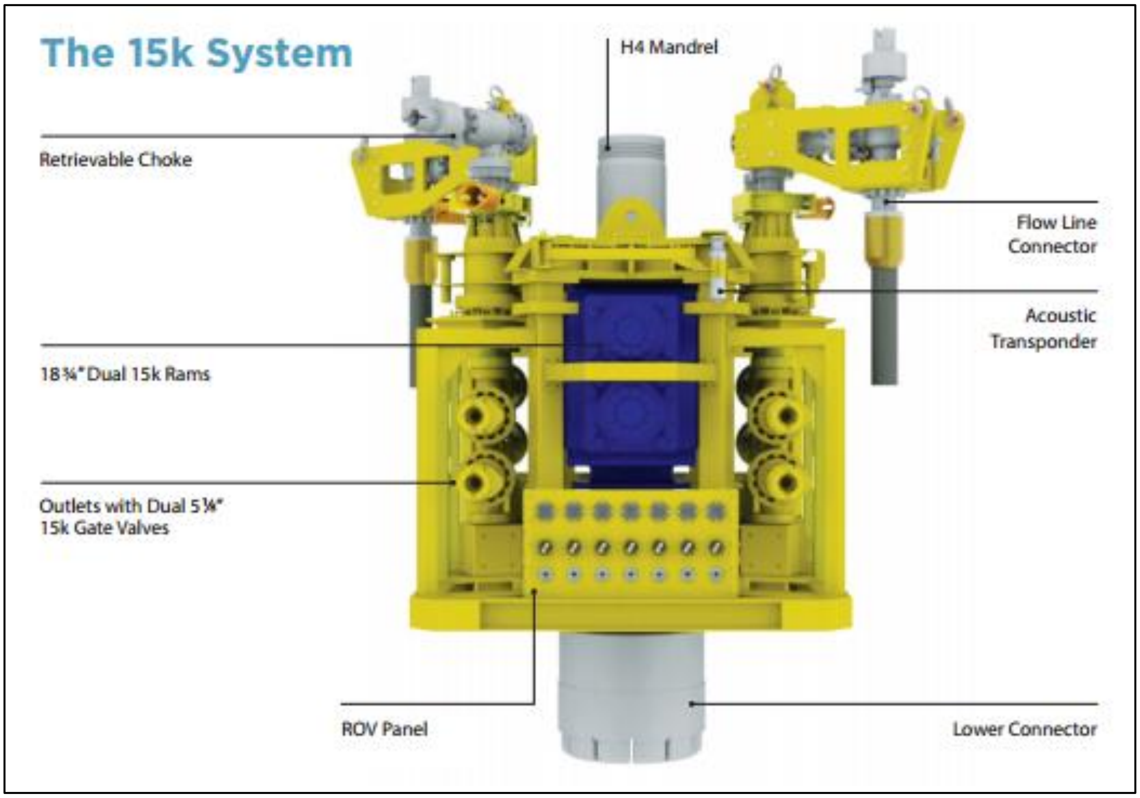
Well Capping

A subsea well capping stack is a specialized piece of equipment used to "cap", (*i.e.*, stop or redirect) the well flow while work to permanently kill the well is undertaken. Capping stacks are designed to withstand the maximum anticipated wellhead pressure generated by the well (rated at up to 15,000-psi).

BP has contributed to the provision of industry capping stacks, and along with other operators in industry, continues to refine and enhance the deployment of capping stacks being developed today.

A number of capping stacks are stored in strategic locations across the globe in Brazil, Norway, Singapore and South Africa. Capping equipment is stored ready for immediate use and onward transportation by sea or air in the event of an incident.

For Scotian Basin wells, BP's current primary plan is to access the capping stack stored in Stavanger, Norway, which is a capping stack capable of managing up to 15,000 psi. A diagram of the 15,000 psi capping stack that would be used is shown in Figure 8.3.3.



Source: OSRL 2014

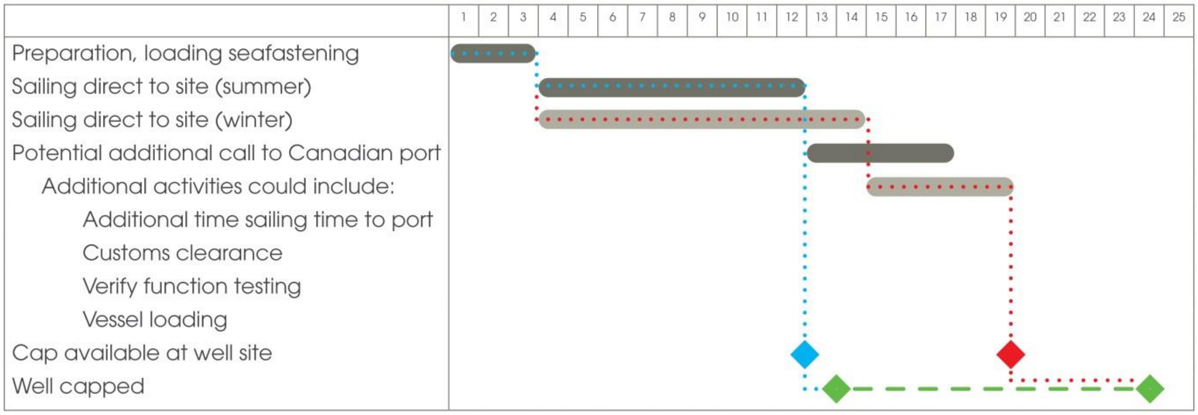
Figure 8.3.3 18.3/4" 15,000psi Capping Device

If a blowout incident were to occur, BP would immediately commence the mobilization of the primary capping stack from Stavanger. The capping stack would be transferred from Stavanger on a vessel. Prior to departure, the capping stack would be prepared, tested and then transferred on to the vessel.

Sailing times from Stavanger to the Project Area are dependent on vessel cruising speeds, which are in turn dependent on metocean conditions. Metocean conditions, and therefore sailing times, are likely to differ between summer and winter.

Estimated sailing times from Stavanger to the ELs have been calculated and are presented in Figure 8.3.4 below. While it is preferred that the cap is transported directly to the well site on-board a vessel with suitable deployment capabilities, it may become necessary to make an intermediate port call in St. John's (Newfoundland and Labrador) or Halifax. If this were to become necessary, the required customs clearances, functional checks, cargo transfers, *etc.*, could add several days to the overall transit time. These potential additional durations are shown in Figure 8.3.4 below.

Mobilization of subsea capping equipment to the wellsite is estimated to take 12 to 19 days dependent on weather conditions and vessel availability.



Note:
Blue represents predicted cap mobilization during the summer months
Red represents cap mobilization during the winter months
Green represents anticipated capping window

Figure 8.3.4 Cap Mobilization Sequence and Durations

During the cap transit, the necessary engineering analysis, technical review, debris clearance, and site preparations will have been underway such that cap installation can begin upon arrival of the cap at the well site.

Precise durations for cap installation and closure would be highly dependent on local conditions specific to the incident. A straightforward installation and closure under good conditions would take approximately 24 hours. A more complicated installation, with potential weather-related downtime, could take longer.

Allowing for these uncertainties, BP estimates that a well could be capped between 13 and 25 days after an incident.

Relief Well Drilling

Depending on the circumstances where well control cannot be reestablished, a relief well may be drilled to kill the well. BP has master service agreements in place for specialist assistance to help with engineering and operational support for a relief well.

The relief well would be drilled using a similar execution plan to a standard well. A relief well is typically drilled as a vertical hole down to a planned deviation (“kick-off”) point, where it is turned toward the target well using directional drilling technology and tools.

Once the target well is intersected, dynamic kill well control commences by pumping drilling fluid down the relief well and into the incident well to kill the flow. Concrete may follow to seal the original well bore.

A MODU would be mobilized to Nova Scotia waters should a relief well be required. The duration of mobilization and drilling a relief well has been based on a conservative (P90) time forecast and includes a 50% non-productive time assumption, resulting in an estimate of 165 days to kill the well.

Wellheads, running tools, connectors and tubulars will be transported by air and sea as appropriate such that equipment required in the top-hole sections of the relief well construction would be available prior to spud.

8.3.3.3 Oil Spill Tactical Response Methods

BP's SRP will contain specific details of response methods that can be used in the event of an oil spill. A toolkit of different tactical response methods will be available to be used depending on the specific conditions of a spill event. The effectiveness of some of the methods described below will be affected by specific environmental conditions (*e.g.*, wave height and visibility), and it is possible that some of the below options may not be feasible at the time of a spill. Specific details about the tactical response methods will be further defined in the SRP, including a description of how different tactics will be selected for different scenarios and locations.

Tactical response methods that will be considered following a spill incident include, but are not limited to those described below.

Surveillance and Tracking

Surveillance and tracking of an oil spill, using trained and experienced personnel, is necessary to determine the extent, behaviour and trajectory of a spill in order to determine the most appropriate response options.

Surveillance of an oil spill is accomplished using a variety of platforms, potentially including boats, manned aircrafts, unmanned aerial vehicles, and satellites, as well as utilizing a variety of sensors. Surveillance is used to inform the response with the respect to the location, condition and movement of oil so as to maximize the effectiveness of tactical response, assist in trajectory modelling, and help determine strategic response options.

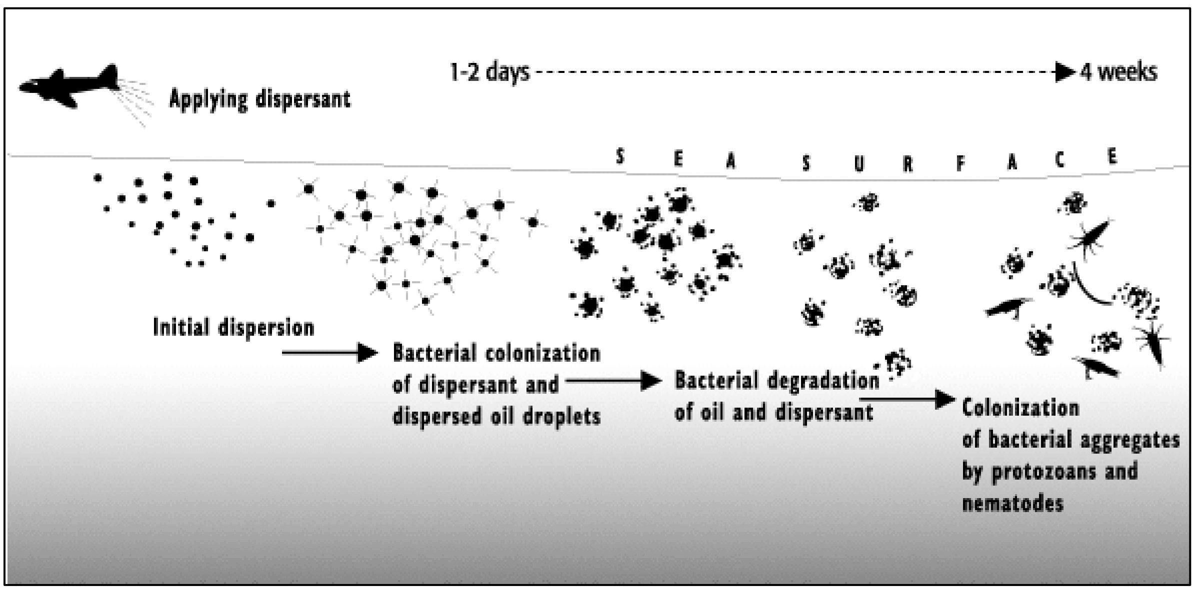
Offshore Containment and Recovery

Offshore containment and recovery of oil includes booming and skimming operations. Booms are floating physical barriers that can be used in a variety of ways to contain, deflect and control the movement of surface oil. Booms can be used to contain oil in a defined area, which increases the effectiveness of oil recovery equipment (*e.g.*, that of skimmers and vacuums). Booms can also be used to divert oil away from sensitive receptors (*e.g.*, rafting bird assemblages or shorelines) to reduce the likelihood or magnitude of adverse environmental effects.

Dispersant Planning and Application

Dispersants are chemicals that, when applied to oil, reduce the interfacial tension between the oil and water, allowing the oil to be broken down into smaller droplets, thus substantially enhancing the natural dispersion and subsequent biodegradation of the oil droplets. Dispersants are made up of two primary components – a surfactant and emulsifier. These surfactants and emulsifiers are commonly found in a wide variety of household products including skin creams, mouthwash, food emulsifiers, baby bath, cosmetics, and cleaning agents.

Dispersants do not reduce the total volume of oil in the environment; however, dispersants increase the surface area of oil exposed to the environment, which helps to accelerate oil biodegradation, and typically reduce the extent of surface and onshore oiling. Once dispersants have been applied, dispersed oil moves down into the water column and eventually, dispersed oil droplets degrade into naturally occurring substances as shown in Figure 8.3.5. There is evidence that dispersed oil degrades more quickly than oil that has not been dispersed (Lee *et al.* 2013).



Source: NOAA 2016a

Figure 8.3.5 Degradation of Oil Following Dispersant Application

Chemical dispersant may be applied at the sea surface, or subsea in the event of a subsurface release such as a blowout incident. A number of factors determine which application method is appropriate in any spill scenario, some of which are provided below.

Surface application is often used in conjunction with other spill response tactics, including those listed within this Section of the EIS. Surface application involves spraying the dispersant aerially from deployed aircraft or from available vessels. Weather conditions (*e.g.*, wind, wave height and visibility) are key factors which dictate effectiveness and method of surface dispersant application and would be taken into account by spill responders when analyzing the situation for a dispersant plan. To increase the chances that an application will be effective, spill responders monitor and analyze the situation to determine the best combination of dispersant droplet size, concentration, and rate and method of application.

Surface application by aircraft allows for quick transit to the spill site and covering of large areas in a short period of time; however, this method can be limited by poor visibility and weather that can affect the safe operation of aircraft and the accurate application of the dispersant. Surface application by vessels can result in a more focused application of the dispersant and application in some areas where aircraft cannot operate, however, the amount of oil that can be treated by dispersants applied from vessels is limited due to the speed of the vessels and width of the spray.

It should be noted that as the oil weathers, primarily through evaporation and emulsification, the effectiveness of dispersants is reduced. This resulting "window of opportunity" needs to be considered and monitored when considering dispersant use.

In the event of a blowout incident, dispersant can also be injected subsea, close to the point of release at the wellhead. Subsea dispersant injection (SSDI) was used as one of the response measures deployed in response to the DWH incident in 2010. In subsea dispersant injection, dispersant is injected directly at, or near, the source of the release.

This increases the "encounter rate" of the dispersant with the oil, resulting in a reduction in the size of oil droplets and an associated enhancement and acceleration of in-water-column microbial degradation of hydrocarbons.

Dispersed oil droplets rise very slowly through the water column, or become neutrally buoyant. This results in the dispersed hydrocarbons being transported from the release site via subsea drift, quickly reducing concentration and making oil droplets more accessible to oil-degrading microbes. All of the world's oceans have natural hydrocarbon seeps (Kvenvolden and Cooper, 2003), and oil degrading microbes are found in all marine environments—even cold, dark environments—having evolved to degrade petroleum from these seeps. This is also true for Nova Scotia, where a BP-funded microbiology study revealed that oil serves as a significant energy/nutrient source for the indigenous field-collected microbes (Yergeau *et al.* 2014). The water depth at which a submerged plume of dispersed oil is formed and the direction in which the plume drifts will be a function of the prevailing conditions and currents in the water.

The primary reason for any dispersant use, including SSDI, is to prevent, or minimize, the amount of oil that may subsequently impact shallow coastal waters and the shore, where it could cause considerable damage to sensitive environmental resources on the surface and shoreline, such as seabirds and mammals, and disrupt socio-economic activities. Additional benefits of SSDI include:

- reducing the amount of liquid oil and volatile organic compounds (VOCs) that reach the surface of the ocean, therefore, reducing potential health and safety impacts to response workers at the surface, especially in the context of exposure to the VOCs;
- increasing the "encounter rate" of the dispersant with the oil, therefore reducing the amount of dispersant required compared to surface application;
- facilitating a continuous response, being able to be maintained day and night, and in adverse weather and sea conditions that often preclude use of other response techniques; and
- the high temperature of the oil released from a blowout, where the dispersant is injected, means that oil weathering and viscosity issues are not a factor for effectiveness of dispersion, such as they would be for surface application of dispersants.

Dispersants will not be used by BP without prior regulatory approval.

In May 2016, Regulations Establishing a List of Spill-treating Agents under the *Canada Oil and Gas Operations Act* came into force, listing spill-treating agents (dispersants) Corexit© EC9500A and Corexit© EC9580A as acceptable for use in Canada's offshore. While this does not imply pre-authorization for use, these regulations, along with provisions in the *Energy Safety and Security Act*, lifts legal prohibitions that would otherwise prevent the use of spill-treating agents if, among other stipulations, the CNSOPB's Chief Conservation Officer determines that its use is likely to achieve a net environmental benefit in the particular circumstances of the spill and approves the use of the spill-treating agent.

Authorization for the use of dispersants as part of emergency response measures is currently being reviewed by the CNSOPB as part of the Accord Act. If dispersant use is advisable, BP will seek approval from the CNSOPB Chief Conservation Officer. BP will undertake a NEBA as part of the preparation of the SRP to evaluate the benefits associated with different spill response strategies including dispersant application.

NEBA is a tool that aids in the design of response planning through consideration of the best available information about the relative impacts of spilled oil and the probable capabilities and consequences of response options in the area of concern. A NEBA will be used to assess and compare the feasibility and environmental and socio-economic impacts of employing different oil spill response techniques (including but not limited to dispersant application) to prevent or reduce contact of the oil with resources most likely to be affected. The baseline case for the NEBA for the Project will be one of "no action" (*i.e.*, the use of no tactical response methods) to assess the relative merits of each potential approach.

Operational considerations in evaluating the role of various spill response strategies (including use of dispersants) will consider: the feasibility of the response technique in prevailing conditions; capability of the response technique to significantly affect the outcome; and the availability of equipment and personnel to deploy the response technique. In addition to these operational considerations, other factors may influence response effectiveness. The rapid evaporation of very light oils or the rapid formation of emulsified oil can change the amounts and nature of floating oil on the surface, shoreline oiling, or the amount of oil that can be effectively dispersed and diluted in the water column. Spills that occur near sensitive ecological areas may not allow sufficient time to mobilize slower responding vessel equipment, making aerial dispersant application the optimal way to intercept the oil before it reaches shore. Alternatively, wind or water currents may alter the course of an oil slick which may influence the time to landfall, therefore influencing the potential window to apply dispersants to minimize the extent of shoreline oiling.

The plan to use dispersants as part of any response plans will take into account the operational considerations and prevailing conditions. Further information about the potential ways in which dispersants may be used as part of the Project will be included in the SRP.

Dispersant Effects

Use of dispersants can alter the relative importance of exposure pathways to oil for wildlife (BP 2014). In many cases, risk of adverse environmental effects is lessened due to the reduction in floating oil on the sea surface. Subsea dispersant injection may therefore greatly reduce potential for interaction of crude oil with marine birds, mammals, sea turtles and shoreline habitats (*e.g.*, Sable Island). Oil on the water surface can pose an inhalation and ingestion risk as well as an external exposure risk through skin and eye irritation to certain marine and coastal species. Surface oil can also smother some small species and some life stages of fish or invertebrates, and coat feathers and fur, reducing birds' and mammals' ability to maintain their body temperatures (refer to Section 8.5 for more information on the effects of hydrocarbons on the marine environment). However, the use of dispersants (as is the case with any spill response measure) may also result in adverse environmental effects. With the objective of attaining a net environmental benefit, the NEBA evaluates "trade-off" situations whereby the acceptance of certain adverse effects (*e.g.*, those associated with dispersant use) may be necessary to avoid other, more significant adverse environmental effects on habitats and receptors (*e.g.*, oiling of marine birds and shoreline habitats) (Stantec 2012c).

There have been many reports and publications examining the toxicity and effectiveness of dispersant products (including toxicity of dispersed oil) including laboratory experiments, field studies and actual spill response activities and the results were used for regulatory approval of dispersant applications in many countries, including Canada. The toxic response of an organism to dispersants and dispersed oil is dependent primarily on the extent of exposure (chemical form, concentration, duration) to the substance. Different species or life stages of the same species may exhibit different degrees of response to similar exposure conditions and species sensitivity distributions are derived to establish thresholds for environmental effects (BP 2014b).

Due to the dynamic nature of the marine environment, exposure conditions are rarely constant. Exposures to dispersants and dispersed oil are dynamic events for oil spills in open waters, with concentrations diminishing over time in offshore waters following treatment of surface oiling (BP 2014). Use of subsea dispersant treatments for prolonged releases at well control events can generate more consistent exposure conditions at points near the sources. These dynamic exposure conditions must be taken into account in order to more accurately characterize the potential environmental toxicity of dispersed oil in the environment (BP 2014b). Subsea injection of dispersants could result in a temporary, localized increase in risk of adverse environmental effects to invertebrates and plankton in the water column in the vicinity of the application (*i.e.*, wellhead) (HDR Inc. 2015). However, few species (*e.g.*, invertebrates, plankton) would be exposed to dispersant concentrations greater than their laboratory LC50 value, and those concentrations are unlikely to be sustained long enough to elicit a toxic effect. For continuous, subsea injection of dispersants at well control events, concentrations of dispersants not associated with the oil would be low at the source of treatment, and would diminish quickly due to dilution as currents move the dispersant away from the treatment site. This would lead to very localized potential areas of effect from dispersant alone (BP 2014b).

In general, dispersed oil is believed to result in reduced adverse environmental effects on marine mammals and birds due to the reduction of exposure to floating oil on the sea surface. However, dispersant use in close proximity to various species may reduce surface tension at the feather/fur-water interface thereby reducing the capacity of insulation provided by feathers or fur. The magnitude of these effects depends on the proximity of wildlife during dispersant application as well as the effectiveness of the dispersant on the surface oil (NRC 2005b). As discussed in Section 8.5.3, exposure to oil will also affect thermal regulation.

Given the relative distance of most Special Areas from the Project Area, predicted effects of dispersant use with respect to the protection of Special Areas are generally positive, related to the reduction of risk of exposure to surface oil or stranded oil on shorelines (*e.g.*, Sable Island; mainland Nova Scotia). Dilution of dispersants in the water column as currents move the dispersant away from the treatment site will reduce likelihood of toxicity effects on the Haddock Box and sponge conservation areas.

From a socio-economic perspective, although studies indicate that dispersants have relatively low toxicity to fish species, dispersant use may increase public concern over seafood safety, thereby potentially prolonging effects on commercial and Aboriginal fisheries (HDR Inc. 2015).

In a NEBA framework, potential biophysical and socio-economic risks would be weighed against risks of not dispersing surface oil, including the risk to marine life associated with surface slicks and shoreline (*e.g.*, Sable Island) contamination. The NEBA will analyze the trade-off between the toxic effects of the dispersed oil in the water column relative to the advantages of removing floating oil from the surface and preventing shoreline impacts.

In-Situ Burning

Controlled in-situ burning can be used to quickly and efficiently reduce the volume of oil on the water surface that could otherwise reach shorelines and nearshore sensitive receptors. In-situ burning can only take place when oil has been contained within fire resistant booms and when meteorological conditions are suitable (*i.e.*, calm seas and light winds). In-situ burning will not be used by BP without prior regulatory approval.

Shoreline Protection

Shoreline protection involves deploying barriers, including boom and berms, to deflect and protect coastal environmental sensitivities from the surface oil. A range of equipment can be used for shoreline protection, including deflection booming, which is used to divert oil to a suitable collection point on the shoreline or at sea, and protection booming, which is used to hold oil back from environmental or socio-economic sensitivities. Additionally, sand, sand bags and earth barriers can be used to prevent the ingress of oil to specific areas. Selection of equipment and strategies is dependent on local conditions and the outcome of spill trajectory modelling.

Shoreline Clean Up

In the event that oil threatens or reaches the shoreline, a shoreline response program will be initiated. Shoreline clean-up assessment technique (SCAT) teams will be mobilized to perform systematic surveys to document the location, degree and type of shoreline oiling. This information will be used establish shoreline treatment recommendations appropriate for each area. Treatment measures can include a range of options including, but not limited to, low-pressure flushing, mechanical collection, manual cleaning, plowing, soil washing, and natural attenuation. Stakeholders are engaged to build consensus on clean-up endpoints, based on net environmental benefit. SCAT teams will also be used to monitor and evaluate the effectiveness of the clean-up operations.

Oiled Wildlife Response

Oiled wildlife response may be required for fauna encountered at sea and on the shorelines of islands and the mainland. Where it is required, BP will draw upon the expertise and equipment of specialist contractors to support the oiled wildlife response effort. Oiled wildlife response typically is based on a three tier approach:

1. Primary response: surveillance to determine the location and extent of wildlife injuries and death; and deflecting oil away from areas of high sensitivity where practicable.

2. Secondary response: deterring fauna from affected or potentially affected areas; and pre-emptive capture and exclusion activities.

3. Tertiary response: capture and stabilization of oiled wildlife (using boats, or on the shoreline); transport to treatment facilities and treatment of affected fauna.

8.3.4 Lessons from the Deepwater Horizon Incident

On April 20, 2010, a well control event allowed hydrocarbons to escape from the Macondo well in the Gulf of Mexico onto the Transocean DWH MODU, resulting in explosion and fire on the MODU and the loss of 11 lives. BP Exploration and Production Inc. was the lease operator of the well. Hydrocarbons flowed from the reservoir through the wellbore and the BOP for 87 days, causing a spill of national significance. In January 2015, the United States District Court for the Eastern District of Louisiana found that 3.19 million barrels of oil were discharged into the Gulf of Mexico.

A BP priority is to prevent any similar oil spill from taking place. BP's 2010 internal investigation into the DWH incident, known as the Bly Report, concluded that no single cause was responsible for the incident. A complex, inter-linked series of mechanical failures, human judgments, engineering design, operational implementation and team interfaces (involving several companies including BP), contributed to the incident.

BP's internal investigation, which culminated in the Bly Report, involved a team of over 50 internal and external specialists from a variety of fields, including safety, operations, subsea, drilling, well control, cementing, well flow dynamic modelling, BOP systems, and process hazard analysis. Eight key findings relating to the causal chain of events were made, with 26 associated recommendations to enable the prevention of a similar accident and aimed at further reducing risk across BP's global drilling activities.

Table 8.3.2 outlines the eight key findings related to the cause of the DWH incident, as outlined in the Bly Report (BP 2010). It also addresses how these lessons are applied to this Project in order to prevent a reoccurrence of the DWH incident.

Table 8.3.2 Key Findings from the Macondo Well Blowout Incident and Application to the Scotian Basin Exploration Drilling Project

Finding	Summary Description	Investigation Conclusion	Application to this Project
Critical factor: Well integrity was not established, or failed			
1. The annulus cement barrier did not isolate the hydrocarbons.	The day before the accident, cement had been pumped down the production casing and up into the wellbore annulus to prevent hydrocarbons from entering the wellbore from the reservoir. The annulus cement that was placed across the main hydrocarbon zone was light, nitrified foam cement slurry. This annulus cement did not isolate the wellbore annulus from the hydrocarbon zone.	There were weaknesses in the cement design and testing, quality assurance and risk assessment.	BP's Zonal Isolation Practice was updated and clarified, establishing clear requirements for annular cement well barrier elements and verification of these barriers during well construction, temporary abandonment and permanent abandonment. BPs zonal isolation objectives, within the Practice, are designed to prevent unintended movement of fluids between distinct permeable zones (DPZ), flow to surface or seabed, development of sustained casing pressure (SCP) during well operations due to communications between a DPZ and the surface or seabed, and contamination of potable-water aquifers. BP's established a comprehensive set of cementing documents to provide clear engineering guidance to BP Engineers when designing cement jobs to achieve zonal isolation requirements. BP established a global Cementing Engineering Team to enhance cementing discipline capability, to provide increased assurance of cement designs and to fulfill the cement job design review requirements outlined in the Zonal Isolation Practice. BP conducted a review of the quality of the services provided by all cementing service providers working with BP globally and new providers are reviewed before their services are contracted. BP provided leadership for a Work Group within the American Petroleum Institute (API) that updated the industry recommended practice for the preparation and testing of foamed cement slurries.

Table 8.3.2 Key Findings from the Macondo Well Blowout Incident and Application to the Scotian Basin Exploration Drilling Project

Finding	Summary Description	Investigation Conclusion	Application to this Project
2. The shoe track barriers did not isolate the hydrocarbons.	Having entered the wellbore annulus, hydrocarbons passed down the wellbore and entered the 9 ⅞" x 7" production casing through the shoe track, installed in the bottom of the casing. Flow entered into the casing rather than the casing annulus. For this to happen, both barriers in the shoe track must have failed to prevent hydrocarbon entry into the production casing. The first barrier was the cement in the shoe track, and the second was the float collar, a device at the top of the shoe track designed to prevent fluid ingress into the casing.	Hydrocarbon ingress was through the shoe track, rather than through a failure in the production casing itself or up the wellbore annulus and through the casing hanger seal assembly. Potential failure modes were identified that could explain how the shore track cement and the float collar allowed hydrocarbon ingress into the production casing.	BP's updated Well Barrier Practice provides the requirements for the design, selection, installation, maintenance, monitoring and management of well barriers and well barrier elements throughout the full life cycle of the well. Per the practice, well barriers are generally required to isolate energy sources within the earth from each other, the surface environment, and people. Dual well barriers (primary and a secondary) are required between energy sources and the surface. This BP practice applies to all wells regardless of where they are in their life cycle, including those wells under construction, actively in service, temporarily abandoned or permanently abandoned. Well barrier elements are verified to acceptance criteria in BP's Well Barrier Practice. For a cemented shoe track to be used as a well barrier element, it must have two independent floats for redundancy to prevent backflow of cement; have cement verified with a length and compressive strength required in BP's zonal isolation practice; and have successfully passed both a positive test and a negative test as outlined in BP's pressure testing practice.
Critical factor: Hydrocarbons entered the well undetected and well control was lost			
3. The negative-pressure test was accepted although well integrity had not been established.	Prior to temporarily abandoning the well, a negative pressure test was conducted to verify the integrity of the mechanical barriers (the shoe track, production casing and casing hanger seal assembly). The test involved replacing heavy drilling mud with lighter seawater	The Transocean MODU crew and BP well site leaders reached the incorrect view that the test was successful and that well integrity had been established.	BP's practices address both the positive and negative pressure testing requirements for wells. This updated practice requires prior approval of the engineering procedures for negative testing, and also specifies the minimum criteria to be met for a successful test. The Well Site Leader interprets the results of the test

Table 8.3.2 Key Findings from the Macondo Well Blowout Incident and Application to the Scotian Basin Exploration Drilling Project

Finding	Summary Description	Investigation Conclusion	Application to this Project
	to place the well in a controlled underbalanced condition. In retrospect, pressure readings and volume bled at the time of the negative pressure test were indications of flow-path communication with the reservoir, signifying that the integrity of these barriers had not been achieved.		against the engineered acceptance criteria. The Well Superintendent, who has an off-site supervisory role, then approves the negative pressure test. Both staff positions are classified as critical roles that undergo mandatory competency assessments. With the aim of building and maintaining competency of its staff, BP delivers in-house industry-accredited well control training with staff instructors and full-size drilling simulators in its own facilities in Houston, Sunbury, and, from 2016, in Baku. In addition, building on its Applied Deep Water Well Control course that BP developed and delivered in recent years to its entire deep water rig fleet, BP has an agreement with Maersk Training to use its state-of-the-art immersive simulation training facilities and instructors to provide an enhanced development program for rig teams. The integrated rig teams -- including individuals from BP, drilling contractors and service companies -- work through simulator-based scenarios to practice procedures, roles and responsibilities in challenging drilling and completion situations before they potentially encounter those situations in actual operations.
4. Influx was not recognized until hydrocarbons were in the riser.	With the negative pressure test having been accepted, the well was returned to an overbalanced condition, preventing further influx into the wellbore. Later, as part of normal operations to temporarily abandon the well, heavy drilling mud was again replaced with seawater, under-balancing the well. Over time, this allowed hydrocarbons to flow up through the production casing and past	The rig crew did not recognize the influx and did not act to control the well until hydrocarbons had passed through the BOP and into the riser.	BP's well monitoring practice lists the responsibilities and requirements for verifying and documenting that well monitoring has been properly implemented. The requirements include alarm setting and actions to be taken, fluid volume and density monitoring, flow checking, and actions to verify conformance with the practice. The BP practice requires a tailored regional wellbore monitoring procedure that is communicated to

Table 8.3.2 Key Findings from the Macondo Well Blowout Incident and Application to the Scotian Basin Exploration Drilling Project

Finding	Summary Description	Investigation Conclusion	Application to this Project
	the BOP. Indications of influx with an increase in drill pipe pressure are discernible in real-time data from approximately 40 minutes before the rig crew took action to control the well. The rig crew's first apparent well control actions occurred after hydrocarbons were rapidly flowing to the surface.		personnel with responsibilities for well monitoring, including the rig contractor and mud logger. The Well Site Leader, through BP's self-verification and oversight process, helps assure that the crew's actions conform to the wellbore monitoring procedure. As described in item 3, BP well site leaders and superintendents undergo competency assessments for their role. Relevant BP, rig contractor and well services company staff are required to receive industry-recognized well control certification. Also, BP provides enhanced, scenario-based training for rig crews.
5. Well control response actions failed to regain control of the well.	The first well control actions were to close the BOP and diverter, routing the fluids exiting the riser to the DWH mud gas separator (MGS) rather than to the overboard diverter line.	If fluids had been diverted overboard, rather than to the MGS, there may have been more time to respond, and the consequences of the accident may have been reduced.	BP's practices provide requirements and options for well control risk mitigation, response, and remediation on all BP operated activity throughout the lifecycle of a well. These practices incorporate enhanced industry standards that BP and others developed to advance capabilities across the industry following industry incidents. As described in item 3, BP well site leaders and superintendents are required to undergo competency assessments for their role. BP, rig contractor and well services company staff are required to receive industry-recognized well control certification. Also, BP provides enhanced, scenario-based training for rig crews.
Critical factor: Hydrocarbons ignited on Deepwater Horizon			
6. Diversion to the mud gas separator resulted in gas venting onto the	Once diverted to the MGS, hydrocarbons were vented directly onto the rig through the 12" goosenecked vent exiting the MGS, and other flowlines	The design of the MGS system allowed diversion of the riser contents to the MGS vessel although the well was in a	BP's practices outline the methods and tools to achieve design safety through management of hazards. Managing hazards involves eliminating or minimizing major accident hazards (MAHs) at source

Table 8.3.2 Key Findings from the Macondo Well Blowout Incident and Application to the Scotian Basin Exploration Drilling Project

Finding	Summary Description	Investigation Conclusion	Application to this Project
rig.	also directed gas onto the rig. This increased the potential for the gas to reach an ignition source.	high flow condition. This overwhelmed the MGS system.	and preventing those that remain from becoming major accidents. This may include equipment and design modification before the MODU begins a drilling program. For example, BP design requirements for mud gas separators have been changed in order to divert gas overboard and not near equipment or personnel. In addition, BP conducts hazard and operability reviews (HAZOPs) of surface gas and fluid systems for all BP-owned and BP-contracted drilling rigs, which include a review of hydrocarbon vent locations and design. For additional assurance, BP's Rig Engineering team inspects new MODUs before well operations begin and all MODUS on a periodic basis.
7. The fire and gas system did not prevent hydrocarbon ignition.	Hydrocarbons migrated beyond areas on DWH that were electrically classified to areas where the potential for ignition was higher.	The heating, venting and air conditioning (HVAC) system probably transferred a gas-rich mixture into the engine rooms, causing at least one engine to overspeed, creating a potential source of ignition.	
Critical factor: The blowout preventer did not seal the well			

8. The BOP emergency mode did not seal the well.	Three methods for operating the BOP in the emergency mode were unsuccessful in sealing the well.
	• The explosions and fire very likely disabled the emergency disconnect sequence, the primary emergency method available to the rig personnel, which was designed to seal the wellbore and disconnect the marine riser from the well.
	• The condition of critical components in the yellow and blue control pods on the BOP very likely prevented activation of another emergency method of well control, the automatic mode function, which was
		There were indications of potential weaknesses in the testing regime and maintenance management system for the BOP.	BP's Well Control Practice specifies that:
			• all dynamically positioned (DP) rigs be equipped with subsea BOPs that have two blind shear rams and a casing shear ram;
			• before beginning drilling new wells, a remotely operating vehicle (ROV) demonstrates the ability to access the subsea BOP control panel to pressurize and activate the shear rams;
			• a third party will certify that;
			  o the BOP has been inspected and its design reviewed in accordance with the original equipment manufacturer (OEM) specifications,
			  o modifications to the BOP, if any, have not compromised its design or function,

Table 8.3.2 Key Findings from the Macondo Well Blowout Incident and Application to the Scotian Basin Exploration Drilling Project

Finding	Summary Description	Investigation Conclusion	Application to this Project
	designed to seal the well without rig personnel intervention upon loss of hydraulic pressure, electric power and communications from the rig to the BOP control pods. An examination of the BOP control pods following the accident revealed that there was a fault in a critical solenoid valve in the yellow control pod and that the blue control pod AMF batteries had insufficient charge; these faults likely existed at the time of the accident. • Remotely operated vehicle intervention to initiate the autoshear function, another emergency method of operating the BOP, likely resulted in closing the BOP's blind shear ram (BSR) 33 hours after the explosions, but the BSR failed to seal the well.		o testing and maintenance of BOPs are performed in accordance with OEM guidelines and API Standard 53. This practice also requires confirmation by a shear specialist that the BOP has the ability to shear drill pipe under maximum anticipated surface pressure (MASP) conditions. Also, BP maintains dedicated subsea BOP reliability personnel with a global remit to support all offshore BP drilling activities and can be called upon to assist with BOP related issues. BP's subsea BOP reliability personnel work with its drilling contractors and their original equipment manufacturers (OEMs) to monitor BOP performance and further enhance BOP system reliability through oversight of maintenance and testing. Also, BP and others in industry have advanced industry standards for BOP equipment through the American Petroleum Institute (API). In addition, efforts through API, the International Association of Oil and Gas Producers (IOGP), the International Association of Drilling Contractors (IADC) and other industry groups is focused on sharing information on BOP performance.

8.3.5 Incorporating Lessons Learned

Every official investigation report released to date, including those from the Presidential Commission, the US Coast Guard, the Bureau of Ocean Energy Management (Regulation and Enforcement), and the National Academy of Engineering/National Research Council, reinforces the Bly Report's core conclusion that this was a complex accident with multiple causes involving multiple parties.

The Bly Report recommended a number of measures to strengthen BP's operational practices, and these are being addressed through the implementation of enhanced drilling requirements. Key requirements that have been captured in guidance documents and engineering technical practices are described below.

- **Cementing or zonal isolation**

  BP issued revised mandatory zonal isolation requirements and nine associated engineering guidance documents covering key cementing activities. BP established a global Cementing Engineering team to increase cementing discipline capability and provide increased technical and operational assurance for cementing operations.

- **Integrating process safety concepts into the management of wells**

  BP produced a technical practice specifying minimum requirements for well barrier management to manage the movement of fluids and gas during the life cycle of the well.

- **Well casing design**

  BP updated its design manual for well casing and tubing to include new requirements for pressure tests and revised technical practices. BOP stacks – BP issued a revised technical practice on well control, defining and documenting requirements for subsea BOP configurations. BP requires two sets of BSR and a casing shear ram for all subsea BOPs used on deepwater DP MODUs. BP also requires that third-party verification be carried out on the testing and maintenance of subsea BOPs in accordance with recommended industry practice, and that ROVs capable of operating these BOPs be available in an emergency.

- **Rig audit and verification**

  BP continued the MODU audit process that was enhanced in 2011. BP has conducted detailed hazard and operability reviews for key fluid handling systems on all offshore MODUs contracted to BP. New MODUs contracted to BP are subject to a full independent S&OR Rig Verification assessment and 'readiness to operate' is verified with a detailed go/no-go process assured by S&OR. This verification process includes a checklist, which among other things, assists in assessing that the MODU conforms to applicable BP practices and industry standards and has the right technical specification, and that all actions required for start-up are completed. All MODUs are also subject to subsequent periodic Rig Verification assessments.

In addition to these technical requirements, BP has focused on enhancement of capability and competency; verification, assurance and audit; and process safety performance management.

8.3.6 Progress on Recommendations of the Bly Report

Progress on implementing the recommendations from the Bly Report, BP's investigation into the Deepwater Horizon accident, from an independent expert appointed to provide an objective assessment of this progress, concluded in February 2016 that all 26 Bly Report recommendations had been closed out to his satisfaction. Further information is provided in the BP 2015 Sustainability Report (http://www.bp.com/en/global/corporate/sustainability/reporting.html). Table 8.3.3 outlines progress against the Bly Report recommendations.

Table 8.3.3 Progress Against the Bly Report Recommendations

No.	Finding	Progress (at end 2015)
1	Update and clarify cementing practice and guidelines.	Complete
2	Update requirements for subsea BOP configuration.	Complete
3	Update recommendations for negative pressure tests and lock-down rings.	Complete
4	Update practice on working with pressure, including contingency and testing procedures.	Complete
5	Strengthen incident reporting standards for well control and well integrity.	Complete
6	Proposal of recommended practice for design and testing of foamed cement slurries to API.	Complete
7	Assess risk management and Management of Change (MoC) processes for life cycle global wells activities.	Complete
8	Strengthen the technical authority's role in cementing and zonal isolation.	Complete
9	Enhance drilling and completions competency programs for key operations and leadership positions.	Complete
10	Develop advanced deepwater well control training.	Complete
11	Establish BP in-house expertise for subsea BOP and BOP control systems.	Complete
12	Request the IADC to develop subsea engineering certification.	Complete
13	Strengthen BP's rig audit process to improve closure and verification of audit findings across the rigs BP owns and contracts.	Complete
14	Establish key performance indicators (KPIs) for well integrity, well control, and rig safety-critical equipment.	Complete
15	Require drilling contractors to implement auditable integrity monitoring system.	Complete
16	Assess cementing service provider capabilities.	Complete

Table 8.3.3 Progress Against the Bly Report Recommendations

No.	Finding	Progress (at end 2015)
17	Confirm well control and monitoring practices are defined and applied.	Complete
18	Require hazard and operability reviews for surface gas and drilling fluid systems.	Complete
19	Include study of all drilling rig surface system hydrocarbon vents in all hazardous operations (HAZOPS).	Complete
20	Establish minimum levels of redundancy and reliability for BOP systems.	Complete
21	Strengthen BP's requirements for BOP testing by drilling contractors, including emergency systems.	Complete
22	Strengthen BP's requirements for BOP maintenance management systems by drilling contractors.	Complete
23	Set minimum standards for drilling contractors' MoC for subsea BOPs.	Complete
24	Develop a clear plan for ROV intervention for each subsea BOP.	Complete
25	Require contractors to verify BSR performance capability.	Complete
26	Include testing and verification of revised BOP standards in MODU audit.	Complete

8.4 SPILL FATE AND BEHAVIOUR

Spill fate modelling has been undertaken to evaluate the effects of potential spill scenarios that could arise as part of the Project. The fate and behaviour of spilled oil is dependent on a number of factors at the point of release and the effects on any VC are contingent on how the VC and oil interact. Spill fate modelling will also be used to inform the response strategies selected as part of the SRP.

This section sets out the methodology and assumptions used for the modelling work, and a summary of the modelling outputs is provided to describe spill fate and behaviour. The spill modelling report is included as Appendix H.

8.4.1 Spill Fate Modelling Approach

As discussed in Section 8.2, a number of potential spill scenarios could occur during Project activities as a result of an accidental event.

BP has modelled a number of these scenarios to inform the assessment of potential environmental effects associated with spills that could occur during exploration drilling activity. The primary objective of spill modelling carried out for the Project was to assess transport, fates and effects of oil associated with each scenario. Modelling was carried out using BP's preferred model, the SINTEF Oil Spill Contingency and Response (OSCAR). Prior to modelling, BP consulted with technical experts from applicable regulatory agencies (*e.g.*, CNSOPB, DFO, Environment

Canada) to discuss the proposed modelling approach including the use of OSCAR, data inputs (*e.g.*, metocean and oil characteristics), modelling scenarios and modelling thresholds.

The scope of the modelling included several aspects:

- a prediction of the movement and weathering of the oil originating from release sites using spatial wind data, current data and specific hydrocarbon properties;
- stochastic modelling to predict the probability and areal extent of oiling above threshold levels at the sea surface, on shorelines and in the water column for each scenario;
- deterministic modelling to show the single spill trajectory with the highest amount of oil reaching the shore for each scenario; and
- a calculation of the maximum amount of oil that could contact the shoreline.

Scenarios were modelled to represent both a low probability, large scale event (*i.e.*, a subsea blowout incident) and an instantaneous, small scale spill scenario (*i.e.*, a surface release of diesel). The scenarios were modelled at two potential drilling locations in the ELs to evaluate the potential impact of water depth and proximity to sensitive receptors in and around the ELs. For all scenarios, the models were run without mitigation until the amount of oil in the system fell below the significance thresholds described in 8.4.6.

Results from a 10 bbl diesel spill at the MODU were used to inform an assessment of a nearshore PSV diesel spill. Additionally, SBM modelling conducted for the Shelburne Basin Venture Exploration Drilling Project (RPS ASA 2014, included as Appendix C in Stantec 2014a) has been referenced as appropriate to inform the assessment of a SBM spill (refer to Section 8.4.10).

8.4.2 Spill Model

BP carried out the modelling work using its preferred model for oil spill trajectory modelling, SINTEF's [(1)] OSCAR model. OSCAR is a sophisticated 3-dimensional model that calculates and records the distribution (as mass and concentrations) of oil on the water surface, on the shorelines and in the water column. The model computes surface spreading, slick transport, entrainment into the water column, evaporation, emulsification and shoreline interactions to determine oil drift and fate at the surface. In the water column, horizontal and vertical transport by currents, dissolution, adsorption, settling and degradation are simulated.

There are two types of model simulations that can be generated: stochastic simulations and deterministic simulations. Both simulation types are used in different ways during the modelling process to inform the various stages of assessing the risk posed by the scenarios. Together, the

(1) For more information on SINTEF see www.sintef.no.

two model types provide an indication of both likelihood and magnitude of any potential effects.

Stochastic Modelling Simulations

Stochastic modelling is used to predict the probability of sea surface, shoreline or water column oiling that may occur following a spill event. This type of modelling accounts for the variability of metocean conditions in the study area over the anticipated operational period to provide insight into the probable behaviour of the potential spills.

Stochastic modelling involves running numerous individual spill trajectory simulations using a range of prevailing wind and current conditions that are historically representative of the season and location of where the spill event may occur. The trajectory results are then combined to produce statistical outputs that include the probability of where oil might travel and the time taken for the oil to reach a given shoreline. The stochastic model output does not represent the extent of any one oil spill event (which would be substantially smaller) but rather provides a summary of the total individual simulations for a given scenario or oil type. Stochastic models are used for emergency response planning purposes.

Deterministic Modelling Simulations

Deterministic modelling (or single spill trajectory analysis) is used to predict the fate (transport and weathering behaviour) of spilled oil over time under predefined hydrodynamic and meteorological conditions.

When carrying out deterministic modelling, BP typically selects the conditions that give rise to the simulation with the greatest shoreline oiling from the stochastic modelling.

8.4.3 Model Scenarios

Further to the information presented about potential scenarios that could arise during the Project in Section 8.2, two categories of scenarios were modelled as part of the EIS. Two tentative locations were selected on the basis of preliminary seismic data processing and interpretation. These are located in different water depths and at varying distances to sensitive receptors within and around the ELs (shown in Figure 8.4.1). Both locations represent viable drilling prospects in the Scotian Basin.

Table 8.4.1 Release Locations

Location	Block	Water Depth	Longitude	Latitude	Distance from Sable Island
Site 1	EL 2434	2104 m*	60.434610	43.046428	105 km
Site 2	EL 2432	2652 m	61.229314	42.692076	170 km

* Referred to as shallow site given relative water depth within BP's Project Area and prospective drilling prospects.

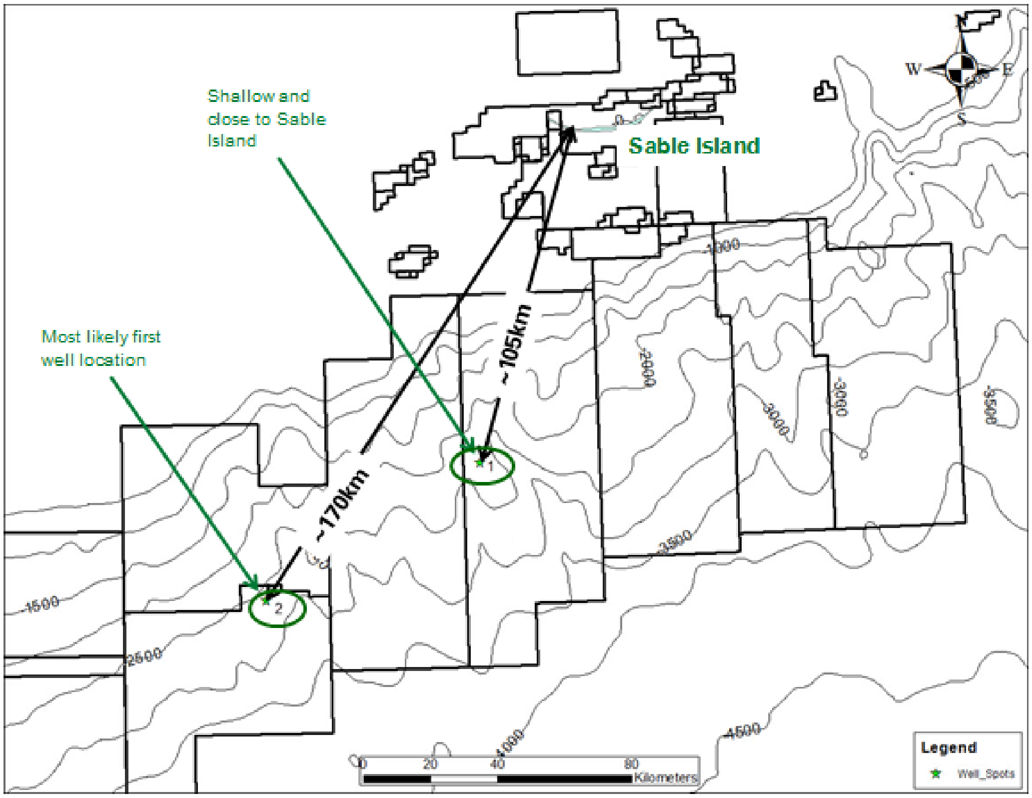


Figure 8.4.1 Release Locations

The scenarios that were modelled were:

1. **A surface release of diesel**

   Two surface diesel release scenarios have been modelled to represent a loss of containment at the MODU. This scenario represents the most likely spill scenario that could occur on the MODU.

   The spill volumes modelled included 10 bbl, to represent a hose failure, *i.e.*, an operational and maintenance spill, and 100 bbl, to represent a tank failure, *i.e.*, a bulk spill. For a conservative assessment, the location selected for the diesel releases was the wellsite closest to the shoreline of Sable Island.

2. **A subsea blowout of crude oil**

   Two subsea blowout scenarios have been modelled at different locations within the ELs. As a precautionary measure, in both wells, BP assumed 100% oil content in the reservoir sands (*i.e.*, 0% water cut in the formations). Both blowout scenarios assume the presence of two high pressure sands, which are both exposed in a blowout scenario. Release volumes varied between the two locations. The first location (Site 1) at 2,104 m water depth has a total flow rate of 24,890 barrels per day (bpd). The second location (Site 2), at 2,652 m water depth, has a total flow rate of 35,914 bpd.

Steady state uncontrolled well discharge modelling has been undertaken to assess the potential worst-case credible discharge that could occur as a result of a blowout incident at the two potential locations. The well discharge model and analysis was prepared by BP subject matter experts against internal standards and has been peer reviewed internally. The provisional well design presented in the Project Description (Section 2.4.2) was used as the casing configuration for the well discharge modelling. It has been assumed that if two sands are exposed then the pipe diameter will be 12 ¼ inches.

For modelling purposes, BP has assumed a release duration of 30 days. This duration is slightly more conservative than estimated times for the deployment of a capping stack. BP will mobilize and deploy cap and containment equipment and tools as soon as possible. As described previously, current estimates indicate that the well can be capped between 13 and 25 days after an incident.

In line with the precautionary principle, BP has selected the worst-case credible discharge for each scenario. All modelled scenarios were run unmitigated (*i.e.*, without any oil spill tactical response methods such as those presented in Section 8.3.3.3) with the use of a capping stack for the blowout incident scenarios. In reality, spill mitigation measures such as oil spill containment, recovery and shoreline protection measures would be implemented in the event of a spill to reduce adverse effects to marine and coastal resources, thereby mitigating the full impact of a spill.

Variable environmental conditions for the region, including wind and currents were considered as part of the modelling work. Hindcast metocean data was used as part of the model. The hindcast data incorporates data from January 2006 to December 2010. The impact of large winter storms has therefore been accounted for as these are well-represented in the metocean data. Further information about metocean data used in support of the modelling work is presented in 8.4.5.

Stochastic and deterministic modelling were carried out for each scenario. Separate stochastic simulations were carried out to represent the following weather seasons:

- Winter season (November - April)
- Summer season (May to October)

Forty-five (45) simulations were run per year for each season over the timeframe of the metocean data (*i.e.*, from January 2006 to December 2010) resulting in a total of 210 simulations per season for the blowout scenarios and 225 simulations per season for the surface diesel release scenarios.

The scenarios that have been run as part of the modelling work are summarised in Table 8.4.2.

Table 8.4.2 Modelled Scenarios

Scenario	Location	Water Depth	Modelled Scenario	Released Product	Release Duration	Release Volume	Modelling Type
Scenario 1	Site 1	2,104m	Blowout	Crude Oil (Sture Blend)	30 days	733,000 bbl * (24,890 bpd)	Stochastic & deterministic
Scenario 2	Site 2	2,652m	Blowout	Crude Oil (Sture Blend)	30 days	1,056,000 bbl * (35,914 bpd)	Stochastic & deterministic
Scenario 3	Site 1	2,104m	Batch Spill	Marine Diesel	Instantaneous	10 bbl	Stochastic & deterministic
Scenario 4	Site 1	2,104m	Batch Spill	Marine Diesel	Instantaneous	100 bbl	Stochastic & deterministic

* Note:
Flow rate declines over duration of release.

8.4.4 Predicted Fluid Characteristics

The oil types modelled include marine diesel and crude oil.

Oil and chemical databases supply chemical and toxicological parameters required by the OSCAR model. A unique strength of the model is its foundation on an observational database of oil weathering properties. The laboratory and field methods developed at SINTEF for weathering of crude oils and petroleum products are described in Daling *et al.* (1990, 1997). Numerous field tests have verified the reliability of weathering predictions based on this methodology, in order to avoid unrealistic results.

The oil database contains complete weathering information for more than 50 crude oils and petroleum products. It also contains crude assay data for approximately 150 other crude oils. These latter data are derived from the Hydrocarbon Processing Industry (HPI) database (HPI 1987). Since no empirical observations of weathering are available for these oils, model estimates of oil weathering are less reliable than for oil for which oil weathering studies have been carried out.

SINTEF (Aamo *et al*. (1993) and Daling *et al*. (1997)) use a multivariate approach to group oil types based on a limited data set available from crude oil assays (wax/asphaltene content, viscosity, density, pour point and the true boiling point curve). This approach can be used to match new oil types to oils where their weathering properties are already mapped or characterized to select analogue oils for OSCAR modelling.

Marine Diesel

Marine diesel is a standard diesel used widely in offshore activity including shipping and oil and gas activity. It has a low viscosity and high aromatic content. Its characteristics are well known and tested. Characteristics of marine diesel were derived from the SINTEF database. Refer to Table 8.4.3 for marine diesel fluid properties.

Table 8.4.3 Diesel Fluid Properties

Parameter	Value
API gravity	36.4
Specific gravity	0.843
Pour point	-36˚C
Dead oil viscosity at reference (surface) temperature	3 cP
Reference temperature	13 ˚C

Crude Oil

Given that the wells to be drilled for this Project are exploratory, the exact nature of the well hydrocarbon fluids that may be encountered is unknown. The crude oil characteristics were selected to align with the expected reservoir characteristics.

Petroleum fluid properties in exploration areas can be predicted using a bottom-up petroleum system analysis approach. Specific properties of the petroleum fluid will depend on the richness, quality and thermal maturity of the source rocks. Where available, top-down observations on petroleum fluid analogues from offset wells or nearby areas can be used to further constrain expected fluid properties.

Two potential formations that could be encountered during drilling operations were considered as part of the blowout incident modelling. The estimated properties of the reservoir fluid in the reservoir conditions are presented in Table 8.4.4.

Table 8.4.4 Reservoir Fluid Properties at Reservoir Conditions

Fluid Properties	Lower Sand @ Reservoir Conditions	Upper Sand @ Reservoir Conditions	Units
Reference Pressure	13,000	10,000	psi
Reference Temperature	356 / 180	257 / 125	°F/°C
Boi	1.23	1.24	rvb/stb
Initial Gas Oil Ratio	756	756	scf/stb
Viscosity	0.643	0.738	cp
Compressibility	1.0757	1.0087	10^{-5} psi^{-1}
Density	0.8852	0.8757	g/cc
Psat	2,581	2,077	Psi

Note:
Boi=Oil Formation Volume Factor at Initial Reservoir Pressure; cp=Centipoise; Psat=Saturation Pressure; scf=square cubic feet (surface volume); rvb = reservoir barrel; stb = stock tank barrel

Using the multivariate analysis best fit approach developed by SINTEF described above, Sture Blend oil has been shown to provide the best overall match of oil properties to those predicted for the wells selected for modelling. This is demonstrated in the table below.

Table 8.4.5 Reservoir Fluid Properties

Fluid Properties:	Estimated Fluid Properties	Analogue Sture Blend	Units
API gravity	34.1	35.5	
Specific gravity	0.854	0.847	
Pour point	-5	-3	°C
Wax content	4.1	4	wt%
Asphaltene content	4.6	0.2	wt%
Nickel	5.7	n/a	ppm
Vanadium	4.7	n/a	ppm
Dead oil viscosity at reference (surface) temperature	12.5	10	cP
Reference (surface) temperature	16	13	°C
Live oil viscosity at reservoir temperature	0.7		cP
Reservoir temperature	115		°C

8.4.5 Metocean Model Information

Currents, winds and other metcoean factors are critical parameters which can influence the fate and behaviour of oil following a spill. Metocean data is available from a number of sources and can be formatted to work in the OSCAR model.

BP commissioned an independent, assurance review of potential metocean models to use in modelling work to support the Scotian Basin EIS. The review compared hindcast data of two potential metocean models to published data to identify which is the better representation of the expected conditions in the Scotian Basin.

The assurance work was designed to take account of the following features:

- **Regional:** circulation, sea surface height, sea surface temperature;
- **Sub-regional**: circulation, temperature and salinity transects, tides, drifters; and
- **Scotian Shelf**: hydrography, moorings.

The independent assurance assessment has identified a shortlist of metocean models (identified in Table 8.4.6) that provide the most accurate representation of the anticipated conditions in offshore Nova Scotia. For each physical parameter of interest, hindcast data from between

January 1, 2006 and December 31, 2010 was used to compile a multiyear data set to support the oil spill modelling work.

In the event that spill modelling is required during the drilling campaign to support a response effort, BP will use forecast metocean data. BP has an automated process where forecasts of high quality wind and current data are downloaded on a daily basis to an internal webserver, where they are then automatically reformatted into the correct formats ready for use in OSCAR.

Table 8.4.6 Metocean Data Parameter Inputs

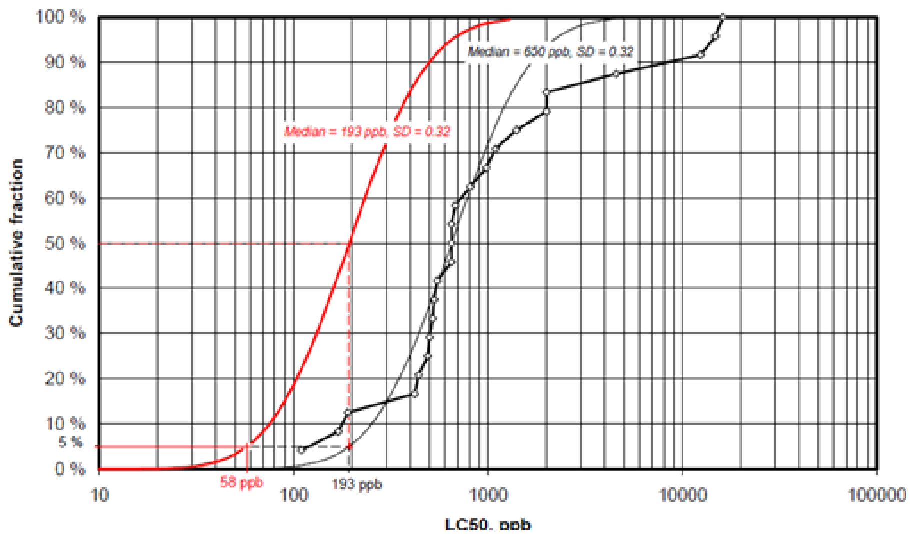
	Input Data	Reference
Bathymetry	GEBCO-1 minute	http://www.gebco.net/
Current velocity components	HYCOM	https://hycom.org/
Sea-surface elevation	HYCOM	https://hycom.org/
Temperature	HYCOM	https://hycom.org/
Salinity	HYCOM	https://hycom.org/
Tides	Oregon TPX07.2	http://volkov.oce.orst.edu/tides/global.html
Wind	NOAA	http://www.noaa.gov/
Atmospheric forcing	CFSR	http://cfs.ncep.noaa.gov/cfsr/
Wave heights	Calculated in OSCAR	n/a
Wind induced current	Calculated in OSCAR	n/a

8.4.6 Modelling Thresholds

Following a spill, it is expected that oil will spread over the water surface and will disperse throughout the water column. To assess the probability or likelihood of potential effects of a spill, specific thresholds for surface oil thickness, shoreline oiling and in water concentration have been used. The chosen hydrocarbon thresholds for probability of exposure at the sea surface, entrained and dissolved in the water column and stranded on shorelines and the justification for their use is presented in Table 8.4.7.

Table 8.4.7 Thresholds Used in Spill Modelling

Selected Threshold	Rationale
Surface Oil Thickness	
0.04 µm	Visible sheens on the water surface can have a socio-economic effect as commercial resources can be affected. For example, fisheries are typically closed when a visible sheen is detected. A visible sheen can be detected from 0.04 µm oil thickness. The Bonn Agreement Oil Appearance Code (BAOAC) is a series of five categories that relate the appearance of oil on the sea surface to the thickness of the oil layer. Between 0.04 µm and 0.30 µm oil thickness, a silvery grey sheen may be visible. A rainbow sheen is visible between 0.30 µm and 5.0 µm, a metallic sheen is visible between 5.0 to 50µm, a discontinuous true oil colour is visible between 50 and 200 µm, and a continuous true oil colour is visible at 200 µm oil layer thickness. The minimum thickness of oil that may result in harm to seabirds through ingestion from preening of contaminated feathers, or loss of thermal protection from their feathers, has been estimated by different researchers to range between 10 µm (10 g/m^2) to 25 µm (25 g/m^2) (French-McCay 2009). A conservative surface thickness threshold of 0.04 µm was used in the modelling in recognition of potential socio-economic effects (*e.g.*, fisheries closure) in the presence of a barely visible or silver sheen on the water surface.
Shoreline Mass	
1.0 g/m^2	Oil on the shoreline can have an effect on environmental and socio-economic receptors. French-McCay (2011) quotes shoreline impact lethal thresholds of 1 kg/m^2 (1mm) for vegetation growing along flat shorelines with soft sediments and 100 g/m^2 (0.1 mm) for epifaunal invertebrates (*e.g*., mussels, crabs, starfish). However, a conservative stranded oil threshold of 1.0 g /m^2 was used in the stochastic modelling as that amount of oil would conservatively trigger the need for shoreline clean-up. This is equivalent to a density of 1" diameter tarballs at 0.12 to 0.14 tarballs per m^2 of shoreline.
In-Water Concentration (dissolved and entrained, top 100m)	
58 ppb total hydrocarbons	Carls *et al*. (2008) found that the acute toxicity of water-soluble fraction of oil (lethal concentration at which 50% death may occur) for fish embryos varies from 200 to 5,000 ppb total hydrocarbons. Based on extensive toxicity tests of crude oils and oil components on marine organisms, the OLF (the Norwegian Oil Industry Association) *Guideline for risk assessment of effects on fish from acute oil pollution* (2008) concluded that threshold concentration for an expected "no observed effect concentration" (NOEC) for acute exposure for total hydrocarbons ranges from 50 - 300 ppb. Work undertaken by Neilson *et al.* (2005, as reported in OLF 2008) proposed a value for acute exposure to dispersed oil of 58 ppb, based on the toxicity of chemically dispersed oil to various aquatic species, which showed the 5% effect level is 58 ppb (see Figure 8.4.2).



Source: Neilson *et al.* (2005, as reported in OLF 2008)

Figure 8.4.2 Threshold Concentrations for "No Observed Effect Concentration" (NOEC) for Acute Exposure for Total Hydrocarbons

8.4.7 Stochastic Modelling Results

Stochastic modelling outputs illustrate the probabilistic locations of surface oiling, water column dispersed and dissolved oil concentrations, and shoreline oiling for spills based on seasonal metocean conditions. Associated minimum arrival times for threshold exceedances are also provided in the stochastic modelling outputs.

8.4.7.1 Interpretation of Model Results

Probability of Oiling

The probability of oiling locations was based on a statistical analysis of the resulting accumulation of individual trajectories for each spill scenario (210 individual model runs over 5 years [2006-2010]). The stochastic modelling output figures do not imply that the entire contoured area, or even a large portion of this area, would be covered in oil in the event of an unmitigated spill, but rather the location of possible oil contamination. The figures do not provide information on the quantity of oil in a given area; rather they indicate the probability of oil exceeding the given threshold over the entire accumulation of runs at each point (*i.e.*, location). Figures relevant to water column dispersed and dissolved oil concentration illustrate oiling frequency, but do not specify the given water depth at which oiling will occur. These figures do not imply that the oiling will occur throughout the entire water column (*i.e.*, from the surface to the sea bed).

Minimum Travel Times

The footprint for the "minimum arrival times" figures correspond with the associated probability of oiling figures. Each figure illustrates the shortest time required for oil to exceed the defined thickness or concentration threshold at each point within the footprint of the spill location, based on all individual trajectories run for that scenario.

8.4.7.2 Oil Fate Results

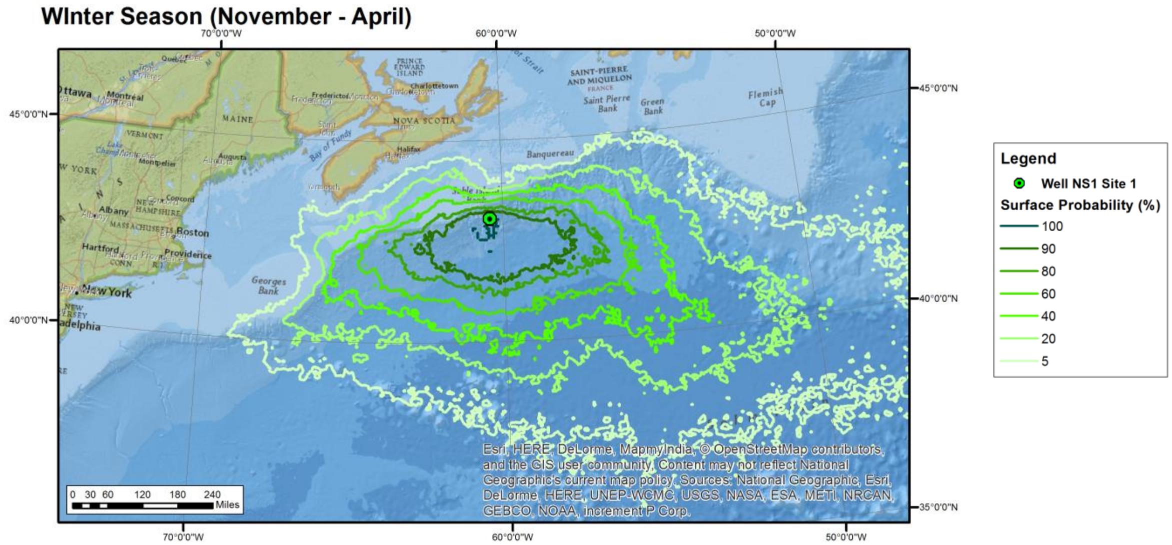
A total of 210 individual releases were modelled for both Sites 1 and 2. Each individual scenario was run for the initial 30 day release period, and an additional 90 days to show the fate and trajectory of oil after the well had been capped (i.e., for 120 days in total). This approach allowed the spill scenarios to be evaluated to the point where either the oil had reached a negligible amount or the shoreline was reached as per the EIS Guidelines.

Each individual run assumed the use of no tactical response methods to contain or control any released hydrocarbons (*i.e.*, the releases were unmitigated). In reality, BP would deploy a suite of spill response methods as explained in Section 8.3.3. This approach of assuming no mitigation measures in the spill fate modelling allows an evaluation of the potential worst case credible effects from a spill and helps to inform the most effective response strategy.

Site 1 is a smaller volume and shallower water release of modelled spilled oil (24,890 bpd at a water depth of 2,104 m), while Site 2 was a larger volume of modelled spilled oil at a greater water depth (35,914 bpd at a depth of 2,652 m). Seasonal summaries of stochastic analyses of potential surface oiling (Figures 8.4.3 to 8.4.6) and water column dispersed and dissolved oil concentrations (Figures 8.4.7 to 8.4.10) illustrate the locations of potential oil contamination in Canadian waters surrounding Nova Scotia and Newfoundland, US waters to the east of New England, and international waters south of Canada for Sites 1 and 2.

As noted above, the oiling footprint locations provided in the stochastic modelling outputs are not the expected extent of oiling from a single release of oil. The locations of the oiling footprints represent the potential areas in which oil could travel following a 30-day unmitigated release. Each scenario was run for the 30 day release period, and an additional 90 days to show the fate of oil after the well was capped. The modelling results predict that the majority of oil will remain in offshore waters with a <20% probability that surface oil exceeding the 0.04 µm (Bonn Agreement Oil Appearance Code (BAOAC) "Sheen") will enter nearshore waters of Nova Scotia for both the summer and winter scenarios. In the event that surface oil was to enter the nearshore area of Nova Scotia, it would take a minimum of between 30 to 50 days to arrive. The in-water dispersed and dissolved oil threshold exceedance of 58 ppb for total hydrocarbons (THC) is also expected to remain in offshore waters; however, the location impacted is predicted to be smaller. The modelling results indicate that the in-water oil exceedance will not reach the nearshore waters of mainland Nova Scotia. Although the winter (November to April) scenario predicts that no in-water oil will reach Sable Island, there is a 5% probability that in-water oil concentrations will exceed the threshold around Sable Island for the summer (May to October) scenario. The minimum arrival times for in-water oil concentrations exceeding the threshold to waters surrounding Sable Island in the summer is predicted to be between 10 and 20 days.

For the two modelled unmitigated blowout scenarios (Sites 1 and 2), the probability of shoreline oiling exceeding the 1 µm threshold (or 0.001 litres/m^2 for "stain/film" oiling) is moderate, ranging up to a maximum of 50 % probability at Sable Island (Site 1 summer season; see Figure 8.4.12). Shoreline oiling is possible for both scenarios (Sites 1 and 2) for both seasons (summer and winter), with the summer season resulting in the most oil stranded onshore. The earliest arrival time for shoreline oil exceeding the threshold for Site 1 occurs during the summer with an arrival time of approximately 3.8 days to the nearest shoreline (Sable Island). In the winter season, the earliest arrival time is approximately 5.8 days to Sable Island. For spill Site 2, the earliest arrival time for shoreline oiling (Sable Island) above the threshold occurs during the summer approximately 6.6 days following the start of the release. During the winter, the earliest arrival time occurs after approximately 10.5 days. Figures 8.4.11 to 8.4.14 depict shoreline oiling probabilities, arrival times, and associated thickness.



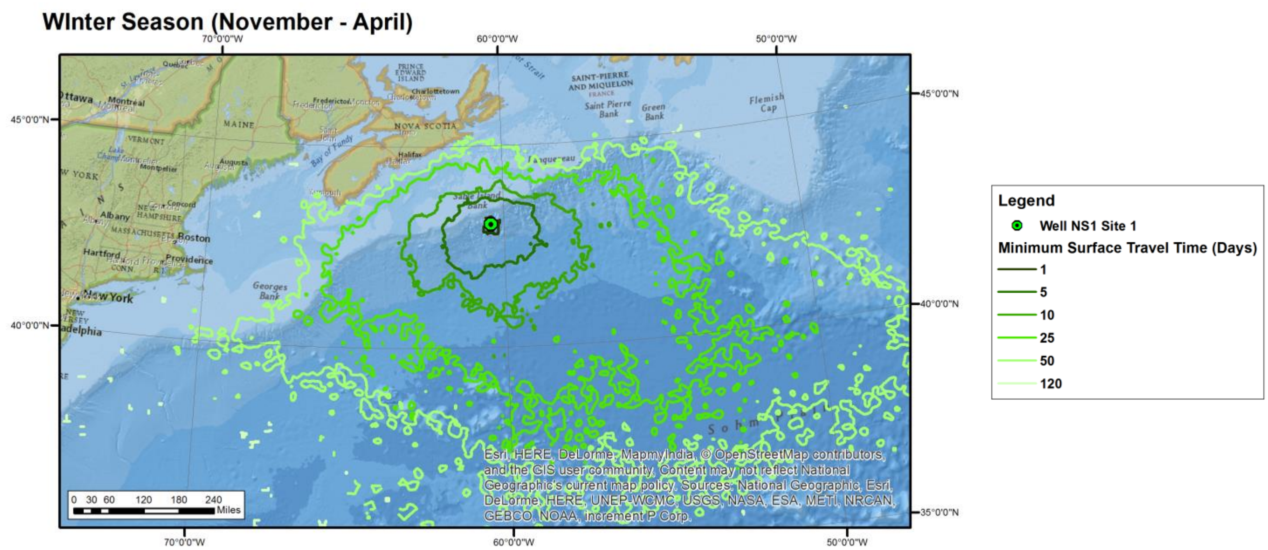


Figure 8.4.3 Winter (November to April) stochastic model output (210 individual runs) showing maps of the predicted probability of sea surface oiling exceeding the 0.04 µm thickness threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 24,890 bpd blowout incident at Site 1.

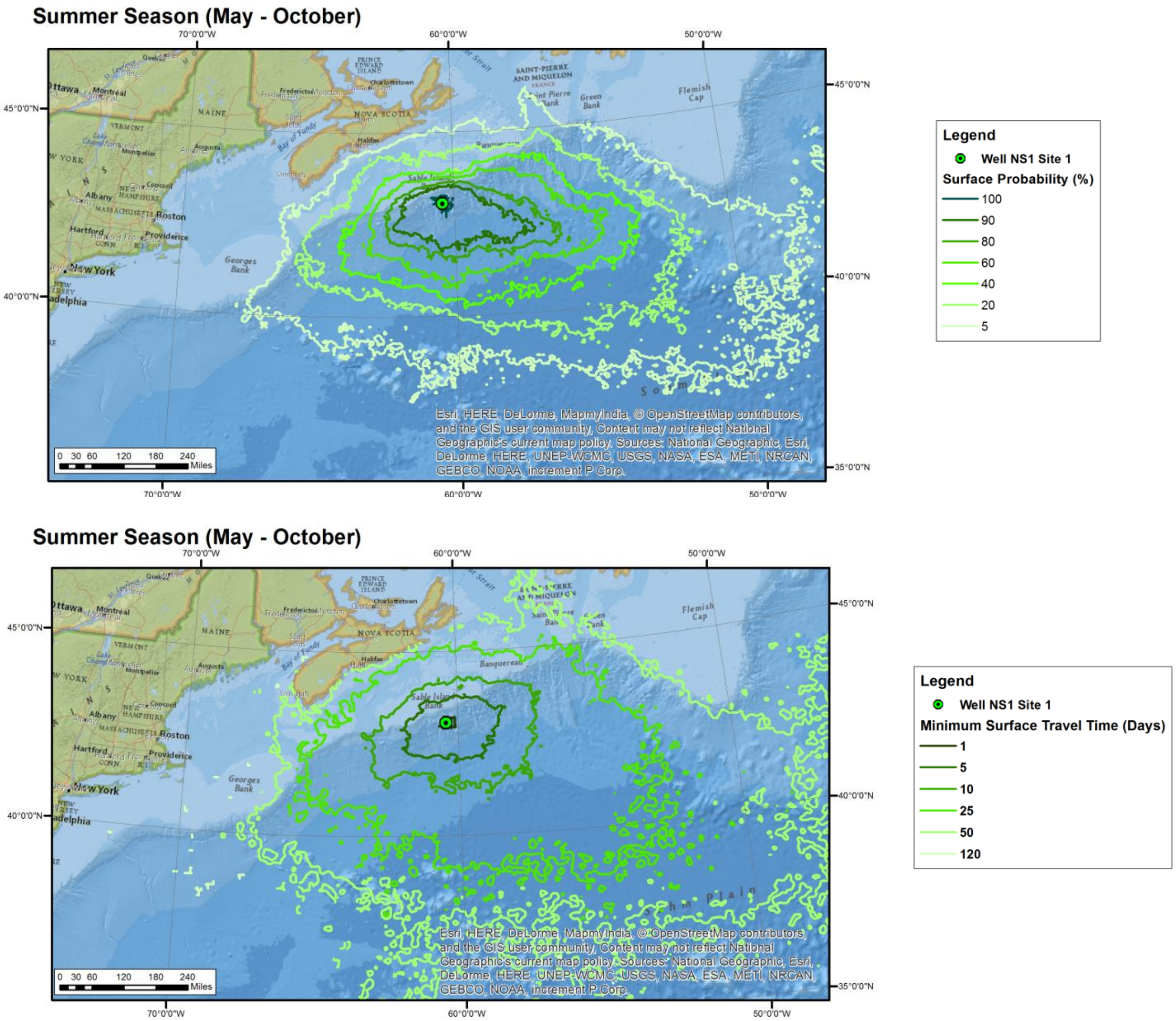


Figure 8.4.4 Summer (May to October) stochastic model output (210 individual runs) showing maps of the predicted probability of sea surface oiling exceeding the 0.04 µm thickness threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 24,890 bpd blowout incident at Site 1.

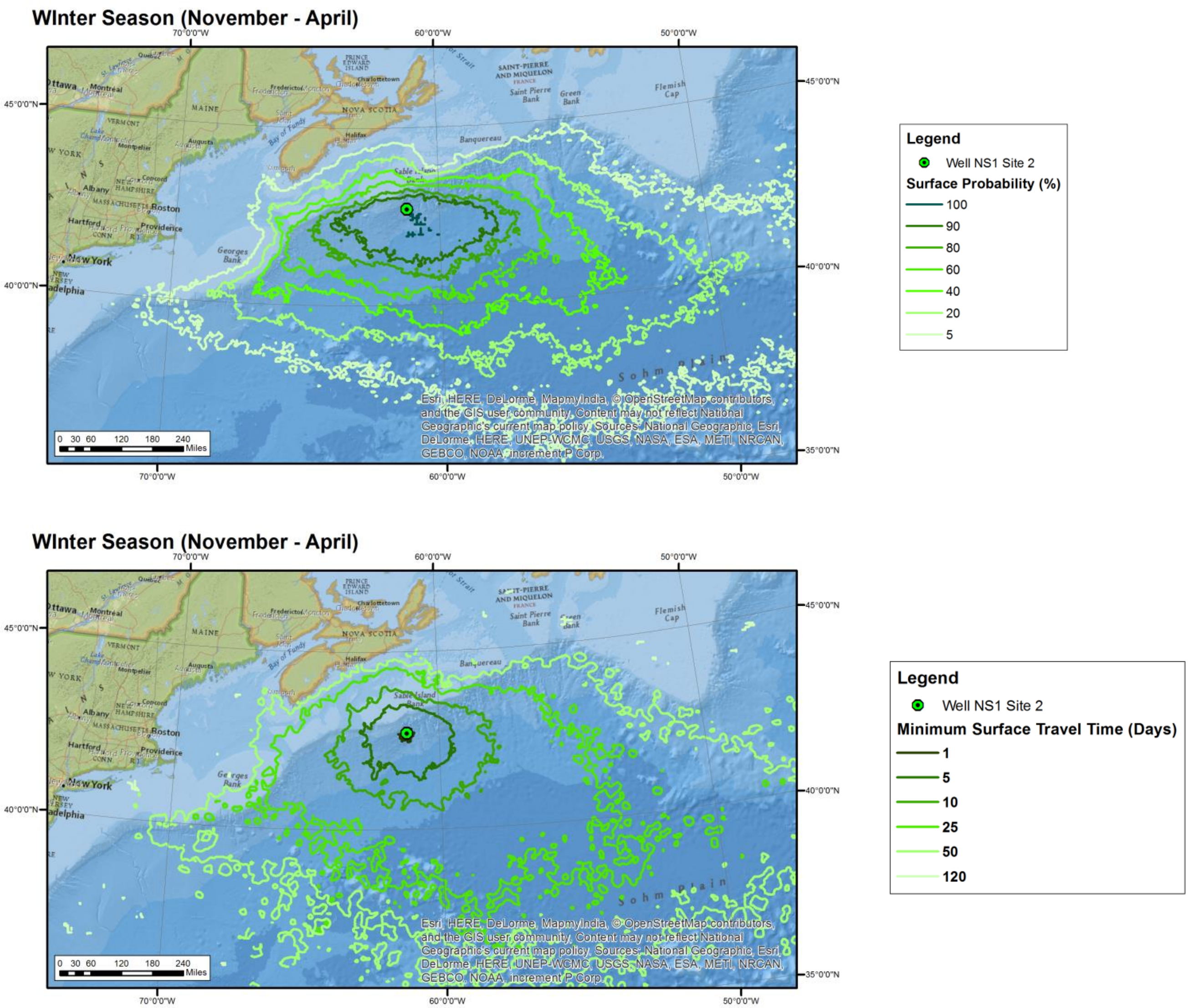


Figure 8.4.5 Winter (November to April) stochastic model output (210 individual runs) showing maps of the predicted probability of sea surface oiling exceeding the 0.04 µm thickness threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 35,914 bpd blowout incident at Site 2.

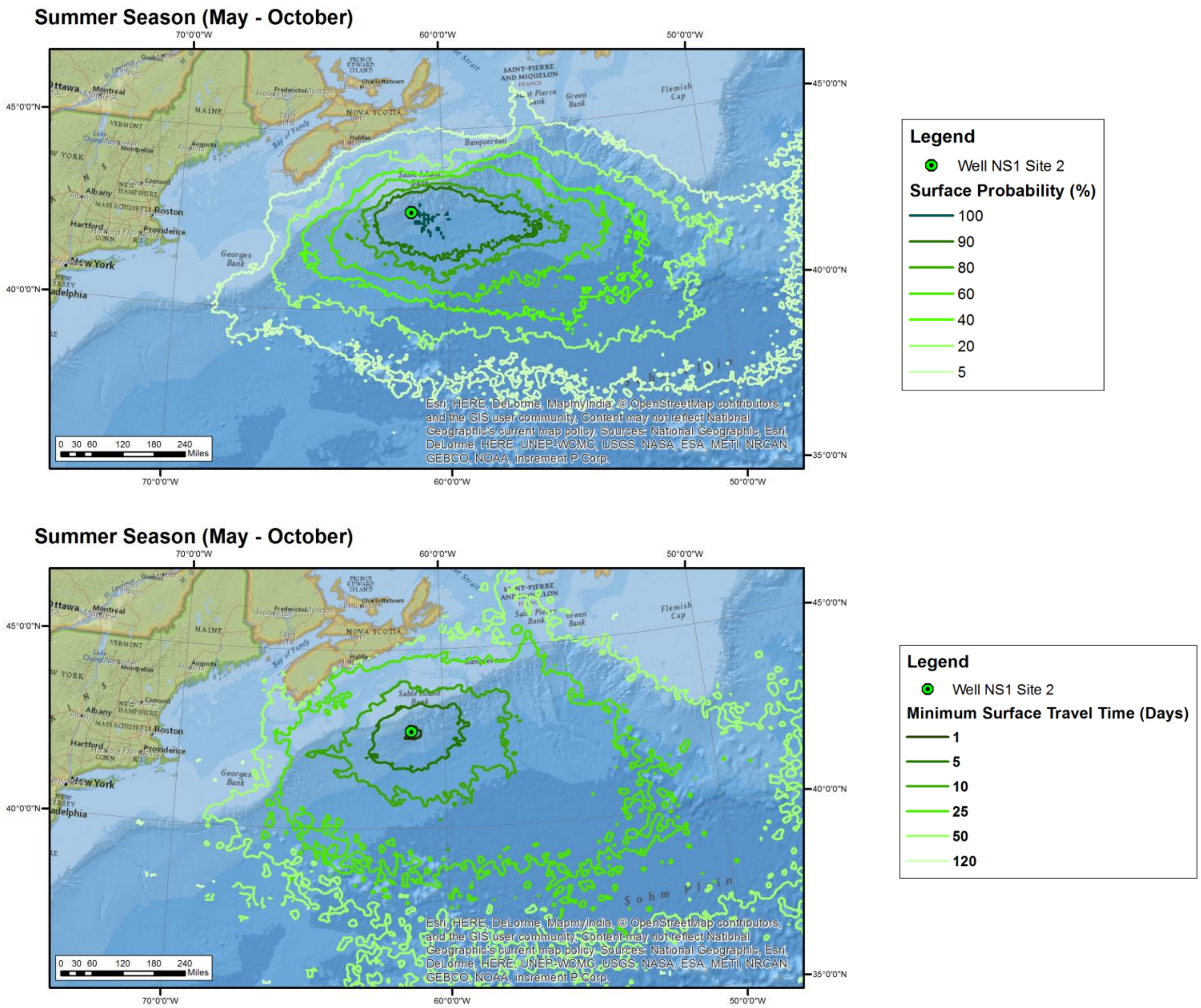


Figure 8.4.6 Summer (May to October) stochastic model output (210 individual runs) showing maps of the predicted probability of sea surface oiling exceeding the 0.04 µm thickness threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 35,914 bpd blowout incident at Site 2.

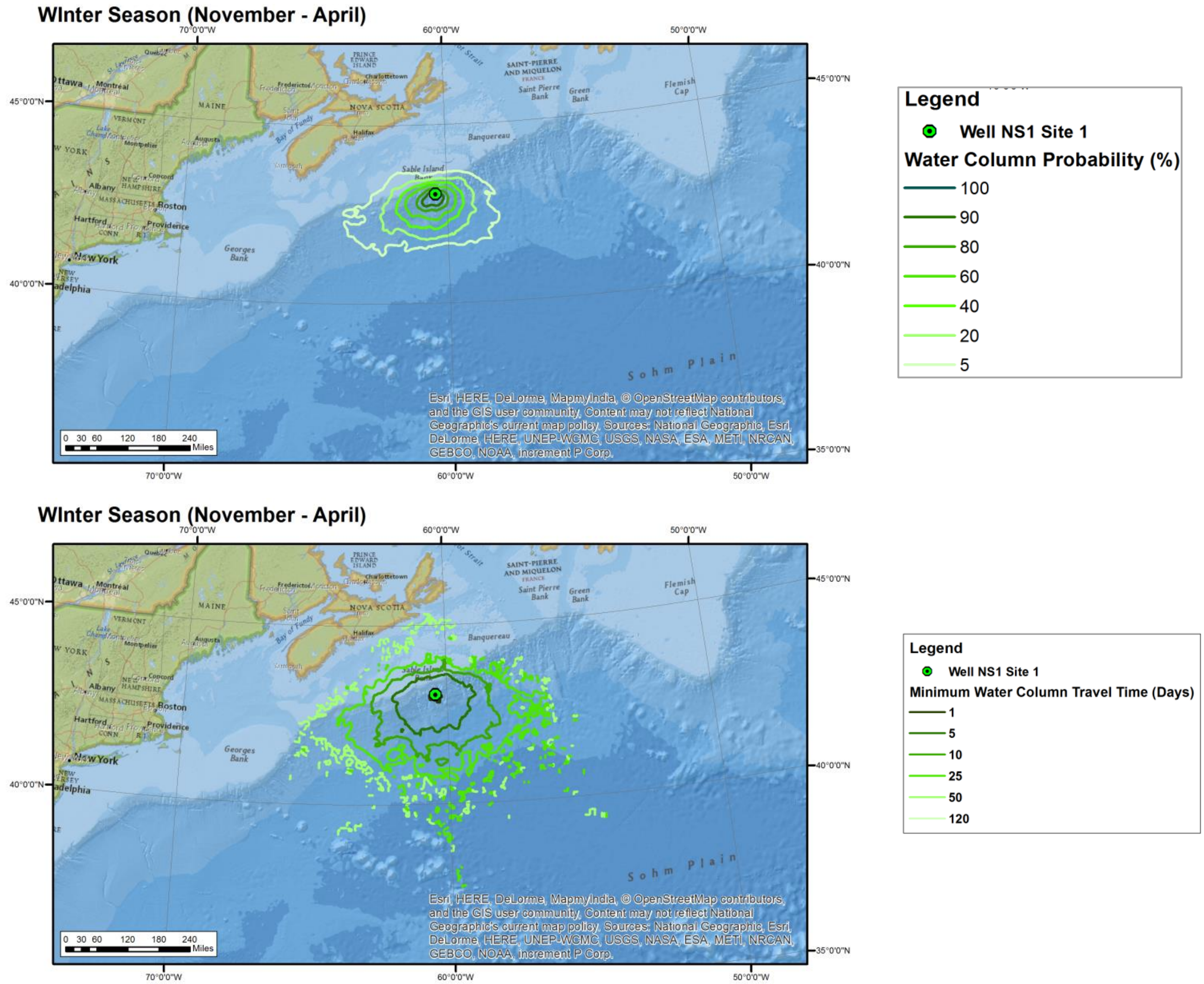


Figure 8.4.7 Winter (November to April) stochastic model output (210 individual model runs) showing maps of the predicted probability of water column dispersed and dissolved oil concentrations exceeding the 58 ppb total hydrocarbon threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous blowout incident at Site 1.

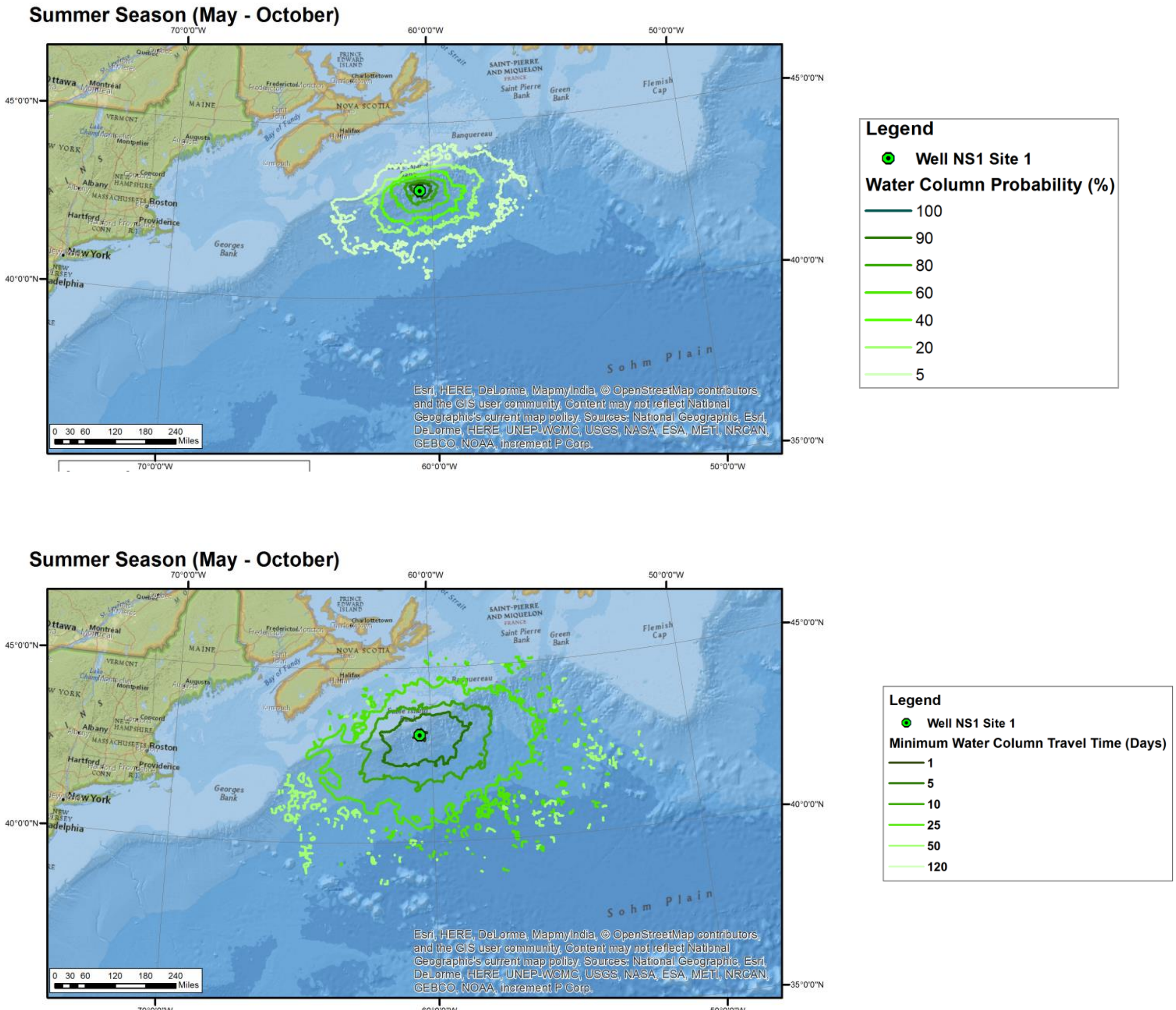


Figure 8.4.8 Summer (May to October) stochastic model output (210 individual model runs) showing maps of the predicted probability of water column dispersed and dissolved oil concentrations exceeding the 58 ppb total hydrocarbon threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous blowout incident at Site 1.

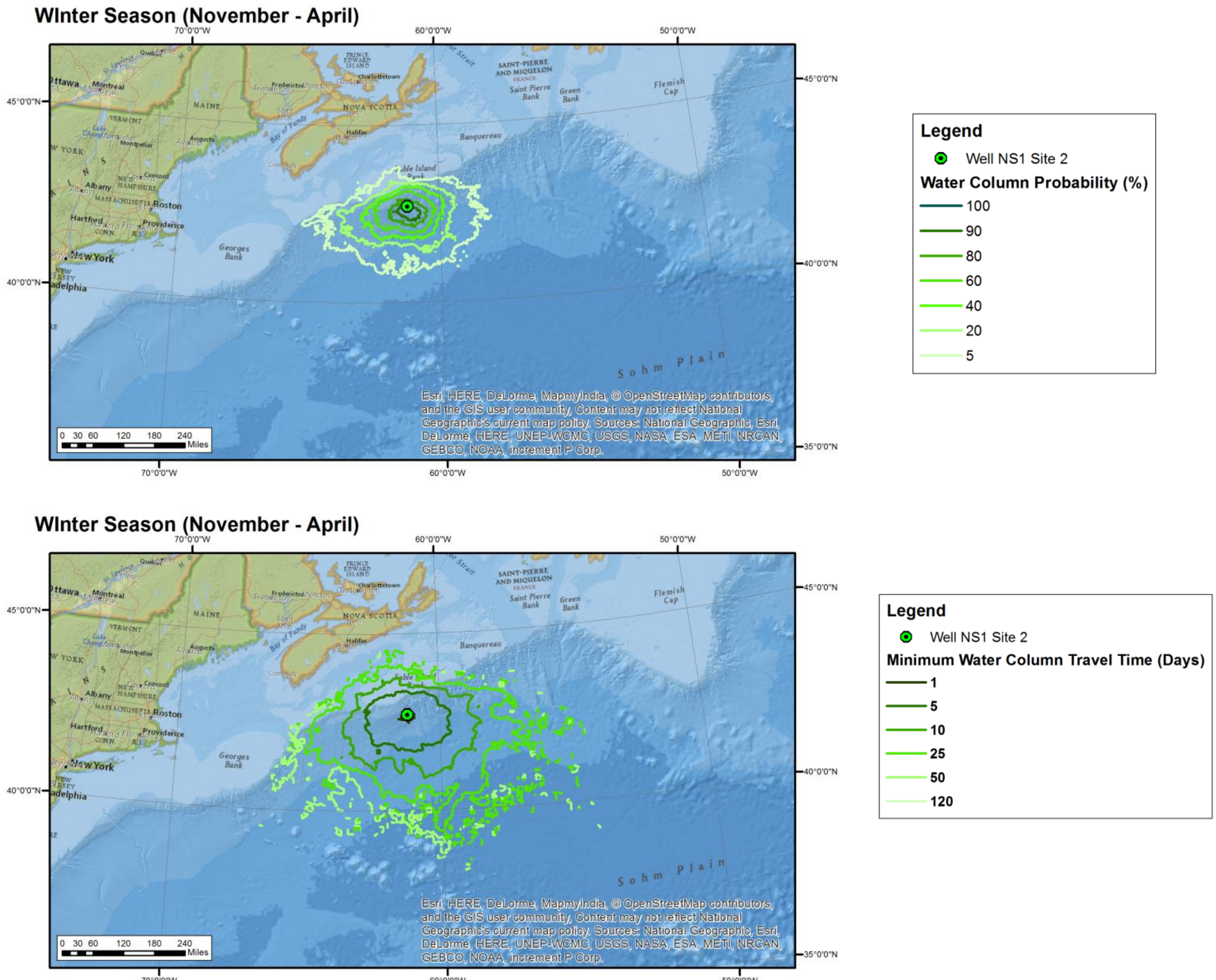


Figure 8.4.9 Winter (November to April) stochastic model output (210 individual model runs) showing maps of the predicted probability of water column dispersed and dissolved oil concentrations exceeding the 58 ppb total hydrocarbon threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous blowout incident at Site 2.

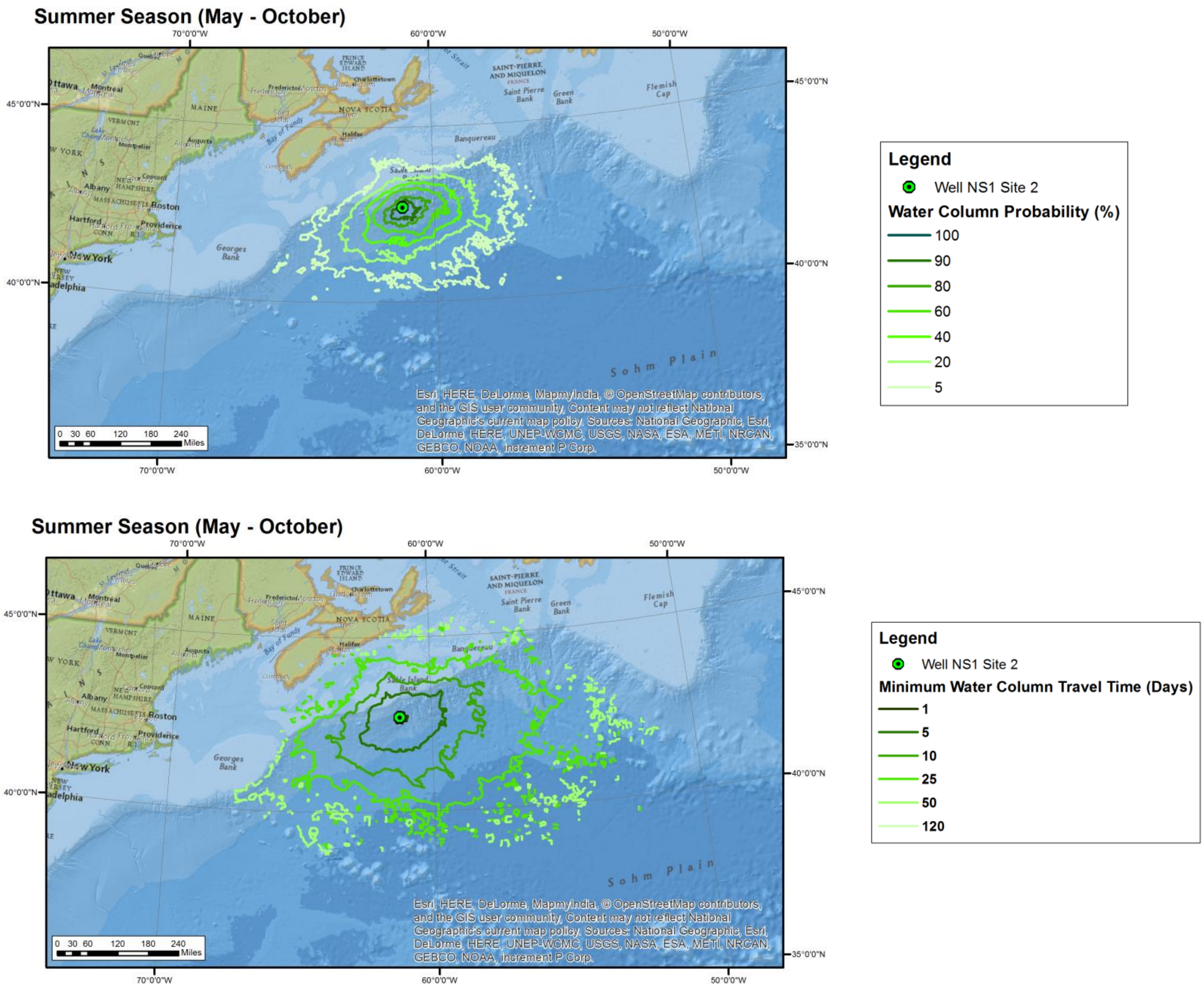
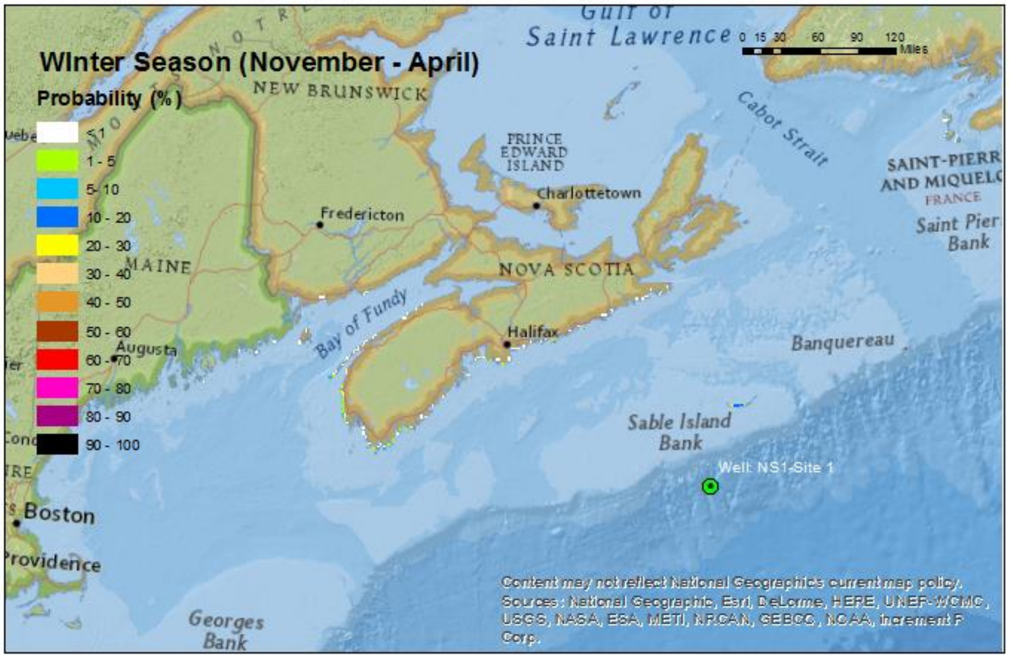


Figure 8.4.10 Summer (May to October) stochastic model output (210 individual model runs) showing maps of the predicted probability of water column dispersed and dissolved oil concentrations exceeding the 58 ppb total hydrocarbon threshold (top panel) and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous blowout incident at Site 2.


Winter Season (November - April)
Probability (%)
< 1
1 - 5
5- 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
Gulf of Saint Lawrence
NEW BRUNSWICK
PRINCE EDWARD ISLAND
Charlottetown
Fredericton
Cabot Strait
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
MAINE
NOVA SCOTIA
Bay of Fundy
Halifax
Augusta
Banquereau
Sable Island Bank
Well: NS1-Site 1
Boston
Providence
Georges Bank
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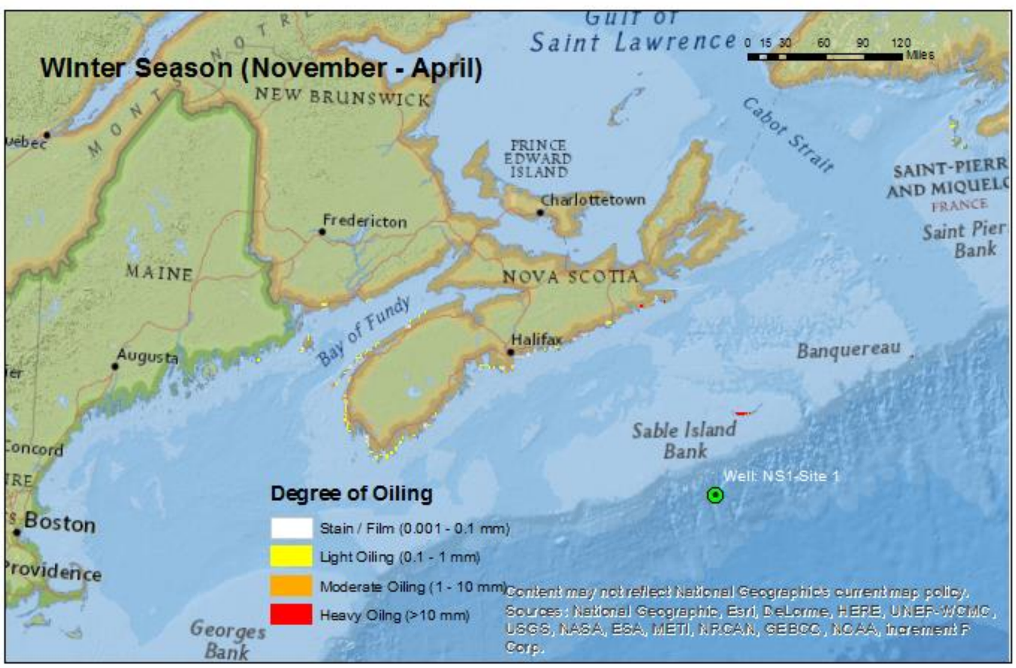

Winter Season (November - April)
Gulf of Saint Lawrence
NEW BRUNSWICK
PRINCE EDWARD ISLAND
Charlottetown
Fredericton
Cabot Strait
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
MAINE
NOVA SCOTIA
Bay of Fundy
Halifax
Augusta
Banquereau
Sable Island Bank
Well: NS1-Site 1
Concord
Boston
Providence
Georges Bank
Degree of Oiling
Stain / Film (0.001 - 0.1 mm)
Light Oiling (0.1 - 1 mm)
Moderate Oiling (1 - 10 mm)
Heavy Oilng (>10 mm)
Content may not reflect National Geographic's current map policy.
Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

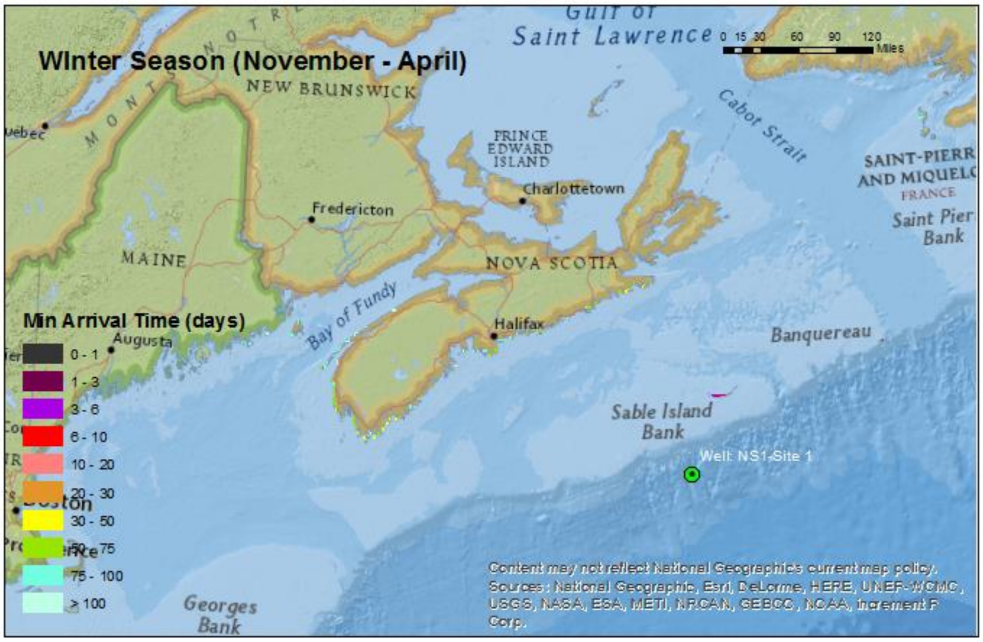
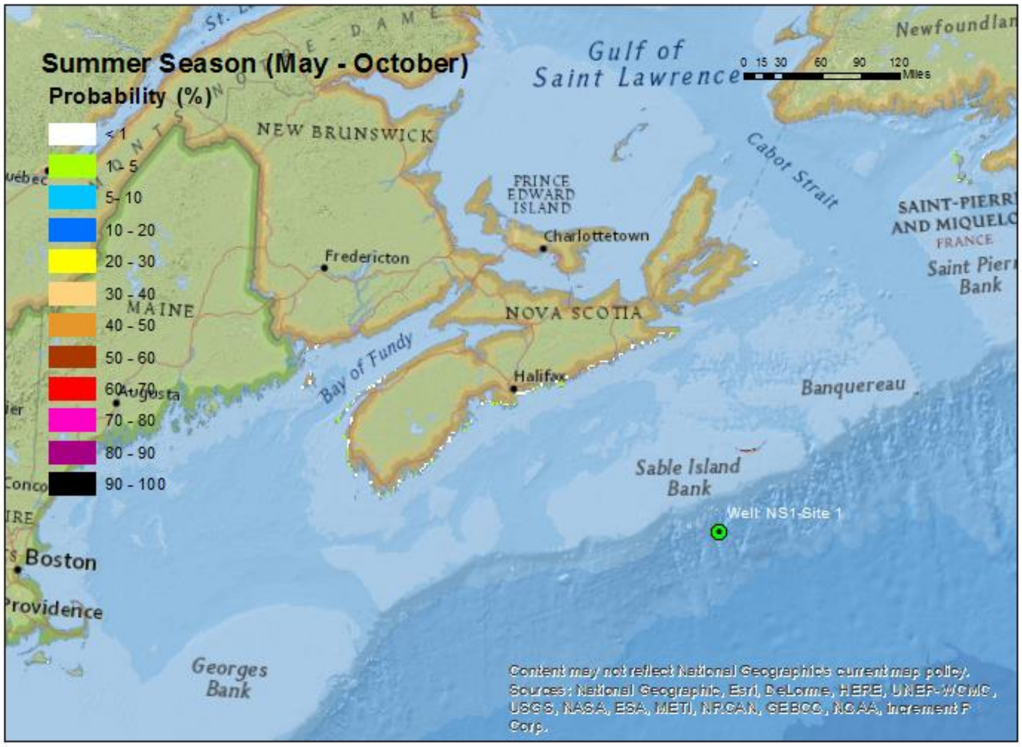
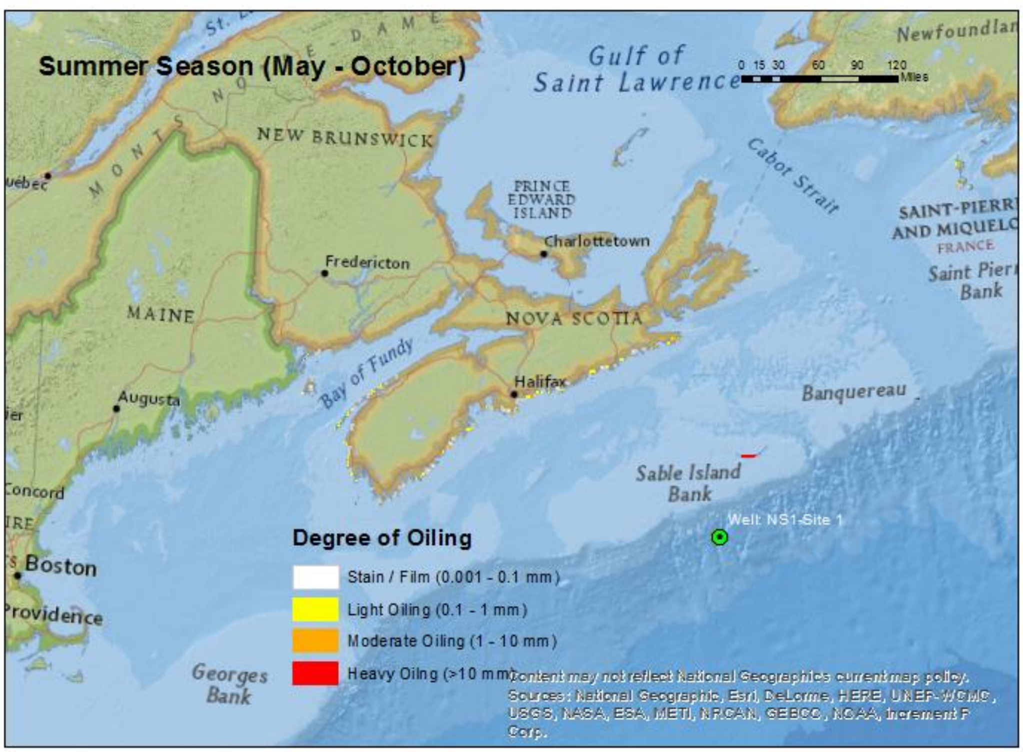


Figure 8.4.11 Winter (November to April) stochastic model output (210 individual model runs) showing maps of the predicted probability of shoreline oiling exceeding the 1µm threshold (top panel), the maximum accumulated thickness of oil on the shoreline exceeding 1 µm (middle panel), and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 24,890 bpd blowout incident at Site 1.


Summer Season (May - October)
Probability (%)
< 1
1 - 5
5 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
Gulf of Saint Lawrence
NEW BRUNSWICK
PRINCE EDWARD ISLAND
Charlottetown
Fredericton
NOVA SCOTIA
MAINE
Augusta
Bay of Fundy
Halifax
Cabot Strait
Newfoundland
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
Banquereau
Sable Island Bank
Well: NS1-Site 1
Boston
Providence
Georges Bank
0 15 30 60 90 120 Miles
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.


Summer Season (May - October)
Gulf of Saint Lawrence
NEW BRUNSWICK
PRINCE EDWARD ISLAND
Charlottetown
Fredericton
NOVA SCOTIA
MAINE
Augusta
Bay of Fundy
Halifax
Cabot Strait
Newfoundland
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
Banquereau
Sable Island Bank
Well: NS1-Site 1
Concord
Boston
Providence
Georges Bank
Degree of Oiling
Stain / Film (0.001 - 0.1 mm)
Light Oiling (0.1 - 1 mm)
Moderate Oiling (1 - 10 mm)
Heavy Oilng (>10 mm)
0 15 30 60 90 120 Miles
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

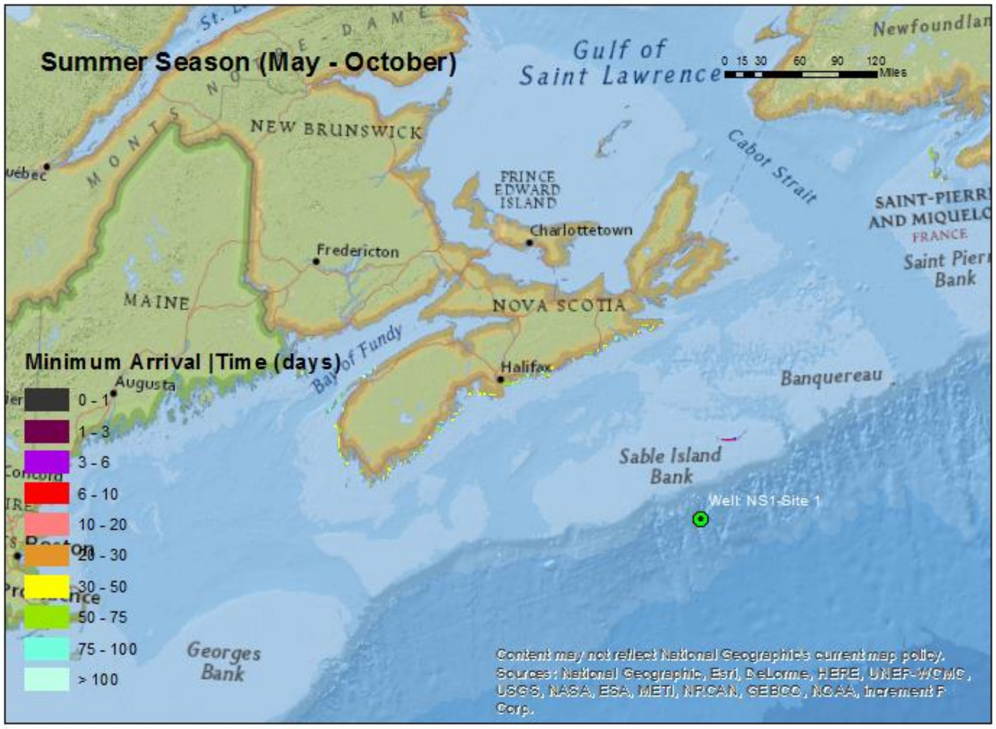
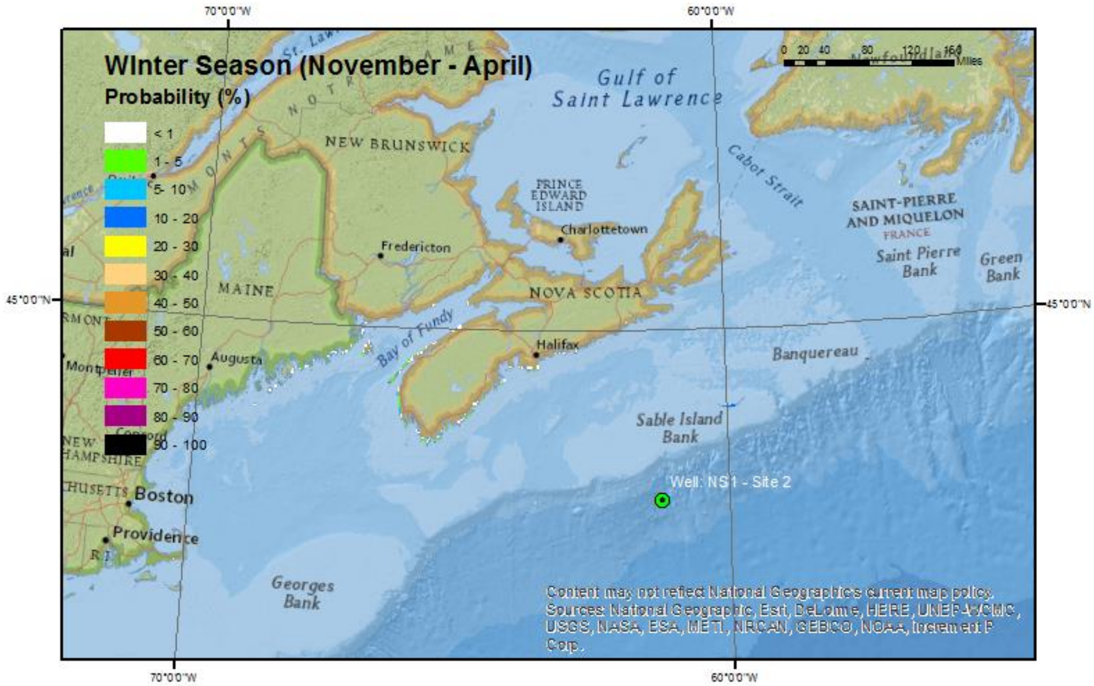
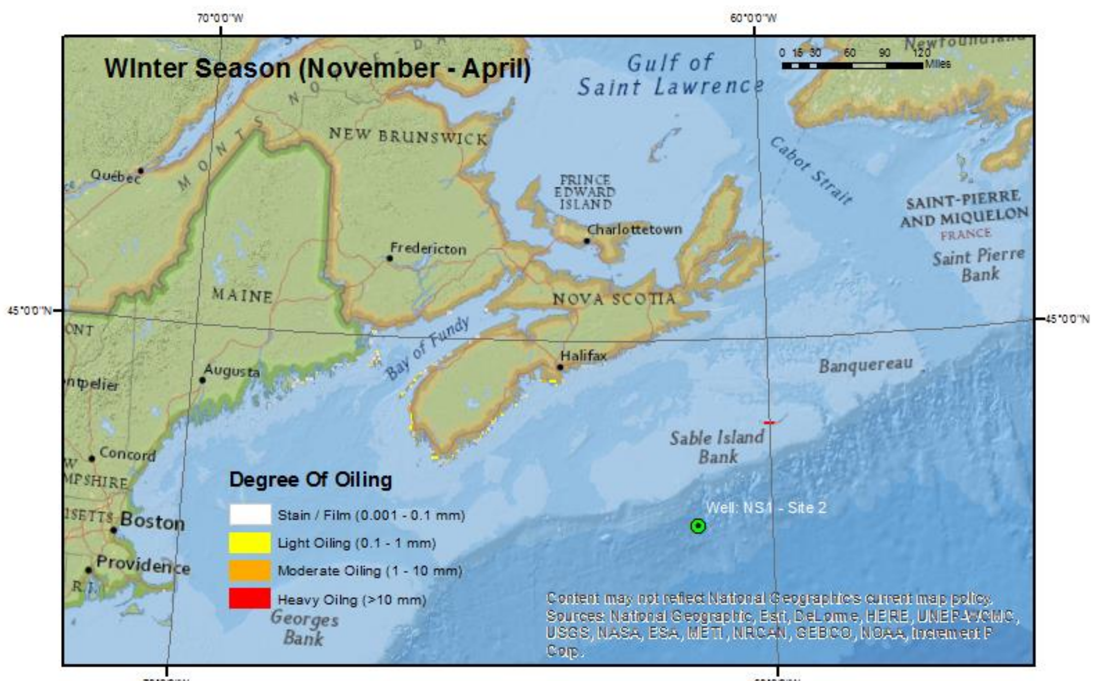


Figure 8.4.12 Summer (May to October) stochastic model output (210 individual model runs) showing maps of the predicted probability of shoreline oiling exceeding the 1µm threshold (top panel), the maximum accumulated thickness of oil on the shoreline exceeding 1 µm (middle panel), and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 24,890 bpd blowout incident at Site 1.


Winter Season (November - April)
Probability (%)
< 1
1 - 5
5- 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
Gulf of Saint Lawrence
NEW BRUNSWICK
PRINCE EDWARD ISLAND
Charlottetown
Fredericton
MAINE
NOVA SCOTIA
Bay of Fundy
Halifax
Augusta
Boston
Providence
Cabot Strait
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
Green Bank
Banquereau
Sable Island Bank
Well: NS1 - Site 2
Georges Bank
70°0'0"W
60°0'0"W
45°0'0"N
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.


Winter Season (November - April)
Gulf of Saint Lawrence
NEW BRUNSWICK
Québec
PRINCE EDWARD ISLAND
Charlottetown
Fredericton
MAINE
NOVA SCOTIA
Bay of Fundy
Halifax
Augusta
Concord
Boston
Providence
Cabot Strait
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
Banquereau
Sable Island Bank
Well: NS1 - Site 2
Degree Of Oiling
Stain / Film (0.001 - 0.1 mm)
Light Oiling (0.1 - 1 mm)
Moderate Oiling (1 - 10 mm)
Heavy Oilng (>10 mm)
Georges Bank
70°0'0"W
60°0'0"W
45°0'0"N
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

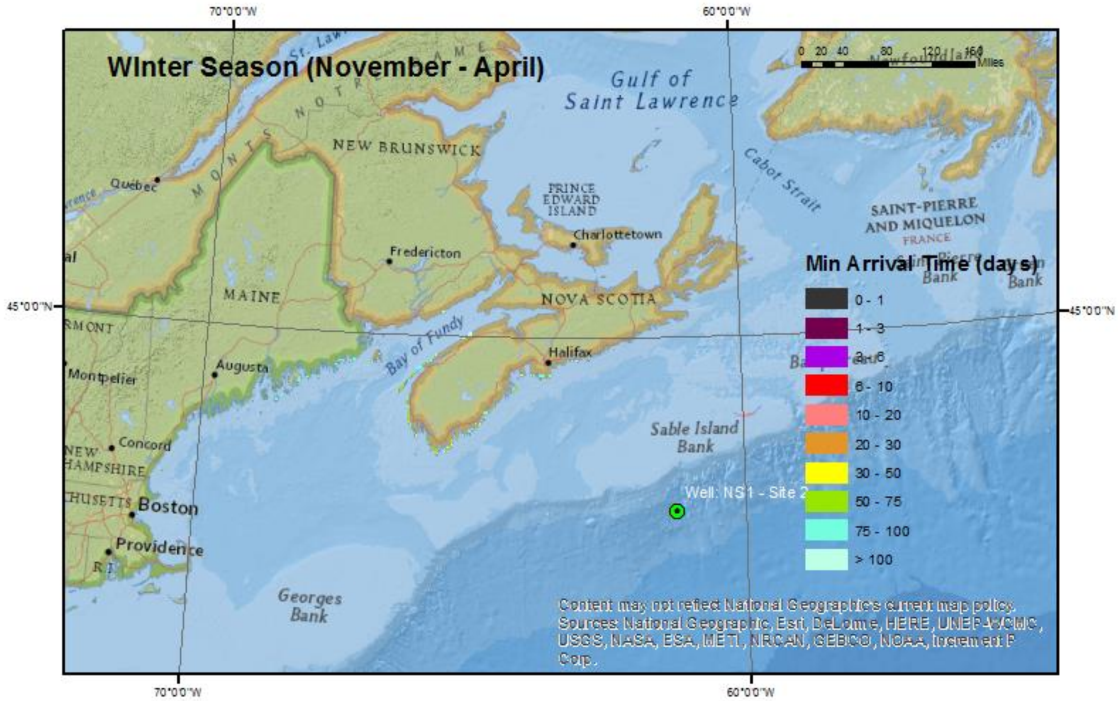
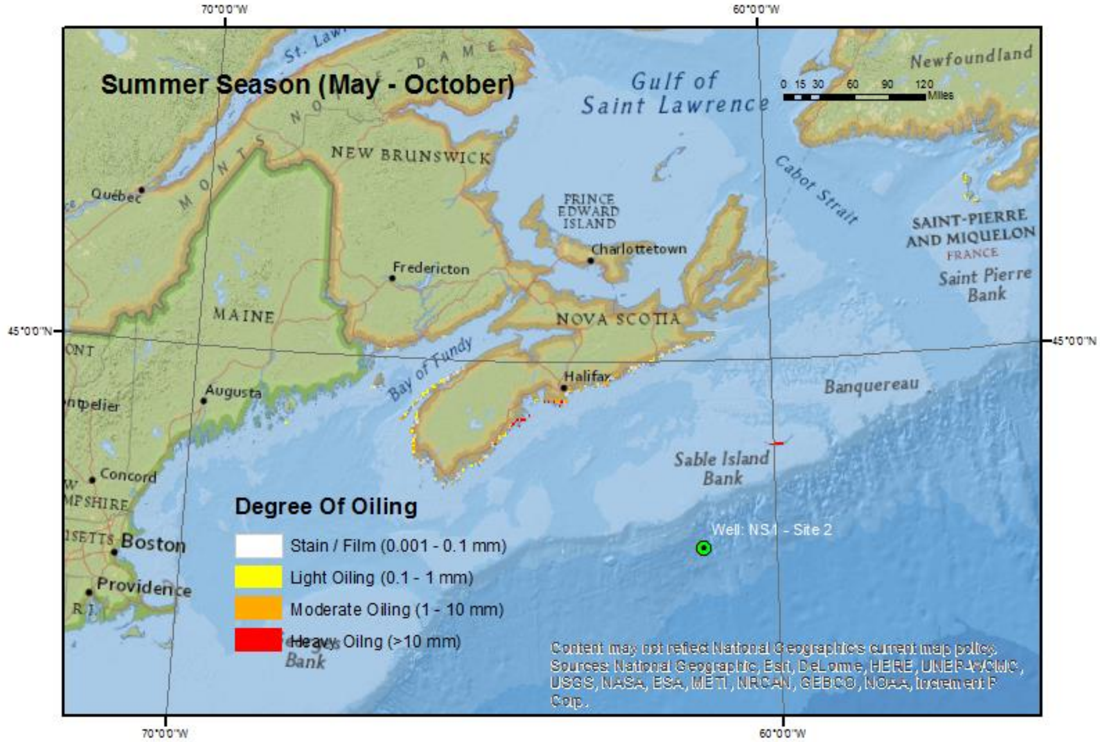
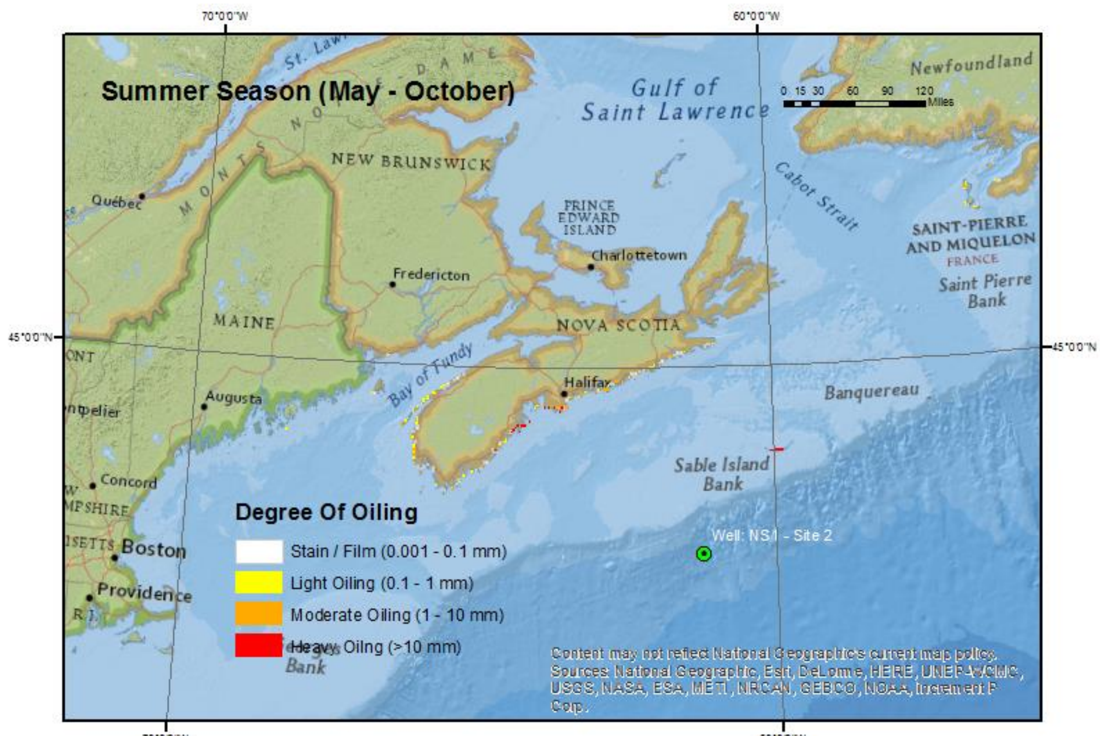


Figure 8.4.13 Winter (November to April) stochastic model output (210 individual model runs) showing maps of the predicted probability of shoreline oiling exceeding the 1µm threshold (top panel), the maximum accumulated thickness of oil on the shoreline exceeding 1 µm (middle panel), and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 35,914 bpd blowout incident at Site 2.


Summer Season (May - October)
Degree Of Oiling
Stain / Film (0.001 - 0.1 mm)
Light Oiling (0.1 - 1 mm)
Moderate Oiling (1 - 10 mm)
Heavy Oilng (>10 mm)
Well: NS1 - Site 2
Gulf of Saint Lawrence
NEW BRUNSWICK
PRINCE EDWARD ISLAND
NOVA SCOTIA
MAINE
Newfoundland
Cabot Strait
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
Banquereau
Sable Island Bank
Halifax
Charlottetown
Fredericton
Augusta
Concord
Boston
Providence
Québec
Bay of Fundy
70°0'0"W
60°0'0"W
45°0'0"N
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.


Summer Season (May - October)
Degree Of Oiling
Stain / Film (0.001 - 0.1 mm)
Light Oiling (0.1 - 1 mm)
Moderate Oiling (1 - 10 mm)
Heavy Oilng (>10 mm)
Well: NS1 - Site 2
Gulf of Saint Lawrence
NEW BRUNSWICK
PRINCE EDWARD ISLAND
NOVA SCOTIA
MAINE
Newfoundland
Cabot Strait
SAINT-PIERRE AND MIQUELON
FRANCE
Saint Pierre Bank
Banquereau
Sable Island Bank
Halifax
Charlottetown
Fredericton
Augusta
Concord
Boston
Providence
Québec
Bay of Fundy
70°0'0"W
60°0'0"W
45°0'0"N
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

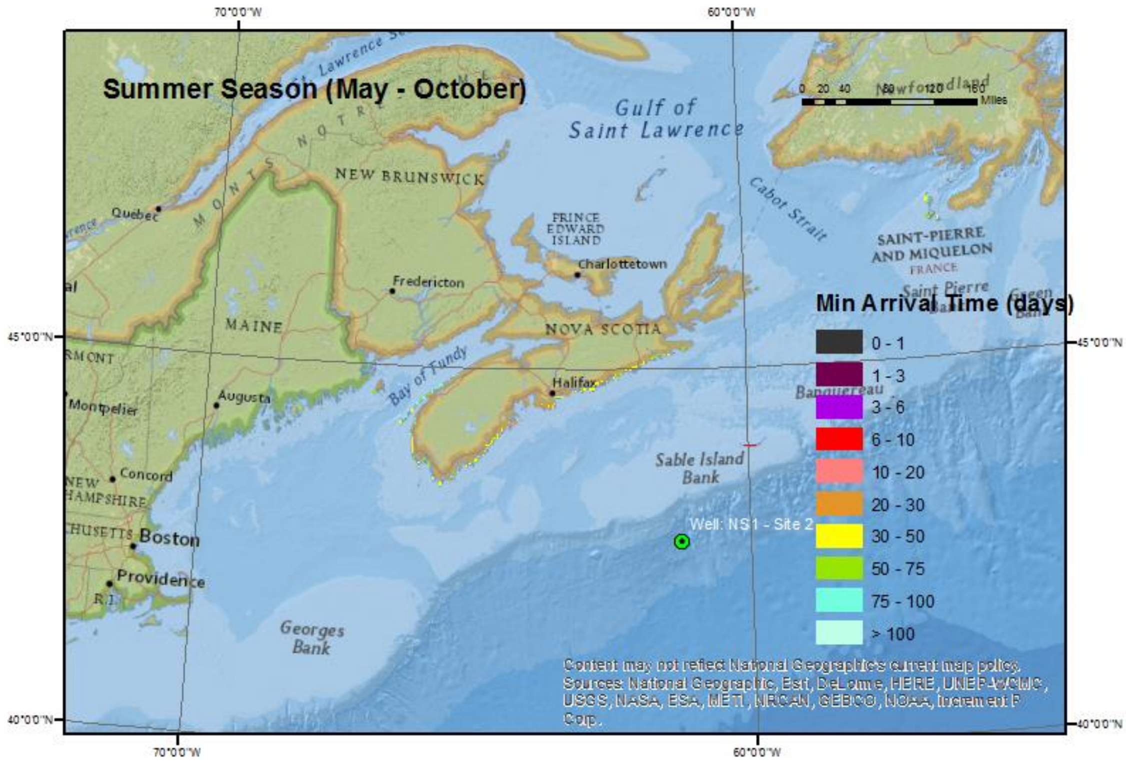


Figure 8.4.14 Summer (May to October) stochastic model output (210 individual model runs) showing maps of the predicted probability of shoreline oiling exceeding the 1µm threshold (top panel), the maximum accumulated thickness of oil on the shoreline exceeding 1 µm (middle panel), and the associated minimum arrival times (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 35,914 bpd blowout incident at Site 2.

8.4.7.3 Transboundary Effects

A stochastic modelling approach was used to produce statistical outputs that include the probability of where oil might travel and the time taken for the oil to reach a given boundary or shoreline (refer to Section 8.4.2 for a description of the stochastic modelling approach). The stochastic modelling results for this Project demonstrated the potential locations for spill effects exceeding threshold levels beyond the RAA boundary, and in some cases, beyond Canadian jurisdiction. Figure 8.4.15 illustrates the average probability of transboundary effects from an unmitigated spill (Site 1 summer season). Assuming no mitigation, the model estimates a 16 % probability of surface oil resulting as a sheen (0.04 µm surface layer thickness) within the international boundaries of Saint-Pierre et Miquelon (France), which could occur in a minimum of 12 days of a blowout event, but would generally average 34 days for the minimum arrival time. For Site 1 in the summer, the average probability of an unmitigated spill resulting in surface oiling exceeding the threshold level within the US waters is approximately 7% (with a minimal arrival time of approximately 22 days but on average a minimum of 55 days); this average probability increases to 14% for Site 2 in winter with similar minimum arrival times. The average probability of an unmitigated spill resulting in surface oiling exceeding the threshold level within the waters of Bermuda is approximately 2%, with a minimum arrival time of approximately 44 days but on average a minimum of 60 days.

In the unlikely event that a well blowout incident does occur, transboundary effects are unlikely to occur following the implementation of BP's risk management (refer to Section 8.1) and response management (refer to Section 8.3) measures to control the source of the release, contain, and recover surface oil.

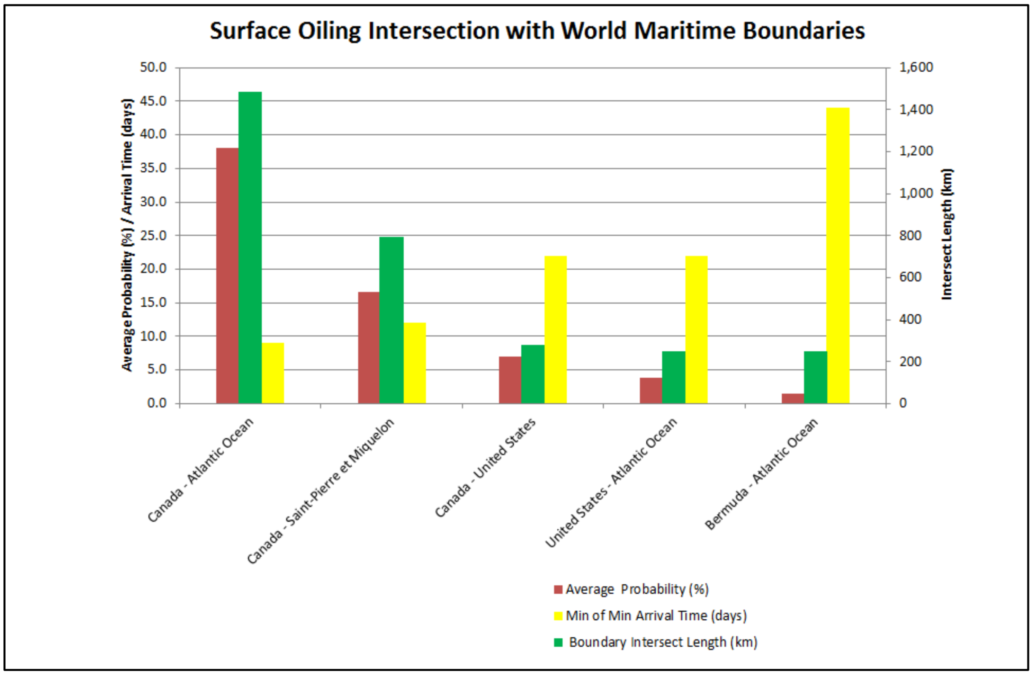


Figure 8.4.15 Site 1 Summer Season Unmitigated Blowout Incident and Sea Surface Oiling Intersection with World Maritime Boundaries (emulsified oil thicknesses exceeding the 0.04 μm (BAOAC "Sheen") thickness threshold)

8.4.8 Deterministic Modelling Results

A single worst-case credible scenario was selected based on the maximum shoreline oiling for both well sites from the stochastic modelling analyses. Deterministic trajectory models were run using these credible worst-case scenarios to illustrate the spatial area and degree of surface, water column, and shoreline oiling that may occur and which cannot be assessed using stochastic models.

The worst-case credible-scenarios for maximum shoreline oiling were identified for each of the 12 monthly stochastic modelling scenarios. These cases were then separated into winter and summer scenarios, and the scenario with the maximum shoreline oiling within each season were identified and run as an individual deterministic trajectory.

The results of representative cases identified for maximum shoreline oiling, from each stochastic analysis, for both well sites and for winter and summer seasons, are provided in Table 8.4.8. Table 8.4.9 also describes the specific details for each scenario including the time for oil to reach the shoreline, maximum mass of oil on the shoreline, length of coastline impacted, and the total amount of oil released.

Figures 8.4.16 to 8.4.19 provide outputs for representative summer, 30-day unmitigated blowout incident scenarios depicting surface oiling, in-water oiling, and shoreline oiling for Sites 1 and 2. Descriptions of these figures are provided below to assist with the interpretation.

1. *Surface Oil Figures:* The surface oil figures show the footprint of maximum floating surface oil and the associated thicknesses (µm) at all-time steps during the individual spill simulation. Surface oil contamination figures show only thicknesses greater than the 0.04 µm threshold.

2. *Water Column Figures:* The water column figures show the footprint of maximum water column concentration of dissolved oil (ppb) at all-time steps during the individual spill simulation. Water column oiling figures show only concentrations ≥58 ppb total hydrocarbon.

3. *Mass Balance Figures:* The mass balance figures provide an estimate of the oil's weathering and fate for a specific run for the entire model duration as a fraction of the oil released up to that point. Components of the oil tracked over time include the proportion of oil on the sea surface, entrained into the water column, stranded on shore, evaporated into the atmosphere, and that which has been degraded through biodegradation.

4. *Shoreline Impact Figures:* Figure showing mass of oil deposited onto shoreline. Only shoreline oiling exceeding 1 µm (which is roughly equivalent to 1 g/m^2 [French McCay *et al.* 2004]) is depicted.

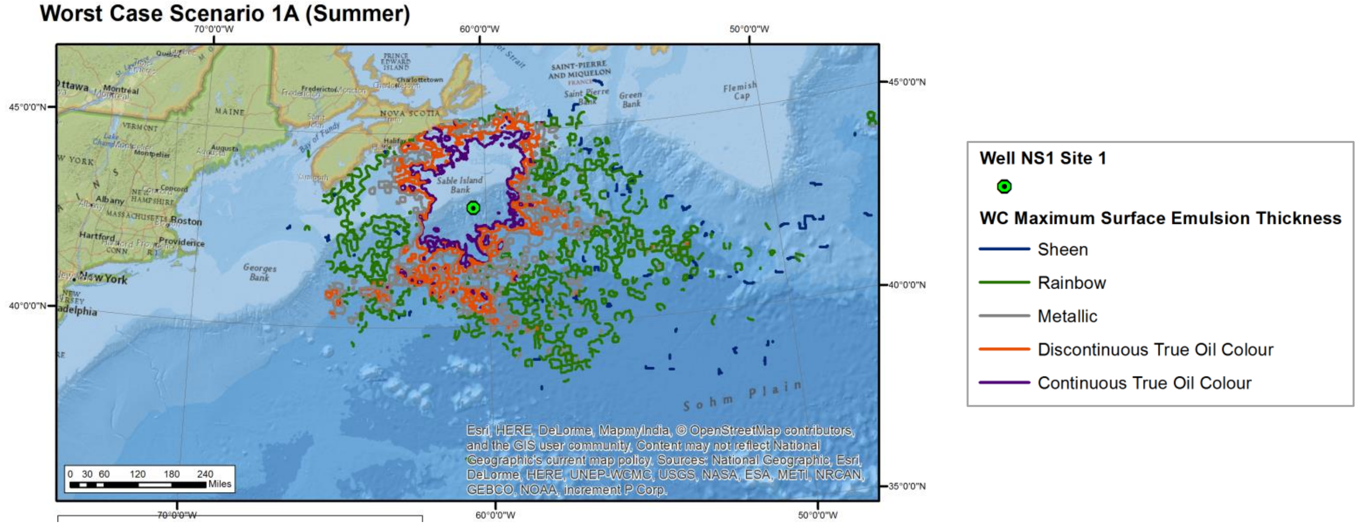
The modelling results for Site 1 predict that the majority of oil would remain offshore. In the event that surface oil was to enter the nearshore area of Nova Scotia, it is predicted to have a thickness of between 0.04 and 0.3 µm. Exceedances of the in-water oil threshold are predicted to also be limited to offshore waters; however, the area impacted is smaller than that of surface oiling. Shoreline oiling exceeding the threshold level is expected to be limited to the coastline of Sable Island. Unmitigated oiling on Sable Island is predicted to be heavy with a thickness of > 10 mm. The maximum oil on shoreline scenario predicts that shoreline oiling at Sable Island would occur after 7 days, with a maximum mass of 670 tonnes of oil onshore and 27.8 km of coastline being affected.

The results for Site 2 illustrate that surface oiling exceeding the threshold will occur in the nearshore waters of Nova Scotia, with surface thicknesses ranging from 0.04 µm to 200 µm. The in-water oil threshold follows the same trend with in-water oil concentrations ranging from 58 ppb to 1000 ppb in the nearshore waters around Nova Scotia. A snapshot at day 101 of the deterministic run for Site 2 indicates that there will be shoreline oiling along the coastlines of both Sable Island and mainland Nova Scotia (Figure 8.4.19). The maximum oil on shoreline scenario predicts that shoreline oiling would occur after 12 days, with a maximum mass of 669 tonnes of oil on shore and a maximum length of 79.5 km of coastline being affected.

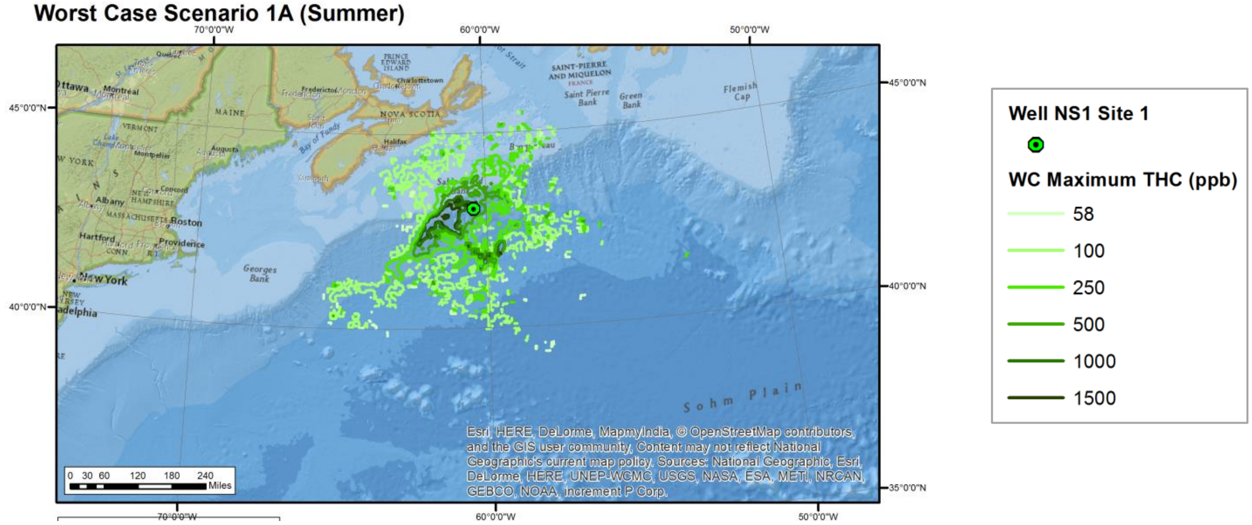
Table 8.4.8 Summary of Deterministic Modelling Scenarios and Results

Deterministic simulations	Scenario - Site 1 (Maximum oil on shoreline - Winter Season)		Scenario - Site 1 (Maximum oil on shoreline - Summer Season)		Scenario - Site 2 (Maximum oil on shoreline - Winter Season)		Scenario - Site 2 (Maximum oil on shoreline - Summer Season)	
	24,890 bpd (Initial oil release rate) / 30 days duration (capping stack)		24,890 bpd (Initial oil release rate) / 30 days duration (capping stack)		35,914 bpd (Initial oil release rate) / 30 days duration (capping stack)		35,914 bpd (Initial oil release rate) / 30 days duration (capping stack)	
Season	Winter (November - April)		Summer (May - October)		Winter (November - April)		Summer (May - October)	
Simulation number	31		13		161		104	
Start time	November 4, 2006	21:00	June 19, 2006	23:00	April 18, 2009	3:00	June 24, 2008	3:00
Simulation duration	120	days	120	days	120	days	120	days
Release duration	30	days	30	days	30	days	30	days
Initial Release rate	24,890	bpd	24,890	bpd	35,914	bpd	35,914	bpd
Total oil release	115,377	tonnes	99,190	tonnes	142,902	tonnes	142,903	tonnes
First shore hit	5.0	days	7.0	days	31.0	days	12.0	days
Maximum mass on shoreline	239	tonnes	670	tonnes	224	tonnes	669	tonnes
Ashore time (maximum mass)	18.01	days	42.01	days	37.01	days	32.01	days
Length of coastline impacted (at maximum mass ashore)	27.8	km	27.8	km	23.8	km	27.8	km
Maximum length of coastline impacted	27.8	km	27.8	km	31.8	km	79.5	km
Ashore time (maximum length)	12.0	days	13.0	days	89.0	days	101.0	days
First shore hit (shortest possible)	5.82	days	3.81	days	10.52	days	6.61	days
	140	hours	91	hours	252	hours	159	hours

Worst Case Scenario 1A (Summer)



Worst Case Scenario 1A (Summer)



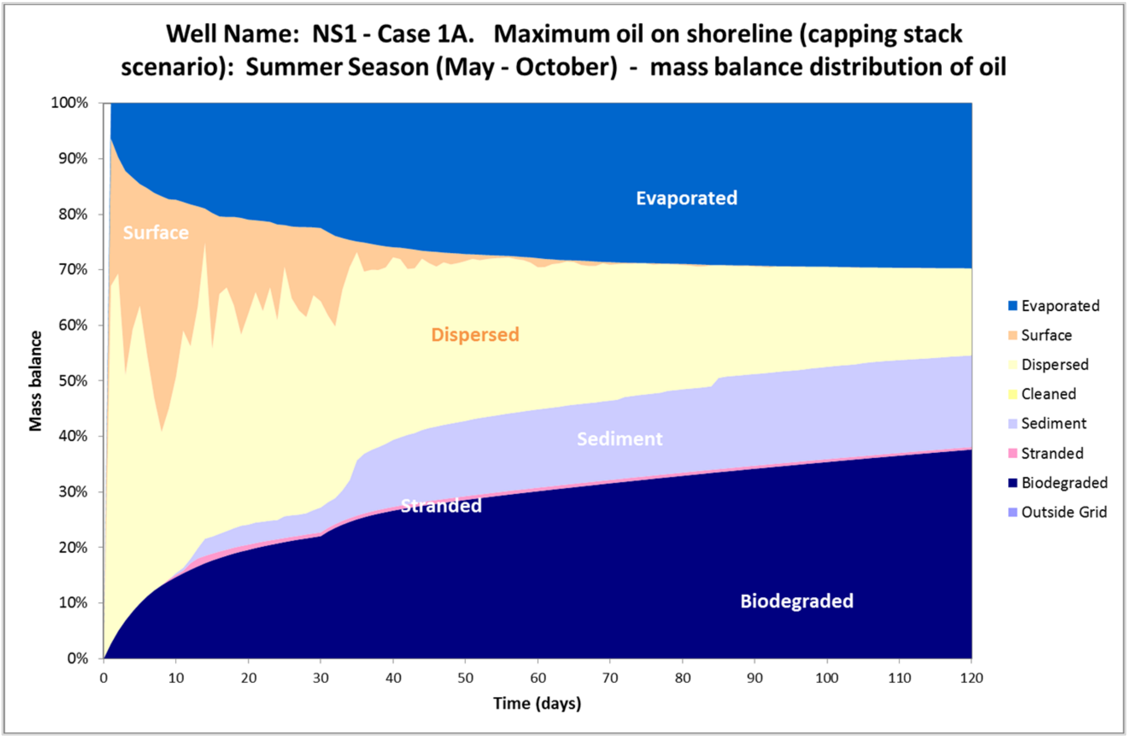


Figure 8.4.16 Site 1 Summer (June 19 2006, 23:00) deterministic model output showing maps of the predicted levels of surface oiling exceeding the 0.04 µm threshold (top panel), the levels of in-water oil concentration exceeding the 58 ppb threshold (middle panel), and the associated mass balance (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 24,890 bpd blowout incident.

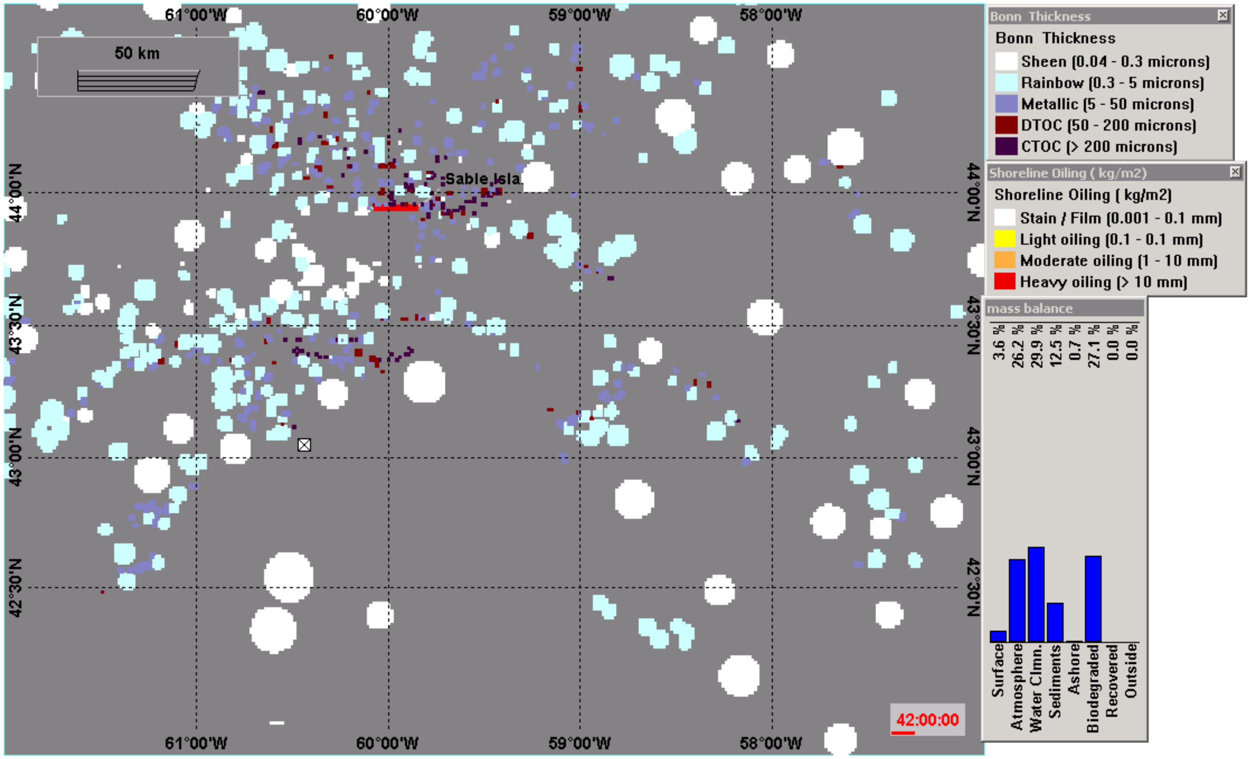
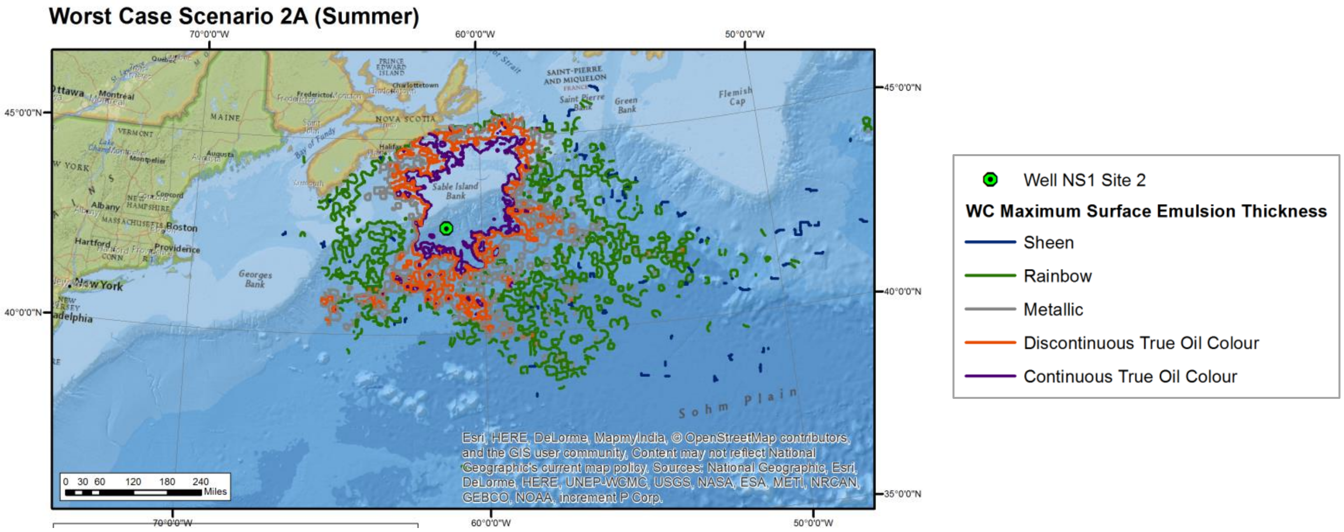
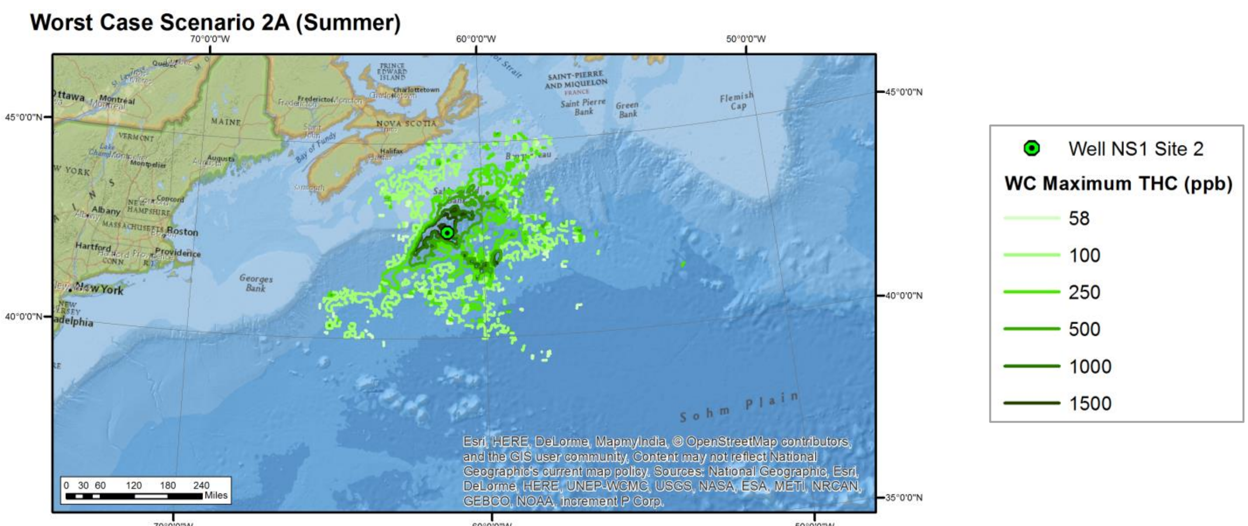


Figure 8.4.17 Site 1 summer (June 19 2006, 23:00) deterministic model output showing a snapshot of shoreline oiling on day 42 after the release for a worst credible case (*i.e.*, unmitigated), 30-day continuous 24,890 bpd blowout incident.


Worst Case Scenario 2A (Summer)
Well NS1 Site 2
WC Maximum Surface Emulsion Thickness
Sheen
Rainbow
Metallic
Discontinuous True Oil Colour
Continuous True Oil Colour
Sable Island Bank
Georges Bank
Sohm Plain
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community. Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
0 30 60 120 180 240 Miles


Worst Case Scenario 2A (Summer)
Well NS1 Site 2
WC Maximum THC (ppb)
58
100
250
500
1000
1500
Georges Bank
Sohm Plain
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community. Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
0 30 60 120 180 240 Miles

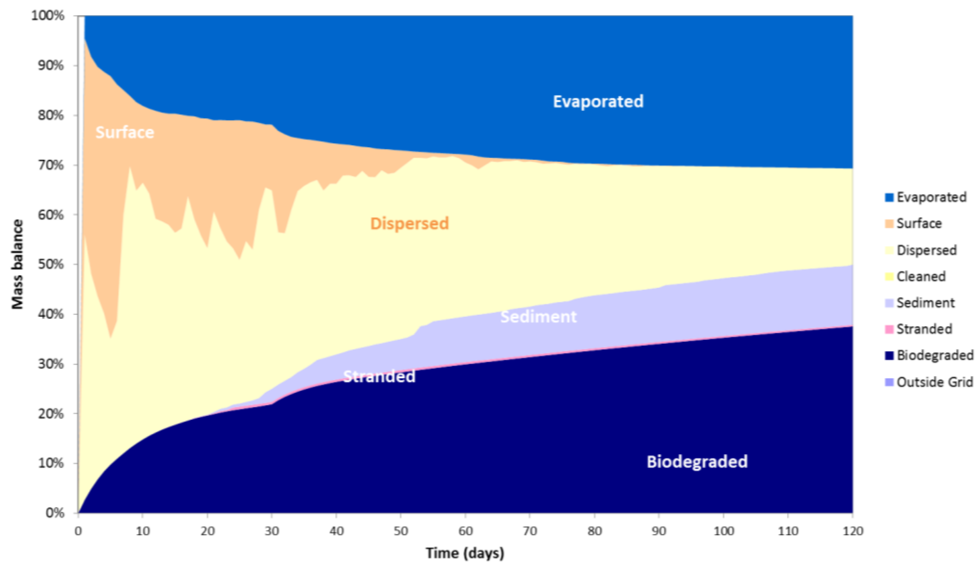


Figure 8.4.18 Site 2 summer (June 24 2008, 03:00) deterministic model output showing maps of the predicted levels of surface oiling exceeding the 0.04 µm threshold (top panel), the levels of in-water oil concentration exceeding the 58 ppb threshold (middle panel), and the associated mass balance (bottom panel) for a worst credible case (*i.e.*, unmitigated), 30-day continuous 35,914 bpd blowout incident.

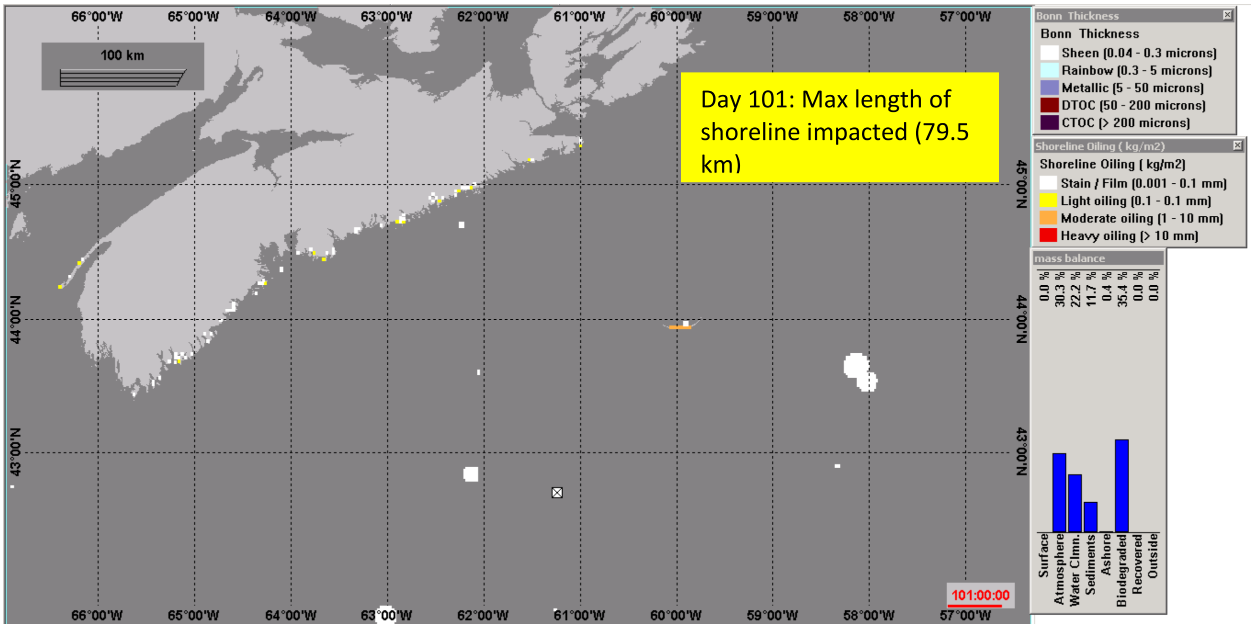
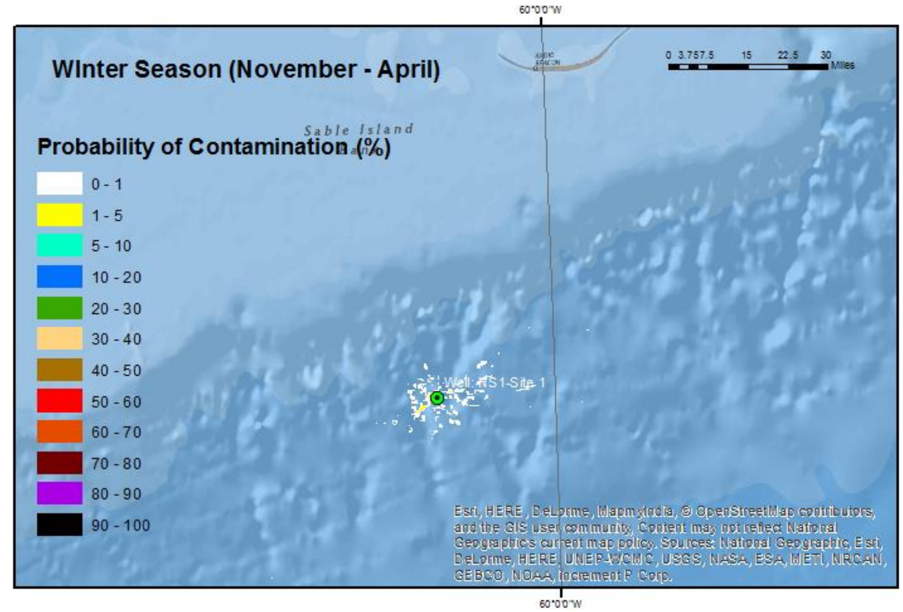


Figure 8.4.19 Site 2 summer (June 24 2008, 03:00) deterministic model output showing a snapshot of shoreline oiling on day 101 after the release for a worst credible case (*i.e.*, unmitigated), 30-day continuous 35,914 bpd blowout incident.

8.4.9 Diesel Batch Spill Modelling Results

To simulate an accidental discharge from Project vessels, two batch spills of diesel were modelled as a surface release using stochastic and deterministic methods. Modelling for the batch release of diesel was undertaken for unmitigated incidents involving a hose failure (a 10 bbl surface release over 1 hour) and a tank failure (a 100 bbl surface batch release over 6 hours). Simulations were run over the course of a 30 day and 50 day periods for the 10 bbl and 100 bbl spills, respectively, for both summer (May to October) and winter (November to April) seasons at Site 1 (Figure 8.4.1). The location of threshold exceedances for effects is expected to occur over a greater area if a spill occurs during the summer than for winter. Stochastic modelling outputs are provided in Figures 8.4.20 and 8.4.21, which depict the probability of sea surface emulsified oil thickness exceeding the 0.04 µm threshold. The models comprise 225 individual modelling runs for the 10 bbl and 100 bbl scenarios. Figures 8.4.22 and 8.4.23 illustrate the stochastic modelling results for the maximum time-averaged emulsified oil thickness on the sea surface exceeding the 0.04 µm threshold for both spill scenarios. Stochastic modelling results indicate that the maximum exposure time for emulsified oil thickness on the sea surface exceeding the 0.04 µm threshold would be less than 1 day.

Deterministic results provided in Figures 8.4.24 and 8.4.25 indicate that, for both scenarios, surface oil would rapidly evaporate and disperse into the water column following release. In the 100 bbl batch spill scenario, approximately 65% of the spill evaporated from the surface within three days following the release, with remaining proportions dispersing or biodegrading within the same period. For the 10 bbl and 100 bbl deterministic scenarios, areas of 23 km^2 and 336 km^2, respectively, experienced maximum total in-water concentrations of dissolved oil in excess of 1 ppb (Figures 8.4.24 and 8.4.25). Results from the 10 bbl and 100 bbl scenario indicate that all of the total in-water dissolved oil falls within the concentration range of 1 to 10 ppb (0.001 to 0.01 ppm). Deterministic runs of the maximum surface emulsified oil thickness indicate that for the 10 bbl batch spill, the maximum area of surface coverage would be approximately 0.82 km^2. The majority of the surface oil thickness is predicted to fall within the range of 0.04 to 5 µm, with a very small area falling within the 5 to 50 µm range. The deterministic run for the 100 bbl batch spill predicts that the oil thickness of the spill would cover a maximum area of approximately 4.4 km^2, with a thickness of 0.04 to 5 µm. The thickness of oiling is predicted to decrease with distance from the release site. Unless the release occurs from a PSV transiting in the nearshore area, it is not expected that a batch spill would reach the coastline of Nova Scotia or Sable Island.



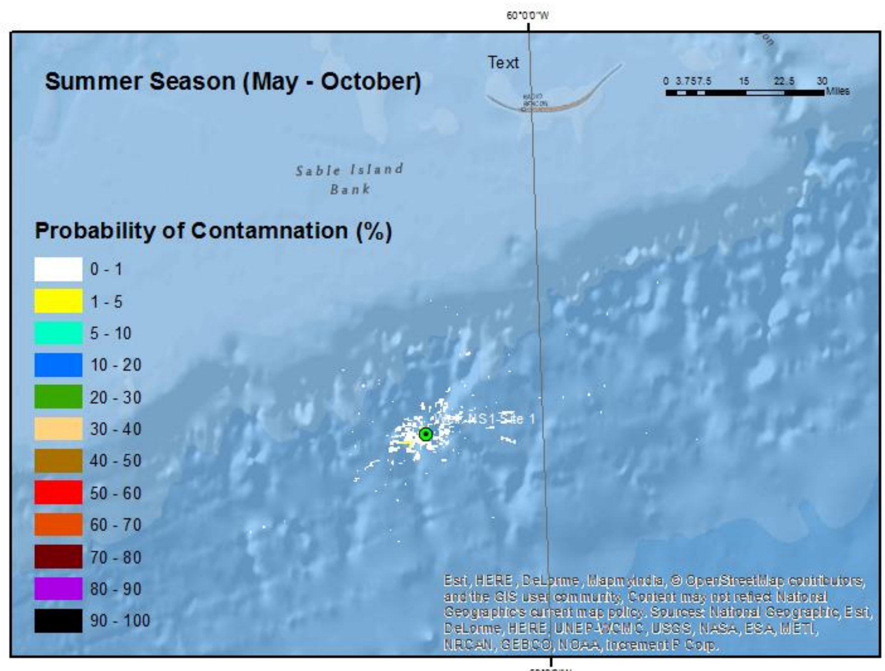
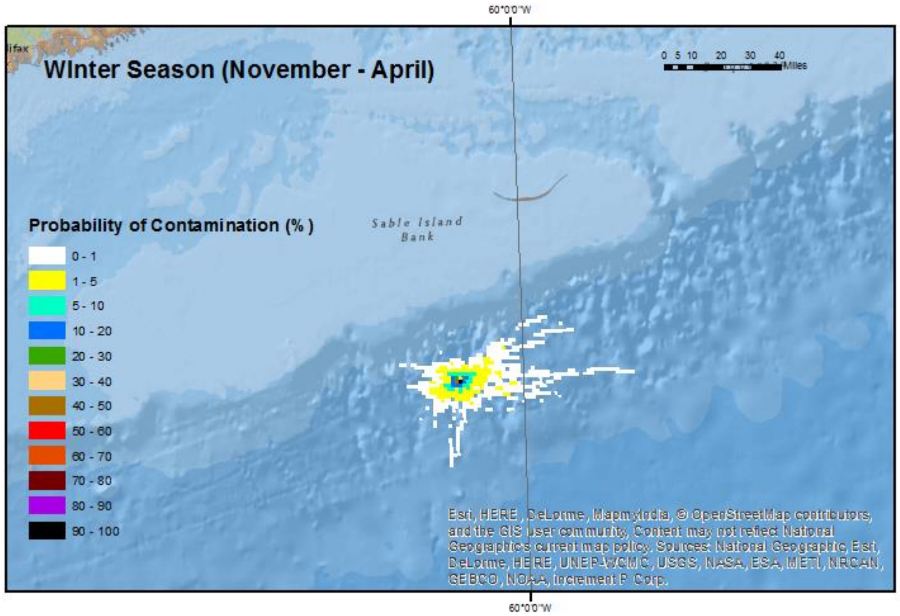


Figure 8.4.20 Stochastic model output (225 individual model runs) showing the probability of sea surface emulsified oil thickness exceeding 0.04 µm for an unmitigated 10 bbl surface batch release of diesel at Site 1.



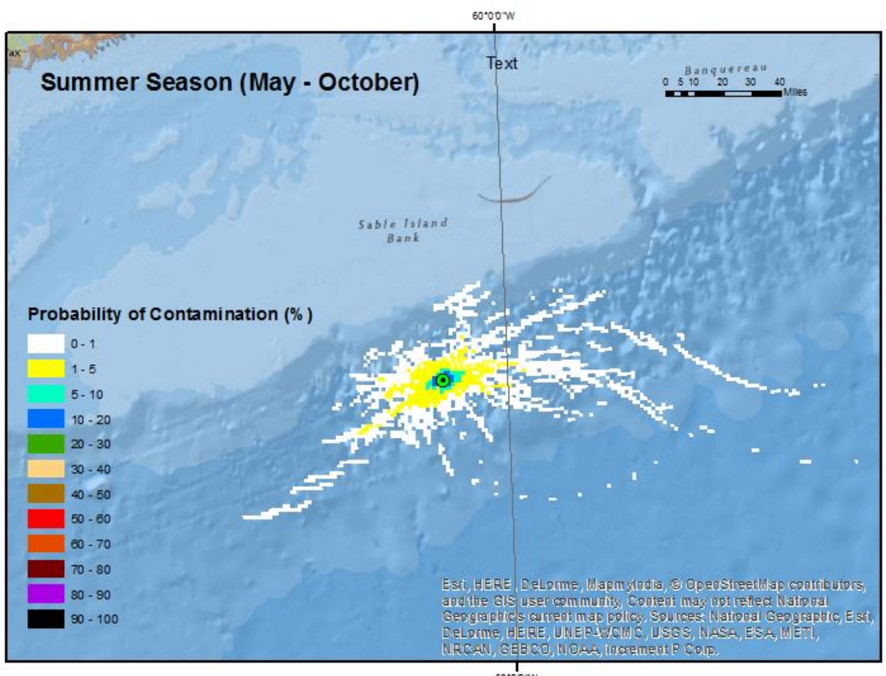
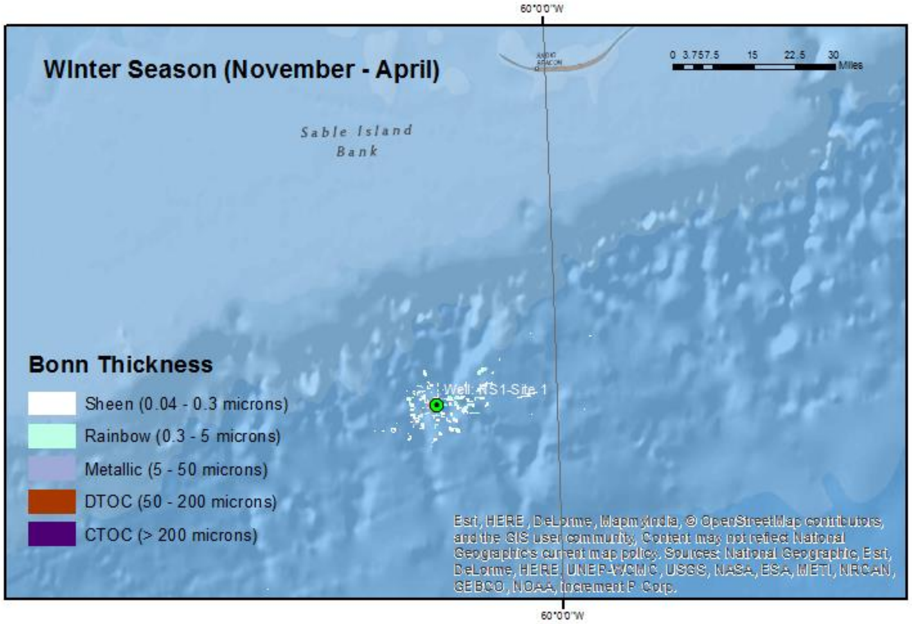


Figure 8.4.21 Stochastic model output (225 individual model runs) showing the probability of sea surface emulsified oil thickness exceeding 0.04 µm for an unmitigated 100 bbl surface batch release of diesel at Site 1.



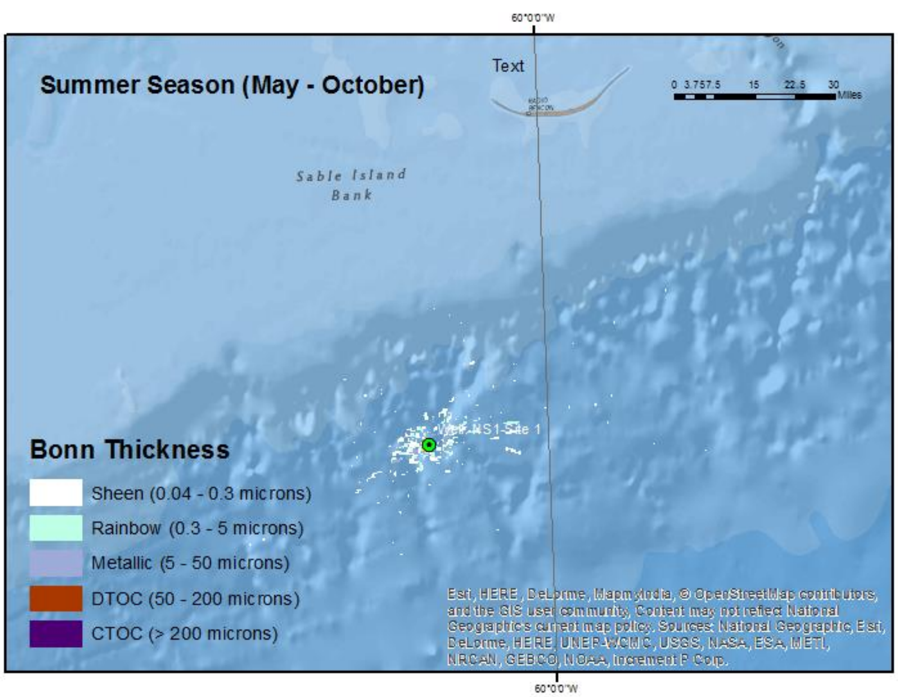
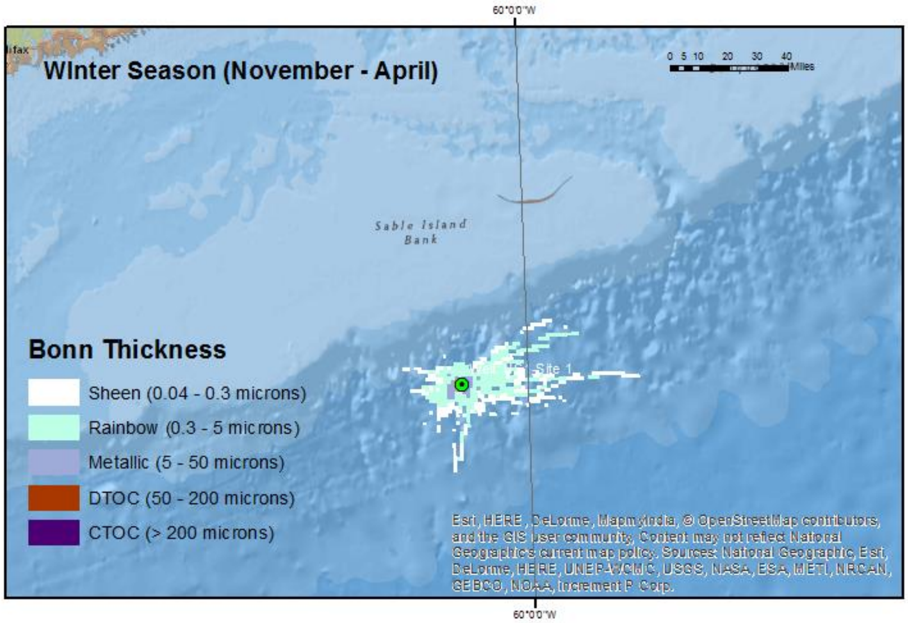


Figure 8.4.22 Stochastic model output (225 individual model runs) showing the maximum time-averaged emulsified oil thickness on the sea surface (exceeding the 0.04 μm threshold) for an unmitigated 10 bbl batch release of diesel at Site 1.



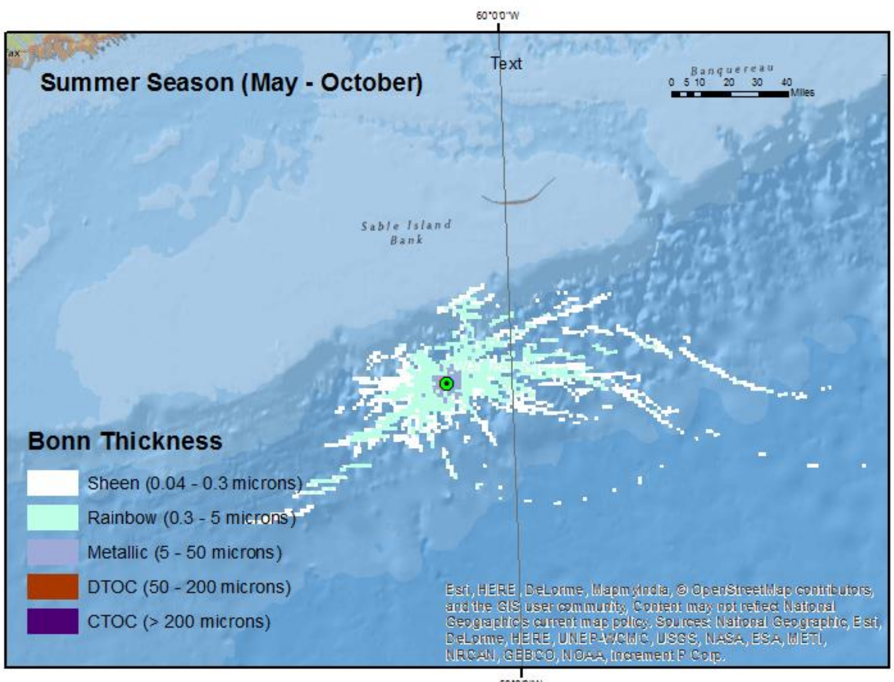
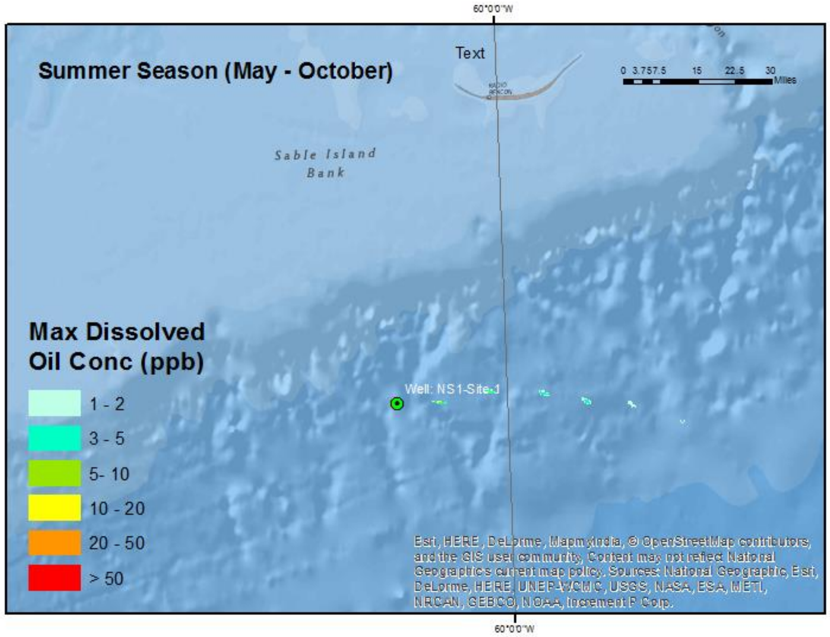


Figure 8.4.23 Stochastic model output (225 individual model runs) showing the maximum time-averaged emulsified oil thickness on the sea surface (exceeding the 0.04 μm threshold) for an unmitigated 100 bbl batch release of diesel at Site 1.



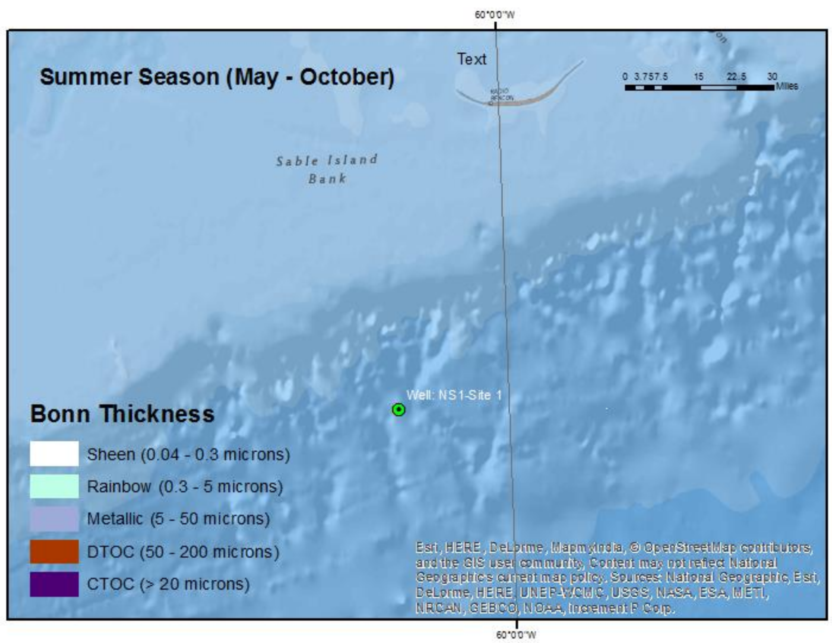
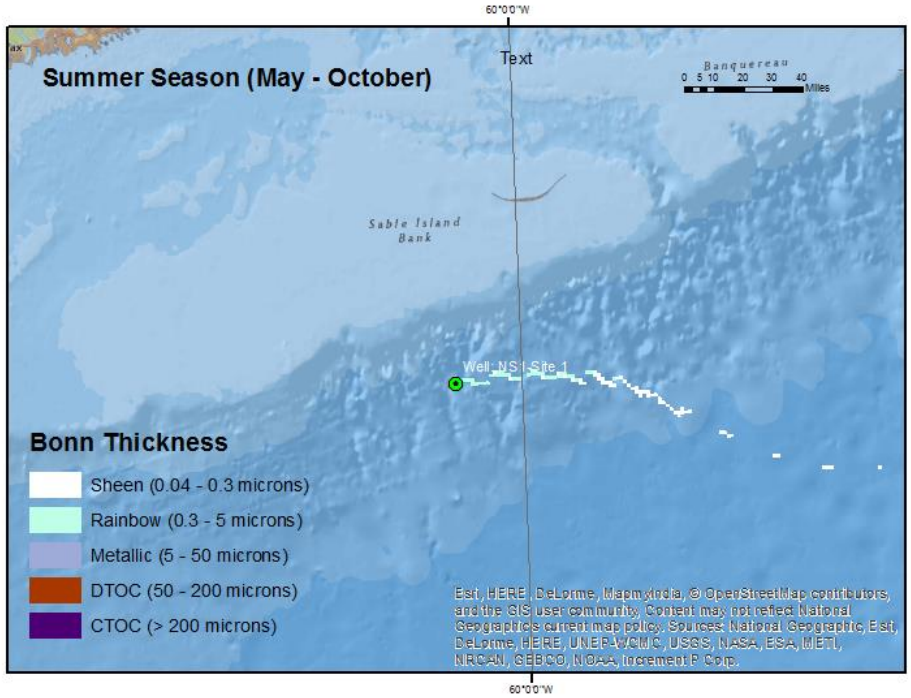
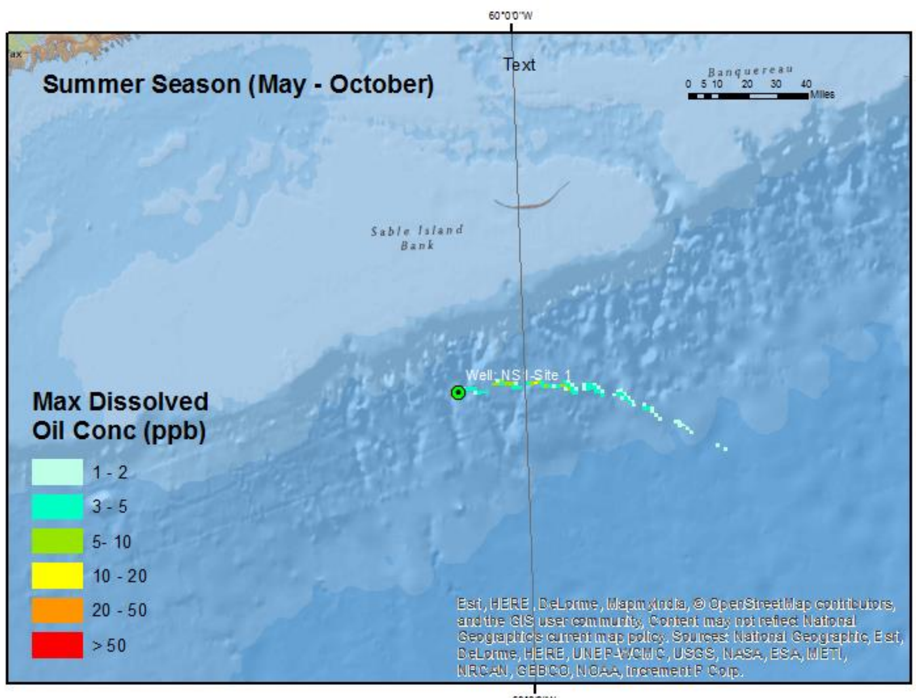


Figure 8.4.24 The total dissolved oil concentration in excess of 1 ppb is depicted for an unmitigated 10 bbl batch diesel spill at Site 1 (top panel) along with the associated surface thickness that is expected over the modelled 30-day period (bottom panel) (deterministic model starting June 3, 2009 at 05:00 GMT).


60°0'0"W
Text
Summer Season (May - October)
Banquereau
0 5 10 20 30 40
Miles
Sable Island Bank
Well: NS1-Site 1
Bonn Thickness
Sheen (0.04 - 0.3 microns)
Rainbow (0.3 - 5 microns)
Metallic (5 - 50 microns)
DTOC (50 - 200 microns)
CTOC (> 200 microns)
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community. Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
60°0'0"W


60°0'0"W
Text
Summer Season (May - October)
Banquereau
0 5 10 20 30 40
Miles
Sable Island Bank
Well: NS1-Site 1
Max Dissolved Oil Conc (ppb)
1 - 2
3 - 5
5- 10
10 - 20
20 - 50
> 50
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community. Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
60°0'0"W

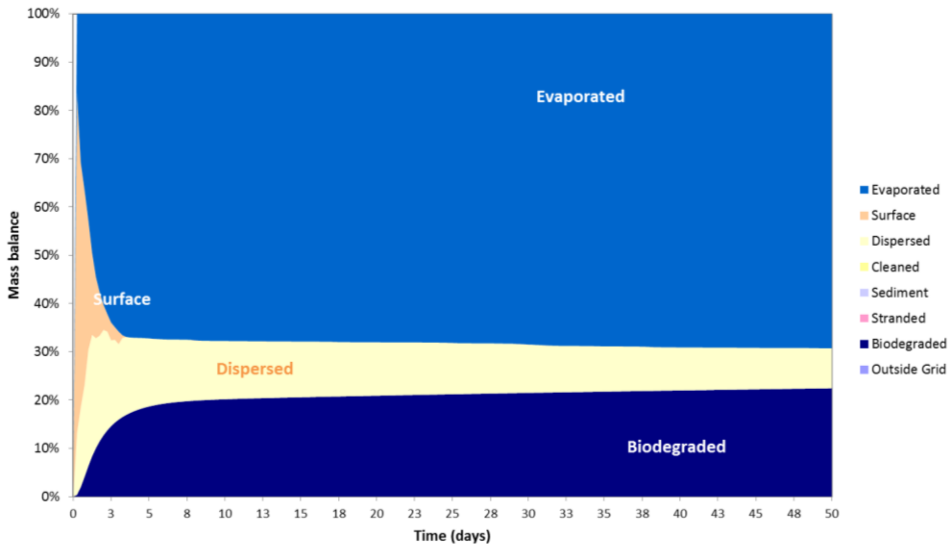


Figure 8.4.25 The total dissolved oil concentration in excess of 1 ppb is depicted for an unmitigated 100 bbl batch diesel spill at Site 1 (top panel) along with the associated surface thickness that is expected over the modelled 30-day period (middle panel). The associated mass balance figure is included (bottom panel) (deterministic model starting June 3, 2009 at 05:00 GMT).

8.4.10 SBM Spill

Given the proximity on the Scotian Slope and similarities in water depth, the modelled predictions for a SBM spill on the Shelburne Basin Venture Exploration Drilling Project are considered valid to inform the assessment for the Project.

For the Shelburne Basin Venture Exploration Drilling Project, a larger volume SBM spill (3,604 bbl; 573 m^3) was modelled to represent a full riser release associated with a disconnection of the riser at the BOP, which is considered the worst-case credible subsea discharge scenario. A smaller volume spill (377 bbl; 60 m^3) was modelled to represent a worst-case credible surface discharge of a full mud tank on the MODU. Both scenarios were modelled at two sites in the Shelburne Basin Venture Exploration Drilling Project Area representing various water depths (1,770 m and 2,550 m).

Modelling conducted by RPS ASA (2014, Appendix C in Stantec 2014a) predicted that due to the relatively small release volumes and fine particle sizes associated with the SBM, the sea surface release (60 m^3) quickly dispersed below levels detectible by the model and did not contribute to mass accumulation on the seabed. Deposition resulting from the 573 m^3 SBM releases on the seabed was limited to thicknesses below 10 mm at both sites. Contours of 1 mm thickness were predicted to extend up to 690 m from the release sites, and cover a maximum area of 0.27 ha of the seabed.

RPS ASA's modelling (2014, Appendix C in Stantec 2014a) also predicted that sediment plumes resulting from the accidental discharges of SBM would extend between 5,080 m and 9,620 m from the release site. As with the patterns of deposition, the extent of the plume and maximum total suspended solids (TSS) concentration were larger for the releases associated with the marine riser as compared to the surface discharges. The maximum predicted concentration of suspended sediments in the water column (corresponding to the weakest current regime) was 29,401 mg/L for the marine riser discharge and 2,424 mg/L for the surface release, with most of the suspended sediment released from the MODU to remain within the uppermost 10 to 20 m of the water column. In all modelled scenarios, the water column was predicted to return to ambient conditions (<1 mg/L) within 30 hours of the release (RPS ASA 2014, Appendix C in Stantec 2014a).

8.5 ENVIRONMENTAL EFFECTS ASSESSMENT

The assessment of accidental events relies extensively on spill modelling conducted for the Project (refer to Section 8.4 for an overview and Appendix H for the modelling report). In line with the precautionary principle, spill modelling work carried out for the Project was based on the worst-case credible for each scenario. No oil spill tactical response methods were applied as mitigation measures and for the blowout incident scenarios, the flow rates used were the worst-case credible discharge at the two potential locations.

Results of spill modelling demonstrate that the geographic extent of an unmitigated spill will most likely be limited within the RAA. It is possible, however, that some blowout spill scenarios could result in some oil extending beyond the boundaries of the RAA. To be conservative, this potential has been considered in the individual VC assessments below, where relevant. The temporal boundaries for the assessment of the Project include the periods of mobilization, operations, and abandonment. Up to seven exploration wells may be drilled sequentially over the term of the ELs, with each well taking up to 120 days to drill.

For each VC, the assessment considers the following accidental spill scenarios:

- instantaneous spill of marine diesel from the MODU including 10 bbl and 100 bbl volume scenarios;
- spill of marine diesel from a PSV;
- continuous 30-day well blowout incident including 733,000 bbl [24,890 bpd] and 1,056,000 bbl [35,914 bpd] scenarios; and
- instantaneous spill of SBM from the MODU (surface release [60 m^3 or 377 bbl] and subsea release [573 m^3 or 3604 bbl]).

These scenarios are consistent with those identified in Section 8.2 as credible spill event scenarios for the Project. Accidental spills, which result in an unplanned release of hydrocarbons, (*i.e.* marine diesel or crude oil) to the marine environment, are collectively referred to as "oil spills" in this section, focusing on interactions between hydrocarbon material and the VCs being assessed. The chemical composition of a hydrocarbon will affect the physical properties of the oil (*e.g*., how heavy or thick it is), its behaviour in the environment (*e.g.*, how it spreads, disperses, or sinks), its toxicity to receptors, and its susceptibility to degradation by weathering (Lee *et al*. 2015). SBM spills are not considered to be "oil spills" and are addressed separately.

Section 8.4.4 describes the characteristics of the marine diesel and crude oil used in the modelling scenarios. The toxicity of oil to marine life varies with exposure, where exposure is a function of oil type, environmental conditions, and the life history and physiology of each species (Lee *et al*. 2015).

Marine diesel spills from a PSV are included as a scenario for assessment in recognition of the potential for a spill to occur as a result of PSV collision during transit to or from the MODU. These spills were not included in the spill modelling study; effects are addressed qualitatively. Diesel spills from a PSV spill are assumed to be in the order of 10 bbls and assumed to interact with marine wildlife similarly to marine diesel spills from the MODU (where 10 bbl spill scenarios were modelled). However, a PSV spill scenario includes a nearshore diesel spill.

As noted in Section 8.4.10, a SBM spill scenario was not specifically modelled for this Project, although recent modelling for the Shelburne Basin Venture Exploration Drilling Project (RPS ASA 2014, included as Appendix C in Stantec 2014a) has been referenced as appropriate to inform the effects assessment.

In identifying interactions between the VC and a potential accident scenario, a credible worst-case event was assumed as described in Section 8.4.3. As part of the assessment methods, environmental effects pathways are identified and discussed, including a review of available research and scientific data on these effect pathways. VC-specific mitigation has been identified where appropriate, although for all VCs the focus is on emergency response and spill management as outlined in Section 8.3. Spill modelling results presented in Appendix H are for unmitigated events (*i.e.*, no emergency response measures to contain or recover oil), which adds another element of conservatism to the effects assessment. Residual effects are characterized in residual effect summary tables. The significance of residual effects is determined using the same VC-specific thresholds for determining the significance of residual environmental effects as used for routine Project activities (refer to Sections 7.2 to 7.7).

8.5.1 Fish and Fish Habitat

As described in Section 5.2.5 and summarized in Section 7.2.6, the Project Area is located to the south of Sable Island and Western Banks on an area of the Scotian Shelf and Slope. The Project Area, LAA and RAA provide habitat for a variety of groundfish, pelagic fish, and invertebrate species. There are 24 fish Species at Risk (SAR) and Species of Conservation Concern (SOCC) that may be present on the Scotian Shelf or Slope at various times of the year. Within the Project Area, LAA and RAA there are five fish species formally protected under the *Species at Risk Act* (SARA): Atlantic salmon (Inner Bay of Fundy population); Atlantic wolffish; Northern wolffish;

spotted wolffish; and white shark. While the potential for occurrence of these SAR in the Project Area is believed to be low based on known habitat preferences, distribution mapping and catch data (where available), in the event of a spill there is potential for interaction with these species in the larger RAA. Section 5.2.5 describes marine fish found in the RAA, with a focus on offshore species most likely to interact with the Project during routine activities.

There is a potential for an interaction between nearshore receptors and oil from a release from a PSV in a nearshore area or well blowout incident. Additional details on inshore fish and fish habitat is provided below. For the purpose of this assessment, offshore is referred to as the zone beyond the nearshore (inshore) zone where sediment motion induced by waves alone effectively ceases and where the influence of the seabed on wave action is small in comparison with the effect of wind. Inshore/nearshore is defined as the zone extending from the low tide mark to the offshore, typically reaching water depths of the order of 20-30 m (DFO 1996; Voigt 1998).

A variety of fish species have been recorded in Nova Scotia's nearshore, including groundfish, pelagic species, diadromous species and invertebrates. Some species enter the inshore only to feed and others are seasonal migrants. Some species spend their whole life in inshore areas while others spend only certain life stages of their life in the inshore. Coastal and estuarine areas offer suitable cover for use as spawning and nursery grounds. Species that spawn in inshore areas include Atlantic herring, haddock, pollock, witch flounder and yellowtail flounder (species descriptions for marine fish can be found in Section 5.2.5). Juvenile cod (up to the age of four) prefer habitats that provide protection and cover such as inshore waters with eelgrass or areas with rock and coral (COSEWIC 2010d). Diadromous species, such as alewife and American eel, spend only a portion of their life in the inshore environment.

At least 58 species of groundfish are known to occur in the inshore areas of the Scotian Shelf, although few are restricted to the inshore only (Bundy 2014). Most frequently encountered groundfish are Atlantic cod, skates, winter flounder, pollock, haddock, sea raven (*Hemitripterus americanus*), and yellowtail flounder (Bundy *et al*. 2014). The inshore pelagic habitat extends from surface waters to near bottom (Bundy *et al*. 2014). Large pelagic species observed inshore include bluefin tuna, swordfish, and several shark species (porbeagle shark, spiny dogfish, blue shark and shortfin mako). These species are typical of offshore habitats but enter shallower waters of the Scotian Shelf in the warmer months to feed (Bundy *et al*. 2014). Small pelagics in the inshore include Atlantic herring and Atlantic mackerel.

Diadromous fishes require both salt and freshwater environments to complete their lifecycle. As the interface between salt and freshwater environments, the inshore area is particularly important to diadromous species. Those found in the inshore region of Nova Scotia include: sea lamprey (*Petromyzon marinus*), Atlantic sturgeon, blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudolarengus*), American shad (*Alosa sapidissima*), Atlantic whitefish (*Coregonus huntsmani*), Atlantic salmon, rainbow smelt (*Osmerus mordax*), Atlantic tomcod (*Microgadus tomcod*), striped bass, and American eel.

Many invertebrates spend their entire life in the inshore region (*e.g.*, lobster, green crab (*Carcinus maenas*), rock crab (*Cancer irroratus*), sea urchins, blue mussels (*Mytilus edulis*), and oysters) (Bundy *et al.* 2014). Other invertebrate species that can be found in inshore waters include jellyfish, scallops, shrimp, squid, whelks, numerous crab species, periwinkles, sea cucumbers, sea stars, and sand dollars. The invertebrates found in the inshore region tend to be sessile or have limited mobility and the inshore area provides a variety of food sources to support their life cycle. Many of these species support commercial fisheries (Bundy *et al.* 2014). The highest abundances of American lobster are off southwest Nova Scotia (Hastings *et al*. 2014).

The potential environmental effects, effect pathways, and measureable parameters identified in Table 7.2.1 for Fish and Fish Habitat for routine activities remain valid for the assessment of potential environmental effects as a result of an accidental event. Likewise, the criteria for characterizing residual environmental effects and determining significance (refer to Section 7.2.5) remain valid for the accidental events assessment.

8.5.1.1 Project Pathways for Effects

All of the identified spill scenarios have potential to result in a Change in Risk of Mortality or Physical Injury and/or Change in Habitat Quality and Use for Fish and Fish Habitat. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in both space and in time. As noted earlier, the assessment is conservative (*i.e.*, geographic and temporal overlap are assumed to occur and modelling results assume no implementation of mitigation measures).

Potential effects pathways for a Change in Risk of Mortality or Physical Injury and/or Change in Habitat Quality and Use for Fish and Fish Habitat due to an oil spill include: reduction of water and/or sediment quality; reduced primary productivity due to a reduction in air-water gas exchange and light penetration; and lethal and sub-lethal effects from acute or chronic exposure to water-soluble fractions of hydrocarbons.

Potential effects pathways for a Change in Risk of Mortality or Physical Injury and/or Change in Habitat Quality and Use for Fish and Fish Habitat due to an accidental SBM release include: smothering of sessile or slow-moving individuals and food sources for fish and shellfish; sedimentation; and potential for contamination. Elevated total suspended solid (TSS) levels can have detrimental effects on fish including physiological stresses, reduced growth, and adverse effects on survival, with the severity of these effects dependent on various factors including life-history stage and risk of exposure (*e.g.,* ability of fish to avoid undesirable conditions).

Effects of Hydrocarbons on Fish and Fish Habitat

The risk of exposure of fish and invertebrates to an oil spill is dependent on the type of oil and the extent of the spill, but also on the habitat these species occupy, their behaviour, the time of year, their life history and the general health of the stock at the time of the spill. Fish kills are typically brief and localized following a discrete spill event due to the rapid loss of the acutely lethal low-molecular weight components of oil due to dilution and weathering (Lee *et al*. 2015), the ability of mobile species to detect and avoid impacted areas, and the ability of phytoplankton, zooplankton, and adult fish to metabolize hydrocarbons (Wolfe *et al.* 1996; Graham *et al.* 2010).

In general, adult pelagic and benthic fish occurring in relatively deep waters have lower exposure risk because they are highly mobile and able to avoid oiled areas (Irwin 1997; Law *et al*. 1997). Larval and juvenile pelagic and benthic fish species are at a greater risk of exposure as they are often less mobile than adults (Yender *et al*. 2002) and have shown higher sensitivity to lower concentrations of hydrocarbons since they may not have yet developed detoxification systems allowing them to metabolize hydrocarbons (Rice 1985; Carls *et al*. 1999; Incardona *et al.* 2013; Lee *et al*. 2015). Fish that spawn or occur in nearshore intertidal and subtidal zones and in shallow reef zones are at higher risk of exposure where there is shoreline oiling or contamination of sediments thereby potentially increasing the risk for chronic exposure (Yender *et al.* 2002; Lee *et al.* 2015). Benthic invertebrates have a moderate to high risk of exposure, depending on their mobility and use of contaminated sediments (Yender *et al*. 2002; Lee *et al*. 2015).

Effects on phytoplankton and zooplankton vary by species, with mortality more dependent on exposure time (some zooplankton have been shown to avoid spills) than hydrocarbon concentration (Abbriano *et al.* 2011; Seuront 2010). Reduction of air-water gas exchange and light penetration following a spill generally results in reduced productivity and growth and ultimately a change in community composition (Teal and Howarth 1984; Abbriano *et al.* 2011; Gilde and Pinckney 2012).

Post-spill studies on phytoplankton conducted using crude oil obtained from the DWH oil spill and a mixture of Texas crude samples found that total phytoplankton biomass declined with increasing concentration of oil, and that the phytoplankton community was modified. Diatoms, cyanobacteria, euglenophytes, and chlorophytes were found to be relatively resistant to contamination, while cryptophytes were found to be vulnerable (Gilde and Pinckney 2012).

Zooplankton have also been shown to be sensitive to hydrocarbons, with increased mortality, decreased feeding, and decreased reproduction (Suchanek 1993; Seuront 2011). Zooplankton with the ability to sense and avoid spills (*e.g.*, copepods) can reduce contact and mortality risk (Seuront 2010). At sub-lethal levels, hydrocarbons accumulated in zooplankton after a spill can be depurated within days of moving to clean water (Trudel *et al.* 1985). Recovery of zooplankton communities are likely to occur soon after a spill due to their short generation time, high fecundity, and the ability of some zooplankton to actively avoid spill sites (Seuront 2011). When there is a spill of crude oil or hydrocarbons, the bacteria capable of degrading the substance proliferate and multiply quickly (ASM 2011). The local community of microbes in an area is adapted to the background supply of hydrocarbons. When a spill occurs, there is a lag time during which the microbes replicate and increase their populations in response to the influx of a new energy source. During an oil spill, the volume of oil released into the environment initially out paces the ability of bacteria to degrade the substance until the community catches up in numbers in response to the increased availability of a hydrocarbon source. In coordination with other physical processes including evaporation, dissolution, dispersion, and photo-oxidation, bacteria will eventually clean up the spill by consuming the hydrocarbon compounds which are biodegradable (ASM 2011). Studies have shown that bacterial respiration, through biodegradation of hydrocarbons, has the potential to cause oxygen depletion, eventually leading to hypoxia in areas near oil spills (Adcroft *et al*. 2010).

Various experimental studies have shown sub-lethal toxic effects of hydrocarbons on early life stages of pelagic fish (Marty *et al.* 1997; Peterson and Kristensen 1998; Carls *et al.* 1999; Heintz *et al.* 1999; Couillard 2002; Pollino and Holdway 2002; Colavecchi *et al.* 2004; Incardona *et al.* 2004; Hendon *et al.* 2008; Incardona *et al.* 2014).

After the DWH oil spill, early life stages of coastal fishes using seagrass habitat in the northern Gulf of Mexico were investigated. The studies concluded that immediate, catastrophic losses of 2010 cohorts were largely avoided, and that no shifts in species composition occurred following the spill. However, it was pointed out that this did not preclude potential long-term effects experienced by fishes as a result of chronic exposure and delayed indirect effects (Fodrie and Heck 2011). In another study, commercial fish and shellfish (crab, shrimp, oyster) species were collected after the DWH oil spill from closed fishing grounds along the Mississippi coast. Higher levels of PAHs were detected in all four taxa (fish, crab, shrimp, oyster) during the early sampling. When compared with later months, and after one year, polycyclic aromatic hydrocarbon (PAH) levels in the collected samples were similar to those reported in commonly consumed processed foods and below regulated levels (Xia *et al.* 2012).

Effects of hydrocarbon spills are most realistically examined using the water-soluble fractions of oil or light hydrocarbon products since natural weathering of the oil, including dispersion and dissolution cause the water-soluble hydrocarbons to move from the surface oil slick into the water column. As referenced in Section 8.4.6, the OLF Guideline for risk assessment of effects on fish from acute oil pollution (2008) concluded that threshold concentration for no observed effect from acute exposure to total hydrocarbons ranges from 50 to 300 ppb. Neilson *et al.* (2005, as reported in OLF 2008) proposed a value for acute exposure to dispersed oil of 58 ppb, based on the toxicity of dispersed oil to various aquatic species, which showed the 5% effect level is 58 ppb. This threshold was used as a modelling reference and is used to predict environmental effects of hydrocarbon spills (well blowout incident, diesel spills) on marine fish.

Effects of SBM Spill

Synthetic-based mud (SBM) is a heavy, dense fluid which sinks rapidly in the water column when released (refer to Section 2.8.2 for information on SBM constituents). SBM constituents will be selected in line with the OCSG so that low toxicity chemicals are used wherever practicable. Therefore, environmental effects are mostly restricted to smothering of sessile or slow moving individuals and sedimentation. In the event of an accidental batch spill of SBM, the pathways for effects would be similar to that assessed for routine drilling discharges (refer to Section 7.2). Elevated TSS levels can cause physiological stress, reduce growth and cause adverse effects on survival of fish, although increases in TSS levels would be very temporary as a result of a SBM spill (refer to Section 8.2.2). An accidental spill of SBM would also have the potential to result in a small, thin surface sheen with effects similar to those discussed above for hydrocarbon spills, but more limited in nature.

8.5.1.2 Mitigation of Project-Related Environmental Effects

BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. As noted in Section 8.3, the Project will operate under an Incident Management Plan (IMP) which will include a number of specific contingency plans for responding to specific emergency events, including potential spill or well control events. The IMP and supporting specific contingency plans, such as a Spill Response Plan (SRP), will be submitted to the CNSOPB prior to the start of any drilling activity as part of the OA process. The SRP will clarify tactical response methods, procedures and strategies for safely responding to different spill scenarios. Tactical response methods that will be considered following a spill incident include, but are not limited to: offshore containment and recovery; surveillance and tracking; dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response. Refer to Section 8.3 for details on incident management and spill response.

BP will undertake a NEBA as part of the OA process with the CNSOPB to evaluate the risks and benefits of chemically dispersing oil into the water column, including potential effects on fish and fish habitat, and will obtain regulatory approval for any use of dispersants as required.

In the unlikely event of a spill, specific monitoring (*e.g.*, environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

8.5.1.3 Characterization of Residual Project-Related Environmental Effects

Diesel Spills (PSV and MODU)

Stochastic modelling for the batch release of diesel was undertaken for unmitigated incidents involving a hose failure (10 bbl surface batch release of diesel) and tank failure (100 bbl surface batch release of diesel). Modelling was conducted for both summer (May to October) and winter (November to April) seasons from one spill site within the EL blocks. Environmental effects are anticipated to occur over the greatest area if a spill was to occur during the summer season. Figures 8.4.24 and 8.4.25 illustrate the cumulative affected area in which dissolved hydrocarbons in the water column over the duration of the simulation exceed 1 ppb during the worst-case credible scenario throughout the stochastic simulations.

Modelling results indicate that diesel spills from the MODU or PSV are not likely to result in biological effects on fish over a large area (refer to Section 8.4.10 or Appendix H). For the 100 bbl spill scenario, approximately 65 % of the spill evaporated within three days. For the 10 bbl and 100 bbl spill scenarios, 23 km^2 and 336 km^2, respectively, experienced maximum total in-water concentrations of dissolved hydrocarbons in excess of 1 ppb. Results from both the 10 bbl and 100 bbl scenario indicate that all of the total in-water dissolved total hydrocarbons fall within the concentration range of 1 to 10 ppb. With respect to a Change in Habitat Quality and Use, the majority of diesel from a spill from either the MODU or PSV will evaporate and disperse within the first three days following the release (refer to Appendix H). This will create a temporary and reversible degradation in habitat quality. Depending on the location and extent of the spill, nearshore spawning and nursery areas could potentially be affected. Diesel is known to have immediate toxic effects on many intertidal (*e.g.*, molluscs, amphipods) and benthic organisms (Stirling 1977; Simpson *et al.* 1995; Cripps and Shears 1997) with sessile and early life stages (eggs, larvae) are the most at risk as they are unable to actively avoid the diesel and/or are during sensitive life-stage development periods. Benthic invertebrates, including commercial species, have experienced sub-lethal effects resulting from low-level exposure to hydrocarbons, with crustaceans being the most sensitive taxa (Sanders *et al.* 1980; Jewett *et al.* 1999).

However, given the small-scale nature of the spill, effects on nearshore areas are expected to be limited to a scenario in which marine diesel is spilled from a PSV transiting close to the shore. Oil spill containment and recovery operations will further reduce residual effects on fish and fish habitat associated with total dissolved hydrocarbons.

With respect to a Change in Risk of Mortality or Physical Injury, although there is a risk of mortality of phytoplankton and zooplankton (food sources), and sub-lethal and lethal effects to larval and juvenile fish species present in the mixed surface layer of the water column, these residual effects will likely be restricted to a localized area. The potential for these effects would also be temporary and reversible. Adult fish species in surface waters will largely be unaffected due to avoidance mechanisms; demersal (bottom dwelling) species are unlikely to be exposed to harmful concentrations of dissolved total hydrocarbons. Residual effects following a nearshore diesel spill from the PSV could include localized mortality and sub-lethal effects to fish eggs, larvae and juveniles.

Well Blowout Incident

A, blowout scenario has the greatest potential for environmental effects. The actual effects of a blowout incident would depend in large part upon the duration and volume of the spill, as well as the environmental conditions at the time of the spill.

With respect to Change in Risk of Mortality or Physical Injury to Fish and Fish Habitat in offshore waters, effects on slow moving or sedentary species would be similar to those of diesel on phytoplankton, zooplankton, larval and juvenile fish species, but over a greater area. Greater concentrations of total hydrocarbons in spilled oil and present in the surface mixed layer following an incident during winter conditions, may be expected to result in higher mortalities and sub-lethal effects on fish eggs, larvae and juveniles. In the unlikely event that dissolved hydrocarbons are transported towards inshore waters, residual effects on fish may extend to lethal and sub-lethal effects on the eggs, larvae and juveniles of demersal species and other fish species including those in spawning and nursing areas.

In the event of a blowout scenario, there will be a temporary decline in the abundance of phytoplankton in the immediate area of the spill. Zooplankton communities may be able to avoid exposure. Zooplankton which cannot avoid exposure and experience sub-lethal effects will depurate once the spill has subsided due to mitigation (*e.g.*, containment and/or recovery) and natural weathering processes. The majority of adult finfish will be able to avoid exposure via temporary migration. In the event that the spill encompasses areas where fish eggs or larvae are located, lethal and sub-lethal effects could occur. It should be emphasized that the majority of fish species on the Scotian Shelf and Slope spawn in a variety of large areas, over long time scales, and a spill is not predicted to encompass all of these areas or time scales within the RAA to such a degree that natural recruitment of juvenile organisms may not re-establish the population(s) to their original level within one generation.

The majority of spawning areas for fish species in the RAA occur on the Scotian Shelf, with the eggs and larvae of some species being found along the Scotian Slope and shelf break (refer to Section 5.2.1.4). In the event of a large blowout incident, the area affected will not encompass all of the spawning locations for any one species. The majority of fish species on the Scotian Shelf and Slope spawn in multiple locations within the RAA with the exception of a few species. There are a few species which tend to spawn in a limited geographic area. These species include the smooth skate and sand lance. However, these species have the potential to spawn over many months or the entire year and with mitigation (*e.g.*, containment and/or recovery), their spawning window will not be completely affected by a blowout incident. In the event of a major blowout incident, due to the fact that most species spawn in multiple locations within the RAA or over long time scales, it is not likely that an entire year class would be lost due to the toxic effects of oil on early life stages of fish species.

Following a continuous, 30-day unmitigated blowout scenario, the geographic extent of residual effects on Change in Habitat Quality and Use (using a 58 ppb total hydrocarbon concentration as an effect threshold) could extend into the RAA with a low probability of extension beyond the RAA. While the modelling demonstrates a potentially large affected area, it is important to note that many of the areas delineated through the modelling have low probabilities of occurrence and that results are based on an unmitigated release. In an actual incident, emergency response measures are likely to have some effect on limiting the magnitude and duration of the spill thereby limiting the geographic extent and potential environmental effects. As indicated by the modelling, an unmitigated spill is unlikely to reach the shoreline (except for Sable Island discussed in Section 8.5.4) or nearshore environments and the implementation of mitigation measures would further reduce this likelihood.

The extent of the potential effects will depend on how the spill trajectory and fish and fish habitat overlap in both space and in time. As discussed in Section 8.4 (Table 8.4.7), a 58 ppb concentration of dispersed oil has been identified as a threshold for acute exposure of aquatic species.

Stochastic oil release modelling was undertaken for unmitigated blowout incidents at each of the two well locations based on worst-case credible discharges (WCCD). Modelling was conducted for both summer and winter season spill scenarios. Applying the 58 ppb total hydrocarbon threshold for effects to fish (an in-water concentration of dissolved and entrained oil in the top 100 m), these levels are most likely to be encountered on the Scotian Slope, with 7 to 11% average probability of these levels occurring in the Haddock Box and 9 to 13% average probability of these levels reaching the Emerald, Western, and Sable Banks on the shelf (refer to Figures 8.4.7 to 8.4.10).

The models indicate that the minimum time for in-water oil concentrations >58 ppb to arrive at the maximum distance from the well is between 50 and 75 days (illustrated in Figure 8.4.10, Site 2 summer season). As noted in Section 8.3.3, well intervention response strategies could be implemented within 2 to 5 days for BOP intervention and the well could be capped between 13 and 25 days thereby decreasing the spatial extent of a spill. These activities were not factored into the model in order to demonstrate the worst-case credible scenario of an unmitigated blowout incident. Exposure time to oil concentrations above 58 ppb is also contingent on spill response time. For the unmitigated scenario (Site 2 summer season), the predicted duration of exposure to in-water concentrations of oil >58 ppb around the wellsite is greater than 30 days, while in-water exposure time of one day or less may be expected at the outer extent of the predicted threshold exceedance area (Figure 8.4.10).

SBM Spill

A Change in Risk of Mortality or Physical Injury in the case of an unintended bulk release of SBM would likely be restricted to smothering effects on highly immobile individuals and benthic prey species within tens of metres from the spill site. Results from the modelling conducted for the Shelburne Basin Venture Exploration Drilling Project (RPS ASA 2014, Appendix C in Stantec 2014a) indicate that effects from both the surface and subsurface SBM spill would likely be temporary, reversible and highly localized around the wellsite. In particular, modelling of accidental SBM spills at the sea floor is limited to thicknesses below 10 mm at both sites. Sediment thickness contours of 1 mm were predicted to extend up to 41 m from the release sites, and cover a maximum area of 0.27 ha of the seabed. This thickness is well below the thickness likely to cause smothering.

With respect to a Change in Habitat Quality and Use following an SBM spill, there would likely be a temporarily and reversible degradation in habitat quality within tens of metres from the spill site. Results from the modelling indicate that effects from an SBM spill would likely be temporary, reversible and highly localized around the wellsite.

Summary

Table 8.5.1 provides a summary of predicted residual environmental effects of accidental events on Fish and Fish Habitat.

Table 8.5.1 Summary of Residual Project-Related Environmental Effects on Fish and Fish Habitat – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury/Change in Habitat Quality and Use							
10 bbl Diesel Spill	A	L	LAA	ST	S	R	U
100 bbl Diesel Spill	A	M	RAA	ST	S	R	U
PSV Diesel Spill	A	M	RAA	ST-MT	S	R	U
Well Blowout Incident	A	M	RAA*	ST-MT	S	R	U
SBM Spill	A	L	LAA	ST	S	R	U

KEY:
See Table 7.2.2 for detailed definitions

N/A: Not Applicable
Direction:
P: Positive
A: Adverse
N: Neutral
Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*".
Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous
Reversibility:
R: Reversible
I: Irreversible
Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.5.1.4 Determination of Significance

Based on information presented above and a consideration of the significance criteria, the predicted residual adverse environmental effects from any of the accidental event scenarios on Fish and Fish Habitat would be not significant. This determination takes into account the conservatism of the spill modelling (results show an unmitigated release), the use of mitigation measures to prevent and reduce effects from a spill, and the nature of the adverse effects as described in the literature summarized above. This conclusion is made with a high level of confidence for the 10 bbl diesel spill and a SBM spill scenarios based on the low magnitude and geographic extent of likely effects. A medium level of confidence is assigned to the 100 bb diesel spill, PSV diesel spill, and well blowout scenarios given the potential for oil to reach spawning areas on the Scotian Shelf and/or nearshore. However, as noted above, the majority of fish species on the Scotian Shelf and Slope spawn in a variety of large areas, over long time scales, and a spill is not predicted to encompass all of these areas or time scales within the RAA to such a degree that natural recruitment of juvenile organisms may not re-establish the population(s) to their original level within one generation. Furthermore, none of the spill scenarios are expected to result in permanent alteration or irreversible loss of critical habitat as defined in a recovery plan or an action strategy.

8.5.2 Marine Mammals and Sea Turtles

As described in Section 5.2.6 and 7.3.6 there are six species of mysticetes (baleen whales), eleven species of odontocetes (toothed whales), five species of phocids (seals), and four species of sea turtles (see Tables 5.2.9 and 5.2.12), that could potentially be present in the Project Area and surrounding LAA and RAA. Ten of these species are designated at risk by either SARA or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (three species of mysticetes, four species of odontocetes, and two species of sea turtles; see Table 7.3.3).

The majority of mysticetes are migratory, and are present on the Scotia Shelf and Slope from late spring through fall. The fin whale, however, is present year-round (see Table 5.2.10 for information on presence and timing of marine mammals known to occur near the Project Area). On the Scotian Shelf and Slope there is designated critical habitat under SARA for endangered species including the North Atlantic right whale and the northern bottlenose whale (refer to Figure 5.2.30). Critical habitat for the endangered North Atlantic right whale has been identified in Roseway Basin on the Scotian Shelf within the RAA (Brown *et al*. 2009). Critical habitat for the endangered northern bottlenose whale has been designated in the Gully and in the Shortland and Haldimand Canyons on the east of the Scotian Shelf and Slope (DFO 2010). There have also been sightings of the northern bottlenose whale along the shelf break and within Dawson and Verrill Canyons, within the Project Area.

Seals are most commonly found over the Scotian Shelf, north of the Project Area, in the nearshore waters around Sable Island. They are less common in the open waters over the Scotia Slope, where the Project Area is located. Sable Island hosts the world's largest breeding colony of grey seals (DFO 2011a; Freedman 2014a) (refer to Section 5.2.6). Other species known to breed and forage in the area include harp, hooded, and ringed seals. No seal populations on the Scotian Shelf are designated at risk under SARA or by COSEWIC. Within Halifax Harbour, where PSVs will be transiting to and from the supply base, harbour seals have been observed in large numbers, particularly in the Bedford Basin, during winter; grey seals have also been observed occasionally (Brodie 2000).

Harbour porpoise and Atlantic white-sided dolphins have been sighted at locations in Halifax Harbour, with occasional sightings of larger whales at the approaches to the harbour (Brodie 2000).

Within the Scotian Shelf and Slope waters, four species of sea turtles can be found migrating and foraging. Two sea turtle species, the leatherback sea turtle (listed as endangered on Schedule 1 of SARA) and the loggerhead (assessed as endangered by COSEWIC but not listed under SARA) are most likely to occur. Critical habitat for leatherback turtles in Atlantic Canada has been proposed based on a DFO Science Advisory Process (DFO 2011b) but not yet formally designation under SARA.

The potential environmental effects, effect pathways, and measureable parameters identified in Table 7.3.1 for the assessment of routine Project activities on Marine Mammals and Sea Turtles remain valid for the assessment of potential environmental effects as a result of an accidental event. Likewise, the criteria for characterizing residual environmental effects and determining significance (refer to Section 7.3.5) remain valid for the accidental events assessment.

8.5.2.1 Project Pathways for Effects

All of the identified accidental event scenarios (*i.e.*, batch diesel spill, PSV spill, SBM spill and well blowout incident) have the potential to result in a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in both space and in time. As noted earlier, the assessment is conservative (*i.e.*, geographic and temporal overlap are assumed to occur and modelling results assume no implementation of mitigation measures).

Effects of Hydrocarbons on Marine Mammals

The effects of oil on marine mammals and sea turtles depend on the extent of exposure to toxic components of oil. Exposure may be derived from external coatings of oil (*e.g*., interaction with surface slicks when animals surface for air, clogging of baleen plates), inhalation of aerosols of particulate oil and hydrocarbons, and ingestion of contaminated prey (Lee *et al*. 2015). French–McCay (2009) describes biological effects associated with oil spills. Wildlife individuals that move through the area swept by floating oil (*e.g.*, slicks, emulsions, or other floating forms such as tar balls) are assumed to be oiled based on probability of encounter and those oiled above a threshold dose are assumed to die. Based on available scientific data, a combined probability of oil encounter and mortality once oiled assumed for species groups, if present in the area swept by oil exceeding a threshold thickness of 10 μm (for spills larger than 230 m in diameter), was 0.1% for cetaceans and 75% for fur-bearing marine mammals (*e.g*., seals). Aquatic mammals that rely on fur for insulation experience similar effects associated with thermoregulatory failure as is seen in birds (Lee *et al*. 2015) (refer to Section 8.5.3).

Several studies have demonstrated varying results on the ability of marine mammals to detect and/or avoid oil-contaminated waters (Engelhardt 1983; St. Aubin *et al.* 1985; Smultea and Würsig 1995; Ackleh *et al*. 2012). Several species of cetaceans and seals have been documented behaving normally in the presence of oil (St. Aubin 1990; Harvey and Dahlheim 1994; Matkin *et al.* 1994). It is possible that cetaceans swim through oil because of an overriding behavioural motivation (*e.g.,* feeding). Some evidence exists that dolphins attempt to minimize contact with surface oil by decreasing their respiration rate and increasing dive duration (Smultea and Würsig 1995).

Other studies document examples of individuals avoiding surface slicks. Aerial surveys conducted offshore Atlantic Canada between 1979 and 1982 monitored the presence of individuals near small oil slicks, noting some individuals swimming near surface oil but rarely within surface slicks (Sorensen *et al*. 1984).

In some cases, marine mammals may avoid an affected area beyond the detected slick. Based on a comparison of sperm whale acoustic activity from pre-spill (2007) and post-spill (2010 DWH oil spill) conditions, Ackleh *et al.* (2012) noted that sperm whales may have relocated out of the areas with a high concentration of oil and pollutants (possible shortages of food) and increased boat traffic (and therefore increased anthropogenic noise).

Humpback whales may have shown temporary avoidance during the 1989 *Exxon Valdez* spill in Prince William Sound, Alaska (von Ziegesar *et al.* 1994), although another study noted that killer whales were observed swimming through surface oil within 24 hours of the spill (Matkin *et al*. 2008).

Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980, 1982). Species like the humpback whale, right whale, beluga and harbour porpoise that feed in restricted areas may be at greater risk of ingesting oil (Würsig 1990). Hydrocarbons consumed through eating contaminated prey can be metabolized and readily excreted, but some is stored in blubber and other fat deposits (Lee *et al*. 2015). Absorbed oil can cause toxic effects such as minor kidney, liver, and brain lesions (Geraci and Smith 1976; Geraci 1990; Spraker *et al.* 1994). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982).

In baleen whales, crude oil could coat the baleen plates and reduce filtration efficiency, but these effects are considered reversible (Geraci 1990). Geraci (1990) noted that adverse effects on cetaceans, such as sickness, stranding or mortality, tended to be associated with crude or bunker C oil, which is not the type of oil that would result from a spill or blowout incident for this Project. Most marine mammals can withstand some oiling without toxic or hypothermic effects. Whales and seals use blubber to maintain core body temperature, which is not affected by a covering of oil. Hypothermia is possible, such as if a young seal pup is covered in oil because it takes several months to build up a blubber layer sufficient to maintain body heat.

Direct contact with oil can cause fouling in fur-bearing marine mammals such as seals, reducing thermoregulation abilities (Kooyman *et al*. 1977). However, hypothermia may be offset somewhat by thick layers of blubber (Lee *et al.* 2015). Following the *Exxon Valdez* spill, harbour seals were observed swimming through and surfacing in floating oil while feeding and moving to and from haulout sites (Lowry *et al.* 1994). Oil fouling might affect seal locomotion, with heavy oiling causing flippers to stick to the body; contact with oil also reduces the insulative value of hair, but in healthy seals this is not likely to be a major problem as they rely primarily on blubber for insulation. Seals became cleaner over time if they were not repeatedly exposed to oil. Various types of skin lesions in harbour seals were probably caused by crude oil. Examination of dead, oiled seals suggested lesions may have been related to inhalation of toxic fumes and mortality could have resulted from behavioural disorientation, lethargy and stress response (Ott *et al.* 2001).

Monitoring studies of marine mammals following oil spill events in different parts of the world have demonstrated evidence implicating oil spills with the mortality of cetaceans. Sea otters (*Enhydra lutris*), harbour seals, Stellar sea lions (*Eumetopias jubatus*), killer whales and humpback whales were most affected by the *Exxon Valdez* oil spill (Lee *et al*. 2015). Continued monitoring over sixteen years after the spill indicates a measurable decrease and lack of recovery in the population size of a fish-eating killer whale pod using the area affected by the spill (Dahlheim and Matkin 1994; Matkin *et al.* 2008). Continued monitoring over sixteen years indicates that the killer whale pod had still not returned to its pre-spill population abundance, and the population's rate of increase was significantly less than other fish-eating pods in the area (Matkin *et al.* 2008). More recently, Matkin's conclusion that the killer whale deaths could be attributed to the *Exxon Valdez* spill has been challenged by Fraker (2013), who argues that there is not a clear and plausible connection given other factors (including frequency of bullet wounds) which might have factored into the documented mortalities.

Also following the *Exxon Valdez* spill, five harbour porpoises were found dead in Prince William Sound. While three autopsied animals showed elevated levels of hydrocarbons in blubber and liver tissues, the levels of assimilated oil were not high enough to determine with certainty that the animals died from exposure to crude oil (Dalheim and Matkin 1994). The deaths might have been the result of a combination of factors, including acute toxicity of crude oil, starvation due to chronic respiratory damage, increased energy expenditure from epidermal fouling, reduced prey abundance and increased susceptibility to parasitism or disease (Albers and Loughlin 2003; Lee *et al*. 2015).

Following the DWH oil spill in the Gulf, a total of 171 dolphins and whales were collected from April 30, 2010 to February 15, 2011, either from stranding or directed capture in the open water (NOAA 2014a). Of these, 153 were collected dead, with almost 90% of individuals being bottlenose dolphins. Of the 109 marine mammals collected as of November 10, 2010, only 6 individuals were visibly oiled (NOAA 2010). The low estimated carcass recovery rates of cetaceans (as low as 2%) after the DWH oil spill (Williams *et al*. 2011) limits the statistical validity of proposed cause-effect relationships. This is one example of why it has historically been challenging to link oil exposure to acute and chronic effects in marine mammals (Lee *et al*. 2015).

Effects of Hydrocarbons on Sea Turtles

It is unknown if sea turtles are able to detect oil spills but evidence suggests that they do not avoid oil at sea (Milton *et al.* 2010). Gramentz (1988) reported that sea turtles did not avoid oil at sea, and sea turtles experimentally exposed to oil showed a limited ability to avoid oil (Vargo *et* *al.* 1986) or petroleum fumes (Milton *et al*. 2010). Exposure pathways for effects on sea turtles are similar to those of marine mammals: external coatings of oil (*e.g*., interaction with surface slicks when animals surface for air), inhalation of aerosols of particulate oil and hydrocarbons, and ingestion of contaminated prey.

French–McCay (2009) assume a combined probability of oil encounter and mortality once oiled of 5% for juvenile and adult sea turtles and 50% for hatchling sea turtles. This is based on a moderate to high short-term survival rate if oiling occurs as indicated by the literature (Vargo *et al.* 1986), but also taking into consideration that there are few definitive data regarding the long-term effects of oil on reptiles. Hatchlings are particularly vulnerable since they spend most of their in-water time at the surface, and their size and anatomy (and weaker mobility) increases their susceptibility to passing oil and suffocating as a result of this exposure. Once oiled, hatchlings may not be able to swim as well, thereby increasing their predation risk. French–McCay (2009) acknowledges that the likely range of probability for oiling and dying of hatchlings is 10 to 100%, but uses 50% as a best estimate. Compared to hatchlings, juveniles and adults spend less time at the sea surface, which may reduce their exposure to smaller oil slicks. The data on hatchlings is provided for context, although is less relevant in this case given the absence of sea turtle hatchlings in Atlantic Canada waters.

In addition to surface oiling, sea turtles are particularly vulnerable to prolonged exposure to petroleum vapours as a consequence of their diving behaviour, which requires rapidly inhaling large volumes of air prior to diving and continually resurfacing (Milton *et al.* 2010).

Even if sea turtles avoid direct contact with oil slicks, they can still be directly affected through ingestion of oil or contaminated prey. As turtles consume anything that appears to be the same size as their preferred prey (*e.g.*, jellyfish), ingestion of tarballs is an issue for turtles of all ages. Ingested oil can be retained within a turtle's digestive tract for several days thereby increasing likelihood of absorption of toxic compounds and risk of gut impaction (Milton *et al.* 2010). Sea turtle exposure to oil has been shown to result in histologic lesions (Bossart *et al.* 1995) as well as a reduction in lung diffusion capacity, decrease in oxygen consumption or digestion efficiency, and/or damage to nasal and eyelid tissue (Lutz *et al.* 1989). Hall *et al.* (1983) observed seven live and three dead sea turtles following the Ixtoc 1 oil well blowout incident in 1979; two of the carcasses had oil in the gut but no lesions, and there was no evidence of aspirated oil in the lungs. However, hydrocarbon residues were found in kidney, liver, and muscle tissue of all three dead turtles, and prolonged exposure to oil may have disrupted feeding behaviour and weakened the turtles.

Following the DWH oil spill in the Gulf, a total of 1,146 turtles were collected from April 30, 2010 to February 15, 2011, either from stranding or capture in the open water (NOAA 2014c). Of these, 537 were collected alive (456 of which were visibly oiled) and 609 were dead (18 of which were confirmed to have visible oiling) (NOAA 2010). Seventy percent of those captured were Kemp's ridley turtle. The NOAA Fisheries national sea turtle coordinator reported that of the 461 live sea turtles collected between May and September 2010, approximately 420 were rehabilitated and returned to the wild, with the longer-term, less visible effects of the oil on sea turtles remaining undetermined (NOAA 2014d). Of significance, NOAA reports thousands of sea turtle strandings every year along the Gulf of Mexico and US east coast even prior to this spill and continues to investigate possible reasons for these events (NOAA 2010).

For this Project, it is assumed that any turtles occurring within the zone of influence of an accident event scenario have the potential to be exposed to oil and experience related health effects, as described above. As the turtles occurring in the RAA would be juveniles and adults, the potential for mortality as a result of oil exposure would be lower than for hatchlings. Turtles would also experience a short-term reduction in habitat quality, during which they have the potential to ingest oil or oiled prey.

Effects of SBM Spill

SBM is a heavy, dense fluid which sinks rapidly in the water column when released. SBM constituents selection is controlled by the OCSG so that low toxicity chemicals are used wherever practicable. Therefore, SBMs are considered to be of low toxicity and environmental effects are mostly restricted to physical smothering effects on the sea floor (C-NLOPB 2011). Any interaction between an SBM whole mud spill and marine mammals and sea turtles would be limited given the scale of effects in the water column and low toxicity of the material, resulting in a temporary reduction in habitat quality. Any risk of physical injury would be limited to individuals in the immediate vicinity of the spill. A subsea release of SBM at the wellsite would have no expected effects on sea turtles given the water depth.

8.5.2.2 Mitigation of Project-Related Environmental Effects

BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. As noted in Section 8.3, the Project will operate under an IMP which will include a number of specific contingency plans for responding to specific emergency events, including potential spill or well control events. The IMP and supporting specific contingency plans, such as a SRP, will be submitted to the CNSOPB prior to the start of any drilling activity as part of the OA process. The SRP will clarify tactical response methods, procedures and strategies for safely responding to different spill scenarios. Tactical response methods that will be considered following a spill incident include, but are not limited to: offshore containment and recovery; surveillance and tracking; dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response. Refer to Section 8.3 for details on incident management and spill response.

BP will undertake a NEBA as part of the OA process with the CNSOPB to evaluate the risks and benefits of dispersing oil into the water column, including potential effects on marine mammals and sea turtles, and will obtain regulatory approval for any use of dispersants as required.

In the unlikely event of a spill, specific monitoring (*e.g.*, environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

8.5.2.3 Characterization of Residual Project-Related Environmental Effects

Diesel Spills (PSV and MODU)

Maximum time-averaged emulsified oil thickness on the sea surface (stochastic results) can be seen in Figures 8.4.22 and 8.4.23 in Section 8.4. Modelling results indicate that diesel spills from the MODU or PSV are not likely to result in biological effects on marine mammals over a large area. The potential for environmental effects are anticipated to occur over the greatest area if a spill was to occur during the summer months (May to October). In the case of the 10 bbl surface batch spill, the majority of the oil thickness on the surface falls within the 0.04 to 0.3 μm range, with lesser surface area being covered by 0.3 to 5 μm and 5 to 50 μm. The results from the 100 bbl surface batch spill depict higher surface areas covered by thicker oil in a more widespread area. The extent of the 5 to 50 μm thickness in Figures 8.4.22 and 8.4.23 approximates the location in which the 10 μm threshold may be exceeded.

With respect to a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles, the majority of diesel from a spill from either the MODU or PSV will evaporate and disperse within the first three days following the release (refer to Appendix H). This will create a temporary and reversible degradation in habitat quality. Depending on the location and extent of the spill, it could directly and indirectly reduce the amount of habitat available to marine mammals and sea turtles for foraging and other life history activities. These effects would be short-term in duration until the slick disperses and diesel content in the area reaches background levels. A batch spill of diesel is not expected to create permanent or irreversible changes to Habitat Quality and Use.

With respect to Change in Risk of Mortality or Physical Injury, the accidental release of diesel fuel has the potential to affect various physical and internal functions of marine mammals and sea turtles. As noted above, the behaviour of species influences the likelihood of their being oiled with probabilities of lethal effects on exposure varied among species groups. Fur-bearing marine mammals are the most susceptible to contact with hydrocarbons. Direct contact with hydrocarbons can cause fouling in fur-bearing marine mammals such as seals, reducing thermoregulation abilities. Hydrocarbons can be inhaled or ingested, leading to behavioural changes, inflammation of mucous membranes, pneumonia and neurological damage (Geraci and St. Aubin 1990). Except in the case of a vessel spill of diesel during transit to the nearshore, the likelihood of seals coming into contact with oil from a Project-related diesel spill would be very low. Diesel fuel would disperse faster than crude oil, limiting the potential for surface exposure, although there would be increased toxicity associated with this spill and risk of inhalation of toxic fumes is present for either type of spill (crude oil or diesel).

Marine mammals and sea turtles are not considered to be at high risk from a diesel spill, due to the fact that it is probable that only a small proportion of a species population would be within the area affected by the spill which is expected to be limited in size. In addition, it is expected that most marine mammals would avoid surfacing in areas of harmful hydrocarbon concentrations.

Well Blowout Incident

A well blowout incident has the potential to result in a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use for Marine Mammals and Sea Turtles. The extent of the potential effects will depend on how the spill trajectory and Marine Mammals and Sea Turtles overlap in both space and in time. A threshold concentration for lethal effects to marine mammals and sea turtles was identified as a 10 µm thick layer of on-water oil (French *et al*. 1996; French-McCay and Rowe 2004; French McCay 2009). This threshold was applied to determine effects to marine mammals and sea turtles from a subsea blowout incident. However, a more conservative threshold of 0.04 µm (visible sheen) was used in the modelling in recognition of potential socio-economic effects on fisheries. Marine mammals can congregate in high numbers, but, except for species at risk, the number of individuals likely to be present in an area of oiling at the time of a spill is unlikely to represent a high proportion of any marine mammal population. In a worst-case scenario, where a group of non-fur-bearing individuals (*e.g.*, cetaceans) were to come in contact with surface oil, the risk of mortality is considered low. However, based on an understanding of critical habitat for species at risk and important breeding locations in the RAA for certain marine mammals and predicted well blowout incident modelling results, there is potential for population level effects to occur in the unlikely event of a well blowout incident.

Stochastic modelling predicts the average probability of surface oiling (exceeding a thickness of 0.04 µm) reaching the Gully marine protected area (MPA) (designated critical habitat for the northern bottlenose whale) to be approximately 61% during the summer season (worst-case credible scenario) (May to October). The maximum exposure time for surface oil exceeding the 0.04 µm threshold in the Gully is 4 to 7 days. The maximum time-averaged thickness of surface oil predicted in the Gully MPA may reach more than 200 µm; however, the average time-averaged thickness is predicted to be less than 50 µm. Therefore there is potential for adverse environmental effects on species (including marine mammal species at risk) present in this area in the unlikely event of a well blowout incident. These effects could include physiological effects associated with direct oiling or ingestion of prey as described above in 8.5.2.1 and/or indirect effects associated with a change in behaviour (including habitat use). A Change in Risk of Mortality or Physical Injury as well as a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles is predicted to occur as a result of a well blowout scenario.

The likelihood of fur-bearing seals coming into contact with oil from a Project-related spill is low except for seals inhabiting Sable Island where there is a 28% probability of surface oiling (characterized by a 0.04 µm-thick oil layer) and 55% average probability of stranded oil (1 µm) on the coastline, based on stochastic modelling results for a well blowout incident at Site 1 (summer season) (worst-case scenario). The average minimal arrival time for the oil to reach Sable Island using this threshold is predicted to be five days (refer to Figure 8.4.4). French-McCay (2009) proposes a mortality exposure index for wildlife on or along an affected shore to be length of shoreline oiled by 100 µm thick (>100 g/m^2) emulsion. Emulsion thickness of 100 µm thickness would be characterized as "light oiling". Oiling of Sable Island based on modelling of an unmitigated well blowout incident is predicted to be heavy (maximum time-averaged emulsion thickness > 10 mm [10,000 µm]). Increased toxicity associated from the spill as a result of physical contact and from the inhalation of toxic fumes is possible. Given the relatively high potential for shoreline oiling, short minimum arrival time for oil to reach the Sable Island shore, and average degree of oiling, and the known aggregations of breeding seals on Sable Island (including the world's largest breeding colony of grey seals), population level effects could occur in the unlikely event that there is a well blowout incident.

Stochastic modelling of offshore spills indicates a low potential (0 to10%) for shoreline oiling along the Nova Scotia coastline, with most predicted contact locations being less than 1%. A higher probability for shoreline emulsion mass exceeding 1 µm (minimum threshold for "stain/film" oiling) is predicted to occur during the summer season (May to October). The minimal arrival time for this coastline interaction ranges from 20 to 100 days. This timeframe would provide sufficient time to mobilize spill response in these areas. Although physical effects or mortality to seals is possible in the unlikely event that oil reaches the nearshore and shoreline region, population level effects are not anticipated.

SBM Spill

Based on results from the modelling conducted for the Shelburne Basin Venture Exploration Drilling Project (RPS ASA 2014, Appendix C in Stantec 2014a), an accidental release of SBM whole mud would result in elevated levels of TSS in the water column, with modelling of an accidental release of SBM showing that the plume travels with ambient currents until dispersion and turbulence cause the TSS concentrations to fall below the 1 mg/L threshold. These plumes extend from 5 to 10 km from the site with ambient conditions being returned to within 30 hours of the spill. A SBM whole mud spill could cause a temporary reduction in habitat quality for marine mammals and sea turtles due to increased levels in TSS and the potential for a thin sheen associated with the spill. This reduction in habitat quality and use would be temporary, reversible and localized.

Summary

Table 8.5.2 provides a summary of predicted residual environmental effects of accidental events on Marine Mammals and Sea Turtles.

Table 8.5.2 Summary of Residual Project-Related Environmental Effects on Marine Mammals and Sea Turtles – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury and Habitat Quality and Use							
10 bbl Diesel Spill	A	L	LAA	ST	S	R	U
100 bbl Diesel Spill	A	M	LAA	ST	S	R	U
PSV Diesel Spill	A	M	LAA	ST-MT	S	R	U
Well Blowout Incident	A	H	RAA*	ST-MT	S	R	U
SBM Spill	A	L	LAA	ST	S	R	U

KEY:
See Table 7.3.2 for detailed definitions

N/A: Not Applicable
Direction:
P: Positive
A: Adverse
N: Neutral
Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*"
Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous
Reversibility:
R: Reversible
I: Irreversible
Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.5.2.4 Determination of Significance

Based on the above analysis, it is predicted with high confidence that a diesel or SBM spill scenario associated with the Project will not result in any significant adverse residual environmental effects to Marine Mammals or Sea Turtles. This conclusion is based on the conservatism of the spill modelling (results show an unmitigated release), the use of mitigation measures to prevent and reduce effects from a spill, and the nature of the potential effects as described in the literature summarized above. A significant adverse residual environmental effect is predicted for Marine Mammals and Sea Turtles in the event of a well blowout incident in recognition of the probability of interaction with breeding seals on Sable Island and marine mammal and sea turtle species at risk inhabiting the affected area. However, this significant effect is not likely to occur given the extremely low probability of a blowout incident occurring. A medium level of confidence is assigned to this significance determination based on the conservatism of the spill modelling and the uncertainty of interaction with breeding seals or species at risk depending on the timing of the spill of this magnitude.

8.5.3 Migratory Birds

As described in Section 5.2.8, an estimated 30 million seabirds use the eastern Canadian waters each year including breeding marine birds and migrating birds from the southern hemisphere and northeastern Atlantic (Fifield *et al*. 2009). The combination of northern hemisphere and southern hemisphere birds results in peak diversity during spring and summer months (Fifield *et al*. 2009). Significant numbers of overwintering birds, including alcids, gulls, and Northern Fulmars can also be found in Atlantic Canadian waters during the fall and winter (Brown 1986), whereas species assemblages are dominated by shearwaters, storm-petrels, Northern Fulmars and gulls in summer (Fifield *et al.* 2009).

The waters of the RAA are known to support approximately 19 species of pelagic seabirds, 14 species of neritic seabirds, 18 species of waterfowl and loons and 22 shorebird species (see Table 7.4.3), with more occurring in the area as rare vagrants or incidentals. It is important to note, however, that many of these species have a coastal affinity and would be unlikely to regularly occur in waters of the Project Area. Seven marine bird species listed as either SAR or SOCC are known to occur in waters of the Scotian Shelf and Slope and could potentially occur within the RAA: Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, Red-necked Phalarope and Barrow's Goldeneye. A number of breeding, migrant, and vagrant landbirds also occur within the RAA, including two SAR and SOCC species which have coastal affinities: Peregrine Falcon and Savannah Sparrow.

Throughout the summer months, the coastline of the RAA supports over two hundred colonies of nesting marine birds. These colonies are known to support Atlantic Puffins, Black-legged Kittiwakes, Common Eiders, cormorants, Leach's Storm-petrels, Great Black-backed Gulls, Herring Gulls, Razorbills and terns. Leach's Storm-petrel is the most numerous breeding seabird in the RAA. Sable Island, which is migratory bird sanctuary and contains SARA-designated critical habitat for the Roseate Tern, is also an important breeding area for colonial marine birds, including gulls, terns, cormorants, as well as other migratory birds.

Within the RAA there are 14 coastal Important Bird Areas (IBAs), including Sable Island. These IBAs are scattered throughout the RAA and have been designated as IBAs for a variety of reasons including the presence of breeding habitat for species at risk, important shorebird migration habitat, important coastal waterfowl habitat, and/or the occurrence of regionally significant colonial water bird colonies. Nine of the fourteen IBAs are considered to be globally significant (refer to Section 5.2.8.3). Based on stochastic modelling results for the well blowout scenarios, it is possible that environmental effects could extend beyond the RAA and affect three additional IBAs not previously discussed in Section 5.2.8.3) (see below).

The Brier Island and Offshore Waters IBA (NS021) which is located at the extreme western end of Nova Scotia, 50 km southwest of Digby could potentially experience shoreline oiling. This IBA is recognized as one of the most important bird areas in the Maritimes given the diversity of birds found there. Additionally, it is a great migration trap for landbirds and important year-round feeding area for marine birds. Although no systematic counts have been made, the waters immediately offshore from Brier Island represent one of the most important areas for phalaropes in North America with mixed flocks of Red-necked Phalarope and Red Phalarope regularly numbering in the millions (IBA Canada n.d.[a]). Other marine species seen in large numbers include shearwaters, kittiwakes and alcids. The most common landbird migrants in the fall are Yellow-rumped Warbler (*Setophaga coronate*), Dark-eyed Junco (*Junco hyemalis*), Golden-crowned Kinglet (*Regulus satrapa*), White-throated Sparrow (*Zonotrichia albicollis*), and Magnolia Warbler (*Setophaga magnolia*).

The Scatarie Island IBA (NS052) is located off the northeastern tip of Cape Breton Island and encompasses 6,765 ha (IBA Canada n.d.[b]). It includes Scatarie Island, which is one of Nova Scotia's largest Islands (1500 ha), as well as several other small islands (IBA Canada 2014; NSE 2014). Based on stochastic modelling results for the well blowout scenarios, islands in this IBA could potentially experience shoreline oiling. Scatarie Island is an important breeding area for Bicknell's Thrush (*Catharus bicknelli*), which is listed as Threatened under SARA and COSEWIC and listed as Endangered under the NS *Endangered Species Act*. Although no systematic survey has been completed, the island is believed to support 10 to 25 males of this species (IBA Canada n.d.[b]). In addition, the island serves as a breeding site for Leach's Storm-petrels; it is believed that up to several thousand pairs may breed here in burrows created in rock crevices (IBA Canada n.d.[b]). Migrating Whimbrels (*Numenius phaeopus*) feed on berries found on the island from mid-July to September. Buff-breasted Sandpipers (*Calidris subruficollis*) have also been observed on the island (IBA Canada n.d.[b]).

The Grand Manan Archipelago IBA (NB011) is located on the western side of the mouth of the Bay of Fundy and encompasses 100,076 ha of shoreline, islands, and open ocean (IBA Canada n.d.[c]). The IBA includes a 1-km strip of land along the coast of Grand Manan Island and a 10-km strip of ocean surrounding the large island, which encompasses several smaller islands in the archipelago (including Kent Island) (IBA Canada n.d.[c]). Pelagic birds that feed in this IBA include Red-necked Phalaropes, Greater Shearwaters and Wilson's Storm-petrels (IBA Canada n.d.[c]). Grand Manan is an important IBA for coastal-feeding migrants, including the Semipalmated Plover, Black-bellied Plover, Greater Yellowlegs, and Least Sandpiper. The most notable species of this IBA is the Razorbill, which winters on and around Grand Manan Island. Other species that winter here include Purple Sandpipers, Great Black-backed Gulls, Common Eiders, and the endangered Harlequin Duck. Dovekies, Common Murres and various other species are also known to frequent this IBA (IBA Canada n.d.[c]). This IBA is also an important stopover for landbirds during migration. Around 200 bird species have been recorded on Kent Island, a small island in the archipelago. Kent Island supports a large breeding colony of Herring Gulls and around 1000 pairs of Leach's Storm-petrels (IBA Canada n.d.[c]).

With respect to the nearshore environment near Halifax Harbour, migratory bird habitat in the area has been noted for Great Blue Heron (*Ardea herodias*); Common Eider; Common Tern; Canada Goose; and American Black Duck. Maugher Beach, on the western shore of McNabs Island, provides unclassified tern habitat as well as habitat for Piping Plover. There is also Piping

Plover habitat located on beaches east of the approaches to Halifax Harbour (*e.g.*, Cow Bay Beach and Rainbow Haven Beach).

The potential environmental effects, effect pathways, and measureable parameters identified in Table 7.4.1 for Migratory Birds for routine activities remain valid for the assessment of potential environmental effects as a result of an accidental event. Likewise, the criteria for characterizing residual environmental effects and determining significance (refer to Section 7.4.5) remain valid for the accidental events assessment.

8.5.3.1 Project Pathways for Effects

All of the identified accidental event scenarios (*i.e.*, batch diesel spill, PSV spill, SBM spill and well blowout incident) have the potential to result in a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use for Migratory Birds. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in both space and in time. As noted earlier, the assessment is conservative (*i.e.*, geographic and temporal overlap are assumed to occur and modelling results assume no implementation of mitigation measures).

Effects of Hydrocarbons on Migratory Birds

Aquatic migratory birds are among the most vulnerable and visible species to be affected by oil spills. French-McCay (2009) considered the probability of exposure to oil by grouping seabirds based on their behaviour patterns and developing a combined oil encounter and mortality rate of 99% for surface divers, 35% for nearshore aerial divers, 5% for aerial seabirds and 35% for wetland birds. Based on available literature, the probability of mortality once oiled is assumed to be 100% for birds.

A Change in Risk of Mortality or Physical Injury for Migratory Birds exposed to hydrocarbons can occur through three main pathways: external exposure to oil (resulting in coating of oil on feathers); inhalation of particulate oil and volatile hydrocarbons; and ingestion of oil.

External exposure to oil occurs when flying birds land in oil slicks, diving birds surface from beneath oil slicks, and swimming birds swim into slicks. Reported effects vary with species, type of oil, weather conditions, time of year, volume of the spill, and duration of the spill (Gorsline *et al.* 1981).

Physical alteration of feathers through oiling leads to thermal and buoyancy deficiencies that typically result in death from a combination of heat loss, starvation, and drowning (Leighton 1993). Oiling of feathers can also affect flight, also increasing risk of drowning and starvation (Lee *et al*. 2015). Issues of thermoregulation are particularly acute if birds are oiled during winter months or during spring or fall migration (Lee *et al*. 2015).

Diving species such as Black Guillemot, murres, Atlantic Puffin, Dovekie, eiders, Long-tailed Duck, scoters (*Melanitta spp.*), mergansers, loons, and grebes are considered to be the most susceptible to the immediate effects of surface slicks (Leighton *et al.* 1985; Chardine 1995; Wiese and Ryan 1999; Irons *et al.* 2000). Other birds such as Northern Fulmar, shearwaters, storm-petrels, gulls, phalaropes, and terns are vulnerable to contact with oil because they feed over wide areas and make frequent contact with the water's surface. They are also vulnerable to the disturbance and habitat damage associated with oil spill clean-up (Lock *et al.* 1994). Shorebirds and phalaropes may be more affected by oil spills than has been suggested by carcass counts (Larsen and Richardson 1990). This may be due to the higher mobility of oiled shorebirds.

Ingestion of oil as a result of preening or consumption of contaminated food or drinking water can also result in physiological and pathological issues. These long-term physiological changes may eventually result in death (Ainley *et al.* 1981; Williams 1985; Frink and White 1990; Fry 1990), or decrease long-term survival (Esler *et al.* 2002). However, the extent of bioaccumulation of the chemical components of oil in birds is limited because vertebrate species are capable of metabolizing them at rates that minimize bioaccumulation (Neff 1985, in Hartung 1995). Assuming the birds are healthy enough after a spill to continue to feed properly, they have the ability to excrete much of the hydrocarbons within a short time period (McEwan and Whitehead 1980).

Nesting seabirds that have survived oil contamination generally exhibit decreased reproductive success (see Hartung 1965; Holmes *et al.* 1978; Szaro *et al.* 1978; Vangilder and Peterle 1980; Ainley *et al.* 1981; Stubblefield *et al.* 1995). When oiled birds return to nests, they risk exposing eggs to oil and causing high mortality of embryos. Mortality and developmental defects in avian embryos exposed to even small quantities of oil (*i.e.*, 1 to 20 μL) have been documented (Leighton 1993; Lee *et al*. 2015). Other contributing factors affecting mortality of young include change in prey availability (Velando *et al.* 2005), and changes in normal parental behaviour (Eppley and Rubega 1990), including abandonment of nests (Butler *et al.* 1988). Determining the numbers of birds potentially affected by a spill can be challenging, particularly since many oiled birds are never recovered, causing mortalities to be under-reported. Mean mortality of over-wintering birds in the Gulf of Mexico following the DWH oil spill was estimated to be between 600,000 and 800,000 birds (Haney *et al.* 2014), although only a fraction of carcasses of oiled birds were recovered, most likely due to inefficient collection methods by limited personnel, lacking in training or experience (Belanger *et al*. 2010). This spill event is believed to have had population level effects on seabird species including Northern Gannet, Brown Pelican (*Pelecanus occidentalis*), Laughing Gull (*Leucophaeus atricilla*), and Royal Tern (*Thalasseus maximus*) (Haney *et al*. 2014).

Following the *Exxon Valdez* spill, nearly 30,000 birds were collected, with total mortality estimates ranging from 100,000 to 650,000 birds (reviewed by Day *et al.* 1997). Almost 10,000 carcasses were collected following the sinking of the tanker *Prestige* off the coast of Spain in 2002, with Common Murre, Atlantic Puffin and Razorbill being most affected (Oropesa *et al.* 2007). The 1984 blowout incident at the Uniacke G-72 well (near Sable Island) resulted in a spill of 240 m^3 (1,510 bbl) of condensate. A survey of an extensive area around the well after the well was capped (11 days after the blowout incident) observed a total of seven oiled marine birds (three Dovekies and four murres), with no obvious oiling of gulls, kittiwakes and fulmars (Martec Ltd. 1984, in Hurley and Ellis 2004).

To help provide additional context, it is estimated that approximately 21,000 birds die annually from operational spills on the Atlantic coast of Canada, and 72,000 in all of Canada (Thomson *et al.* 1991). Clark (1984) estimated that 150,000 to 450,000 birds die annually in the North Sea and North Atlantic from oil pollution from all natural and anthropogenic sources.

The scientific literature is divided with respect to long-term population effects on migratory birds as a result of oil spills. Several studies suggest that oil pollution is unlikely to have major long-term effects on bird productivity or population dynamics (Butler *et al.* 1988; Boersma *et al.* 1995; Erikson 1995; Stubblefield *et al.* 1995; White *et al.* 1995; Wiens 1995, 1996; Seiser *et al.* 2000). Conversely, others (Leighton 1993) do show long-term effects of oil pollution on birds (*e.g.*, birds having ingested oil no longer contribute to the reproductive output of a species). These differences can be explained, in part, by varying circumstances of the spill event (acute or chronic exposure, location of spill, time of year) and health of bird populations (Burger 1993; Wiese and Robertson 2004). An assessment of environmental effects of oil spills in Greenland (Mosbech 2002) concluded that while major oil spills have the potential to deplete bird populations or cause single seabird colonies to be deserted, reports from several spills demonstrate the resiliency of seabird populations to single catastrophic events. It was also concluded that an oil spill can play more of a role where other factors hamper the recovery of the population (*e.g.*, hunting), and the population is small or has a restricted distribution (Mosbech 2002). Similarly, it has been found that population effects are more likely to be realized where spill events involve ongoing exposure (Wiese *et al.* 2004). For example, Wiese and Robertson (2004) reported that the chronic oiling due to bilge dumping killed around 300,000 birds annually around southeastern Newfoundland.

Murphy and Mabee (1999) assessed the effects of the *Exxon Valdez* on Black Oystercatchers (*Haematopus bachmani*) population in Prince William Sound almost a decade after the spill. Authors reported that while sub-lethal effects to the breeding population were evident in post-spill assessments conducted between 1989 and 1993, results from 1998 indicated no oiling effects on nesting effort, breeding phenology, egg volumes, chick growth rates, or chick survival at either a regional or territorial scale. In contrast, Trust *et al.* (2000) looking at recovery of harlequin duck populations in Prince William Sound from 1995 to 1997 concluded that chronic exposure to oil and resulting biochemical and physiological changes in individuals was hindering the population recovery of some sea duck species in Prince William Sound. Esler *et al.* (2002) further concluded that recovery of Harlequin Duck populations continued to be hindered as many as nine years after the oil spill, postulating that life history characteristics of this species and their benthic, nearshore feeding habits make them susceptible to both initial and long-term oil spill effects.

The use of dispersants during oil spills has been promoted as a means of reducing effects to birds. In particular, dispersants can result in less exposure of marine birds to spilled oil because the major oiling of birds occurs at the surface and the amount of oil that is likely to be taken up by birds while moving through the water column while diving for food is considered small (Peakall *et al*. 1987). Dispersed oil is less likely to reach nearshore and coastal areas (Kildrufff and Lopez 2012) where birds may congregate (*e.g*., near breeding colonies) and the use of dispersants has potential to provide an important means of protection where large numbers of over-wintering birds are present and response strategies are limited by ice or other factors (Chapman *et al*. 2007). Although the use of dispersants has potential to reduce exposure of marine birds to spilled oil, they may cause a short term increase in exposure to dispersed oil to organisms in the water column, such as corals and shellfish.

There are few studies on the effects of chemically treated oil on the thermal balance of birds and differing opinions on whether they should be employed for the purpose of reducing effects on seabirds. However, a review of the effects of oil pollution, chemically treated oil, and cleaning on the thermal balance of birds indicated that the effects of contamination by oil-dispersant mixtures may be similar to that of the oil alone, with results of one study indicating that oil treated with dispersants may be more harmful to birds than untreated oil (Jenssen 1994 and references therein). Dispersant-oil mixtures have been found to reduce the water repellency of plumage and result in water absorption and to increase heat loss and metabolic rate (Lambert *et al*. 1982; Jenssen and Ekker 1991). For example, Jenssen and Ekker (1991) reported that a much smaller volume of chemically treated crude oil was required to cause adverse effects on plumage insulation and thermoregulation in eiders than crude oil itself. Another study found that ducks exposed to dispersant in water were less buoyant and stayed wet longer than control birds or oil-exposed birds (Lambert *et al*. 1982). The low tolerance for chemically treated oil may be a result of the surfactants in the dispersants more easily adhering to feathers (possibly by binding to the hydrophobic waxes in the plumage), reducing the surface tension at the feather-water interface and enhancing the effects of contamination on their insulating properties (Jenssen 1994). Dispersants and dispersed oil have also been shown to have toxic effects on bird eggs that are similar or worse than from untreated oil (Jenssen 1994 and references therein).

Hydrocarbon spills can also result in a Change in Habitat Quality and Use for Migratory Birds. Day *et al.* (1997) examined the effects of the *Exxon Valdez* oil spill on marine bird habitat use, determining that while initial effects were severe, most of the habitat use for the majority of bird species recovered within 2.5 years of the spill. While initial effects to bird habitat were severe, this rate of recovery was attributed to high-latitude seabird populations which appear to be fairly resilient to environmental perturbations, as well as Prince William Sound being a high wave energy and a largely rocky substrate environment where oil does not persist as long as other settings (Day *et al.* 1997).

Effects of SBM Spill

SBM is considered to be of low toxicity (IOGP 2016) and environmental effects are mostly restricted to physical smothering effects on the sea floor. A release of SBM would result in elevated levels of TSS in the water column and possibly a small thin sheen on the surface, with effects potentially similar to those discussed above for hydrocarbon spills, but more limited in magnitude given the comparative volume and physical property of the SBM. O'Hara and

Morandin (2010) investigated the effects of thin oil sheens associated with both crude oil and synthetic based drilling fluids on the feathers of pelagic seabirds (Common Murre and Dovekie) and found that feather weight and microstructure changed significantly for both species after exposure to thin sheens of both hydrocarbons, concluding a plausible link between even operational discharges of hydrocarbons and increased seabird mortality.

8.5.3.2 Mitigation of Project-Related Environmental Effects

BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. As noted in Section 8.3, the Project will operate under an IMP which will include a number of specific contingency plans for responding to specific emergency events, including potential spill or well control events. The IMP and supporting specific contingency plans, such as a SRP, will be submitted to the CNSOPB prior to the start of any drilling activity as part of the OA process. The SRP will clarify tactical response methods, procedures and strategies for safely responding to different spill scenarios. Tactical response methods that will be considered following a spill incident include, but are not limited to: offshore containment and recovery; surveillance and tracking; dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response. Refer to Section 8.3 for details on incident management and spill response.

Of particular relevance to migratory birds are the commitments related to shoreline protection and clean up, and oiled wildlife response (refer to Section 8.3.3). In the event that oil threatens or reaches the shoreline, SCAT teams will be mobilized to the affected areas. SCAT teams will also be used to monitor and evaluate the effectiveness of the clean-up operations. A SCAT survey will be conducted to inform shoreline clean-up and remediation as applicable. BP will also engage specialized expertise to deflect oil from sensitive areas, and recover and rehabilitate wildlife species as needed (refer to Section 8.3.3.3 for BP's oiled wildlife response approach).

BP will undertake a NEBA as part of the OA process with the CNSOPB to evaluate the risks and benefits of chemically dispersing oil into the water column, including potential effects on migratory birds, and will obtain regulatory approval for any use of dispersants as required.

In the unlikely event of a spill, specific monitoring (*e.g.*, environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

8.5.3.3 Characterization of Residual Project-Related Environmental Effects

Diesel Spills (PSV and MODU)

A batch diesel spill or vessel spill has the potential to result in a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use for Migratory Birds. As noted above, two thresholds were established to assess the effects to migratory birds. A threshold concentration for lethal effects to seabirds is the open water area covered by an oil plume greater than 10 μm thick (>10 g/m^2).

Modelling results indicate that diesel spills from the MODU or PSV are not likely to result in biological effects on migratory birds over a much smaller area relative to a well blowout scenario. Environmental effects are anticipated to occur over the greatest area if a spill was to occur during the summer months (May to October). In the case of the 10 bbl surface batch spill, the majority of the oil thickness on the surface falls within the 0.04 to 0.3 μm range, with lesser surface area being covered by 0.3 to 5 μm and 5 to 50 μm. The stochastic modelling results from the 100 bbl surface batch spill depict locations with a wider area covered by thicker oil. The locations of the 5 to 50 μm thickness in Figures 8.4.22 and 8.4.23 approximates the area in which the 10 μm threshold may be exceeded. For each of the 10 bbl and 100 bbl batch spill scenarios, the majority of the spill locations is below the 10 μm lethal effects threshold. Furthermore, the maximum exposure time for emulsified oil thickness on the sea surface which exceeds 0.04 μm is one day. Deterministic model results indicate that the surface area covered by oil in excess of 0.04 μm will equate to 0.82 km^2 for the 10 bbl spill scenario and 4.4 km^2 for the 100 bbl spill scenario.

With respect to a Change in Habitat Quality and Use, the majority of diesel from a spill from either the MODU or PSV will evaporate and disperse within the first three days following the release (refer to Appendix H). The maximum exposure time for oil on the surface with a thickness greater than 0.04 μm is one day. As a result, this will create a temporary and reversible degradation in habitat quality. Depending on the location and extent of the spill, it could directly and indirectly reduce the amount of habitat available to migrating birds at sea. In the event of a vessel spill in the nearshore area, there is the potential for shoreline to be affected by a diesel spill. When diesel spills interact with the shoreline, it tends to penetrate porous sediments quickly and washes off quickly by waves and tidal flushing (NOAA 2016c). These effects would be short-term in duration until the slick disperses and the diesel content in the area reaches background levels. A batch spill of diesel is not expected to create permanent or irreversible changes to Habitat Quality and Use.

With respect to Change in Risk of Mortality or Physical Injury for Migratory Birds, the accidental release of diesel fuel has the potential to affect migratory birds through direct contact, although it is predicted that the number of birds affected would be limited due to the short time and small area where the diesel would be on the water's surface. Mortality can be caused by ingestion during preening as well as through hypothermia due to matted feathers (NOAA 2016c). Some birds may survive the immediate effects of contact with diesel, although there is the potential for long-term physiological changes resulting in lower reproductive rates or premature death. Migratory birds foraging at sea have the potential to become oiled and bring hydrocarbons back to their nest, contaminating their eggs or nestlings, causing embryo or nestling mortality.

Well Blowout Incident

A well blowout incident has the potential to result in a Change in Risk of Mortality or Physical Injury and Change in Habitat Quality and Use for Migratory Birds. Two thresholds were established to assess the effects to migratory birds. These thresholds were based on the predominant habitats of seabirds (open water) and shorebirds (shorelines). Although potential for direct effects on nesting habitat is possible, there is greater potential for direct effects on foraging habitat at sea. A threshold concentration for lethal effects to seabirds is the open water area covered by an oil plume greater than 10 µm thick (>10 g/m^2) (French *et al*. 1996; French-McCay and Rowe 2004; French-McCay 2009). For shorebirds (and other wildlife) on or along the shore, an exposure index is length of shoreline oiled by 100 µm thick (>100 g/m^2) emulsion (French-McCay 2009). Emulsion thickness of 100 µm thickness would be characterized as "light oiling".

With respect to a Change in Risk of Mortality or Physical Injury, exposure to hydrocarbons frequently leads to hypothermia and deaths of affected marine birds. Although some may survive these immediate effects, long-term physiological changes may eventually result in lower reproductive rates or premature death. Sub-lethal effects of hydrocarbons ingested by marine birds may affect their reproductive rates or survival rates (Fingas 2015). Sub-lethal effects may persist for a number of years, depending upon generation times of affected species and the persistence of any spilled hydrocarbons. Most marine birds are relatively long-lived. Adult marine birds foraging offshore to provision their young may become oiled and bring hydrocarbons on their plumage back to the nest to contaminate their eggs or nestlings, causing embryo or nestling mortality. It is generally agreed that the survival rate for oiled birds is very low, regardless of rescue and cleaning attempts (French-McCay 2009). The probability of lethal effects to birds is therefore primarily dependent on the probability of exposure, which is influenced by behaviour, including the percentage of the time an animal spends on the water or shoreline as well as any oil avoidance behaviour (French-McCay 2009). Table 8.5.3 indicates the combined probabilities of oiling and mortality once oiled for various generic behaviour categories.

Table 8.5.3 Combined Probability of Encounter with Oil and Mortality once Oiled for Generic Behaviour Categories (If Present In The Habitats Listed and Area Swept by Oil Exceeding Threshold Thickness)[1]

Wildlife Group	Probability	Habitats[2]
Surface birds in seaward habitats only	99%	All seaward intertidal and subtidal
Surface diving birds in seaward habitats only	35%	All seaward intertidal and subtidal
Aerial divers in seaward habitats only	5%	All seaward intertidal and subtidal
Surface birds in landward habitats only	99%	All landward intertidal and waters
Surface diving birds in landward habitats only	35%	All landward intertidal and waters
Aerial divers in landward habitats only	5%	All landward intertidal and waters
Surface diving birds in water habitats only	35%	All waters
Aerial divers in water only	5%	All waters

Table 8.5.3 Combined Probability of Encounter with Oil and Mortality once Oiled for Generic Behaviour Categories (If Present In The Habitats Listed and Area Swept by Oil Exceeding Threshold Thickness)[1]

Wildlife Group	Probability	Habitats[2]

Note:
[1] If diameter of the spill is less than 230 m in diameter a thickness of 100 µm is assumed as threshold thickness for oiling mortality of wildlife. If the spill is less than 230 m in diameter 10 µm is assumed as a threshold thickness for oiling mortality.
[2] Intertidal includes all between-tide or terrestrial areas flooded by tides or by storm surges; seaward and landward designations are operationally defined for the area modelled.

Source: Modified from French-McCay 2009

There are six marine bird SOCC that occur within the RAA for the Project: Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, and Barrow's Goldeneye, with the Ivory Gull and Roseate Tern being the most likely to occur within the Project Area. Roseate Tern is a diving species known to breed on Sable Island, which based on modelling results, would be susceptible to shoreline and surface oiling as a result of an unmitigated blowout incident. As noted above, deterministic modelling results predicts that surface oiling from an unmitigated blowout could exceed a surface thickness threshold of 10 µm over a total area of 91,778 km^2.

Deterministic models were not run to specifically identify the 10 µm threshold; however, Figures 8.4.16 and 8.4.18 illustrate the maximum time-averaged oil thickness on the sea surface for the two deterministic case models run (refer to Section 8.4.9). The extent of the 5 to 50 µm thickness approximates the area in which the 10 µm threshold coverage may be exceeded.

With respect to a Change in Habitat Quality and Use for Migratory Birds, hydrocarbon spills are not likely to permanently alter the quality of marine bird habitat. Prey availability may be reduced or migratory birds may avoid affected habitat. However, spill cleanup and natural weathering processes are likely to result in the eventual recovery of such habitat. Following the 1989 *Exxon Valdez* oil spill, in Prince William Sound, recovery of marine bird abundance and use of oiled shorelines sites back to estimated (naturally variable) baseline levels, was reported to occur for all species surveyed within 12 years (Wiens *et al*. 2004). On oiled rocky and open coast soft-sediment shorelines, the recovery of sessile, mobile and infaunal invertebrate species, which provide an important food source for marine birds, is expected to occur within five to 10 years following shoreline oiling (Moore 2006). The recovery rate for sand beaches is variable, depending on conditions and initial disturbance during spill response, but is estimated to occur within three years (French-McCay 2009).

Deterministic modelling of a single unmitigated blowout scenario (Site 2 [maximum oil on shoreline – summer season scenario]) predicted a maximum length of affected coastline (oiling above the 1.0 g/m^2 threshold and equivalent to 1 µm oil thickness) to be 79.5 km along Sable Island and mainland Nova Scotia. Stochastic modelling for Site 2 summer season indicated a low probability (1 to 5%) for shoreline oiling to exceed the 1.0 g/m^2 threshold along coasts of the Bay of Fundy, Scatarie Island, Gulf of Maine, and St. Pierre et Miquelon (Figure 8.4.14).

As indicated on Figures 8.4.11 to 8.4.14, there are several coastline areas that could potentially be exposed to shoreline oiling above the 1.0 g/m^2 threshold. For both Site 1 and Site 2 (both winter and summer seasons) Sable Island could be expected to result in heavy oiling (>10 mm thickness of emulsified oil on the shoreline). Stochastic modelling results for Site 2 (summer season) show more extensive shoreline oiling ranging from a stain/film (0.1 to 0.001 mm) to heavy oiling (>10 mm) in some locations along the Nova Scotia mainland coastline. As indicated in Section 5.2.8.3, there are several seabird colonies and IBAs along the coast (including small coastal islands) which potentially could be affected by a well blowout incident. The average minimum timeframe required for oil to potentially reach these areas at a threshold of 1 μm (minimum approximately 30 days for mainland) would allow for response measures and containment equipment to be placed in advance to avoid or mitigate adverse effects. Response measures could result in disruption of nesting birds and reproductive failure. The average minimum arrival time for shoreline emulsion mass exceeding 1 μm at Sable Island would be 5 days (Site 1, summer) which would greatly reduce the opportunity for implementation of response measures to avoid or mitigate adverse effects on birds nesting there.

As noted above, a threshold of 100 μm is used as an exposure index for mortality of shorebirds on the shore, therefore this would provide additional response time to intervene prior to shoreline emulsion reaching levels predicted to result in shorebird mortality.

SBM Spill

There is potential for a SBM spill to result in a surface sheen which in turn could potentially cause a Change in Risk of Mortality or Physical Injury for seabirds present in the immediate area. If the wind and wave conditions were such that a sheen formed, it would be temporary and limited in size, such that only birds in the immediate area of the spill would likely be affected. Furthermore, given the low surface oil thickness required to result in a sheen (0.04 μm), it is expected that effects would be minor and unlikely to result in seabird mortality.

Summary

Table 8.5.4 provides a summary of predicted residual environmental effects of accidental events on Migratory Birds.

Table 8.5.4 Summary of Residual Project-Related Environmental Effects on Migratory Birds – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury and Habitat Quality and Use							
10 bbl Diesel Spill	A	L	LAA	ST	S	R	U
100 bbl Diesel Spill	A	M	RAA	ST	S	R	U
PSV Diesel Spill	A	M	RAA	ST-MT	S	R	U
Well Blowout Incident	A	H	RAA*	ST-MT	S	R	U
SBM Spill	A	L	LAA	ST	S	R	U

KEY:
See Table 7.4.2 for detailed definitions

N/A: Not Applicable
Direction:
P: Positive
A: Adverse
N: Neutral
Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*"
Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous
Reversibility:
R: Reversible
I: Irreversible
Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.5.3.4 Determination of Significance

Based on the characterization of residual effects above, a precautionary conclusion is drawn that the residual adverse environmental effect of a blowout incident, large batch spill, or vessel spill is predicted to be significant for Migratory Birds, but not likely to occur. Infrequent small spills, as well as a SBM release, would be not significant.

Although hydrocarbon spills could result in some mortality at the individual level, these residual adverse environmental effects are predicted to be reversible at the population level. However, these environmental effects could be significant if the consequences carried over more than one generation according to the significance threshold used in this environmental assessment or self-sustaining population objectives or recovery goals for listed species are jeopardized. Again, this is considered unlikely given the low probability of a large spill event to occur and the response that would be in place to reduce the consequences of such an event.

A medium level of confidence is assigned to the significance determination for all accident scenarios, with the exception of a blowout incident (which is made with high confidence), as the significance is based on a worst-case credible scenario, with the actual significance influenced by a number of factors such as volume spilled, duration, location, season, presence of birds, and effectiveness of mitigation.

8.5.4 Special Areas

As discussed in Section 5.2.9, there are two Special Areas partially located within the Project Area: the Scotian Slope EBSA and the Haddock Box. The Scotian Slope EBSA is of importance due to its high productivity; species diversity and richness; unique and sensitive benthic communities; migratory routes; overwintering habitat; foraging area for leatherback sea turtles; and habitat for Greenland sharks (*Somniosus microcephalus*) (Doherty and Horsman 2007; DFO 2014). Approximately 87% of the Project Area falls within the Scotian Slope EBSA. However, the EBSA is roughly 72,568 km^2, and therefore the Project Area constitutes only 17% of the total EBSA area. The Haddock Box represents an important nursery area for the protection of juvenile haddock. This area is closed to the commercial groundfish fishery year-round by DFO. Only 0.01% of the Haddock Box area is within the Project Area, constituting approximately 153 ha.

Beyond the Scotian Slope EBSA and the Haddock Box, there are several Special Areas located within the RAA, most of which could potentially interact with a Project-related accidental spill. Of particular note is the distance of the Project Area in close proximity to Special Areas providing critical habitat for species at risk and/or important habitat for migratory birds including Sable Island National Park Reserve (48 km), the Gully MPA (71 km), Shortland Canyon and Haldimand Canyon (139 km and 171 km, respectively). PSV transit activities could also potentially intersect with the Emerald Basin Sponge Conservation Area, and to a lesser extent, the Sambro Bank Sponge Conservation Area. IBAs are addressed in Section 8.5.3.

Additional designated protected areas (*e.g.*, national park, wilderness areas, nature reserve), along the coast of Nova Scotia could also potentially interact with a Project-related spill. These areas were not previously addressed in Section 5.2.9 since routine Project activities were predicted to not interact with these areas. However, based on stochastic modelling predicting various scenarios where oil from a well blowout incident could potentially reach the Nova Scotia shoreline, these areas have been considered in the context of accidental events. Figure 8.5.1 shows these additional designated protected areas relative to the offshore Special Areas described in Section 5.2.9 assessed in Section 7.5. A brief description is provided in Table 8.5.5. Although the assessment of Special Areas focuses on specific designated protected areas, predicted interactions and effects could be similar for other coastal features (beaches, parks) providing ecological and/or socio-economic (*e.g.*, recreation) value and not specifically identified on Figure 8.5.1 and Table 8.5.5.

The potential environmental effects, effect pathways, and measureable parameters identified in Table 7.5.1 for Special Areas for routine activities remain valid for the assessment of potential environmental effects as a result of an accidental event. Likewise, the criteria for characterizing residual environmental effects and determining significance (refer to Section 7.5.5) remain valid for the accidental events assessment.

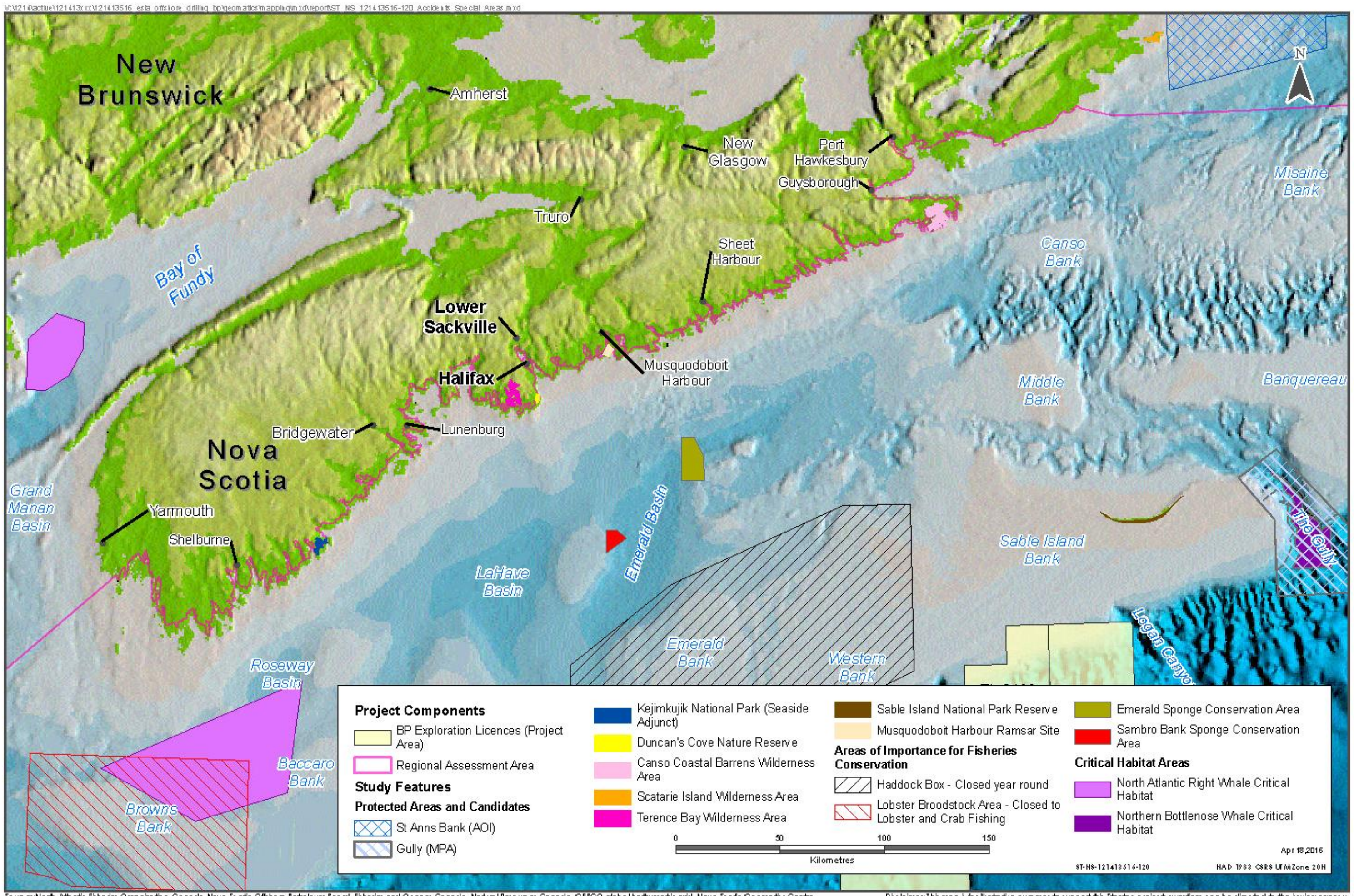


Figure 8.5.1 Special Areas (focusing on Coastal Areas) Considered in Accidental Events Assessment

Table 8.5.5 Coastal Special Areas Potentially Intersected by Stranded Oil and/or Surface Oiling

Description of Special Area	
Kejimkujik National Park - Seaside	
Location and Proximity to Project Area	• The Seaside adjunct to Kejimkujik National Park is located approximately 97 km from the inland portion of the National Park, on the southwest Nova Scotia coastline between Liverpool and Lockeport. The Seaside Adjunct occupies an area of approximately 2,000 ha. • Approximately 260 km from the Project Area.
Designation and Administration	• Kejimkujik was acquired from the province in 1967 and was formally established as a national park in 1974 to protect a representative example of the Atlantic Coastal Uplands Natural Region. Kejimkujik Seaside was acquired from the province in 1985 and was designated as part of Kejimkujik National Park in 1988 to provide protection for the unique coastal attributes of the region (Parks Canada 2010).
Ecological Significance	• Kejimkujik National Park and National Historic Site of Canada (including the Seaside Adjunct) is located within the United Nations Educational, Scientific and Cultural Organization (UNESCO) Southwest Nova Biosphere Reserve, which contains over three-quarters of Nova Scotia's species listed under SARA and/or COSEWIC and the provincial *Endangered Species Act*, including the endangered Piping Plover (Parks Canada 2012).
Bonnet Lake Barrens Wilderness Area	
Location and Proximity to Project Area	• Located on the Canso Peninsula, in Guysborough County, Nova Scotia and approximately 10,380 ha in size. • Approximately 199 km from the Project Area.
Designation and Administration	• Designated in 1999 as a Wilderness Area under the Nova Scotia *Wilderness Protection Act*. Additional lands were designated in 2012 under the Bonnet Lake Barrens Wilderness Area Designation of Additional Lands Regulations pursuant to the Act. • Wilderness Areas protect representative examples of Nova Scotia's natural landscapes, maintain and restore the integrity of natural processes and biodiversity, and protect outstanding, unique, rare and vulnerable natural features. They are used for scientific research, education and a variety of recreation and nature-tourism related activities (NSE 2014).
Ecological Significance	• Includes large, ecologically sensitive raised bogs; rare plants; and an array of water bodies, including Bonnet Lake, which contains unique, crescent shaped beaches originally formed from glacial debris (NSE 2014). • Representative of Canso Coastal Granite Barrens landscape (NSE 2014).

Table 8.5.5 Coastal Special Areas Potentially Intersected by Stranded Oil and/or Surface Oiling

Description of Special Area	
Canso Coastal Barrens Wilderness Area	
Location and Proximity to Project Area	• Located in Guysborough County, Nova Scotia and approximately 8,026 ha in size. • Approximately 197 km from the Project Area.
Designation and Administration	• Designated in 1999 as a Wilderness Area under the Nova Scotia *Wilderness Protection Act*. • Wilderness Areas protect representative examples of Nova Scotia's natural landscapes, maintain and restore the integrity of natural processes and biodiversity, and protect outstanding, unique, rare and vulnerable natural features. They are used for scientific research, education and a variety of recreation and nature-tourism related activities (NSE 2014). • The provincial protected areas program is administered by the Protected Areas Branch of NSE.
Ecological Significance	• Provides habitat for rare, arctic-alpine plants and is frequented by numerous sea and land birds as well as seals. Whales are also present off the coast of the Wilderness Area (NSE 2014). • Representative of Canso Coastal Granite Barrens landscape (NSE 2014).
Duncan's Cove Nature Reserve	
Location and Proximity to Project Area	• Located on the Chebucto Peninsula in the Halifax Regional Municipality (HRM), NS, approximately 17 km south of Halifax in the Pennant Granite Barrens natural landscape (NSE 2014). • Approximately 396 ha in size and approximately 205 km from the Project Area.
Designation and Administration	• Designated in 2004 as a Nature Reserve under the Duncan's Cove Nature Reserve Ecological Site Designation Regulations pursuant to the Nova Scotia *Special Places Protection Act*. • Nature Reserves are areas selected to preserve and protect, in perpetuity, representative (typical) and special natural ecosystems, plant and animal species, features and natural processes. Scientific research and education are the primary uses of nature reserves and recreation is generally restricted (NSE 2014). • The management objectives in the Regulations state that, "[a]s provided for in the *Special Places Protection Act*, Duncan's Cove Nature Reserve is to be managed to a high standard of protection, equivalent to the International Union for Conservation of Nature (IUCN) Class Ia (Strict Nature Reserve), in keeping with the overriding goal of maintenance and restoration of ecological integrity."

Table 8.5.5 Coastal Special Areas Potentially Intersected by Stranded Oil and/or Surface Oiling

Description of Special Area	
Ecological Significance	• Representative coastal headland, barren, and bog complex (NSE 2014). • Particularly valued because of its proximity to the Halifax metropolitan area and its popularity as a natural area (NSE 2014). • It is the only known location in mainland Nova Scotia that supports the provincially rare Arctic blueberry (*Vaccinium uliginosum*) (NSE 2014).
Musquodoboit Harbour	
Location and Proximity to Project Area	• Located on the Eastern Shore of Nova Scotia at the mouth of the Musquodoboit River in HRM. • Musquodoit Harbour Outer Estuary occupies an area of approximately 1,925 ha (NCC 2015). • Approximately 203 km from the Project Area.
Designation and Administration	• Musquodoboit Harbour Outer Estuary was designated as a Ramsar Site in 1987 under the *Convention on Wetlands of International Importance* (Ramsar Convention). It is also recognized as an IBA of international importance (NCC 2015). • The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are 169 Contracting Parties, including Canada (Ramsar 2014). • Martinique (provincial) Game Sanctuary includes most of the aquatic and intertidal areas within the seaward portion of the inlet. Martinique Beach Park (also provincial) encompasses a barrier beach and associated connected islands. Both park and sanctuary were established in the 1970s (IBA Canada n.d.).
Ecological Significance	• Complex system of coastal islands, salt marshes, mudflats, barrier beaches, bogs, barrens and coastal forest (NCC 2015). • IBA NS014 (Musquodoboit) supports huge congregations of Canada geese from the breeding population in Newfoundland and Labrador. During spring migration the site supports approximately 8,000 geese representing 7% of the estimated population; during fall migration it supports approximately 2,000 geese (about 2% of the estimated population); and during the winter it supports approximately 5,000 geese (4% of the population). As more open water has appeared in the mid-1970s, geese have become increasingly more common in winter. Numbers of the Newfoundland/Labrador-breeding geese are now supplemented by local Nova Scotia-breeding birds (IBA Canada n.d.). • American black ducks are also found in Musquodoboit Harbour in winter and can number as high as 2,000 to 3,000 birds (representing 1% of the global population of the species). These numbers are peak numbers, while typical numbers are somewhat lower. Piping Plovers (globally vulnerable, nationally endangered) are also found at this site in breeding season. Other bird species found in the IBA include Savannah Sparrow and Semipalmated Plover (IBA Canada n.d.).

Table 8.5.5 Coastal Special Areas Potentially Intersected by Stranded Oil and/or Surface Oiling

Description of Special Area	
Terence Bay Wilderness Area	
Location and Proximity to Project Area	• Located in Williamswood, HRM, Nova Scotia. • Approximately 4,507 ha in size. • Approximately 213 km from the Project Area.
Designation and Administration	• Designated in 1999 as a Wilderness Area under the Nova Scotia *Wilderness Protection Act*. • Wilderness Areas protect representative examples of Nova Scotia's natural landscapes, maintain and restore the integrity of natural processes and biodiversity, and protect outstanding, unique, rare and vulnerable natural features. They are used for scientific research, education and a variety of recreation and nature-tourism related activities (NSE 2014). • The provincial protected areas program is administered by the Protected Areas Branch of NSE.
Ecological Significance	• The lands of Terence Bay Wilderness Area protect an example of the rugged, granite coastal and near coastal landscape of this part of HRM; provide wildlife habitat and a refuge for vulnerable species, such as rare lichens and the endangered mainland moose; and offer opportunities for recreational activities (*e.g.*, sport fishing, hiking, hunting, canoeing, camping, kayaking, *etc.*) in a wilderness setting (NSE 2010).

8.5.4.1 Project Pathways for Effects

All of the identified accidental event scenarios (*i.e.*, batch diesel spill, PSV spill, SBM spill and well blowout incident) have the potential to result in a Change in Habitat Quality for Special Areas. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in both space and in time. As noted earlier, the assessment is conservative (*i.e.*, geographic and temporal overlap are assumed to occur and modelling results assume no implementation of mitigation measures).

Special Areas provide important habitat and may be comparatively more vulnerable to Project-related effects, including effects from accidental events, than other areas. Adverse effects on Special Areas could degrade the ecological integrity of the Special Area such that it is not capable of providing the same ecological function for which it was designated (*e.g.*, protection of sensitive or commercially important species). The assessment of Special Areas is therefore closely linked to all of the other VCs considered in this assessment. This consideration is particularly true for accidental events where the physical effects on the biological resources found in these areas represent the potential effects of greatest concern. These potential effects are discussed in Sections 8.5.1 to 8.5.3 for Fish and Fish Habitat, Marine Mammals and Sea Turtles and Migratory Birds, and are not repeated in this section. The assessment of effects on Special Areas therefore focuses on a Change in Habitat Quality.

In some cases, Special Areas are designated to protect populations that are considered at risk. In these cases, while the effect mechanisms are similar to species not at risk, the significance of the effect can be greater, particularly if the effect involves the loss of a species at risk.

8.5.4.2 Mitigation of Project-Related Environmental Effects

BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. As noted in Section 8.3, the Project will operate under an IMP which will include a number of specific contingency plans for responding to specific emergency events, including potential spill or well control events. The IMP and supporting specific contingency plans, such as a SRP, will be submitted to the CNSOPB prior to the start of any drilling activity as part of the OA process. The SRP will clarify tactical response methods, procedures and strategies for safely responding to different spill scenarios. Tactical response methods that will be considered following a spill incident include, but are not limited to: offshore containment and recovery; surveillance and tracking; dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response. These tactical response methods will be used as applicable to mitigate potential environmental effects of oil on Special Areas, including, but not limited to, Sable Island National Park Reserve. Refer to Section 8.3 for details on incident management and spill response.

BP will undertake a NEBA as part of the OA process with the CNSOPB to evaluate the risks and benefits of dispersing oil into the water column, including potential effects on Special Areas, and will obtain regulatory approval for any use of dispersants as required.

In the unlikely event of a spill, specific monitoring (*e.g.*, environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

8.5.4.3 Characterization of Residual Project-Related Environmental Effects

Diesel Spills (PSV and MODU)

A 10 bbl batch spill will be limited in magnitude, geographic extent and duration, and limited to a small portion of the Scotian Slope EBSA. A swath of surface oiling in excess of 0.04 µm from a 100 bbl spill could migrate to the Haddock Box and the Gully MPA. Due to the limited (patchiness) and temporary nature of any surface oiling, it is not expected to result in permanent alteration or destruction of habitat in these Special Areas. A vessel spill could potentially occur anywhere along the transit route between the MODU and the supply base in Halifax Harbour and therefore has the potential to affect the following Special Areas, in addition to the ones discussed above: Sambro Bank Sponge Conservation Area, Emerald Sponge Conservation Area, and shoreline habitat (if a spill should occur close to port). Dissolved hydrocarbons from spilled diesel would be limited to the surface and mixed layer of the water column, therefore the potential for deeper sponges to be exposed is considered low. While haddock is a demersal species, sub-lethal and lethal effects can result for eggs and larvae present in the mixed surface layer of the water column. The relatively limited zone of influence of a vessel spill would prevent any wider spread and potentially significant adverse effects from occurring, and adverse effects would be considered temporary and reversible.

Well Blowout Incident

A well blowout incident represents the accidental event with the potential for the most widespread effects. Following a blowout incident, for each designated protected area in the RAA, Table 8.5.6 provides the probability from stochastic modelling results of surface oiling exceeding 0.04 µm and the associated exposure time for surface oiling. The 0.04 µm threshold applied corresponds to a visible oil sheen on the surface, and the threshold is conservatively lower than the 10 µm threshold above which the quality of habitat of the Special Areas would be compromised such that harm to marine mammals, sea turtles and seabirds may be expected. The probabilities of the areas in Table 8.5.6 being affected are the result of modelling an unmitigated blowout scenario. An unmitigated release is highly unlikely as it precludes consideration of oil containment and recovery measures, which would be implemented following an actual release.

The greatest probabilities of surface oiling exceeding 0.04 µm are estimated for offshore protected areas such as the Gully MPA (61.1%) and Sable Island National Park Reserve (28.4%). There are lower probabilities (<2%) for surface oiling exceeding 0.04 µm in coastal protected areas within Nova Scotia. Surface oiling can also be expected to occur within the Haddock Box and sponge/coral conservation areas based on stochastic modelling results. Exposure to oil within these areas would be mostly limited to the surface and mixed layer of the water column;

therefore, the potential for sponges and corals on the seafloor to be exposed to in-water oil is considered low. While haddock is a demersal species, sub-lethal and lethal effects to eggs and larvae that drift in the mixed surface layer of the water column may result following exposure to in-water oil, above the 58 ppb and 200 ppb in-water concentrations, respectively.

Table 8.5.6 Surface Oil Interactions with Designated Protected Areas Resulting from a Well Blowout Incident (Site 1, Summer)

Special Area	Average Probability of Surface Oiling exceeding 0.04 µm in a portion of the Designated Protected Area (%)	Total Intersect Area of Surface Oiling exceeding 0.04 µm (km^2)	Average of Maximum Exposure Time (days)
Coastal Special Areas			
Duncan's Cove Nature Reserve	1.9	0.05	1
Musquodoboit Harbour Ramsar Site	1.0	0.42	1
Terence Bay Wilderness Area	0.7	4.90	1
Canso Coastal Barrens Wilderness Area	0.7	24.25	1
Kejimkujik National Park (Seaside Adjunct)	0.5	0.85	1
Scatarie Island Wilderness Area	0.5	1.60	1
Offshore Special Areas			
Gully MPA	61.1	2,371.28	9
Sable Island National Park Reserve of Canada	28.4	14.45	4
Haddock Box	55.0	12,797	8
Stone Fence coral conservation area (Lophelia Coral Conservation Area)	25.7	15	5
Sambro Bank Sponge Conservation Area	25.0	63	6
Emerald Sponge Conservation Area	22.9	197	4
Northeast Channel Coral Conservation Area	16.8	425	4
Lobster Broodstock Closure Area	7.7	6,561	2
North Atlantic Right Whale - Roseway Basin	6.58	3,319	2
Laurentian Channel Area of Interest	4.6	12,647	2
St Anns Bank Area of Interest	0.9	527	1
North Atlantic Right Whale - Grand Manan Basin	0.48	31	1

Stranded oil is of primary relevance to Special Areas with shorelines. Table 8.5.7 presents probabilities and the average degree of shoreline oiling, above the 1g/m^2 threshold, at designated protected areas with shoreline habitat. Sable Island National Park Reserve has the highest probability of stranded oil exceeding thresholds, with the remaining designated protected areas having a low (<5%) probability of stranded oil interaction. Stochastic modelling for an unmitigated blowout incident at Sites 1 and 2 during winter and summer conditions predict areas of heavy oiling (>10 mm thickness of emulsified oil) for Sable Island, with a minimum arrival time to reach 1 µm thickness threshold of 5 to 10 days.

Environmental effects from stranded oil on Sable Island on migratory birds (including the Roseate Tern) are described in Section 8.3 (Migratory Birds). As noted in Section 5.2.10, Sable Island is also important as it hosts the largest breeding colony of grey seals in the world, a population of wild horses, contains one of the largest dune systems in eastern North America, hosts a number of species at risk and endemic species, and exhibits an extremely dynamic ecology (Freedman 2014). Recovery rate of sand beaches (*e.g.*, recovery of vegetation or structure) following oiling is variable, depending on conditions and initial disturbance during spill response, but is assumed to occur within approximately three years (French-McCay 2009).

Table 8.5.7 Stranded Oil Interactions with Designated Protected Areas Resulting from a Well Blowout Incident (Site 1, Summer)

Special Area	Average Probability of Stranded Oil exceeding 1 g/m² in a portion of the Designated Protected Area (%)	Total Intersect Area of Stranded Oil exceeding 1 g/m² (km²)	Average Degree of oiling[1]
Designated Protected Areas			
Sable Island National Park Reserve	55.5	15.41	Heavy
Duncan's Cove	4.0	0.24	Heavy
Canso Coastal Barrens	1.2	17.94	Moderate
Kejimkujik National Park and National Historic site of Canada (Seaside Adjunct)	1.0	5.31	Moderate
Terence Bay	0.7	6.48	Light
Bonnett Lake Barrens	0.6	17.61	Stain/Film
Scatarie Island	0.5	1.49	Moderate

[1]Heavy - >10,000 g/m² (> 10 mm thickness)
Moderate – 1,000 – 10,000 g/m² (1 -10 mm thickness)
Light - 100 – 1,000 g/m² (0.1 – 1.0 mm thickness)
Stain/Film – 1 - 100 g/m² (0.001 - 0.1 mm thickness)

As indicated in Section 8.3.3.3, use of chemical dispersants as a spill response method would potentially reduce the likelihood and extent of stranded oil on coastlines, thereby reducing adverse environmental effects on land-based protected areas as listed above.

Summary

The nature and extent of the effects of an accidental event on Change in Habitat Quality for Special Areas vary considerably depending on the type and magnitude of the event, the proximity to the Special Area, and the ecological characteristics of the Special Area. Table 8.5.8 provides a summary of predicted residual environmental effects of accidental events on Special Areas.

Table 8.5.8 Summary of Residual Project-Related Environmental Effects on Special Areas – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Habitat Quality							
10 bbl Diesel Spill	A	L	LAA	ST	S	R	U
100 bbl Diesel Spill	A	M	LAA	ST	S	R	U
PSV Diesel Spill	A	L-M	LAA	ST-MT	S	R	U
Well Blowout Incident	A	H	RAA*	ST-MT	S	R	U
SBM Spill	A	L	LAA	ST	S	R	U

KEY:
See Table 7.5.2 for detailed definitions

N/A: Not Applicable
Direction:
P: Positive
A: Adverse
N: Neutral
Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*"
Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous
Reversibility:
R: Reversible
I: Irreversible
Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.5.4.4 Determination of Significance

The residual environmental effect of a Change in Habitat Quality for Special Areas for the batch diesel (10 and 100 bbl) and vessel spill scenarios is predicted to be not significant. A medium level of confidence is assigned to the significance determination since the significance would be influenced by a number of factors including volume spilled, duration, location, season, presence of birds, and effectiveness of mitigation.

The residual adverse environmental effect of a Change in Habitat Quality for Special Areas is predicted to be significant for an unmitigated well blowout incident in recognition of potential effects on Sable Island. This significance prediction is made with a high level of confidence given the high probability of heavy oiling and relatively short arrival time of oil to reach the Sable Island shoreline, thereby limiting mitigative response options.

However, the likelihood of a significant adverse effect occurring is considered low given the extremely low probability of a well blowout incident occurring based on historical statistics and the spill prevention and response measures to be implemented by BP on this Project.

The residual environmental effect of an SBM spill on Special Areas is predicted to be not significant with a high level of confidence in recognition of the limited spatial and temporal extent of effects and limited interaction with Special Areas other than the Scotian Slope EBSA.

8.5.5 Commercial Fisheries

The RAA is dominated by commercial fisheries activity with groundfish, pelagic, and invertebrate fisheries occurring on the Scotian Shelf and Slope (see Section 5.3.5). The RAA is located within Commercial Fisheries Management Areas for lobster, shrimp, scallop and crab, and within NAFO Divisions 4VN, 4VS, 4W, 4X, and 5ZE. From 2010 to 2013 in NAFO Divisions within the RAA (Table 5.3.4), invertebrates dominated the commercial landing values with between 71 and 84% of the total catch value in that period. In the Project Area, large pelagics are most commonly harvested (*e.g.,* tuna, swordfish and shark).

Routine Project activities are not predicted to interact with nearshore fisheries, although as shown in stochastic modelling results for an unmitigated well blowout incident, there is potential for oil to reach the nearshore environment. Oil can also interact with nearshore fisheries in the event of a diesel spill from a PSV transiting nearshore waters. Section 5.3.1.2 describes nearshore commercial and recreational fisheries; offshore commercial fisheries are discussed in Section 5.3.5.2. Aboriginal fisheries are discussed in Section 5.3.6 and the Traditional Use Study (Appendix B); effects of accidental events on Aboriginal fisheries are assessed in Section 8.5.6.

Inshore recreational fisheries include American eel, mackerel, herring, and scallop. There are over 250 aquaculture leases in Nova Scotia, including both finfish (*e.g.*, Atlantic salmon, cod, trout) and shellfish (*e.g*., oyster, mussel, scallop, quahaug, clam) operations (NSDFA 2013).

Within Halifax Harbour, where PSVs will be transiting to and from the supply base, nearshore commercial fisheries include a small commercial finish fishery seaward of McNabs Island consisting of groundfish (cod, haddock, pollock and halibut) and pelagic (herring and mackerel) species. The Harbour is located within NAFO Fishery Unit Area 4Wk. Other areas throughout the Harbour support a bait fishery for both commercial and recreational bait (Rozee 2000). Commercial and recreational fisheries for clams and mussels are closed due to fecal coliform levels in the Harbour. Lobster is the primary commercial species harvested within Halifax Harbour with a total of 15 to 20 lobster fishers using the Harbour (Stantec 2014a). The Harbour is included within the boundaries of Lobster Fishing Area (LFA) 33, which extends from Cow Bay, Halifax County to Port La Tour, Shelburne County off southwestern Nova Scotia and into the Bay of Fundy. LFA 33 has the highest landings and most participants of any LFA in Canada (DFO 2013a).

The potential environmental effects, effect pathways, and measureable parameters identified in Table 7.6.1 for Commercial Fisheries for routine activities remain valid for the assessment of potential environmental effects as a result of an accidental event. Likewise, the criteria for characterizing residual environmental effects and determining significance (refer to Section 7.6.5) remain valid for the accidental events assessment.

8.5.5.1 Project Pathways for Effects

Project-related accidental events could potentially affect Commercial Fisheries with respect to a Change in Availability of Fisheries Resources. Section 8.5.1 evaluates effects on Fish and Fish Habitat and concludes that biophysical effects on fish from accidental events will not be significant. However, adverse effects could still be realized by fishers in the event of an offshore or nearshore spill, as a result of reduced access to fishing grounds (*e.g.*, fisheries exclusion), reduced catches, and/or reduced marketability of fish products. In addition, fishing gear or cultivation gear may be lost or damaged as a result of an accidental event. The significance of the potential adverse effects depends on the nature, magnitude, location and timing of a spill.

All of the identified accidental scenarios have the potential to affect Commercial Fisheries, including a batch spill (100 bbl and 10 bbl), PSV spill, SBM spill, and subsea blowout incident.

As noted earlier, the assessment is conservative (*i.e.*, geographic and temporal overlap are assumed to occur and modelling results assume no implementation of mitigation measures).

Effects of Hydrocarbons on Commercial Fisheries

An accidental event could result in effects on availability of fisheries resources, access to fisheries resources, and/or fouling of fishing or cultivation gear. Although the Project is not located within an area of high harvesting activity, hydrocarbons could reach an active fishing area on the Scotian Shelf or shelf break where harvesting activity is more concentrated. Under some circumstances (*e.g.*, nearshore PSV spill, well blowout incident), oil could reach coastal locations, potentially interacting with nearshore fisheries and aquaculture operations. As indicated in Section 8.5.1, adult free-swimming fish rarely suffer long-term damage from oil spills, primarily due to rapid dispersion and dissolution. Sedentary species such as edible seaweeds and shellfish, are particularly sensitive to oiling (ITOPF 2011).

Effects on fisheries resources can vary depending on the spill location, seasonal timing, and how much oil reaches the fisheries resource. Additionally, changes can arise from other factors (*e.g.*, natural fluctuations in species levels, variation in fishing effort, climatic effects, or contamination from other sources) making it difficult to assess implications of an oil spill itself (ITOPF 2011).

Physical and chemical characteristics of oil products, along with environmental and biological factors influence the degree to which seafood may become contaminated (Yender *et al.* 2002). The uptake of oil and PAHs by exposed fish poses a potential threat to human consumers and affects the marketability of catches. However, market perceptions of poor product quality (*e.g.*, tainting) can persist even when results demonstrate safe exposure levels for consumption, thereby prolonging effects for fishers.

The presence of taint, which is recognized as when a food product has an usual odour or flavor (*e.g.*, petroleum taste or smell), can be influenced by the type of oil, species affected, extent and duration of exposure, hydrographical conditions, and water temperature (ITOPF 2011). The hydrocarbon concentrations at which tainting can occur are very low (no reliable chemical threshold has been established) with the presence of taint determined by sensory testing (ITOPF 2011). If seafood is taint-free, it is considered safe to eat since contaminant levels detected during sensory testing are so low (ITOPF 2011).

Reduced demand for seafood that is perceived to be tainted can also lead to depressed market prices. As demonstrated in the Gulf of Mexico following the DWH oil spill, lack of consumer confidence in seafood quality and in the validity of government testing methods can have effects that persist beyond the period of actual effects. Even after federal and state testing showed Gulf seafood to be safe to eat, sales remained depressed due to lack of consumer confidence (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling 2011).

Physical contamination of boats, fishing gear and aquaculture facilities can also occur, with flotation equipment (*e.g.*, buoys, nets, fixed traps) and shoreline cultivation facilities at higher risk. In some cases, fouling of gear can result in oil being transferred to the catch or produce (ITOPF 2011).

Fishery closures may be imposed after a spill to prevent gear from being contaminated and to protect or reassure seafood consumers. Fishery closures are usually implemented in areas (including a buffer) where: a visible sheen exists on the ocean surface; in areas (including a buffer) with detectable levels of subsurface oil; and, as a precautionary measure, in areas where surface oil is predicted to occur based on trajectory modelling (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling 2011). The threshold of 0.04 µm (visible sheen threshold) was used to present spill trajectory modelling results for surface oiling in recognition of the possibility of a fisheries closure occurring at this threshold (refer to Section 8.4).

Closures typically remain in place until: an area is free of oil and oil sheen on the surface; there is low risk of future exposure based on predicted trajectory modelling; and seafood has passed sensory sampling (smell and taste) for oil exposure (taint) and chemical analysis for oil concentration (toxicity) (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling 2011). The implementation of a fishery closure would prevent localized or area-specific harvesting of fish, and potentially alleviate concerns about marketing of tainted product, but it also represents a material concern for fishers.

Effects of SBM Spill on Commercial Fisheries

Previous studies have shown little or no risk of drilling base chemicals to bioaccumulate to potentially harmful concentrations in tissues of benthic animals or to be transferred through marine food webs to fishery species (Neff *et al.* 2000).

8.5.5.2 Mitigation of Project-Related Environmental Effects

BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences (refer to Section 8.3 for details on incident management and spill response plans).

BP will undertake a NEBA as part of the OA process with the CNSOPB to evaluate the risks and benefits of dispersing oil into the water column, including potential effects on fish and fisheries, and will obtain regulatory approval for any use of dispersants as required.

Specific mitigation to reduce effects from an accidental spill on fisheries also includes compensation for gear loss or damage caused by the spill. Specific measures to be implemented by BP to mitigate adverse environmental effects on Commercial Fisheries include the following:

- Implementation of a Fisheries Communication Plan which would include procedures for informing fishers of an accidental event and appropriate response. Emphasis is on timely communication, thereby providing fishers with the opportunity to haul out gear from affected areas, reducing potential for fouling of fishing gear.
- Compensation for damage to gear in accordance with *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).

In the unlikely event of a spill, specific monitoring (*e.g.*, environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

8.5.5.3 Characterization of Residual Project-Related Environmental Effects

Diesel Spills (PSV and MODU)

For this Project, modelling results indicate that batch spills from the MODU (10 bbl and 100 bbl) are not likely to result in effects on fish over a large area (Figures 8.4.24 and 8.4.25 in Section 8.4). Accidental discharges of marine diesel resulted in limited modelled effects. Around 65% of the spill evaporated within three days. Further, the maximum exposure time for emulsified oil thickness on the sea surface that exceed 0.04 µm is one day. Deterministic modelling results indicate that the surface area covered by oil in excess of 0.04 µm will equate to 0.82 km^2 and 4.4 km^2 for the 10 bbl and 100 bbl spill scenarios respectively.

Stochastic modelling shows that the locations of surface oiling in excess of 0.04 µm could extend approximately 50 km to the east and 20 km to the north, south, and west for a 10 bbl spill, as a small portion of weathered diesel may continue to be transported at the surface. For a 100 bbl spill, the locations for oiling in excess of 0.04 µm could extend approximately 100 km to the west and southeast and 30 km in all other directions, with a small portion of weathered diesel continuing beyond these distances. However, this swept area would be characterized as a patchy sheen with weathered oil. A nearshore vessel diesel spill would be expected to behave similarly. Diesel fuel is considered to result in a moderate to high risk of seafood contamination because of the relatively high content of water-soluble aromatic hydrocarbons (Yender *et al.* 2002). However, given the high evaporation rates, exposure of fisheries resources to the diesel would be short-term, thereby reducing risk of contamination of fisheries resources. In the case of a PSV diesel spill, this risk of exposure and subsequent contamination could be greater where there could be a higher density of fisheries resources.

Well Blowout Incident

An unmitigated blowout incident is expected to result in adverse effects to commercial fisheries, with surface and in-water oil expected to predominantly move to the east and southeast of the Project Area as indicated for the deterministic modelling runs (Figures 8.4.24 and 8.4.25). Some seasonal variation in the movement of oil following a release is expected (oil is more likely to be transported to the northeast under summer conditions and move in more uniform, multi-directional transport patterns during winter conditions as indicated for stochastic modelling results). Higher percentages of the released oil were found on the surface in the summer, the result of decreased wind and wave action, which typically disperses and entrain oil into the water column. As indicated by Figures 8.4.3 to 8.4.6, there is a moderate probability of surface oiling (in excess of 0.04 µm) from an unmitigated 35,914 bpd, 30-day continuous blowout reaching the Emerald Basin and Georges Bank. Predictive modelling indicates that the length of time for an unmitigated blowout to reach threshold thickness (0.04 µm for surface oiling) at Emerald Basin or Georges Bank, where fishing effort is considerably more concentrated, would be between approximately 6 to 20 days for Emerald Basin and 30 to 50 days for George's Bank. This would provide an opportunity to notify fishers of the spill and preventing the setting or hauling of gear in the affected area. Fouling of gear and/or catch of contaminated resources would therefore be reduced or avoided. Depending on the duration and volume of the release following a blowout incident, and the effectiveness of mitigation measures, closure areas may not be widespread and fishers may also be able to fish in alternative areas. Given the very low probability of a well blowout incident or other release (refer to Section 8.2), and that the predictive modelling referred to above assumes an unmitigated release, the likelihood of effects to these important fisheries areas is considered low.

Modelled blowout scenarios during the summer resulted in the potential for shoreline oiling, including the portions of the Eastern Shore and Southern Nova Scotia, although the likelihood of this occurring was low (less than 5% in most cases; Figures 8.4.12 and 8.4.14). These coastal areas are known to support aquaculture operations that could also be affected by oiling from either an unlikely blowout scenario or a diesel spill from a PSV travelling to Halifax Harbour. While the effects of oil on aquaculture are similar to other commercial fisheries (*i.e.*, potential for fouling of cultivation gear, tainting of fish and temporary shutdown of operations), aquaculture operations are unique in the type and variety of mitigation that can be used to limit effects of spills if operators are notified in a timely manner. This can include: moving floating facilities to avoid slicks and the transfer of stock to areas unlikely to be affected; however, these mitigation measures can be technically, logistically or financially challenging (ITOPF 2004). Other options include temporary suspension of water intakes for shore tanks, ponds or hatcheries to isolate stock from potential oil contamination and suspension of feeding (ITOPF 2004). A NEBA exercise that would be undertaken by BP prior to using dispersants, would consider proximity to aquaculture operations that may be adversely affected by higher in-water oil concentrations.

SBM Spill

Predictive modelling for a spill of SBM completed for the Shelburne Basin Venture Exploration Drilling Project (RPS ASA 2014, Appendix C in Stantec 2014a) predicts that sediment plumes could travel up to 5 to 10 km from the release site to a TSS concentration of 1 mg/L and that TSS concentrations above 1 mg/L could persist up to 30 hours following the spill event in some circumstances.

All substances that comprise drilling muds are screened through a chemical management system in consideration of the OCSG (NEB *et al.* 2009). Previous studies have shown little or no risk of drilling base chemicals to bioaccumulate to potentially harmful concentrations in tissues of benthic animals or to be transferred through marine food webs to fishery species (Neff *et al.* 2000). The predicted affected area would be limited to within the LAA (up to 9.6 km), any measurable effect on water quality would be temporary (up to 30 hours), and the product is considered to be of low toxicity. A fisheries closure would not likely be necessary, and fouling of gear would be unlikely given the relatively small spatial and temporal footprint of the spill event and limited harvested activity within the LAA.

Summary

Table 8.5.10 summarizes predicted residual environmental effects on Commercial Fisheries from various accidental event scenarios.

Table 8.5.9 Summary of Residual Project-Related Environmental Effects on Commercial Fisheries – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Availability of Fisheries Resources							
10 bbl Diesel Spill	A	L	LAA	ST	S	R	U
100 bbl Diesel Spill	A	M	RAA	MT	S	R	U
PSV Diesel Spill	A	H	RAA	MT	S	R	U
Well Blowout Incident	A	H	RAA*	LT	S	R	U
SBM Spill	A	L	LAA	ST	S	R	U

KEY:
See Table 7.6.2 for detailed definitions

N/A: Not Applicable
Direction:
P: Positive
A: Adverse
N: Neutral
Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*"
Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous
Reversibility:
R: Reversible
I: Irreversible
Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.5.5.4 Determination of Significance

The significance of spill-related adverse effects is influenced by the magnitude, location and timing of a spill. A small spill offshore is unlikely to measurably affect fisheries occurring outside the MODU operational safety (exclusion) zone and therefore would not result in a significant adverse environmental effect on Commercial Fisheries. A spill of the same material and volume occurring in the nearshore environment could have potential effects on nearshore fisheries, potentially displacing fishers from traditional fishing grounds for all or most of a fishing season, depending on the volume, location and timing of the spill.

In the event of a 10 bbl diesel spill, adverse environmental effects are predicted to be not significant for commercial fisheries. This effects prediction is made with a high level of confidence based on the predictive modelling results indicating a limited spatial and temporal exposure of spilled diesel to commercial fisheries in the RAA.

In recognition of variances of magnitude depending on the time of year and location of a PSV spill, this spill scenario is also predicted to potentially result in a significant adverse environmental effect on Commercial Fisheries. A significant adverse environmental effect is also predicted to occur in the event of a 100 bbl diesel spill. However, none of these significant effects is considered likely to occur.

Because of the widespread nature of the worst-case, unmitigated blowout incident, a significant effect is conservatively predicted for commercial fisheries for this scenario. The likelihood of this significant effect occurring is considered low, given the potential for a blowout to occur and given the response measures that would be in place to mitigate potential effects. In addition, while a blowout incident could potentially affect aquaculture operators in Nova Scotia, the likelihood of oil reaching the coast is very low and the time required for oil to reach the shore would give BP and operators time to implement mitigation against oiling of cultivation gear.

A medium level of confidence is assigned to the significance determination for a blowout incident, PSV spill, and 100 bbl batch spill in recognition of the variables which could cause the actual significance to be less than predicted (*e.g.*, proximity to fishing area, timing of spill, effectiveness of response and VC-specific mitigation).

Given the predicted affected area (up to 10 km), temporary period of measurable effect on water quality (up to 30 hours), and the low toxicity of the product, effects of a SBM spill are predicted to be not significant for Commercial Fisheries. This determination is made with a high level of confidence. A fisheries closure would not likely be necessary, and fouling of gear would be unlikely given the relatively small spatial and temporal footprint of the spill event and limited harvested activity within the LAA.

8.5.6 Current Aboriginal Use of Lands and Resources for Traditional Purposes

As reported in the Traditional Use Study (TUS) (Appendix B) and discussed in Section 5.3.6, all 13 Mi'kmaq First Nation communities in Nova Scotia currently have communal commercial fishing licences for various species that may be harvested in the RAA. There are 25 species being fished by the Nova Scotia Mi'kmaq First Nation communities under communal commercial licences within the RAA. Fifteen of these species may also be harvested within the LAA and seven within the Project Area: Atlantic cod, bluefin tuna, halibut, mahi-mahi (*Coryphaena hippurus*), silver hake and swordfish. The NCNS fisher 19 species (including by-catch species) within the RAA under communal commercial licences, with 9 of these being fished in the LAA and 7 within the Project Area. Species fished commercially by the NCNS within the Project Area include: albacore tuna, bluefin tuna, bigeye tuna, halibut (by-catch), mahi-mahi (by-catch), swordfish, and yellowfin tuna (MGS and UINR 2016). Additionally, New Brunswick Mi'kmaq and Wolastoqiyik (Maliseet) also hold communal fishing licences for various species that may be harvested from the RAA. Interviews with Fort Folly, Woodstock and St. Mary's First Nation communities revealed that 16 species are fished within the RAA, 10 of which may also be harvested within the LAA. Silver hake and swordfish are the only species that may also be harvested within the Project Area (MGS and UINR 2016).

According to the TUS (Appendix B), no food, social or ceremonial (FSC) fishing was reported to occur in the Project Area, although it is possible FSC fishing could occur presently or in the future. FSC fisheries for Atlantic herring, Atlantic mackerel, Greenland halibut, lobster, redfish, and silver hake are reported by the Nova Scotia Mi'kmaq First Nation communities and/or the NCNS as occurring in the LAA. Additional species are fished for FSC purposes in the larger RAA.

The potential environmental effects, effect pathways, and measureable parameters identified in Table 7.7.1 for Current Aboriginal Use of Lands and Resources for Traditional Purposes for routine activities remain valid for the assessment of potential environmental effects as a result of an accidental event. Likewise, the criteria for characterizing residual environmental effects and determining significance (refer to Section 7.7.5) remain valid for the accidental events assessment.

8.5.6.1 Project Pathways for Effects

All accidental scenarios considered in this assessment could have an adverse environmental effect on Current Aboriginal Use of Lands and Resources for Traditional Purposes. An accidental event could have an effect on the fisheries resource (direct or indirect effects on fished species affecting fisheries success) and/or fishing activity (displacement from fishing areas, gear loss or damage) resulting in a Change in Traditional Use. Although the TUS indicates that FSC fisheries were not currently identified to occur in the vicinity of the Project Area, in the event of a spill, there could be effects on offshore FSC activities should they be taking place, nearshore fisheries, and/or on FSC species that could be migrating through or otherwise using the affected area. An effect on species fished for traditional (*e.g.*, communal gathering of fish for feasts) or commercial purposes, a change in habitat traditionally fished by Aboriginal peoples, and/or area closures could affect traditional use of marine waters and resources.

In addition to the potential effects on a Change in Traditional Use described above, Section 8.5.5 describes the potential environmental effects of the various spill scenarios on commercial fisheries, Section 8.5.1 describes potential environmental effects on Fish and Fish Habitat, and Section 8.5.4 describes potential effects on Special Areas. These sections also help to inform how the accidental release of hydrocarbons to the marine environment may adversely affect Current Aboriginal Use of Lands and Resources for Traditional Purposes.

As noted earlier, the assessment is conservative (*i.e.*, geographic and temporal overlap are assumed to occur and modelling results assume no implementation of mitigation measures).

8.5.6.2 Mitigation of Project-Related Environmental Effects

BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences (refer to Section 8.3 for details on incident management and spill response plans).

BP will undertake a NEBA as part of the OA process with the CNSOPB to evaluate the risks and benefits of dispersing oil into the water column, including potential effects on fish and fisheries, and will obtain regulatory approval for any use of dispersants as required.

Mitigation to reduce effects from an accidental spill on Current Aboriginal Use of Lands and Resources for Traditional Purposes includes measures which are also intended to mitigate potential effects on Commercial Fisheries including:

- Implementation of a Fisheries Communication Plan which would include procedures for informing fishers of an accidental event and appropriate response. Emphasis is on timely communication, thereby providing fishers with the opportunity to haul out gear from affected areas, reducing potential for fouling of fishing gear.
- Compensation for damage to gear in accordance with *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002)

In the unlikely event of a spill, specific monitoring (*e.g.*, environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

8.5.6.3 Characterization of Residual Project-Related Environmental Effects

Diesel Spills (PSV and MODU)

For this Project, modelling results indicate that batch spills from the MODU (10 bbl and 100 bbl) are not likely to result in effects on fish over a large area (Figures 8.4.2.4 and 8.4.25 in Section 8.4). Accidental discharges of marine diesel resulted in limited modelled effects. Around 65% of the spill evaporated within three days, with the maximum exposure time for emulsified oil thickness on the sea surface exceeding 0.04 μm being one day. Deterministic modelling results indicate that the surface area covered by oil in excess of 0.04 μm will equate to 0.82 km^2 for the 10 bbl spill scenario and 4.4 km^2 for the 100 bbl spill scenario. The effects from a vessel diesel spill would be expected to be of similar magnitude, although a spill could also affect nearshore commercial and/or FSC fisheries if an incident were to occur while the PSV was approaching or departing the onshore supply base. Diesel fuel is considered to result in a moderate to high risk of seafood contamination because of the relatively high content of water-soluble aromatic hydrocarbons, which are semi-volatile and evaporate slowly (Yender *et al.* 2002). If a fisheries closure was implemented due to the spill, this could result in a temporary loss of access to Aboriginal fishers for commercial or FSC purposes.

Well Blowout Incident

As discussed in Section 8.5 (Commercial Fisheries), the effects from an unmitigated blowout incident would be more widespread than for the other spill scenarios. The probability of surface oiling (in excess of 0.04 μm) from an unmitigated 35,914 bpd, 30-day continuous blowout incident has moderate potential to reach Emerald Basin and Georges Bank. Predictive modelling indicates that the length of time for oil from an unmitigated blowout incident to reach threshold concentration (0.04 µm for surface oiling) at Emerald Basin or Georges Bank, where fishing effort is considerably more concentrated, would be between approximately 6 to 20 days for Emerald Basin and 30 to 50 days for George's Bank. This would provide an opportunity to notify fishers of the spill and preventing the setting or hauling of gear in the affected area. Fouling of gear and/or catch of contaminated resources would therefore be reduced. As indicated in the mapping included in the TUS (refer to Appendix B), identified fishing areas for demersal and invertebrate fisheries are almost exclusively located on the Scotian Shelf, whereas pelagic fisheries occur throughout the RAA. Given the very low probability of a well blowout incident or other release (refer to Section 8.2), and that the predictive modelling referred to above assumes an unmitigated release, the likelihood of effects to these traditional use areas is considered low.

SBM Spill

Predictive modelling for a spill of SBM conducted for the Shelburne Basin Venture Exploration Drilling Project (RPS ASA 2014, Appendix C in Stantec 2014a) predicts that sediment plumes could travel up to 9.6 km from the release site to a TSS concentration of 1 mg/L and that TSS concentrations above 1 mg/L could persist up to 30 hours following the spill event in some circumstances. All substances that comprise drilling muds are screened through a chemical management system in consideration of the OCSG (NEB *et al.* 2009). Previous studies have shown little or no risk of drilling base chemicals to bioaccumulate to potentially harmful concentrations in tissues of benthic animals or to be transferred through marine food webs to fishery species (Neff *et al.* 2000). The predicted affected area would be limited to within the LAA (up to 9.6 km), any measurable effect on water quality would be temporary (up to 30 hours), and the product is considered to be of low toxicity. A fisheries closure would not likely be necessary, and fouling of gear would be unlikely given the relatively small spatial and temporal footprint of the spill event and limited harvested activity within the LAA.

Summary

Table 8.5.10 summarizes predicted residual environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes from various accidental event scenarios.

Table 8.5.10 Summary of Residual Project-Related Environmental Effects on Aboriginal Use of Lands and Resources for Traditional Purposes – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Traditional Use							
10 bbl Diesel Spill	A	L	LAA	ST	S	R	U
100 bbl Diesel Spill	A	M	RAA	MT	S	R	U
PSV Diesel Spill	A	H	RAA	MT	S	R	U
Well Blowout Incident	A	H	RAA*	LT	S	R	U
SBM Spill	A	L	LAA	ST	S	R	U

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Frequency:
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R: Regular event
C: Continuous
Reversibility:
R: Reversible
I: Irreversible
Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.5.6.4 Determination of Significance

The significance of spill-related adverse effects depends on the magnitude, location and timing of a spill. A small spill offshore is unlikely to measurably affect fisheries occurring outside the MODU operational safety (exclusion) zone and therefore would not result in a significant adverse environmental effect on Current Aboriginal Use of Lands and Resources for Traditional Purposes. A spill of the same material and volume occurring in the nearshore environment could have potential effects on nearshore fisheries, potentially displacing Aboriginal fishers from traditional fishing grounds for all or most of a fishing season, depending on the volume, location and timing of the spill.

In the event of a 10 bbl diesel spill, adverse environmental effects are predicted to be not significant for Current Aboriginal Use of Lands and Resources for Traditional Purposes. This effects prediction is made with a high level of confidence based on the predictive modelling results indicating a limited spatial and temporal exposure of spilled diesel to Aboriginal fisheries and resource use in the RAA.

In recognition of variances of magnitude depending on the time of year, volume, and location of a PSV spill, this spill scenario is also conservatively predicted to potentially result in a significant adverse environmental effect on Current Aboriginal Use of Lands and Resources for Traditional Purposes. A significant adverse environmental effect is also predicted to occur in the event of a 100 bbl diesel spill. However, none of these significant effects is considered likely to occur. A medium level of confidence is assigned to the significance determination for a blowout incident, PSV spill, and 100 bbl batch spill in recognition of the variables which could cause the actual significance to be less than predicted (*e.g.*, proximity to fishing area, timing of spill, effectiveness of response and VC-specific mitigation).

Because of the widespread nature of the worst-case, unmitigated blowout incident, a significant effect is conservatively predicted for Current Aboriginal Use of Lands and Resources for Traditional Purposes for this scenario. The likelihood of this significant effect occurring is considered low, given the potential for a blowout incident to occur and given the response measures that would be in place to mitigate potential effects. In addition, while a blowout incident could potentially affect nearshore fishing and resource use along the coastline, the likelihood of oil reaching the coast is very low and the time required for oil to reach the shore would give BP and operators time to implement mitigation against oiling of cultivation gear.

Given the predicted affected area (up to 10 km), temporary period of measurable effect on water quality (up to 30 hours), and the low toxicity of the product, effects of a SBM spill are predicted to be not significant on Current Aboriginal Use of Lands and Resources for Traditional Purposes. This determination is made with a high level of confidence. A fisheries closure would not likely be necessary, and fouling of gear would be unlikely given the relatively small spatial and temporal footprint of the spill event and limited harvested activity within the LAA.

9.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Section 19(1)(h) of CEAA, 2012 requires consideration of "any change to the designated project that may be caused by the environment". This section considers how local environmental conditions and natural hazards (*e.g.*, extreme weather) could adversely affect the Project and thus result in potential effects on the environment (*e.g.*, accidental events). Potential adverse effects of the environment on a project are typically a function of project design and environmental conditions that could affect the project. These effects are generally mitigated through engineering and environmental design criteria, industry standards, and environmental monitoring.

Aspects of the environment that could potentially affect the Project include:

- fog;
- sea ice and superstructure icing;
- seismic events and tsunamis;
- extreme weather conditions; and
- sediment and seafloor stability.

9.1 ENVIRONMENTAL CONSIDERATIONS

9.1.1 Fog

Fog, a major cause of low visibility at sea, is reported on the Scotian Shelf approximately 35% of days annually, resulting in a visibility less than 1 km approximately 13% annually (refer to Table 5.1.16). Reduced visibility due to fog is more common in the summer and least common in the fall.

Sea fog or advection fog forms when warm, moist air moves over colder seawater and as the air cools below its saturation point, excess moisture condenses to form fog. Sea fog can cover large areas and persist for long periods as long as a continuous supply of warm moist air is available (DFO 2012c). Sea smoke or evaporation fog forms when cold air moves over warmer seawater (DFO 2012c).

Foggy conditions, resulting in poor visibility, can hinder PSV and helicopter transportation, potentially resulting in delay of supply and personnel movement to and from the MODU, although it is unlikely to result in work stoppage. Based on the consideration of historical visibility data from the Sable Island Weather Station (refer to Table 5.1.16), and implementation of standard operating procedures for safe PSV and helicopter operations, fog is not likely to result in a significant adverse effect of the environment on the Project.

9.1.2 Extreme Weather Conditions

Average wind speeds on the Scotian Shelf range from 4.9 m/s to 8.8 m/s (17.5 km/hour to 31.5 km/hour) in September and January, respectively, with sustained wind speeds of 36.1 m/s (130 km/hour) during severe storm events (Stantec 2013). As indicated in Section 5.1.2.3, wind in the Project Area is predominantly from the northwest during the winter and from the southwest during spring and summer. Maximum wind speeds range from 20.4 m/s (73 km/hour) in May to 29.8 m/s (107 km/hour) In December.

Further environmental information on general and extreme climate and weather data used for the purposes of this analysis are included in Section 5.1.2 of the EIS. Extreme weather that could potentially occur in the Project Area and require consideration for Project planning includes lightning and tropical and extra tropical cyclones. Winds and storm surges generated as a consequence of tropical and extra-tropical cyclones are addressed here; lightning is discussed in Section 9.1.3.

A total of 22 tropical cyclones have passed through the Scotian Shelf and Slope from 2003 to 2014, with 13 passing through or within close proximity to the Project Area. Tropical cyclones that traveled through the Scotian Shelf and Slope have been most prevalent in September, followed by July, October, August, June and November, in decreasing monthly frequency respectively. More detailed information on tropical and extra-tropical cyclones that can affect the Project Area is presented in Section 5.1.2.4.

With respect to wave conditions, on the basis of the MSC50 wave data from 1954 to 2013 and a grid point within the Project Area (refer to Section 5.1.3.3), the maximum hourly significant wave height is highest in January at 13.6 m. The most frequent direction in January for these waves is towards the east.

High wind and wave conditions could delay loading and offloading of cargo to the MODU. In the unlikely event of a spill, it could also potentially affect spill response operations, including the availability and effectiveness of response methods. Consideration has been given to limitations and delays due to weather and sea state in the estimation of the maximum timeline for response to accidental events detailed in Section 8.3.3.

Extreme wind and wave conditions could result in accidental spills, suspension or delay of Project activities, evacuation of the MODU, and in extreme cases, such as the 1982 sinking of the *Ocean Ranger* offshore Newfoundland, loss of life. During a fierce winter storm, the ingress of sea water into the ballast room of the *Ocean Ranger* platform ultimately led to the evacuation and sinking of the rig and the loss of all 84 crew members. The *Ocean Ranger* tragedy resulted in significant improvements for the Canadian offshore petroleum industry, including the establishment of the offshore petroleum boards in Newfoundland and Labrador and in Nova Scotia, and more rigorous requirements around safety training, equipment and inspection (Stantec 2014a).

The local metocean conditions will be a primary consideration when planning drilling activities, supporting logistics (helicopter travel and movement of supplies and personnel), and in the unlikely event of an incident where emergency response or spill response is required.

Mitigation to reduce risks associated with operating in extreme weather is discussed in Section 9.2.

9.1.3 Lightning

Lightning can pose a safety risk to personnel as well as potentially affect electronic systems. However, both the MODU and PSVs will have lightning protection systems to ground lightning electrical charges and to transfer the energy to the sea water where it would dissipate. Lightning is therefore not likely to affect Project equipment. Safe work practices will be implemented to reduce exposure of personnel to lightning risk (*e.g.*, restriction of access to external areas on the MODU or PSV during thunder and lightning events).

9.1.4 Sea Ice and Superstructure Icing

Sea ice (including icebergs) is very rare in the Nova Scotia offshore environment (Worcester and Parker 2010; Environment Canada 2012b). Sea ice is therefore not considered a factor affecting Project operations. Further information on which this assumption is based, as well as figures depicting the maximum extent of median sea ice coverage from 1981–2010 and the maximum sea ice coverage, are shown in Section 5.1.3.5.

Although ice is not considered an important factor affecting Project operations, vessels operating in late fall and winter are likely to experience some degree of icing. Accumulation of ice on the MODU or vessels, sometimes referred to as "superstructure icing", can result from freshwater moisture such as fog, freezing rain, drizzle and wet snow, or from salt water associated with freezing spray or wave wash. Superstructure icing is possible when air temperatures are -2.2˚C or less and winds are more than 31 km/hour (DFO 2012c).

Freezing spray is the most common cause of icing and occurs when the air temperature falls below the freezing temperature of sea water and when sea surface temperatures drop below 6°C (DFO 2012c). Freezing spray is more frequent and severe in coastal waters off eastern Canada. Ice accretion rates from freezing spray can exceed 2 cm/hour and ice build-up of over 25 cm is not uncommon (DFO 2012c).

The rate of ice accumulation also depends on individual vessel characteristics. Smaller vessels are most at risk from spray icing as they are exposed to more spray and lose stability more rapidly than larger vessels (DFO 2012c). The accumulation of ice on a ship's superstructure can raise the centre of gravity, lower vessel speed and cause difficulty in maneuvering. It can also create problems with cargo handling equipment (DFO 2012c). Superstructure icing can cause delays because operations are slowed or suspended to remove or avoid ice accumulations.

Section 9.3 discusses mitigation to reduce effects of sea ice and superstructure icing on PSVs and the MODU.

9.1.5 Seismic Events and Tsunamis

The Scotian Shelf is an area of known seismic activity with recorded earthquakes and fault zones occurring on the Shelf. While the area is seismically active (Figure 9.1.1), events tend to be of a low magnitude (Table 9.1.1). Given the short duration of exploration activities the probability of a major seismic event occurring during an exploration drilling program is low. There have been five earthquakes recorded from 1985 to present in the Project Area, with the strongest occurring in 2005 at a magnitude of 2.9 ML (local magnitude on the Richter scale).

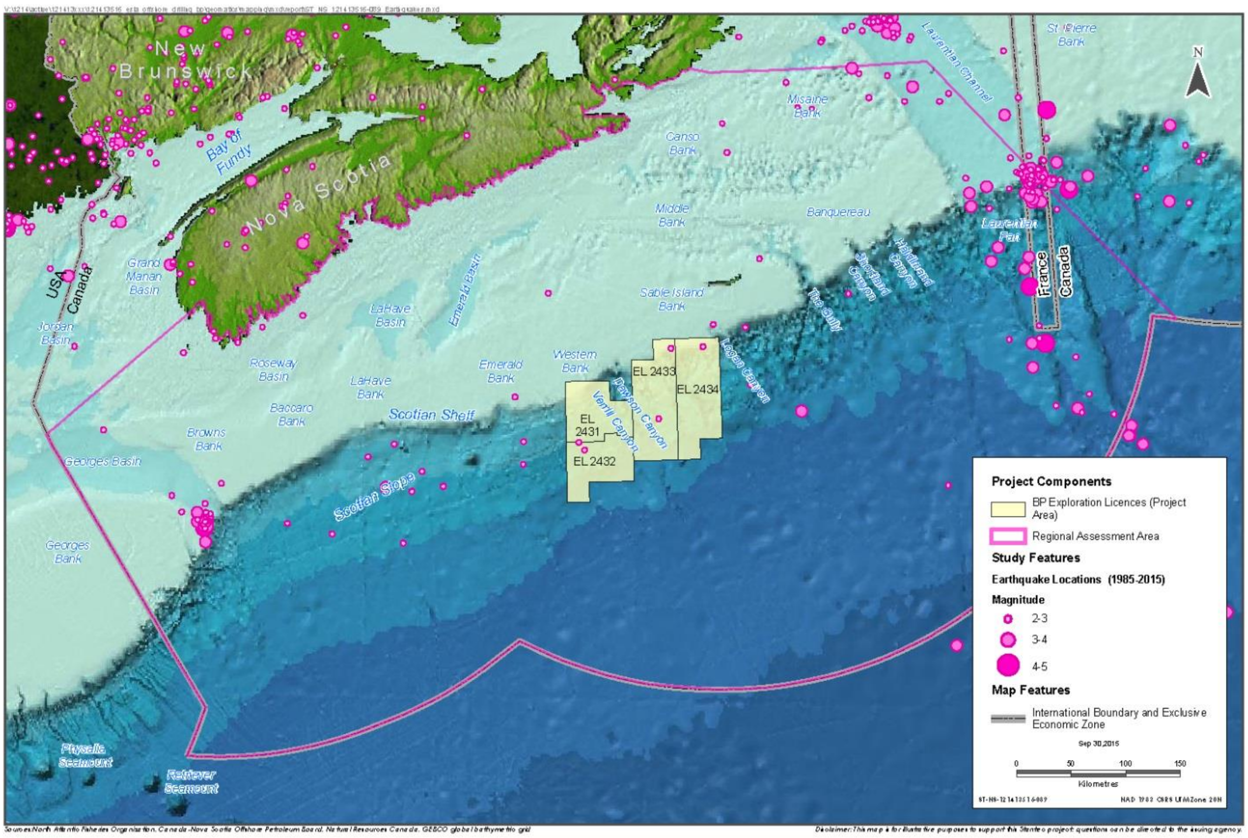

Figure 9.1.1 Earthquakes in or near Nova Scotia, Canada 1977–2015

Table 9.1.1 Earthquakes Recorded within the Project Area, 1985 to 2015

Date	Time (UTC)	Latitude	Longitude	Depth	Magnitude
6/30/2007	03:49:29	42.838000	-60.700000	18.0g	2.8MN
3/14/2007	09:23:18	42.656000	-61.603000	18.0g	2.4MN
10/7/2006	08:45:57	42.592000	-61.540000	18.0g	2.3ML
10/25/2005	23:53:02	43.422000	-60.179000	18.0g	2.9ML
6/19/2002	09:02:40	43.417000	-60.540000	18.0g	2.3ML
g = default depth (18 km) fixed by Geological Survey of Canada seismologist MN = Nuttli magnitude (developed to measure seisms of Eastern Canada) ML = Local magnitude (associated with the Richter scale)					

Source: Earthquakes Canada 2015

Tsunamis are long, surface gravity waves with amplitudes usually less than 2 m in height in the open ocean and are produced by earthquakes, volcanic island explosions and submarine landslides (as well as explosions or the impact of cosmic bodies such as meteorites). Tsunamis can travel at speeds of approximately 750 km/hour in the open ocean (4,500 m deep), slowing down (approximately 350 km/hour in 1,000 m water depth) and gaining wave height as it travels into shallower water (NOAA 2009). In 1929, an earthquake on the Laurentian Slope (approximately 250 km south of the Island of Newfoundland) triggered an underwater landslide that generated a tsunami and impacted Newfoundland's Burin Peninsula causing loss of life (NRCan 2011).

There is a low likelihood of tsunamis occurring on the Scotian Slope, and, given the relatively short period of the exploration drilling program, it is unlikely that a tsunami would occur during the life of the Project. Furthermore, the small wave height in the open ocean and long period of the waves for a tsunami are not anticipated to pose a serious risk to offshore drilling operations.

9.1.6 Sediment and Seafloor Instability and Other Geohazards

Sediment scour, liquefaction of sediments from seismic events, and slope failure on the seafloor are geohazards that could adversely affect exploration drilling activities (Stantec 2014b). Canyons in and around the Project Area (*e.g.*, Dawson and Verrill Canyons) represent possible areas of slope instability as they create steep banks, and provide avenues for sediment transport between the Shelf and the Slope into the deep ocean (Stantec 2013a).

Potential seabed geohazards in the Project Area include local fluid expulsion features, seabed faults, steep slopes related to massive canyons and localized slope failures, and variable soil properties at or near the seabed. Subsurface features may include shallow gas pockets, gas hydrates, and buried faults. Avoidance of geohazards associated with sediment and seafloor instability is critical to the success of drilling programs and to reduce the risk of accidental events.

9.2 MITIGATION

The primary means of mitigating adverse effects of the environment on the Project is through detailed engineering and use of environmental design criteria, compliance with industry codes of practice, and avoidance of environmental hazards where possible.

Fog, Extreme Weather Conditions and Superstructure Icing

The implementation of standard operating procedures, such as reducing vessel or helicopter speed and/or adjusting flight altitude, using appropriate sound and/or light signals, and relying on radar and navigation equipment as appropriate, will help PSVs and helicopters to navigate safely during foggy conditions.

To maintain navigational safety at all times during the Project, obstruction lights, navigation lights and foghorns will be kept in working condition on board the MODU and PSVs. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary. The MODU will be equipped with local communication equipment to enable radio communication between the PSVs and the MODU's bridge. Communication channels will also be put in place for internet access, and enable communication between the MODU and shore.

Safe work practices will be implemented to reduce exposure of personnel to lightning risk (*e.g.*, restriction of access to external areas on the MODU or PSV during thunder and lightning events).

The MODU selected for this Project will be an all-weather drillship or semi-submersible that is specifically designed to operate in harsh, deepwater environments, including during inclement weather. For example, a semi-submersible MODU would be designed to optimize stability in rough sea conditions. This type of MODU has a large deck box that contains the quarters, support system and drilling package that is supported by large columns on a hull consisting of two pontoon structures. In active drilling operations, the pontoons are ballasted down below the sea surface to provide stability. While drilling, the bottom of the deck box is elevated about 13 m above sea level. The design of semi-submersible MODUs provides the advantage of being able to submerge the hull with only limited free surface area in contact with the sea, thus reducing the effect of waves and wind and making these MODUs stable for drilling operations in rough sea conditions. Modern drill ships and rigs have the capability to disconnect the riser from the well in very short periods to reduce the risk of damage to the well, riser and the MODU during extreme weather events.

Once the MODU has been identified, it will be subject to a BP internal rig intake process. The rig intake process provides a means to identify and effectively manage risks for rig start-ups and verify that contracted rigs conform to specified BP practices and industry standards.

Pursuant to the Accord Acts and the requirements of an OA, a Certificate of Fitness for the drilling vessel will be required which will be issued by a recognized Certifying Authority prior to approval for use. BP will obtain a Certificate of Fitness from an independent third party Certifying

Authority for the MODU prior to the commencement of drilling operations in accordance with the *Nova Scotia Offshore Certificate of Fitness Regulations*. The Certifying Authority reviews installations to confirm they are fit for purpose, function as intended, can be operated safely without polluting the environment, and meet the requirements of the regulations. The regulations require that all offshore installations are designed, constructed, transported and installed or established in accordance with Parts I to III of the *Nova Scotia Offshore Petroleum Installations Regulations*, which stipulate that every installation and every component of an installation shall be designed in accordance with good engineering practice, taking into account:

- the nature of activities on and around the installation;
- the type and magnitude of functional loads, environmental loads (*i.e.*, a load imposed by waves, currents, tides, wind, ice, sea ice, snow, an earthquake or any other naturally occurring phenomenon, or by any combination of those phenomena), and foreseeable accidental loads;
- operating ambient temperatures;
- corrosion conditions that may be encountered during the construction, operation and maintenance of the installation;
- the avoidance of damage to any part of the installation that may lead to the progressive collapse of the whole installation; and
- soil conditions.

Part II of the *Nova Scotia Offshore Petroleum Installations Regulations* also requires that the design of an installation be based on analyses, model tests and/or simulations to determine the behaviour of the installation, and of the soils that support the installation or anchoring systems, under all foreseeable transportation, installation and operating conditions. The Certificate of Fitness will therefore provide third party verification that the MODU has been properly designed to operate safely within the wide range of environmental conditions known to occur in the Project Area.

The PSVs selected for this Project will similarly be equipped for safe all-weather operations, including stability in rough sea conditions and inclement weather. In addition, measures to reduce superstructure icing hazards on PSVs will be implemented as necessary and may include (DFO 2012c):

- reducing vessel speed in heavy seas;
- placing gear below deck and covering deck machinery, if possible;
- moving objects that may prevent water drainage from the deck;
- making the ship as watertight as possible; and
- manual removal of ice if required under severe icing conditions.

PSVs will undergo BP's internal verification process as well as additional external inspections/audits inclusive of the CNSOPB pre-authorization inspection process in preparation for the Project.

Icing conditions and accumulation rates on PSVs, helicopters, and the MODU will be monitored during fall and winter operations, particularly when gale-force winds may be combined with air temperatures below -2°C (DFO 2012c). In addition, the observation, forecasting and reporting of physical environment data will be conducted in accordance with the *Offshore Physical Environment Guidelines* (NEB *et al.* 2008) with the intention of promoting the safe and prudent conduct of routine operations and emergency response.

Marine weather observations, forecast bulletins and warnings are issued for Canadian marine areas by Environment Canada through the MSC, Weatheradio and regional Storm Prediction Centres. Observations and forecast bulletins are updated hourly and are available on MSC's Automated Telephone Answering Device and Weatheradio, which continuously broadcasts weather reports over VHF or FM radio. The Atlantic Storm Prediction Centre in Dartmouth, NS provides year-round marine weather and wave height information, consisting of a weather watch, warning and amendment service, for an area including Halifax Harbour and waters off the coast of Nova Scotia out to approximately 250 nautical miles offshore (DFO 2015q). The frequency of these marine forecasts is indicated in Table 9.2.1.

Table 9.2.1 Marine Forecast Schedule

Forecast Name	Details	Issue Time (ADT/AST)
Technical Marine Synopsis	Provides the positions and trends of the main weather systems for the forecast period covering Days 1 and 2.	03:00, 10:00, 15:30, 20:00
Marine Forecast	Provides information on: synoptic warnings, wind, visibility, precipitation and freezing spray. It may include air temperature as appropriate. Valid for Days 1 and 2.	03:00, 10:00, 15:30, 20:00
Extended Marine Forecast	Meant for longer-range planning purposes, it provides an extended marine wind outlook for Days 3, 4, and 5.	03:00, 15:30
Wave Height Forecast	Provides information on significant wave heights for Days 1 and 2.	05:00, 17:00
Marine Weather Statement	Issued when deemed necessary, it provides additional information on potentially high impact marine conditions.	As needed

Source: DFO 2015q

BP and contractors working on the Project will regularly monitor weather forecasts to forewarn PSVs, helicopters and the MODU of inclement weather or heavy fog before it poses a risk to their activities and operations. Extreme weather conditions that are outside the operating limits of PSVs or helicopters will be avoided if possible. Captains/Pilots will have the authority and obligation to suspend or modify operations in case of adverse weather or poor visibility that compromises the safety of PSV, helicopter, or MODU operations.

Geohazard Identification

Prior to any drilling activity, BP will conduct a comprehensive regional geohazard baseline review (GBR), followed by detailed geohazard assessments for each proposed wellsite to identify potential geohazards that may affect drilling operations. The GBR and detailed wellsite assessments will be based primarily on reprocessed 3D WATS seismic data acquired by BP in 2014. Existing regional data, such as geotechnical cores and offset wells, will be incorporated where available. The geohazard assessments will focus on identifying potential drilling hazards at the seabed and subsurface to a depth that is defined by the limit of the first pressure containment casing string (generally from seabed to 1,000 m to 1,200 m below mudline). This work will be conducted by a BP geohazards specialist following internal guidelines that either meet or exceed local regulatory requirements.

The GBR will be completed first and will focus on reprocessed 3D seismic WATS data acquired by BP in 2014 over an approximate 7000 km^2 area that covers water depths between about 1500 m and 3730 m. The WATS data was reprocessed in 2015 to demonstrate that the data can meet sampling rate and frequency required for regional geohazard baseline reviews.

After the GBR, the WATS data will be further reprocessed to increase the sampling rate and frequency requirements for detailed wellsite assessments. This data will be used to assess potential geohazards at potential well locations. After the proposed wellsites have been located to minimize potential geohazards, BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action. Additional information about how the specific well locations will be determined in consideration of survey data is provided in Section 2.2.

9.3 RESIDUAL EFFECTS SUMMARY

The key environmental factors that may affect the Project include reduced visibility, high winds and waves, and geohazards. However, engineering design, operational procedures, geohazard assessments, and other mitigation measures discussed above will reduce the potential adverse effects on, and risks to, the Project. Potential effects from sea ice, seismic activity and tsunamis are unlikely given their low probabilities of occurrence, the distance offshore and water depths at which Project activities and components will be located, the limited duration of offshore activities (*i.e.*, approximately 120 days to drill each individual well (up to seven) between 2018 and 2022), and the absence of fixed offshore infrastructure for the Project. Extreme weather conditions and superstructure icing are also unlikely to adversely affect the Project given that the MODU will be designed for harsh weather conditions, meteorological conditions will be monitored, and stop-work procedures would be implemented should conditions become unsafe.

A **significant adverse residual effect** of the environment on the Project is defined as one that results in one or more of the following:

- damage to the Project infrastructure resulting in harm to Project workers or the public; and
- damage to the Project infrastructure such that the well had to be temporarily abandoned in order to conduct repairs and/or damage resulting in repairs that cannot be technically or economically implemented.

In consideration of the above significance criteria, implementation of appropriate engineering, environmental design standards, and operational procedures; adherence to the *Offshore Physical Environment Guidelines*; and application of the assessment methods described in Section 6.2.3.9, the adverse residual effects of the physical environment on the Project are predicted to be not significant.

10.0 CUMULATIVE EFFECTS

In addition to assessing Project-specific environmental effects, section 19(1)(a) of CEAA, 2012 requires that the EA of a designated project consider "any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out".

This chapter of the EIS identifies past, present, and certain or reasonably foreseeable future physical activities (*i.e.*, projects or activities) with residual environmental effects that could interact cumulatively with the residual environmental effects of the Project, and assesses the significance of the associated potential cumulative environmental effects on the affected VCs.

10.1 CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT SCOPE AND METHODS

The CEA Agency's (2013b) Operational Policy Statement (OPS), *Assessing Cumulative Environmental Effects Under the Canadian Environmental Assessment Act, 2012* was taken into consideration during development of the cumulative environmental effects assessment (CEA) scope and methods for this EIS. This CEA builds on one conducted for the Shelburne Basin Venture Exploration Drilling Project (Stantec 2014a) which assessed cumulative effects within a similar RAA.

10.1.1 Scoping the Assessment

Scoping the assessment of cumulative environmental effects involves selecting the VCs on which to focus the assessment; defining the spatial and temporal boundaries of the assessment; identifying other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities in the RAA where residual environmental effects have potential to overlap spatially and temporally with those of the Project; and establishing criteria for determining the significance of residual cumulative environmental effects.

10.1.1.1 Valued Components

The assessment of cumulative environmental effects considers all six of the VCs for which Project-related environmental effects were assessed, as residual environmental effects were predicted for each VC (refer to Section 7). These six VCs are:

- Fish and Fish Habitat;
- Marine Mammals and Sea Turtles;
- Migratory Birds;
- Special Areas;

- Commercial Fisheries; and
- Current Aboriginal Use of Lands and Resources for Traditional Purposes.

10.1.1.2 Spatial and Temporal Boundaries

The OPS (CEA Agency 2013b) requires determination of spatial and temporal boundaries for the assessment of cumulative environmental effects. In particular, the OPS suggests that spatial boundaries encompass potential environmental effects on the selected VC of the designated project in combination with other physical activities that have been or will be carried out. Temporal boundaries should take into account future physical activities that are certain or reasonably foreseeable, and the degree to which potential environmental effects related to these physical activities will overlap those predicted from the designated project.

The specific spatial and temporal boundaries that are presented for each VC in the respective VC analysis chapter in Section 7 have also been applied to the assessment of cumulative environmental effects for each VC in Section 10.2, including the Project Area, LAA and RAA as illustrated on Figure 10.1.1. The definition of the RAA is particularly relevant with respect to the assessment of cumulative environmental effects and is therefore repeated here for ease of reference. The RAA is larger than the spatial boundaries for Project-related effects in order to encompass the other physical activities outside of the Project Area and LAA that have potential to interact cumulatively with the Project (refer to Section 10.1.1.3).

Regional Assessment Area (RAA): The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities and to provide regional context for the assessment. The RAA is 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 western extent of the RAA encompasses the Georges Bank Oil and Gas Moratorium Area and terminates at the international maritime boundary between Canada and the United States. The RAA is consistent for all VCs and is depicted on Figure 10.1.1.

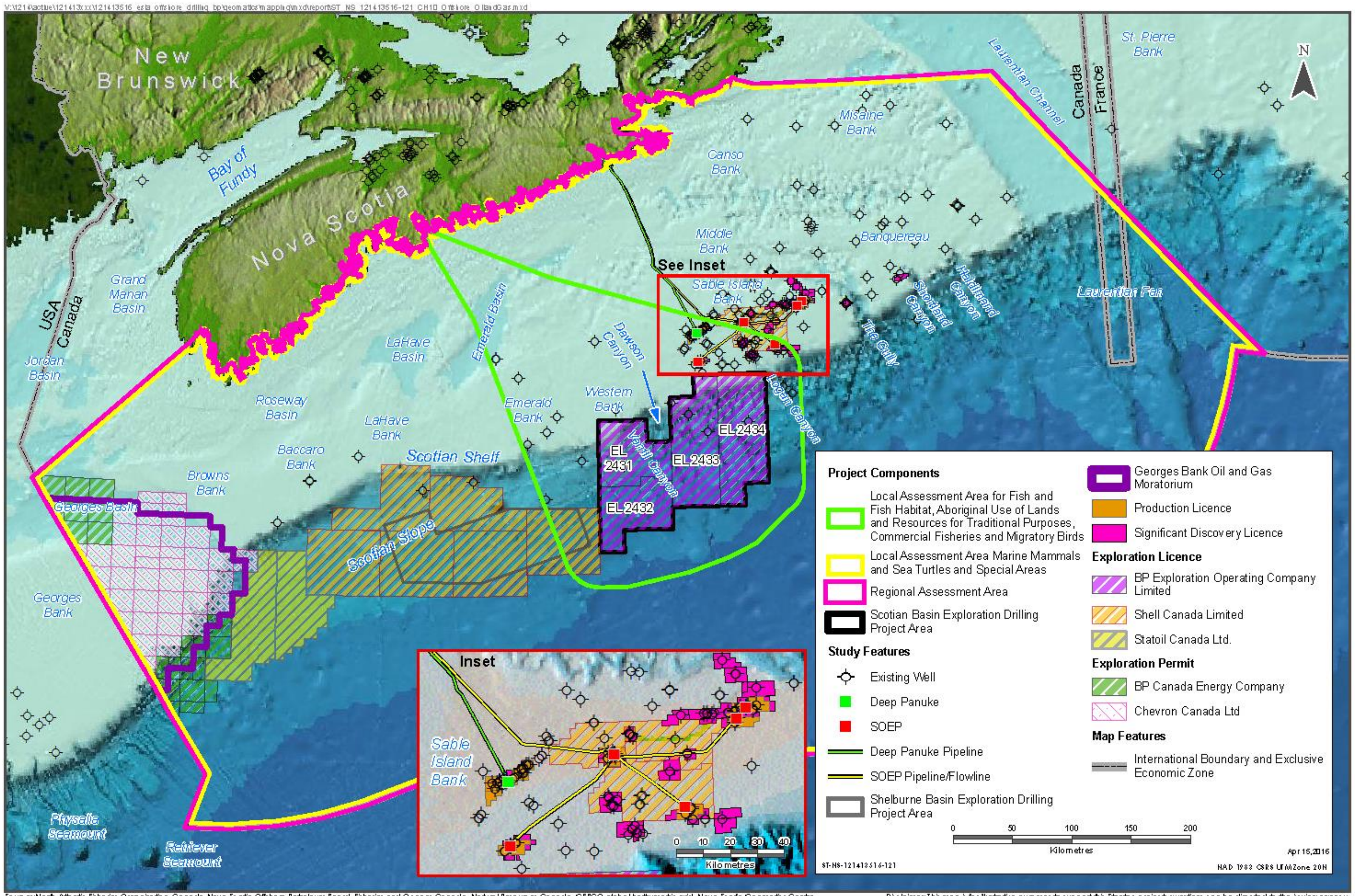

Figure 10.1.1 Other Physical Projects (Oil and Gas) Relative to the Project Area, LAA and RAA

10.1.1.3 Other Physical Activities

In accordance with the OPS (CEA Agency 2013a), the cumulative environmental effects assessment includes consideration of other physical activities that have been, are being, and will be carried out in the RAA. With respect to future physical activities that will be carried out, the assessment considers (CEA Agency 2013a):

- future physical activities that are certain (*i.e.*, the physical activity will proceed or there is a high probability that the physical activity will proceed – *e.g.*, the proponent has received the necessary authorizations or is in the process of obtaining those authorizations); and

- future physical activities that are reasonably foreseeable (*i.e.*, the physical activity is expected to proceed – *e.g.*, the proponent has publicly disclosed its intention to seek the necessary EA or other authorizations to proceed).

The following list identifies the past, present, and future (*i.e.*, certain or reasonably foreseeable) physical activities within the RAA that have potential to cause residual environmental effects that overlap spatially and temporally with the residual environmental effects of the Project.

- Offshore gas development projects on the Scotian Shelf (*i.e.*, SOEP and Deep Panuke);
- Offshore petroleum exploration projects (*e.g.*, Shelburne Basin Venture Exploration Drilling Project);
- Commercial, Aboriginal and recreational fisheries; and
- Other ocean uses, such as shipping, scientific research, and military activities.

The Cohasset-Panuke Project, Canada's first offshore oil project, operated from 1992 to 1999 on the Scotian Shelf in the vicinity of the current Deep Panuke Project (Production Licences 2901 and 2902). Decommissioning and environmental follow-up work was completed in 2009. Regulatory approval was granted to leave flowlines and subsea materials in place and a subsea survey inspection confirmed that the flowlines have become covered through self-burial. No significant adverse environmental effects (including socio-economic effects) were predicted to occur as a result of the decommissioning (CNSOPB 2004b). Given the lack of spatial and temporal overlap of residual effects with the Scotian Basin Exploration Drilling Project, the Cohasset-Panuke Project is not considered in this cumulative effects assessment.

BP's Tangier 3D Seismic Survey was conducted in 2014, with the survey area overlapping the current Project Area. However, this activity (and any other past seismic survey) is not included in this cumulative effects assessment since residual effects from seismic surveys are temporary and do not generally last beyond cessation of the survey. Therefore, while there would be some spatial overlap of residual effects with the current drilling Project, there is no temporal overlap of residual effects that would necessitate consideration in the cumulative effects assessment.

In recent years, the CNSOPB has issued an annual Call for Bids, which is a formal announcement that an exploration licence (EL) is available to be awarded through a competitive bidding process. Industry can submit work expenditure bids in a competitive bidding process, with the winner awarded the rights to the exploration licence. In advance of the Call for Bids, the CNSOPB prepares a Strategic Environmental Assessment (SEA) to inform the Call for Bids process in terms of potential environmental sensitivities and special mitigation measures (including avoidance) that may need to be taken into consideration. Shell and BP were awarded exploration rights through this process for the Shelburne Basin Venture and Scotian Basin Exploration Drilling Projects, respectively. The most recent Call for Bids closed in November 2015, with two ELs awarded to Statoil Canada Ltd. These ELs, located on the Scotian Slope between Shell's ELs and the Georges Bank Moratorium Area (refer to Figure 5.3.2), are active for a nine year term effective January 2016.

Although Statoil has not yet filed any applications for authorizations, its work expenditure bid of $82 million on the two ELs is a good indicator that future exploration activities (*e.g.*, seismic and exploration drilling) are likely to occur in the next nine years. Exploration activities proposed by Statoil would, however, require project-specific environmental assessment and authorization from the CNSOPB. Given the uncertainty of project-specific details at this time and relative distance to the Scotian Basin Exploration Drilling Project Area (225 km), Statoil exploration activities are not specifically considered in this CEA. However, exploration drilling activities described for the Shelburne Basin Venture Exploration Project (and resulting effects) are expected to be similar to drilling activities which might be proposed by Statoil.

The physical activities listed above are included in the scope of the cumulative environmental effects assessment, as applicable, with respect to each VC (*i.e.*, where there is potential for a residual environmental effect of the Project to interact cumulatively with a residual environmental effect of another physical activity on the VC; refer to Section 10.1.2.2).

10.1.2 Cumulative Environmental Effects Assessment Method

The CEA is carried out in three stages: (1) establishing context for the cumulative effects; (2) determining if Project-specific environmental effects interact in space and time with the environmental effects of other physical activities; and (3) assessing the cumulative environmental effects and the Project's contribution to them.

10.1.2.1 Establishing Context for Cumulative Environmental Effects

Existing environmental conditions for the marine physical environment, marine biological environment, and socio-economic environment in the RAA have been, and continue to be, shaped by the cumulative environmental effects of historical physical activities previously carried out in the RAA and ongoing physical activities currently being carried out in the RAA. Likewise, future physical activities in the RAA will influence future environmental conditions in the RAA. Section 5 describes existing conditions in the RAA to characterize the setting for the Project, support an understanding of the receiving environment, and provide sufficient context to enable an understanding of how current environmental conditions might be affected by the Project in combination with other past, present, and future physical activities within the RAA.

It is assumed that the existing status or baseline conditions of each VC reflect the influence of other past and present physical activities within the RAA. Section 10.2.1 provides a brief overview of how the environmental effects of various physical activities in the RAA have affected, are affecting, or are anticipated to affect each VC, independently of the residual environmental effects that will be contributed by the Project. This information establishes context to support the assessment of cumulative environmental effects.

10.1.2.2 Determination of Potential Cumulative Interactions

The following two considerations with respect to each VC are used as criteria to determine whether the Project has potential to interact with another physical activity to contribute to cumulative environmental effects:

1. Whether the Project could result in a demonstrable or measurable residual environmental effect on the VC; and
2. Whether the residual environmental effect of the Project is likely to act in a cumulative fashion with the residual environmental effect of another past, present, or future physical activity (*e.g.*, whether the residual environmental effects of the Project and the other physical activity are likely to overlap spatially and temporally).

An assessment of cumulative environmental effects is not warranted for any given VC unless both of the above criteria are satisfied.

10.1.2.3 Assessment of Cumulative Environmental Effects

When the two criteria in Section 10.1.2.2 above are met for a VC, the assessment of cumulative environmental effects considers how the residual environmental effects of the Project may contribute to changes to the VC from the residual environmental effects of other past, present, or future physical activities.

The potential for residual environmental effects from the Project to cause a change in cumulative environmental effects that could affect the quality or sustainability of the VC is evaluated. The evaluation considers the context for cumulative environmental effects in the RAA, the nature and extent of the potential cumulative interactions, and the planned implementation of mitigation.

Residual cumulative environmental effects are characterized through application of the specific analysis criteria (*i.e.*, magnitude, geographic extent, duration, frequency, reversibility, and context) defined for each VC in its respective VC analysis chapter in Section 7. The significance of potential cumulative environmental effects is then determined based on the same VC-specific thresholds used for the assessment of Project-related environmental effects in Section 7.

Following the determination of significance, follow-up and monitoring programs are recommended, where necessary, to verify cumulative environmental effects predictions or to assess the effectiveness of proposed mitigation measures.

10.2 CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT

10.2.1 Context for Cumulative Environmental Effects

This section provides a brief overview of how the residual environmental effects associated with other past, present, and future physical activities in the RAA have affected, are affecting, or are anticipated to affect each VC prior to any residual environmental effects that will be contributed by the Project.

10.2.1.1 Potential Residual Effects of Offshore Gas Development Projects in the RAA

Various offshore oil and gas activities have occurred in the RAA, including production of offshore oil and gas resources since 1992 (refer to Section 5.3.2.1). ExxonMobil's SOEP and Encana's Deep Panuke are the only offshore oil and gas projects presently operating in the RAA. SOEP has been producing natural gas since 1999 and was projected to have a total project life expectancy of approximately 25 years. ExxonMobil recently announced that they may begin plugging wells in 2017 and has commenced decommissioning studies (NEB 2015; Chronicle-Herald 2015).

Deep Panuke began producing natural gas in 2013 and at that time was anticipated to continue for a mean production life of 13 years (CNSOPB n.d. (a)). However, Encana recently decreased their reserve estimate and announced they were moving to a seasonal production, producing gas only in winter months when local prices are higher (NEB 2015). These ongoing offshore gas development projects comprise similar physical activities and components to the Project being assessed (albeit on a larger spatial and temporal scale) and are subject to the same overall regulatory framework established by the Accord Acts and regulations.

These ongoing offshore gas development projects have resulted or potentially will result in localized residual environmental effects. In particular, they have potential to cause a Change in Risk of Mortality and Physical Injury as well as a Change in Habitat Quality and Use affecting fish and fish habitat, marine mammals, sea turtles, and marine birds; a Change in Habitat Quality for Special Areas; a Change in Availability of Fisheries Resources affecting commercial fisheries; and a Change in Traditional Use affecting Aboriginal fisheries (refer to Table 10.2.1). These potential residual effects are localized in proximity to offshore gas development project activities and components. The nearest production platforms for SOEP and Deep Panuke are located approximately 11 km and 35 km from the LAA, respectively.

Table 10.2.1 Potential Residual Effects Associated with Offshore Gas Development Projects

Activities and Components Associated with Offshore Gas Development Projects	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
Presence and Operation of Offshore Gas Production Platforms and subsea pipelines	Fish and Fish Habitat	Change in Habitat Quality and Use	• Based on EA predictions for SOEP and Deep Panuke (MacLaren Plansearch 1996; Encana 2002; Encana 2006) the sound pressures levels (SPLs) generated by the production platforms operating in support of those offshore gas development projects are assumed to be considerably less than those generated by Project-related exploration drilling activities. Of more relevance would be the reef and refuge effect caused by the platforms and subsea pipelines attracting fish to an area that is protected from no fishing (safety [exclusion] zone), creating a localized Change in Habitat Quality and Use for fish.
	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use	• The SPLs generated by the production platforms and pipelines, as well as the reef and refuge effect realized by prey species could potentially cause a low magnitude and localized Change in Habitat Quality and Use for marine mammals and sea turtles.
	Migratory Birds	Change in Risk of Mortality or Physical Injury	• Nocturnally migrating birds may be attracted and/or disoriented by artificial night lighting on the SOEP and Deep Panuke platforms, thereby increasing their risk of injury or mortality. However, EEM data for these Projects indicate a very minor effect on migratory birds (ExxonMobil 2012; McGregor Geoscience Limited 2013).
	Special Areas	Change in Habitat Quality	• SOEP is located approximately 5 km from Sable Island and 36 km from the Gully. Deep Panuke is approximately 47 km from Sable Island and 114 km from the Gully. Neither development would likely be visible or audible from these Special Areas. Both Encana and SOEP have codes of practice to reduce effects on these Special Areas.
	Commercial Fisheries	Change in Availability of Fisheries Resources	• SOEP and Deep Panuke are situated in NAFO Division 4W. • Offshore gas development projects have localized effects on access to fisheries resources for commercial and Aboriginal fishers due to the establishment of 500-m radius safety (exclusion) zones around their production platforms. Commercial and Aboriginal
	Current Aboriginal Use of Lands and	Change in	

Table 10.2.1 Potential Residual Effects Associated with Offshore Gas Development Projects

Activities and Components Associated with Offshore Gas Development Projects	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
	Resources for Traditional Purposes	Traditional Use	fishing activity has been, and will continue to be, excluded within these safety (exclusion) zones for the duration of gas production from SOEP and Deep Panuke. • Offshore gas development projects also cause environmental effects on fish and fish habitat due to the generation of underwater sound and water quality effects associated with discharges. However, these environmental effects on fish and fish habitat are generally not expected to be of sufficient magnitude, duration, or extent to affect catch rates or otherwise cause a Change in Availability of Fisheries Resources for commercial fisheries or Change in Traditional Use for Aboriginal fisheries.
PSV Operations	Fish and Fish Habitat	Change in Habitat Quality and Use	• Based on EA predictions for SOEP and Deep Panuke (MacLaren Plansearch 1996; Encana 2002; Encana 2006) SPLs generated by the PSVs operating in support of those offshore gas development projects are assumed to be similar to or less than those generated by Project PSVs (*e.g.*, 189 dB re 1 µPa @ 1 m). These SPLs are high enough to cause a localized temporary Change in Habitat Quality and Use for fish within a limited area (refer to Section 7.1.1.2 for a summary of thresholds for physical and behavioural effects on fish).
	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• The SPLs are high enough to cause a localized temporary Change in Habitat Quality and Use for marine mammals and sea turtles. • The transiting of PSVs may also cause a Change in Risk of Mortality or Physical Injury for marine mammals and sea turtles due to potential vessel strikes.
	Migratory Birds	Change in Risk of Mortality or Physical Injury	• Nocturnally migrating birds may be attracted and/or disoriented by artificial night lighting on the SOEP and Deep Panuke PSVs, thereby increasing their risk of injury or mortality. • As indicated in Section 7, the oil and gas industry has adopted PSV and helicopter traffic restrictions around Sable Island which includes maintaining a 2 km buffer from Sable Island, except in the

Table 10.2.1 Potential Residual Effects Associated with Offshore Gas Development Projects

Activities and Components Associated with Offshore Gas Development Projects	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
			case of an emergency, to reduce the potential effects on migratory birds.
Operational Discharges	Fish and Fish Habitat Marine Mammals and Sea Turtles Migratory Birds	Change in Habitat Quality and Use	• Discharges from the SOEP and Deep Panuke production platforms and PSVs (*e.g.*, produced water, grey and black water, ballast water, bilge water, and deck drainage deck drainage) are discharged in accordance with the OWTG and MARPOL and are therefore unlikely to cause a Change in Risk of Mortality or Physical Injury for marine species. • Discharges may cause a Change in Habitat Quality and Use for fish, marine mammals, sea turtles, and migratory birds within a localized area around the PSVs and SOEP and Deep Panuke production platforms. EEM programs conducted for both projects have indicated localized minor effects on habitat quality (ExxonMobil 2012; McGregor Geoscience Limited 2013).
	Special Areas	Change in Habitat Quality	• Air quality monitoring results at the Sable Island monitoring station did not indicate adverse effects on air quality from the offshore oil and gas industry (Environment Canada 2012a, 2013a). • Sable Island provides a platform for beach surveys to monitor oil pollution in Scotian Shelf waters, with surveys dating back to the 1970s. A recent analysis of survey data indicates a declining trend in the oiling rate of beached birds on Sable Island with little indication of local oil pollution from offshore oil and gas projects (Lucas *et al.* 2012).
Helicopter Transportation	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use	• There is potential for helicopter traffic to elicit diving behaviour in marine mammals in response to physical presence or sound, although these behaviours will be temporary.
	Migratory Birds	Change in Risk of Mortality or Physical Injury	• Helicopter traffic may cause a localized Change in Risk of Mortality or Physical Injury for marine birds, due to potential bird strikes, as well as a Change in Habitat Quality and Use for migratory birds in

Table 10.2.1 Potential Residual Effects Associated with Offshore Gas Development Projects

Activities and Components Associated with Offshore Gas Development Projects	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
		Change in Habitat Quality and Use	proximity to the helicopter due to atmospheric sound emissions. • Although there is a helicopter landing pad and refuelling facility on Sable Island, it is only used occasionally by the offshore energy industry (Freedman 2014). As indicated in Section 7, the oil and gas industry has adopted PSV and helicopter traffic restrictions around Sable Island which includes maintaining a 2 km buffer from Sable Island, except in the case of an emergency, to reduce the potential effects on migratory birds on Sable Island.
	Special Areas	Change in Habitat Quality	
Decommissioning	Fish and Fish Habitat Marine Mammals and Sea Turtles Migratory Birds	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• Effects of future decommissioning will be similar to those generated by current operational activities, including lighting effects, ongoing vessel and helicopter traffic, underwater sound, and marine discharges. Depending on the nature of decommissioning activities proposed for SOEP and Deep Panuke (currently not known) and extent of removal of infrastructure on the seafloor, there may be more or less localized benthic disturbance. Effects are predicted to be localized although the duration and reversibility of effects will depend on specific decommissioning plans for these Projects.
	Special Areas	Change in Habitat Quality	
	Commercial Fisheries	Change in Availability of Fisheries Resources	
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	

10.2.1.2 Potential Residual Effects of the Shelburne Basin Venture Exploration Drilling Project

Shell commenced drilling their initial well (Cheshire) of the Shelburne Basin Venture Exploration Drilling Project on October 23, 2015. A second well (Monterey Jack) is planned to follow within the same drilling campaign with drilling predicted to continue through 2016. Depending on the results of these initial wells, Shell may drill up to five additional wells before 2019. Exploration drilling will be conducted using the Stena drillship *IceMax*. Proposed project components and activities are very similar to those proposed for the current Project. The Shelburne Basin Exploration Drilling Project Area is located directly adjacent (approximately 8 km distance) to the Scotian Basin Exploration Drilling Project Area.

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
Presence and Operation of MODU (including safety [exclusion] zone, underwater sound, and lights)	Fish and Fish Habitat	Change in Habitat Quality and Use Change in Risk or Mortality or Physical Injury	• The presence and operation of the MODU could potentially result in a Change in Habitat Quality and Use and a Change in Risk of Mortality or Physical Injury for marine fish, due to the generation of temporary, localized underwater sound during MODU operations, subsequently affecting the quality of the underwater acoustic environment within the Project Area.
	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• Sound pressure levels generated by the MODU are predicted to result in a Change in Habitat Quality and Use and a Change in Risk of Mortality or Physical Injury to marine mammals and sea turtles through behavioural responses, including localized avoidance and displacement.
	Migratory Birds	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• The presence and operation of the MODU is predicted to result in a Change in Habitat Quality for migratory birds due to the generation of drilling sound, lights, and flares. • Sound from the MODU may result in sensory disturbance of migratory birds locally, potentially leading to behavioral responses such as temporary habitat avoidance or changes in activity state. • Change in Risk of Mortality or Physical Injury may occur due to attraction of migratory birds to the MODU.
	Special Areas	Change in Habitat Quality and Use	• Within a localized area, the Scotian Slope EBSA could potentially experience a Change in Habitat Quality and Use from the presence and operation of the MODU and subsequent underwater sound emissions and lights.
	Commercial Fisheries	Change in Availability of Fisheries Resources	• A safety (exclusion) zone will be established around the MODU resulting in a fisheries exclusion of approximately 0.8 km^2 for a maximum of 130 days per well. • Underwater sound emissions will also be generated as a result of the presence of the MODU and its operations during drilling, testing
	Current Aboriginal Use	Change in	

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
	of Lands and Resources for Traditional Purposes	Traditional Use	and abandonment, which may cause fisheries species to temporarily avoid the immediate area surrounding the MODU, particularly during start-up of drilling.
Discharges of Drill Mud and Cuttings	Fish and Fish Habitat	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• The discharge of drill muds and cuttings is expected to result in a localized and temporary Change in Habitat Quality and Use and a Change in Risk of Mortality or Physical Injury for marine fish. • Thicknesses of cuttings piles greater than 10 mm were predicted to extend up to 155 m, with a maximum footprint of 1.89 ha per well. Thicknesses at or above 100 mm will be confined to a distance of 30 m from the wellhead, with a maximum footprint of 0.26 ha per well (Stantec 2014a) (thicknesses of approximately 10 mm or more, can potentially result in changes to the composition of the benthic macro fauna community (See Section 7.1.2)). • Habitat altered by the deposition of drill muds and cuttings will become available for use as fish habitat immediately following the completion of drilling operations, and is expected to be recolonized by benthic communities within approximately one to five years.
	Marine Mammals and Sea Turtles Migratory Birds Special Areas	Change in Habitat Quality and Use	• The discharge of mud and cuttings will be in accordance with the OWTG and OCSG. However, discharges of mud and cuttings will result in localized increases in TSS in the water column, temporarily affecting water quality in a portion of the Shelburne Project Area, potentially resulting in species avoidance.
	Commercial Fisheries	Change in Availability of Fisheries Resources	• The discharge of drill muds and cuttings may interact with fisheries species within a localized area as a result of sedimentation and localized changes in water quality, thereby affecting availability of fisheries resources and/or a change in traditional use for Aboriginal fisheries.

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	
Other Discharges and Emissions (including drilling and testing emissions)	Fish and Fish Habitat Marine Mammals and Sea Turtles	Change in Habitat Quality and Use	• Routine discharges will be in accordance with OWTG and MARPOL requirements and will be non-bio-accumulating, and non-toxic, resulting in localized and temporary effects in water quality. However, Changes in Habitat Quality and Use by fish and marine species is predicted to be not significant with adherence to standard practices and guidelines.
	Migratory Birds	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• The routine discharge of waste and emissions could possibly result in a Change in Habitat Quality and Use and a Change in Risk of Mortality or Physical Injury for migratory birds. Discharges from the MODU will be in accordance with OWTG and MARPOL requirements. • Discharges of sanitary and domestic waste may attract migratory birds and/or prey to the MODU, but non-hazardous waste will be macerated to maximum particle size (6 mm) and treated on board prior to disposal. • Gray water discharge may attract gulls and other species to the vicinity of the MODU, which may slightly increase the Risk of Mortality or Physical Injury of migratory bird species, particularly if they interact with a flare or become stranded on the MODU.
	Special Areas	Change in Habitat Quality and Use	• Discharges and emissions will be emitted into the Scotian Slope EBSA on a regular basis during the duration of the drilling program. However, it is predicted to result in a low magnitude Change in Habitat Quality and Use of the EBSA within the Shelburne Project Area.

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
	Commercial Fisheries	Change in Availability of Fisheries Resources	• Other discharges and emissions (including drilling and testing emissions) will result in temporary and localized effects on water quality around the wellsite in the Shelburne Project Area. • Discharges will be in accordance with the OWTG and are predicted to not adversely affect fish species in the Project Area or the LAA.
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	
VSP	Fish and Fish Habitat	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• VSP surveys could result in a Change in Habitat Quality and Use and a Change in Risk of Mortality or Physical Injury for marine fish (particularly fish eggs and larvae in close proximity to the air-gun array) due to predicted underwater sound emissions.
	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• Sound pressure levels from VSP are expected to result in a Change in Habitat Quality and Use and a Change in Risk of Mortality or Physical Injury to marine mammals and sea turtles. • This effect is predicted to be temporary (surveys are expected to take up to one day per well), and limited in geographic extent (horizontal distances for SPLs of ≤ 200 dB RMS re 1 µPa were predicted to extend up to 78 m from the wellsite during VSP surveys) (Stantec 2014a).
	Migratory Birds	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• Although migratory birds diving in close proximity to loud underwater sounds have the potential to be injured, VSP operations are not anticipated to have a measurable adverse effect on migratory bird mortality risk, given the short duration migratory birds spend underwater during foraging dives, and the short temporal scale of the VSP operations. • VSP operations could potentially result in a Change in Habitat Quality and Use for migratory birds. This change is predicted to be short-term (the VSP will take approximately one day per well), and

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
			reversible with no predicted lasting effects once VSP surveys are complete. • Although migratory birds diving in close proximity to loud underwater sounds have the potential to be injured, VSP operations are not anticipated to have a measurable adverse effect on migratory underwater during foraging dives, and the short temporal scale of the VSP operations.
	Special Areas	Change in Habitat Quality and Use	• VSP surveys could potentially result in a Change in Habitat Quality and Use, largely for marine mammals and sea turtles in the portion of the Scotian Slope EBSA that falls within the Shelburne LAA. • This change in habitat use would be short-term (the VSP will take approximately one day per well), and reversible, with no predicted lasting effects once VSP operations are complete.
	Commercial Fisheries	Change in Availability of Fisheries Resources	• The Shelburne Basin Venture Exploration Drilling EIS predicted that horizontal distances for SPLs of ≤ 160 dB RMS re 1 µPa could extend up to 26 km from the wellsite during VSP surveys (Stantec 2014a). • As noted in Section 7.1.4, startle and alarm responses in fish have been observed at SPLs as low as 156–161 dB re 1 µPa, as such, behavioral responses in fish could occur up to approximately 26 km from the VSP sound source, thereby potentially resulting in a Change in Availability of Fisheries Resources and a Change in Traditional Use. • There are no important spawning areas or unique fishing grounds within 26 km of the Shelburne Project Area.
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
Helicopter Transportation	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use	• Helicopter traffic may cause a Change in Habitat Quality and Use for marine mammals and sea turtles as it may elicit diving behavior as a response mechanism to the physical presence or atmospheric sound created by helicopter traffic. However, these behaviors are predicted to be temporary in nature as any effects from the presence of helicopters will be brief in both space and time.
	Migratory Birds	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• Helicopter traffic may cause a localized Change in Habitat Quality and Use and a Change in Risk of Mortality or Physical Injury for migratory birds, due to potential bird strikes, and atmospheric sound emissions. • To reduce the potential effects on migratory birds, Shell will implement PSV and helicopter traffic restrictions around Sable Island, including maintaining a 2 km buffer from Sable Island, except in the case of an emergency.
	Special Areas	Change in Habitat Quality and Use	• Special Areas could potentially experience effects from the presence and operation of helicopter transportation for the Shelburne Basin Venture Exploration Drilling project. • Helicopter transportation is predicted to have any no substantial interaction with Special Areas, as operators will adhere to the standard code of practice and restrictions for offshore helicopter transportation.
PSV Operations	Fish and Fish Habitat	Change in Habitat Quality and Use	• Operation of PSVs could result in short-term, localized Change in Habitat Quality and Use for marine fish, due to increased vessel traffic within the Project Area and LAA, and subsequent increased underwater sound emissions.
	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use Change in Risk of	• Underwater sounds associated with PSV traffic could result in a Change in Habitat Quality and Use by marine mammals and sea turtles as predicted levels of SPLs generated by the PSV are high

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
		Mortality or Physical Injury	enough to cause changes in swimming, foraging, or vocal behaviours. • The presence and operation of PSVs will also result in an increase in marine traffic within the LAA, potentially resulting in a Change in Risk of Mortality or Physical Injury due to potential for vessel collisions with marine mammals and sea turtles. • Shell is implementing mitigation measures to reduce adverse effects including a limitation on PSV transit speed and avoidance of the Roseway Basin, the Gully, and Shortland and Haldimand Canyons.
	Migratory Birds	Change in Habitat Quality and Use Change in Risk of Mortality or Physical Injury	• PSV activities could potentially result in a Change in Habitat Quality and Use with regard to migratory birds, as the presence of an approaching PSV may alert birds and flush some species from the area. However, PSVs will not come in close proximity to any critical habitat for migratory birds (*i.e.*, Piping Plover or Roseate Tern), or IBAs. • In addition, increased artificial lighting during transiting and operations of the PSVs may present a mortality risk to migratory birds.
	Special Areas	Change in Habitat Quality and Use	• The distance of the Shelburne Project Area (which is approximately 8 km west of the Scotian Basin Project Area) from other Special Areas as well as adherence to standard avoidance mitigation practices will reduce the likelihood of any interaction with Special Areas.
	Commercial Fisheries	Change in Availability of Fisheries Resources	• Environmental effects on fish attributable to PSV traffic and operations would represent a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the RAA.

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	• PSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour, and will adhere to standard navigation procedures, thereby avoiding potential conflicts with commercial, Aboriginal FSC or communal commercial fisheries.
Well Abandonment	Fish and Fish Habitat	Change in Habitat Quality and Use	• Well abandonment could potentially result in a Change in Habitat Quality and Use for marine fish. • Due to the localized nature of well abandonment, it is expected that fish would avoid the immediate area where the mechanical separation activities are taking place. If the wellhead is kept in place, it is expected to be colonized by benthic epifauna.
	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use	• The mechanical separation of the wellhead from the seabed will not produce excess sound or discharge; however, it is likely that marine mammals and sea turtles may temporarily avoid the immediate area during this undertaking.
	Special Areas	Change in Habitat Quality and Use	• Well abandonment is expected to occur via mechanical separation and will have little interaction with the Scotian Slope EBSA outside the immediate vicinity of the wellhead. • This activity will not produce excess sound or discharge, and blasting will not be required. As a result, the residual environmental effects of well abandonment on Special Areas are predicted to be not significant.
	Commercial Fisheries	Change in Availability of Fisheries Resources	• Abandonment of wells could potentially interact with commercial or Aboriginal fishing activity in the Project Area, either through a change in fish habitat or temporary underwater sounds.

Table 10.2.2 Potential Residual Effects Associated with the Shelburne Basin Venture Exploration Drilling Project

Activities and Components Associated with Shelburne Basin Venture Exploration Drilling	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	• Wells will be abandoned in accordance with CNSOPB requirements and will take approximately 7–10 days. • If wellheads are kept in place, they will be mapped on marine charts and are not expected to affect fisheries activities.

10.2.1.3 Potential Residual Effects of Fisheries in the RAA

Fishing is the main socio-economic activity regularly occurring in the RAA potentially affecting all of the selected VCs. As summarized in Sections 5.3.3 and 5.3.4, a diverse range of species is targeted by fisheries in the RAA, including groundfish (*e.g.*, cod, haddock, pollock, flatfishes), small pelagic fishes (*e.g.*, herring, mackerel), large pelagic fishes (*e.g.*, tuna, sharks, swordfish) and invertebrates (*e.g.*, lobster, crab, shrimp, scallop). The different types of gear employed in fisheries in the RAA include otter trawl, seine, longline, gillnet, handline, dredge, weir, traps and pots, and harpoon (Burbridge 2011).

Past and present fishing activities in the RAA have potential to cause a Change in Habitat Quality and Use, and Change in Risk of Mortality or Physical Injury affecting fish and fish habitat, marine mammals and sea turtles, and migratory birds; a Change in Habitat Quality and Use affecting Special Areas; a Change in Availability of Fisheries Resources affecting other commercial fishers; and a Change in Traditional Use affecting other Aboriginal fishers (refer to Table 10.2.3). These potential residual effects are localized in proximity to activities and components associated with fisheries.

Table 10.2.3 Potential Residual Effects Associated with Fisheries

Activities and Components Associated with Fisheries	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
Use of Mobile Bottom-Contact Fishing Gear	Fish and Fish Habitat	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Commercial, recreational, and Aboriginal fisheries within the RAA cause a direct Change in Risk of Mortality or Physical Injury for targeted fish species as well as any non-targeted fish species that may be taken as bycatch. The use of mobile bottom-contact fishing gear that is dragged along the seafloor (*e.g.*, trawlers) for certain commercial groundfish fisheries can remove plants, corals, and sessile food items; overturn rocks; level rock outcrops; crush, bury, or expose benthic organisms; and re-suspend sediments, thereby causing a Change in Habitat Quality and Use and Change in Risk of Mortality or Physical Injury for marine benthos.
	Special Areas	Change in Habitat Quality and Use	• Certain Special Areas are subject to fishing closures or gear restrictions (refer to Table 5.2.18), including the Haddock Box and Emerald Basin and Sambro Bank Sponge Conservation Areas. The Haddock Box is closed to commercial groundfish fisheries and the Emerald Bank and Sambro Bank Sponge Conservation Areas are closed to bottom-contact fishing gear. • Given that the Scotian Slope EBSA is not currently subject to any fishing closures or gear restrictions, the use of mobile bottom-contact fishing gear has potential to cause a Change in Habitat Quality and Use in that Special Area, which is partially located within the Project Area.
Use of Gillnet, Trawl, Seines, Longline Gear	Fish and Fish Habitat Marine Mammals and Sea Turtles Migratory Birds	Change in Risk of Mortality or Physical Injury	• Marine fish can experience a Change in Risk of Mortality or Physical Injury as they are targeted for fisheries, or caught as bycatch. • Entanglement in fishing gear is one of the primary threats for marine mammals in Atlantic Canada waters, including the endangered North Atlantic right whale and leatherback sea turtle (DFO 2014c, 2015o), resulting in a Change in Risk of Mortality or Physical Injury. • Migratory birds, particularly seabirds, can become entangled in fishing gear and potentially drown, thereby resulting in a Change in Risk of Mortality or Physical Injury.

Table 10.2.3 Potential Residual Effects Associated with Fisheries

Activities and Components Associated with Fisheries	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
Vessel Operations	Fish and Fish Habitat Marine Mammals and Sea Turtles Migratory Birds	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Fishing vessels may cause a localized Change in Habitat Quality and Use for fish, marine mammals, and sea turtles through the generation of underwater sound from engines and propellers during transiting. • Although SPLs produced during the transiting of fishing vessels are below the thresholds for physical injury to marine species, SPLs of other third party physical activities that may be carried out by fishing vessels (*e.g.*, depth sounding, bottom profiling, and side scan sonar) are high enough to cause injury or mortality to fish at close ranges. • The transiting of fishing vessels may cause a Change in Risk of Mortality or Physical Injury for marine mammals and sea turtles due to potential vessel strikes. • Atmospheric or underwater sound associated with fisheries vessels has potential to cause a localized Change in Habitat Quality and Use that could result in sensory disturbance of migratory birds. Any vessels that employ artificial night lighting may also attract and/or disorient nocturnally migrating birds and cause an associated Change in Risk of Mortality or Physical Injury.
	Special Areas	Change in Habitat Quality and Use	• Fishing vessels may be present in certain Special Areas (including the Scotian Slope EBSA, Haddock Box, and Emerald Basin and Sambro Bank Sponge Conservation Areas), thereby potentially causing a localized Change in Habitat Quality and Use in Special Areas through the generation of underwater sound levels from engines and propellers during transiting, as well as from other physical activities that may be carried out by fishing vessels (*e.g.*, depth sounding, bottom profiling, and side scan sonar).
Operational Discharges	Fish and Fish Habitat Marine Mammals and Sea Turtles Marine Birds Special Areas	Change in Habitat Quality and Use	• Discharges from fishing vessels (*e.g.*, grey and black water, ballast water, bilge water, and deck drainage) will be discharged in accordance with MARPOL and are therefore unlikely to cause a Change in Risk of Mortality or Physical Injury for marine species. • Discharges may cause a Change in Habitat Quality and Use for fish, marine mammals, sea turtles, and migratory birds within a localized area around fishing

Table 10.2.3 Potential Residual Effects Associated with Fisheries

Activities and Components Associated with Fisheries	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
			vessels. • Depending on the location of the fishing vessel at the time that the discharge is made, this Change in Habitat Quality and Use has potential to occur in a Special Area.
Fishing Activity	Commercial Fisheries	Change in Availability of Fisheries Resources	• Fisheries can occur in any NAFO Division and Unit Area in the RAA and have potential to cause a Change in Availability of Fisheries Resources for competing commercial fisheries in the RAA or Change in Traditional Use for Aboriginal fisheries in the RAA (*e.g.*, through displacement of competitors from their preferred fishing grounds). • If fisheries resources are not harvested sustainably, the residual environmental effects of present fishing activity in the RAA could cause a Change in Availability of Fisheries Resources and Change in Traditional Use for future commercial and Aboriginal fishers due to decreased catch rate as well as resource depletion. • Fisheries also cause localized environmental effects on fish and fish habitat due to the generation of underwater sound and water quality effects associated with discharges. However, these environmental effects on fish and fish habitat are generally not expected to be of sufficient magnitude, duration, or extent to affect catch rate or otherwise cause a Change in Availability of Fisheries Resources for commercial fisheries or Change in Traditional Use Aboriginal fisheries.
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	

10.2.1.4 Potential Residual Effects of Other Ocean Users in the RAA

As summarized in Section 5.3.2, various other ocean users have been, and continue to be, active throughout the RAA, including shipping, scientific research, and military activities. The past and present activities of other ocean users in the RAA have potential to cause a Change in Habitat Quality and Change in Risk of Mortality or Physical Injury affecting fish and fish habitat, marine mammals and sea turtles, and migratory birds; a Change in Habitat Quality and Use affecting Special Areas; a Change in Availability of Fisheries Resources affecting commercial fishers; and a Change in Traditional Use affecting Aboriginal fishers (refer to Table 10.2.4). These potential residual effects are localized in proximity to activities and components associated with other ocean users.

Table 10.2.4 Potential Residual Effects Associated with Other Ocean Users

Activities and Components Associated with Other Ocean Users	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
Vessel Operations	Fish and Fish Habitat Marine Mammals and Sea Turtles Migratory Birds	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Other ocean users in the RAA can cause a Change in Risk of Mortality or Physical Injury and a Change in Habitat Quality and Use for fish, marine mammals, and sea turtles through the generation of underwater sound. • Although the SPLs produced by the types of vessels most commonly used by other ocean users are generally below the thresholds for physical injury to marine species, the SPLs of other physical activities that may be carried out by these ocean users (*e.g.*, naval sonar) are high enough to cause injury or mortality to some marine species in certain circumstances. • Atmospheric and/or underwater sound associated with other ocean users' vessels have potential to cause a localized Change in Habitat Quality and Use that could result in sensory disturbance of migratory birds. Vessels that employ artificial night lighting may also attract and/or disorient nocturnally migrating birds and cause an associated Change in Risk of Mortality or Physical Injury. • The transiting of vessels by other ocean users can cause a Change in Risk of Mortality or Physical Injury for marine mammals and sea turtles due to potential vessel strikes.
	Special Areas	Change in Habitat Quality and Use	• The vessels of other ocean users can cause a Change in Habitat Quality and Use in Special Areas, including the Scotian Slope EBSA and Haddock Box due to the generation of underwater sound emissions.
	Commercial Fisheries	Change in Availability of Fisheries Resources	• Other ocean users can occur in any NAFO Division and Unit Area in the RAA and have potential to cause a Change in Availability of Fisheries Resources for commercial fisheries and a Change in Traditional Use for Aboriginal fisheries through temporary displacement of commercial and Aboriginal fishing activity (due to vessel presence) or damage to fishing gear. • Other ocean users also cause localized environmental effects on fish and fish habitat due to the generation of underwater sound and water quality effects associated with discharges. However, these environmental effects on fish and fish habitat are generally not expected to be of sufficient magnitude, duration, or extent to affect catch rate or otherwise cause a Change in Availability of
	Current Aboriginal Use of Lands and Resources for Traditional Purposes	Change in Traditional Use	

Table 10.2.4 Potential Residual Effects Associated with Other Ocean Users

Activities and Components Associated with Other Ocean Users	VCs Affected	Residual Environmental Effects	Explanation of Residual Environmental Effects
			Fisheries Resources for commercial fisheries or a Change in Traditional Use for Aboriginal fisheries.
Helicopter Transportation	Marine Mammals and Sea Turtles	Change in Habitat Quality and Use	• There is potential for helicopter traffic to elicit diving behaviour in marine mammals in response to physical presence or sound, although these behaviours will be temporary. Helicopter traffic associated with other ocean users (where applicable) may therefore result in a temporary Change in Habitat Quality and Use for marine mammals.
	Marine Birds	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Helicopter traffic may also cause a Change in Risk of Mortality or Physical Injury for migratory birds, due to potential bird strikes, as well as a Change in Habitat Quality and Use for migratory birds due to atmospheric sound emissions.
	Special Areas	Change in Habitat Quality and Use	• Helicopter traffic could potentially cause a Change in Habitat Quality and Use for Special Areas such as Sable Island National Park Reserve.
Operational Discharges	Fish and Fish Habitat Marine Mammals and Sea Turtles Marine Birds Special Areas	Change in Habitat Quality and Use	• Discharges from the vessels of other ocean users (*e.g.*, grey and black water, ballast water, bilge water, and deck drainage) will be discharged in accordance with MARPOL and are therefore unlikely to cause a Change in Risk of Mortality or Physical Injury for marine species. • Discharges may cause a Change in Habitat Quality and Use for fish, marine mammals, sea turtles, and marine birds within a localized area around the vessels of other ocean users. • Depending on the location of the vessel at the time that the discharge is made, this Change in Habitat Quality and Use has potential to occur in a Special Area.

10.2.2 Potential Cumulative Interactions between the Project and Past/Present/Future Activities

The residual environmental effects of the Project on each VC (*i.e.*, Fish and Fish Habitat, Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries, and Current Aboriginal Use of Lands and Resources for Traditional Purposes) could overlap temporally with the residual environmental effects of each of the past, present, and future physical activities identified in Section 10.1.1.3.

The residual environmental effects of routine Project activities on each VC will be spatially limited to the Project Area and LAA. An assessment of cumulative interactions as a result of accidental events is presented in Section 10.2.9. Key spatial considerations for the cumulative effects assessment focusing on routine Project activities are provided in the following:

- With the exception of PSV transit, the residual environmental effects of the Project will not overlap spatially with the residual environmental effects of offshore gas development projects on any VC as the nearest production platforms for SOEP and Deep Panuke are located approximately 11 km and 35 km from the LAA, respectively. The supply base for the Project is at the same location in Halifax Harbour as is being used for SOEP and Deep Panuke; therefore, there could be a cumulative increase in vessel traffic as the PSVs approach Halifax Harbour. However, the incremental addition of PSVs from the Project would result in a low increase in risk of adverse effects to the following VCs: Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries, and Current Aboriginal Use of Lands and Resources for Traditional Purposes.

  Although there is little spatial overlap between the residual environmental effects of the Project and the residual environmental effects of offshore gas development projects (limited to nearshore PSV traffic), certain VCs may nonetheless be affected by sequential exposure to the residual environmental effects of the Project, SOEP, and Deep Panuke. The life cycles of several species of fish, marine mammals, sea turtles, and migratory birds include long-distance movement within the RAA (refer to Section 5.2), and there is potential for individuals of these species to be affected by the combined residual environmental effects of the Project and offshore gas development projects (*i.e.*, the same individuals may be exposed to the residual environmental effects of multiple physical activities during the course of their migrations within the RAA). Similarly, because the customary or traditional fishing grounds of any given commercial or Aboriginal fisher may encompass a broad area or include multiple areas, there is potential for some fishers to be adversely affected by the combined residual environmental effects of the Project and fisheries and other ocean users (*i.e.*, the same fishers may be exposed to the residual environmental effects of multiple physical activities during the course of their harvesting activities within the RAA).

- The residual environmental effects of the Project could potentially overlap spatially and/or temporally with the residual environmental effects of the Shelburne Basin Venture Exploration Drilling Project on every VC. The Scotian Basin Exploration Drilling Project Area is directly adjacent (approximately 8 km at the closest point) to the Shelburne Basin Venture Exploration Drilling Project Area; the LAAs for the two projects overlap offshore as well as nearshore in terms of PSV transit to the supply base in Halifax Harbour. Both projects are predicted to have similar types and magnitudes of environmental effects.

- The residual environmental effects of the Project could overlap spatially with the residual environmental effects of fisheries (commercial and Aboriginal) and other ocean users on every VC. In particular, both the Project and vessels associated with fisheries and other ocean user activities would have routine discharges to the marine environment. With respect to the Project's drilling discharges, the majority of Project-related discharges of drill muds and cuttings is expected to remain confined to an area within 563 m of the release site (refer to Appendix C) and it is anticipated that any potential smothering of marine benthos will be primarily limited to within 116 m (based on an average burial depth of 9.6 mm, cited in Neff *et al.* 2004). Sediment dispersion and deposition resulting from discharges of drill muds and cuttings of 0.1 mm thickness are predicted to extend up to 1,367 m from the release site and may therefore affect benthic species, as well as water and sediment quality, to varying degrees, for fish, marine mammals, sea turtles, and marine birds within that radius. Drill muds and cuttings will be discharged within the Project Area, which overlaps with the Scotian Slope EBSA.

- The life cycles of several species of fish, marine mammals, sea turtles, and migratory birds include long-distance movement within the RAA (refer to Section 5.2), and there is potential for individuals of these species to be affected by the combined residual environmental effects of the Project and fisheries and other ocean users (*i.e.*, the same individuals may be exposed to the residual environmental effects of multiple physical activities during the course of their migrations within the RAA). Similarly, because the customary or traditional fishing grounds of any given commercial or Aboriginal fisher may encompass a broad area or include multiple areas, there is potential for some fishers to be adversely affected by the combined residual environmental effects of the Project and fisheries and other ocean users (*i.e.*, the same fishers may be exposed to the residual environmental effects of multiple physical activities during the course of their harvesting activities within the RAA).

Table 10.2.5 applies the criteria from Section 10.1.2.2 to determine whether further assessment of cumulative environmental effects is warranted for each VC, and indicates where the residual effects of the Project may overlap and interact cumulatively with the environmental effects of other third party physical activities in the RAA. The potential cumulative environmental effects identified in Table 10.2.5 are assessed in Section 10.2.3.

Table 10.2.5 Cumulative Interactions between the Residual Effects of the Project and the Residual Effects of Other Physical Activities on Each VC

Environmental Effect	Potential Cumulative Environmental Effects*			
	Offshore Gas Development Projects	Shelburne Basin Exploration Drilling Project	Fisheries	Other Ocean Users
Fish and Fish Habitat				
Change in Risk of Mortality or Physical Injury	-	✓	✓	✓
Change in Habitat Quality and Use	✓	✓	✓	✓
Marine Mammals and Sea Turtles				
Change in Risk of Mortality or Physical Injury	✓	✓	✓	✓
Change in Habitat Quality and Use	✓	✓	✓	✓
Migratory Birds				
Change in Risk of Mortality or Physical Injury	✓	✓	✓	✓
Change in Habitat Quality and Use	✓	✓	✓	✓
Special Areas				
Change in Habitat Quality and Use	-	✓	✓	✓
Commercial Fisheries				
Change in Availability of Fisheries Resources	✓	✓	✓	✓
Current Aboriginal Use of Lands and Resources for Traditional Purposes				
Change in Traditional Use	✓	✓	✓	✓

Note:

* The "✓" indicates that <u>both</u> of the following criteria are satisfied and that further assessment of potential cumulative environmental effects is warranted:

1) The Project could result in a demonstrable or measurable residual environmental effect on the VC.
2) The residual environmental effect of the Project is likely to act in a cumulative fashion with the residual environmental effect of the other physical activity (*i.e.*, the residual environmental effects of the Project and the other physical activity are likely to overlap).

The "**-**"indicates that the above criteria are not satisfied and that no further assessment of potential cumulative environmental effects is warranted. Where applicable, an explanation is provided in the right-most column of the table.

As indicated in Table 10.2.5, there are no predicted interactions between residual effects of the Project and residual effects of offshore gas development projects that would be expected to result in a cumulative Change in Risk of Mortality or Physical Injury for Fish and Fish Habitat or a Change in Habitat Quality and Use for Special Areas.

The nearest production platforms for SOEP and Deep Panuke are located approximately 35 and 11 km from the Project Area, respectively. The underwater SPLs produced by offshore gas development projects are at levels that would not cause a Change in Risk of Mortality or Physical Injury for fish or their eggs/larvae. Additionally, discharges from the Project and offshore gas development projects will comply with the requirements of OWTG and MARPOL, and will rapidly become highly diluted in the open ocean at levels that are unlikely to cause mortality to fish species.

With respect to a cumulative effect on Special Areas, Project activities and components could result in residual environmental effects on the Scotian Slope EBSA (which is partially located with the Project Area), the Haddock Box and Emerald Basin and Sambro Bank Sponge Conservation Areas (areas crossed by the LAA portion surrounding the PSV route to Halifax Harbour), as well as potentially the Gully and Shortland Canyon (elevated underwater sound levels predicted in winter conditions). The results of EEM studies completed to date for SOEP and Deep Panuke have not identified any apparent residual environmental effects on habitat quality and use in the Haddock Box, Sable Island National Park Reserve, the Scotian Slope EBSA, or any other designated Special Area (ExxonMobil 2012; McGregor Geoscience Limited 2013). The potential Change in Risk of Mortality or Physical Injury for migratory birds nesting in the Sable Island National Park Reserve and associated Sable Island IBA (due to potential attraction to SOEP platforms and subsequent collision or stranding) is considered in the context of the Migratory Birds (Section 10.2.5).

10.2.3 Assessment of Cumulative Environmental Effects on Fish and Fish Habitat

This section assesses the potential cumulative Change in Habitat Quality and Use and the potential cumulative Change in Risk of Mortality or Physical Injury for Fish and Fish Habitat that may be caused by the residual environmental effects of the Project in combination with the residual environmental effects of other past, present, and future physical activities in the RAA.

10.2.3.1 Cumulative Change in Risk of Mortality or Physical Injury

Some of the underwater sound emissions generated by the Shelburne Basin Venture Exploration Drilling Project, fisheries, and other ocean users during vessel transiting and other activities (*e.g.*, depth sounding, bottom profiling, naval or side scan sonar, airgun arrays) generate SPLs that may be harmful to fish at close ranges (refer to Table 5.1.15 in Section 5.1.3.6). SPLs generated by VSP operations, which may be conducted for the Shelburne Basin Venture Exploration Drilling Project as well as this Project, will generate sound levels that may result in physical damage to fish at very close proximity to the sound source. However, the possibility of cumulative interaction is uncertain, though unlikely, given the infrequent nature and short duration (*e.g.*, approximately one day per well) of VSP operations, and which may not be completed for each well for either drilling project.

With respect to other third party physical activities in the RAA that generate underwater SPLs that may cause a Change in Risk of Mortality or Physical Injury, it is expected that the presence of an approaching vessel or drilling activity will locally displace some species from the area around operating VSP, seismic, sounding, profiling, or sonar sound sources before they are exposed to high SPLs in close proximity to those sound sources, and that most species will respond behaviourally to avoid underwater sound at lower levels than those at which injury or mortality might occur. The implementation of ramp-up procedures of the VSP source array in accordance with the SOCP will mitigate potential underwater sound effects on fish, marine mammals, sea turtles, and diving birds in close proximity to Project and non-Project seismic sources.

The SPLs produced by BP's and Shell's proposed VSP operations are each high enough to cause a potential cumulative Change in Risk of Mortality or Physical Injury to fish eggs/larvae within a few metres of the respective seismic source, although this would be expected to be in the range of natural variability (not affecting population viability). Fish eggs/larvae are immotile and are therefore more susceptible to harm in close proximity to these sound sources than other life stages of fish; however, the sound sources themselves are far enough apart that, even if there was some temporal overlap of activities, there will be no spatial overlap (based on predicted propagation of underwater sound levels) of residual environmental effects on fish eggs/larvae. The establishment of a 500-m radius safety (exclusion) zone around the MODU within which non-Project activities are excluded, will further reduce potential cumulative interactions between underwater sound emissions from Project-related VSP operations and from other third party physical activities generating high SPLs in the RAA, as well as prevent the spatial overlap of residual environmental effects on fish eggs/larvae.

The deposition of Project-related drill muds and cuttings may smother marine benthos within a 116 m radius of the wellhead. Sediment (drill waste) dispersion modelling conducted for the Shelburne Basin Venture Exploration Drilling Project predicted a 155 m radius for benthic smothering. These affected areas from both drilling projects will not likely overlap spatially, but could result in additive effects for benthic species on the Scotian Slope, thereby potentially contributing to a cumulative Change in Risk of Mortality or Physical Injury.

The Change in Risk of Mortality or Physical Injury predicted for the Project could also combine with the harmful effects that groundfishing can have on benthic organisms, resulting in adverse cumulative effects. However, the Project Area is not subject to a high level of groundfishing pressure and groundfishing is unlikely to take place in proximity to the MODU during Project activities. Potential cumulative environmental interactions between the Project and groundfisheries will be further limited by the presence of the 500-m radius safety (exclusion) zone excluding other third party physical activities, as well as the highly localized nature of the deposition of drilling muds and cuttings around the wellsite. The residual effects of Project-related drill muds and cuttings discharged inside the safety (exclusion) zone are unlikely to contribute to the residual effects of groundfishing outside of the safety (exclusion) zone.

A cumulative Change in Risk of Mortality or Physical Injury associated with underwater sound is also considered unlikely to occur as a result of the varying spatial and temporal scale of VSP operations. The cumulative Change in Risk of Mortality or Physical Injury associated with the deposition of Project-related drill muds and cuttings is predicted to be primarily limited to the wellsite and Project Area and to be short-term in duration.

The residual cumulative Change in Risk of Mortality or Physical Injury for Fish and Fish Habitat is generally predicted to be adverse, low in magnitude, occur within the LAA, sporadic to regular in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effect of a Change in Risk of Mortality or Physical Injury for Fish and Fish Habitat is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.3.2 Cumulative Change in Habitat Quality and Use

Although routine discharges and underwater sound emissions from the Project are not likely to be detected outside the LAA, for species whose ranges cover a large extent of the RAA, individuals may be exposed to discharges from one or more physical activities, as well as various sources of underwater sound, throughout their life cycle. The Project will introduce an additional source of discharges and underwater sound that these individuals have potential to encounter. Fish and other marine wildlife may temporarily avoid localized areas subject to degraded water quality and/or underwater sound. The cumulative environmental effects of the Project in combination with other physical activities may therefore include a temporary reduction in the amount of habitat available within the RAA (*i.e.*, due to temporary avoidance of multiple areas at once). This cumulative Change in Habitat Quality and Use has potential to disrupt reproductive, foraging and feeding, and/or migratory behaviour if the availability of important habitat areas, including designated Special Areas (*e.g.*, Haddock Box), is affected; however, this is not expected to occur for the reasons provided below.

It is anticipated that routine discharges from the Project and from other third party physical activities will be in compliance with the requirements of OWTG and/or MARPOL (as applicable), at levels that are intended to be prevent damage of the marine environment, including fish and fish habitats.

Routine discharges are predicted to disperse quickly, causing only localized effects in water quality around the source. Given that the concentrations of individual discharges are expected to be rapidly diluted in the open ocean, and given the distances between the Project and other third party physical activities occurring in the offshore (including the exclusion of fisheries and other users within a 500-m radius safety (exclusion) zone surrounding the MODU), Project-related discharges are unlikely to mix or combine with discharges from other physical activities from third parties. Routine discharges from the Project and other third party physical activities are therefore not expected cause a substantial cumulative Change in Habitat Quality and Use.

Although drill waste dispersion modelling results indicate that dispersed sediment from Project-related discharge of drill muds and cuttings may extend up to a maximum distance of 1,367 m from the release site (at a deposition thickness of 0.1 mm), the thickness of sediment discharge which could potentially result in benthic smothering is predicted to be confined to an area within 116 m of the release site (refer to Appendix C). This spatial extent is well within the 500-m radius safety (exclusion) zone around the MODU within which other third party physical activities are excluded, thereby limiting potential cumulative interactions between Project-related drill muds and cuttings discharged inside the safety (exclusion) zone and discharges from other third party physical activities outside the safety (exclusion) zone. It is expected that Project-related discharges of drill muds and cuttings will be at such low water column concentrations outside of the 500-m radius safety (exclusion) zone that any potential cumulative Change in Habitat Quality and Use caused by interaction with the discharges of other physical activities would be negligible. These modelling results are similar to that predicted for the Shelburne Basin Exploration Drilling Project in which the maximum extent of measureable discharge was predicted to be 1,380 m from the wellhead with the majority of discharges expected to be observed within 100 m of the wellhead. Assuming a threshold of 10 mm for mortality due to smothering, a radius of 155 m was predicted to occur for each well drilled for the Shelburne Basin Exploration Drilling Project. Both the Scotian Basin and Shelburne Basin exploration drilling projects involved drilling up to seven wells over their respective EL period, depending on initial well results. Cumulatively, this could result in patchy distributions of drill waste discharges on the sea floor on the Scotian Slope within the respective project areas. However, any cumulative alteration would be negligible and temporary.

It is similarly expected that any potential cumulative Change in Habitat Quality and Use caused by interaction between Project-related drill waste discharges and the sediments temporarily resuspended during groundfishing activity outside of the 500-m radius safety (exclusion) zone would be negligible based on the limited sedimentation expected beyond the safety (exclusion) zone.

The presence of Project and non-Project vessels in any particular area is generally anticipated to be medium-term and transient in nature, thus limiting water quality and sound effects (and associated cumulative Changes in Habitat Quality and Use) at any given location, including designated Special Areas and other areas of importance for reproduction, feeding, and migration of fish. Although PSVs, fishing vessels, and the vessels of other ocean users may be present in designated Special Areas, they are subject to special restrictions where necessary to protect sensitive marine species and habitats.

Underwater sound emissions produced during operation of the Project MODU, Shell's MODU and the production platforms for SOEP and Deep Panuke will be longer lasting and generated from a stationary source for the duration of Project exploration drilling activities at each well (*i.e.*, 120-130 days) and gas production activities at each SOEP and Deep Panuke platform (*i.e.*, several years), respectively. Although fish are not expected to approach close enough to these offshore facilities to be exposed to sound levels capable of causing auditory injury, the sound emissions may cause behavioural responses such as temporary habitat avoidance or changes in activity state. Given their distances from the Project Area (which is located approximately 11 km and 35 km from the nearest SOEP and Deep Panuke platforms, respectively), Browns Bank, the Georges Bank Oil and Gas Moratorium Area, the Georges Bank Fishery Closure (5Z), and the Emerald/Western Bank Haddock Nursery Closure (Haddock Box), sound emissions from the SOEP and Deep Panuke gas production platforms are not anticipated to interact cumulatively with the sound emissions from the Project to result in a cumulative Change in Habitat Quality and Use in designated Special Areas of importance for fish spawning.

In consideration of the above, cumulative water quality and sound effects are considered unlikely to disrupt the use of important habitat areas by fish. The localized areas potentially affected by the Project and other physical activities represent a relatively small proportion of the total amount of habitat available within the RAA and would not interact in such a way that causes any potential cumulative Change in Habitat Quality and Use for fish.

The residual cumulative Change in Habitat Quality and Use for Fish and Fish Habitat is generally predicted to be adverse, low to moderate in magnitude, occur within the LAA, sporadic to regular in frequency, short to medium-term in duration, and reversible. The cumulative Change in Habitat Quality and Use associated with the deposition of Project-related drill muds and cuttings is predicted to be primarily limited to the wellsite and Project Area. With the application of proposed Project-related mitigation and environmental protection measures such as compliance with the OWTG, the residual cumulative environmental effect of a Change in Habitat Quality and Use for Fish and Fish Habitat is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.3.3 Summary of Cumulative Environmental Effects on Fish and Fish Habitat

Cumulative environmental effects on fish and fish habitat are predicted to be adverse, low to moderate in magnitude, occurring within the LAA, sporadic to regular in frequency, short to medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effects on Fish and Fish Habitat are predicted to be not significant. Therefore, no additional mitigation measures beyond those in place to mitigate the Project's direct effects are needed to address potential cumulative effects.

10.2.4 Assessment of Cumulative Environmental Effects on Marine Mammals and Sea Turtles

This section assesses the potential cumulative Change in Habitat Quality and Use and the potential cumulative Change in Risk of Mortality or Physical Injury for Marine Mammals and Sea Turtles that may be caused by the residual environmental effects of the Project in combination with the residual environmental effects of other past, present, and future physical activities in the RAA.

10.2.4.1 Cumulative Change in Risk of Mortality or Physical Injury

Underwater sound emissions from Project-related VSP operations will contribute to the underwater sound emissions of other third party physical activities generating high SPLs in the RAA to potentially result in a cumulative Change in Risk of Mortality or Physical Injury.

There will also be a cumulative Change in Risk of Mortality or Physical Injury for marine mammals and sea turtles due to increased potential for strikes with vessels conducting various physical activities within the RAA (including Project activities). Marine mammals and sea turtles are also at risk of mortality due to entanglement in fishing gear. Project activities, offshore gas development projects, Shell's Shelburne Basin Venture Exploration Drilling Project, and the activities of fisheries and other ocean users all have potential to occur in different parts of the RAA at the same time, thereby cumulatively increasing Risk of Mortality or Physical Injury.

With the exception of the discussion of cumulative environmental effects on fish eggs/larvae and benthic organisms, the analysis of cumulative environmental effects from underwater sound and operational discharges provided in Section 10.2.3 is also applicable for Marine Mammals and Sea Turtles.

The operation of the Project MODU and PSVs will represent only a small incremental increase over existing levels of marine traffic in the RAA, including likely marine traffic associated with the Shelburne Basin Venture Exploration Drilling Project and will therefore only cause a small increase in the cumulative Change in Risk of Mortality or Physical Injury for marine mammals and sea turtles. Project PSVs will reduce the risk of collision with marine mammals and sea turtles by limiting their maximum speed to 22 km/h (12 knots), avoiding known important areas for marine mammals (*e.g.*, Roseway Basin, the Gully, and Shortland and Haldimand Canyons) except as needed in the case of an emergency. In general, the presence of Project and non-Project vessels in any given area is anticipated to be short-term and transient in nature, thereby limiting opportunities for vessel strikes.

The residual cumulative Change in Risk of Mortality or Physical Injury for Marine Mammals and Sea Turtles is predicted to be adverse, low in magnitude, occur within the LAA, sporadic to regular in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effect of a Change in Risk of Mortality or Physical Injury for Marine Mammals and Sea Turtles is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.4.2 Cumulative Change in Habitat Quality and Use

Similar to the cumulative interactions discussed above for Fish and Fish Habitat, water quality and sound effects from the Project and other third party physical activities may temporarily reduce habitat availability within the RAA (*i.e.*, due to the potential for temporary avoidance of multiple areas at once). Although this cumulative Change in Habitat Quality and Use has potential to disrupt reproductive, foraging and feeding, and/or migratory behaviour of marine mammals and sea turtles if the availability of important habitat areas, including designated Special Areas, is affected, the likelihood of this cumulative interaction is considered low given the distances over which Project and non-Project activities are taking place, as well as the localized nature of potential residual Project effects.

Underwater sound generated by various Project activities will contribute to the underwater sound produced by other physical activities in the RAA. The resultant cumulative increase in ambient underwater sound levels may adversely affect marine mammals through the masking of biologically significant sounds as well as avoidance behaviours. The presence and sound of helicopter traffic also has potential to elicit temporary diving responses in marine mammals; thus the presence and sound of Project-related helicopter traffic may potentially trigger additional diving responses in individual marine mammals already exposed to the presence and sound of helicopter traffic from offshore gas development projects, Shell's Shelburne Basin Venture Exploration Drilling Project, and other ocean users (where applicable).

Much of the analysis of cumulative environmental effects from underwater sound and operational discharges provided in Section 10.2.3.2 for Fish and Fish Habitat is also applicable for Marine Mammals and Sea Turtles.

With respect to behavioural responses in marine mammals and sea turtles (*i.e*., masking and avoidance behaviour), Project-related SPLs are predicted to be above thresholds associated with behavioural effects for cetaceans (refer to Section 7.3.8 and Appendix H). Under certain environmental conditions (winter), SPLs from the MODU is predicted to be above 120 db re 1 µPa RMS SPL at distances of more than a 150 km radius from the MODU. This continuous sound could interact cumulatively with transient and intermittent sound from Project and non-Project vessels (including Shelburne Basin Venture Exploration Drilling Project MODU and vessels) within this radius potentially contributing to a cumulative Change in Habitat Quality and Use. Project PSVs will avoid critical habitat for the northern bottlenose whale (the Gully, and Shortland and Haldimand canyons) and the North Atlantic right whale (Roseway Basin).

With respect to behavioural effects on marine mammals due to helicopter presence and sound, the standard protocol for oil and gas operators working offshore Nova Scotia is for helicopters to avoid flying over Sable Island, except in the case of an emergency. This mitigation will limit potential cumulative interactions between helicopter traffic from the Project, SOEP, Deep Panuke, and Shelburne Project Area, and Sable Island seal populations. Project helicopters will also avoid flying over Roseway Basin, except in the case of an emergency. In general, the residual environmental effects of helicopter traffic from the Project will be so spatially and temporally limited that potential cumulative interactions with the residual environmental effects of other helicopter traffic in the RAA will be minimal and are not anticipated to result in a substantial cumulative Change in Habitat Quality and Use for marine mammals.

The residual cumulative Change in Habitat Quality and Use for Marine Mammals and Sea Turtles is predicted to be adverse, low to moderate in magnitude, restricted to the Project Area or RAA, sporadic to regular in frequency, short to medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effect of a Change in Habitat Quality and Use for Marine Mammals and Sea Turtles is predicted to be not significant. This conclusion has been determined with a moderate level of confidence based on a limited understanding of the effects of introduced underwater sound on sea turtles and marine mammals (particularly with respect to species-specific behavioural effects), but a reasonable understanding of the general effects of exploration drilling and VSP on marine mammals and the effectiveness of mitigation measures, including those discussed in Section 7.3.8.2. There are also inherent uncertainties in the acoustic model, as well as scientific disagreement about the appropriateness of the various effects thresholds for marine mammals and sea turtles related to underwater sound.

10.2.4.3 Summary of Cumulative Environmental Effects on Marine Mammals and Sea Turtles

Cumulative environmental effects on Marine Mammals and Sea Turtles are predicted to be adverse, low to moderate in magnitude, occur within the RAA, sporadic to regular in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effects on Marine Mammals and Sea Turtles are predicted to be not significant. Therefore, no additional mitigation measures beyond those in place to mitigate the Project's direct effects are needed to address potential cumulative effects. Marine mammal and sea turtle observation programs implemented by offshore oil and gas operators and seismic survey operators on the Scotian Shelf and Slope, as well as BP's proposed acoustic monitoring program will help to further the understanding of species presence and behaviour on the Scotian Shelf and Slope and potential cumulative environmental effects on Marine Mammals and Sea Turtles.

10.2.5 Assessment of Cumulative Environmental Effects on Migratory Birds

This section assesses the potential cumulative Change in Habitat Quality and Use and the potential cumulative Change in Risk of Mortality or Physical Injury for Migratory Birds that may be caused by the residual environmental effects of the Project in combination with the residual environmental effects of other past, present, and future physical activities in the RAA.

10.2.5.1 Change in Risk of Mortality or Physical Injury

As discussed in Sections 10.2.3 and 10.2.4, underwater sound emissions from Project-related VSP operations will contribute to the underwater sound emissions of other third party physical activities generating high SPLs in the RAA to potentially result in a cumulative Change in Risk of Mortality or Physical Injury. The analysis provided in Section 10.2.3 regarding underwater sound emissions from Project-related VSP operations in combination with the underwater sound emissions of other physical activities generating high SPLs in the RAA could be relevant for diving marine birds. However, based on current scientific knowledge regarding the effects of underwater sound on birds (refer to Section 7.1), diving marine birds appear to be less sensitive to underwater sound emissions than fish, marine mammals, or sea turtles. Migratory birds are therefore assumed to be less susceptible to a potential cumulative Change in Risk of Mortality or Physical Injury from underwater sound than fish or marine mammals and sea turtles.

Migratory birds are vulnerable to potential injury or mortality when exposed to hydrocarbon contamination. Crude and heavy fuel oil, lubricants, and diesels accounted for most of the contamination found on the corpses of the more than 2800 oiled birds that were recovered during beached bird surveys conducted on Sable Island between 1993 and 2002. These fatalities were primarily attributable to unlawful ship-source pollution from large vessels (Stantec 2014b). Thus, non-routine discharges from the Project and various other physical activities in the RAA could contribute to a cumulative Change in Risk of Mortality or Physical Injury for migratory birds. However, routine discharges are expected to comply with government standards and requirements, and residual hydrocarbons in discharges released in accordance with the OWTG and/or MARPOL (as applicable) are generally not associated with the formation of a slick (potentially affecting marine birds) and are therefore unlikely to cause a measurable cumulative Change in Risk of Mortality or Physical Injury to marine birds.

Although rare, it is possible for helicopter traffic from the Project, offshore gas development and exploration projects, and other ocean users (where applicable) to strike flying birds. Thus, the Project may contribute to a cumulative Change in Risk of Mortality or Physical Injury due to potential collisions with migratory birds.

The standard protocol for oil and gas operators working offshore Nova Scotia is for helicopters to avoid flying over Sable Island, except in the case of an emergency; this will mitigate potential disturbance of the Sable Island National Park Reserve (and associated Sable Island IBA) and birds nesting on Sable Island. Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m and at a lateral distance of 2 km away from active colonies when possible, thereby reducing the risk of collisions with migratory birds. In general, the residual environmental effects of helicopter traffic from the Project will be so spatially and temporally limited that potential cumulative interactions with the residual environmental effects of other helicopter traffic in the RAA will be minimal and are not expected to result in a substantial Change in Risk of Mortality or Physical Injury for migratory birds.

Artificial night lighting associated with the Project will contribute to the total amount of night lighting from various sources in the RAA, including lighting on the PSVs and platforms for offshore gas development projects, the Shelburne Basin Venture Exploration Drilling Project, fishing vessels, and the vessels of other ocean users. Each of these sources of artificial night lighting can attract and/or disorient migratory birds, thereby resulting in a cumulative Change in Risk of Mortality or Physical Injury due to potential stranding and increased opportunities for predation, collisions, exposure to vessel based threats, and emissions. Limited flaring by the MODU during Project activities (*e.g.*, testing) may similarly attract migratory birds and result in increased mortality due to the lighting-related hazards identified above as well as the risk of incineration.

Project-related flaring will contribute to the bird mortality risk already associated with gas flaring from offshore gas development projects.

Routine checks for stranded birds on the MODU and PSVs and appropriate procedures for release (*i.e.*, the protocol outlined in *The Leach's Storm Petrel: General Information and Handling Instructions* (Williams and Chardine 1999)) will be implemented to mitigate the environmental effects of Project-related artificial night lighting and flaring on birds. Lighting on Project infrastructure will be reduced, to the extent possible without compromising worker safety. Flaring will only be undertaken during the Project as necessary to characterize the well potential and maintain safe operations, and will be carried out in accordance with CNSOPB *Drilling and Production Guidelines*. Project lighting and flaring will represent only a small increase over existing levels of lighting and flaring in the RAA, will be temporary and localized, and will occur at sufficient distance from other light sources (*i.e.*, at least 500 m from fishing vessels and the vessels of other ocean users) and flaring sources (*i.e.*, approximately 11 km and 35 km from SOEP and Deep Panuke, respectively). Residual lighting and flaring effects of the Project are therefore not anticipated to contribute to those of other third party physical activities within the RAA in such a way that causes a substantive cumulative increase in mortality or injury affecting migratory birds.

The residual cumulative Change in Risk of Mortality or Physical Injury for Migratory Birds is predicted to be adverse, low to moderate in magnitude, occur within the LAA, sporadic (VSP operations) to continuous (artificial night lighting) in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effect of a Change in Risk of Mortality or Injury for Migratory Birds is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other third party physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.5.2 Change in Habitat Quality and Use

For migratory birds whose ranges cover a large extent of the RAA, individuals may be exposed to various sources of liquid emissions and atmospheric sound (*i.e.*, offshore gas development projects, the Shelburne Basin Venture Exploration Drilling Project, fisheries, and other ocean users) throughout their life cycle, thereby potentially resulting in a cumulative Change in Habitat Quality and Use, when combined with discharges and atmospheric sound generated by the Project. Section 10.2.3 discusses potential cumulative interactions with respect to marine discharges.

Sound emissions generated from other third party physical activities may locally displace migratory birds for short durations. The cumulative environmental effects of the Project in combination with other third party physical activities will therefore include a temporary reduction in the amount of migratory bird habitat available within the RAA (*i.e.*, due to temporary avoidance of multiple areas at once). This cumulative Change in Habitat Quality and

Use has potential to disrupt reproductive, foraging and feeding, and/or migratory behaviour if the availability of important habitat areas, including designated Special Areas, is affected. Such a potential cumulative effect is considered unlikely, however, given the mitigation measures that will be taken for the Project to avoid important areas.

The presence of Project and non-Project vessels in a particular area is generally anticipated to be short-term and transient in nature, thus limiting associated atmospheric sound effects at any given location, including Sable Island National Park Reserve and other areas of importance for reproduction, foraging and feeding, and/or migration of birds.

Atmospheric sound emissions produced during operation of the Project MODU and the production platforms for SOEP and Deep Panuke will be generated from a stationary source for the duration of Project exploration drilling activities at each well (*i.e.*, 120 days) and gas production activities at each SOEP and Deep Panuke platform (*i.e.*, several years), respectively. Sound emissions may cause behavioural responses such as temporary habitat avoidance or changes in activity state (*e.g.*, feeding, resting or travelling). However, the affected areas represent a very small portion of the total amount of bird habitat available in the RAA and are not known to contain any uniquely important habitat for migratory birds.

The standard protocol for oil and gas operators working offshore Nova Scotia is for helicopters to avoid flying over Sable Island, except in the case of an emergency, which will mitigate potential disturbance of the Sable Island National Park Reserve (and associated Sable Island IBA) and birds nesting on Sable Island. Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m and at a lateral distance of 2 km over active colonies when possible, thereby reducing disturbance to migratory birds. In general, the residual environmental effects of helicopter traffic from the Project will be so spatially and temporally limited that potential cumulative interactions with the residual environmental effects of other helicopter traffic in the RAA will be minimal and are not expected to result in a substantial Change in Habitat Quality and Use for migratory birds.

In consideration of the above, cumulative atmospheric sound effects are considered unlikely to substantially disrupt the use of important habitat areas by migratory birds. The localized areas potentially affected by the Project and other third party physical activities in such a way that causes a cumulative Change in Habitat Quality and Use for migratory birds will represent a relatively small proportion of the total amount of habitat available within the RAA.

The residual cumulative Change in Habitat Quality and Use for Migratory Birds is predicted to be adverse, low to moderate in magnitude, occur within the LAA, sporadic to regular in frequency, short to medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effect of a Change in Habitat Quality and Use for Migratory Birds is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other third party physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.5.3 Summary of Cumulative Environmental Effects on Migratory Birds

Cumulative environmental effects on Migratory Birds is predicted to be adverse, low to moderate in magnitude, occur within the LAA, sporadic (VSP operations) to continuous (artificial night lighting) in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effects on Migratory Birds are predicted to be not significant. Therefore, no additional mitigation measures beyond those in place to mitigate the Project's direct effects are needed to address potential cumulative effects. Migratory bird monitoring programs implemented by offshore oil and gas operators on the Scotian Shelf and Slope as well as BP's proposed migratory bird monitoring program will help to advance an understanding of species use and distribution as well as potential cumulative effects.

10.2.6 Assessment of Cumulative Environmental Effects on Special Areas

This section assesses the potential cumulative Change in Habitat Quality in Special Areas that may be caused by the residual environmental effects of the Project in combination with the residual environmental effects of other past, present, and future physical activities in the RAA.

10.2.6.1 Change in Habitat Quality

The Scotian Slope EBSA and the Haddock Box are the only Special Areas located within the Project Area. Given the distance of the Project Area from other Special Areas (Table 5.2.17), potential cumulative interactions associated with the presence and operation of the MODU, including discharge of drill muds and cuttings as well as other discharges and emissions, VSP surveys, and well abandonment activities, would be limited, for the most part, to localized areas of the Scotian Slope EBSA and to a lesser extent, the Haddock Box. No Project well locations will be located within the Haddock Box. Cumulative environmental effects from these activities would be localized and not extend to distances that may interact with other Special Areas, except where modelling in winter conditions has predicted underwater sound levels above 120 db RMS re 1 µPa in the Gully and Shortland Canyon (refer to Section 7.5.8.3 and Appendix H). PSV transiting has potential to cumulatively interact with other third party physical activities in the Haddock Box and Emerald Basin and Sambro Bank Sponge Conservation Areas.

Many of the mechanisms for cumulative environmental effects on Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Migratory Birds are also applicable to Special Areas.

- Marine discharges from the Project as well as from other third party physical activities could result in localized areas of water quality reduction throughout the RAA. Fish, marine mammals, sea turtles, and migratory birds may temporarily avoid or be attracted to these areas. This cumulative environmental effect has potential to occur to localized areas of the Scotian Slope EBSA and to a lesser extent, the Haddock Box, (although no drilling will occur here), and in the Sambro Bank and Emerald Basin Sponge Conservation Areas which could be crossed by PSV traffic.

- The dispersion of Project-related discharges of drill muds and cuttings up to 1,367 m (0.1 mm thickness of benthic deposition) from each wellsite could contribute to the residual environmental effects of fishing activity in the RAA, including the resuspension of sediments during groundfishing with mobile bottom contact fishing gear, in such a way that causes a cumulative Change in Habitat Quality for benthic organisms within that 1,367 m radius. This cumulative environmental effect has potential to occur within localized areas of the Scotian Slope EBSA, in which the Project Area is located.
- Underwater sound generated by various Project activities and components will contribute to the underwater sound produced by other physical activities in the RAA. Fish, marine mammals, and sea turtles may temporarily avoid localized areas subject to underwater sound. A cumulative increase in ambient underwater sound level may adversely affect marine mammals causing temporary avoidance. This cumulative environmental effect has potential to occur in the Scotian Slope EBSA, where the Project Area is located, and in the Haddock Box and Emerald Basin Sponge Conservation Area, which are crossed by the PSV route portion of the LAA. Based on acoustic modelling conducted for the Project (refer to Appendix H), it is possible that SPLs of 120 dB RMS re 1 μPA could be exceeded in winter conditions at distances reaching as far as the Gully and Shortland Canyon, both of which comprise SARA designated critical habitat for the northern bottlenose whale. This sound threshold has been cited as potentially resulting in behavioral effects on cetaceans and pinnipeds for continuous sounds (*e.g*., shipping and drilling), although it is noted that there is scientific disagreement and debate concerning the validity of establishing a single threshold (refer to Section 7.3 for more discussion). As noted in Section 7.3.8, the potential magnitude of a response is expected to vary depending on a number of factors, such as the intensity of underwater sound, degree of overlap in frequency between a sound and marine mammal species' hearing sensitivity, as well as the animal's activity state at the time of exposure. Odontocete (*e.g.*, northern bottlenose whale) communication frequency ranges from 2 to over 100 kHz (Au and Hastings 2008), which would only partially be overlapped by the low frequency range of drilling sounds (10 Hz to 10 kHz), suggesting that effects of masking may be of lesser concern than for baleen whales, though recent studies suggest odontocetes may still react to low levels of the high frequency components of vessel sound (*e.g.*, Dyndo *et al.* 2015; Veirs *et al.* 2016).
- As noted in Section 7.3.8.3, Lee *et al.* (2005) reported that northern bottlenose whales in the Gully were not displaced by received sound levels of 145 dB re 1 μPa RMS SPL generated by a seismic survey >20 km away that had been operating for a number of weeks.
- The presence and sound of Project-related helicopter traffic may trigger additional diving responses in individual marine mammals already exposed to the presence and sound of helicopter traffic from offshore gas development projects, the Shelburne Basin Venture Exploration Drilling Project, and other ocean users (where applicable). This cumulative environmental effect has potential to occur in localized areas of the Scotian Slope EBSA.
- Atmospheric sound generated by various Project activities and components will contribute to the atmospheric sound produced by other third party physical activities in the RAA. The

sound emissions from these activities may physically displace migratory birds for short durations. This cumulative Change in Habitat Quality has potential to occur in the Scotian Slope EBSA, which is a feeding/overwintering area for migratory birds.

Given the importance of the Haddock Box and the Sambro Bank and Emerald Basin Sponge Conservation Areas for fish and fish habitat, as well as the importance of the Scotian Slope EBSA for fish, marine mammals, sea turtles, and migratory birds, much of the analysis of cumulative environmental effects provided for fish, marine mammals, sea turtles, and migratory birds in Sections 10.2.3, 10.2.4, and 10.2.5 is also applicable for Special Areas.

The cumulative Change in Habitat Quality associated with the deposition of Project-related drill muds and cuttings is predicted to be primarily limited to the wellsite and Project Area (with potential to extend into the LAA if a drill site is located within 1,367 m of the Project Area boundary) and to be long-term in duration.

The residual cumulative Change in Habitat Quality of Special Areas is predicted to be adverse, low to moderate in magnitude, occur within the LAA, sporadic to regular in frequency, short to medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effects of a Change in Habitat Quality of Special Areas, is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.6.2 Summary of Cumulative Environmental Effects on Special Areas

Cumulative environmental effects on Special Areas are predicted to be adverse, low to moderate in magnitude, occur within the LAA, sporadic to regular in frequency, short to medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effects on Special Areas are predicted to be not significant. Therefore, , no additional mitigation measures beyond those in place to mitigate the Project's direct effects are needed to address potential cumulative effects, assuming other ocean users also respect industry standard protection measures in place for Special Areas (*e.g.*, no bottom contact fishing in Sambro Bank and Emerald Basin Sponge Conservation Areas; buffer zone around Sable Island; and restricted activities within the Gully).

10.2.7 Assessment of Cumulative Environmental Effects on Commercial Fisheries

This section assesses the potential cumulative Change in Availability of Fisheries Resources for Commercial Fisheries that may be caused by the residual environmental effects of the Project in combination with the residual environmental effects of other past, present, and future physical activities in the RAA.

10.2.7.1 Change in Availability of Fisheries Resources

A 500-m radius safety (exclusion) zone will be established around the MODU, in accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, within which fisheries activities will be excluded while the MODU is in operation. This will amount to the localized exclusion of fisheries within an area of approximately 0.8 km^2 for up to 120 days for each of the wells to be drilled in the Project Area. More specifically, the safety (exclusion) zone to be established for the Project will occupy 0.0003% of the total available area in NAFO Division 4W. The safety (exclusion) zones associated with offshore gas development projects and the Shelburne Basin Venture Exploration Drilling Project will increase the cumulative area that will be temporarily unavailable to fishers at any given time during Project activities. For a fisher licensed to fish in NAFO Division 4W, this is predicted to result in the temporary loss of a negligible percentage of the approximately 237,763 km^2 of total available area. No substantial Change in Availability of Fisheries Resources for fishers is anticipated to result from the cumulative interaction of the various safety (exclusion) zones associated with the Project, SOEP, Deep Panuke, and the Shelburne Basin Venture Exploration Drilling Project. Alternative fishing locations are anticipated to be available nearby as these safety (exclusion) zones are relatively small and occupy a negligible amount of the total harvestable grounds in the RAA.

In addition to the safety (exclusion) zones associated with offshore oil and gas exploration and development, the presence of PSVs, competing fishing vessels, and the marine traffic associated with other ocean users are other sources of potential conflict with fishing vessels within the RAA that could cause a Change in Availability of Fisheries Resources for fishers. Project PSVs are not expected to contribute to space-use conflicts with fishing vessels, as Project PSVs will use existing shipping routes when travelling between the MODU and the supply base in Halifax Harbour, and Project-related PSV traffic will represent a minor component of total marine traffic in the RAA, occupy a negligible proportion of the total available fishing area in the RAA, and be short-term and transient in nature.

Fishers may adversely affect one another through direct competition over productive fishing grounds in such a way that causes a Change in Availability of Fisheries Resources. Any fishers that experience a change in access to their customary fishing areas as a result of the Project in combination with other physical activities in the RAA may be required to temporarily relocate their fishing effort. This could put additional pressure on nearby fishing areas, and fishers may be adversely affected by the resultant competition for remaining fishing areas in the LAA and RAA, thereby causing a cumulative Change in Availability of Fisheries Resources. The level of fishing effort within and surrounding the Project Area is relatively low. The LAA does not include any unique fishing grounds or concentrated fishing effort that occurs exclusively within the LAA, nor is it likely to represent a substantial portion of a customary fishing area for a fisher. The potential for temporary loss of access to preferred fishing grounds as a result of the Project is therefore anticipated to be negligible and is unlikely to have any discernable effect on the overall distribution of fishing effort within the RAA.

All of the physical activities within the RAA have some potential to inadvertently result in damage to fishing gear. The Project contributes to a potential cumulative Change in Availability of Fisheries Resources within the RAA due to potential sequential incidents of gear loss or damage. Project-related damage to fishing gear, if any, will be compensated in accordance with the *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2002).

Standard practices for communication among marine users, including the issuance of Notices to Mariners and Notices to Shipping (as appropriate), is expected to mitigate potential conflicts with fisheries as well as other ocean users.

The residual cumulative Change in Availability of Fisheries Resources for Commercial Fisheries is predicted to be adverse, negligible in magnitude, occur within the LAA, continuous in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effect of a Change in Availability of Fisheries Resources for Commercial Fisheries is predicted to be not significant. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.7.2 Summary of Cumulative Environmental Effects on Commercial Fisheries

Cumulative environmental effects on Commercial Fisheries are predicted to be adverse, negligible in magnitude, occur within the LAA, continuous in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effects on Commercial Fisheries are predicted to be not significant. With the application of standard practices for communication among marine users, including fisheries communication plans implemented by other offshore oil and gas operators on the Scotian Shelf and Slope, it is concluded therefore that no additional mitigation measures beyond those in place to mitigate the Project's direct effects are needed to address potential cumulative effects.

10.2.8 Assessment of Cumulative Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

This section assesses the potential cumulative Change in Traditional Use with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes that may be caused by the residual environmental effects of the Project in combination with the residual environmental effects of other past, present, and future physical activities in the RAA.

10.2.8.1 Change in Traditional Use

Similar to the cumulative effects assessed for Commercial Fisheries, the following cumulative environmental effect mechanisms are also applicable with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes, specifically Aboriginal communal commercial fisheries and FSC fisheries:

- temporary displacement of Aboriginal fishers from their traditional fishing grounds due to establishment of 500-m radius safety (exclusion) zones around the Project MODU, offshore gas production platforms for SOEP and Deep Panuke, and the MODU for the Shelburne Basin Venture Exploration Drilling Project;
- space-use conflicts between Aboriginal fishing vessels and vessels associated with various other physical activities;
- increased competition with other displaced fishers over remaining fishing areas; and
- risk of incidents of gear loss or damage caused by the Project in combination with other physical activities in the RAA.

The analysis of cumulative environmental effects provided in Sections 10.2.7 relating to commercial fisheries is also directly applicable for Aboriginal fishers. That section should be referred to for the assessment of potential cumulative effects related to a Change in Traditional Use. The analysis of cumulative effects provided in Section 10.2.3 regarding Fish and Fish Habitat and in Section 10.2.6 regarding Special Areas should also be referenced given that these VCs were identified by Aboriginal groups as important considerations with respect to traditional use.

The residual cumulative Change in Traditional Use with respect to Current Aboriginal Use of Lands and Resources for Traditional Purposes is predicted to be adverse, negligible in magnitude, occur within the LAA, continuous in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effect of a Change in Traditional Use with respect to the Current Aboriginal Use of Lands and Resources for Traditional Purposes is predicted to be not significant. As described in Sections 10.2.3, 10.2.6, and 10.2.7, cumulative effects for Fish and Fish Habitat, Special Areas, and Commercial Fisheries, respectively and are also predicted to be not significant, further supporting this conclusion. This conclusion has been determined with a high level of confidence based on an understanding of the general environmental effects of exploration drilling and other third party physical activities in the RAA, as well as the effectiveness of standard mitigation measures.

10.2.8.2 Summary of Cumulative Environmental Effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes

Cumulative environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes is predicted to be adverse, negligible in magnitude, occur within the LAA, continuous in frequency, medium-term in duration, and reversible. With the application of proposed Project-related mitigation and environmental protection measures, the residual cumulative environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes are predicted to be not significant. With the application of standard practices for communication among marine users, and ongoing Aboriginal engagement efforts from other offshore oil and gas operators on the Scotian Shelf and Slope, it is concluded therefore that no additional mitigation measures beyond those in place to mitigate the Project's direct effects are needed to address potential cumulative effects.

10.2.9 Accidental Events

According to the CEA Agency's OPS, *Assessing Cumulative Environmental Effects Under the Canadian Environmental Assessment Act, 2012*, "the environmental effects of accidents and malfunctions must be considered in the assessment of cumulative environmental effects if they are likely to result from the designated project in combination with other third party physical activities that have been or will be carried out" (CEA Agency 2013a).

The potential environmental effects of various Project-related malfunction and accidental event scenarios are assessed in Section 8. All of these scenarios are considered very unlikely to occur. Of the identified scenarios, the most likely accidental events which could occur are small batch spills from the MODU (*i.e.*, spills less than 10 bbl). Based on Canadian offshore data, the return period for a spill of less than 10 bbl is 41 years (ERC 2014; Appendix F of Stantec 2014a). Spill prevention and response procedures will be in place to reduce the risk of all spills, including small spills, and associated environmental effects (refer to Section 8 for additional information). Other operators will implement spill prevention and response measures. For example, as noted in the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a), Shell will implement best management practices and spill prevention measures to reduce the risk of all spills and associated environmental effects. Given the low likelihood of a spill event occurring for even one physical activity in the RAA, the likelihood of spills occurring from multiple physical activities in such a way that residual environmental effects have potential to overlap spatially or temporally is even more remote.

Although a small batch spill could cause residual adverse environmental effects to various VCs (refer to Section 8.5), it would be unlikely to interact with the residual environmental effects of discharges from offshore gas development projects, the Shelburne Basin Venture Exploration Drilling Project, fisheries, or other ocean users in such a way that causes a cumulative environmental effect.

The exclusion of fisheries and other ocean users within a 500-m radius safety (exclusion) zone surrounding the MODU will prevent undiluted small batch spills from combining with undiluted discharges from other physical activities. The concentrations of discharges from other physical activities are expected to be rapidly diluted in the open ocean prior to any mixing thus avoiding cumulative environmental effects.

In the event of a spill, BP's spill response procedures will be implemented immediately upon identification of the spill with the intention of limiting the spatial extent of the spill (*i.e.*, containing, controlling and cleaning up spills as close to the spill site as possible), thus further limiting potential cumulative interactions between small batch spills and the discharges of other third party physical activities outside of the 500-m radius safety (exclusion) zone. The potential contribution of the residual environmental effects of a small batch spill to the residual environmental effects of another physical activity in the RAA is not considered a likely scenario and is therefore not assessed further.

10.3 FOLLOW-UP AND MONITORING

Given the nature of the Project (*e.g.,* exploration drilling), follow-up and monitoring requirements are limited (refer to Section 13). However, various monitoring programs are/will be undertaken in support of other third party physical activities in the RAA that are regulated by the CNSOPB (*i.e.*, Deep Panuke, SOEP, Shelburne Basin Venture Exploration Drilling Project). Encana and ExxonMobil also have obligations to conduct EEM for their offshore gas development projects (*i.e.*, SOEP and Deep Panuke, respectively), in accordance with an EEM process framework developed jointly in 2005 between the CNSOPB, the CEA Agency, DFO, and Environment Canada (CNSOPB n.d. (b)). Depending on the nature of their activities, fisheries and other ocean users may be subject to various monitoring requirements mandated by DFO, Transport Canada, and/or Environment Canada. Monitoring activities associated with the Project and other physical activities will support the development and implementation of adaptive management measures if previously unanticipated adverse environmental effects are identified, thereby reducing the overall potential for cumulative environmental effects.

BP will communicate with fishers and other ocean users before, during, and after drilling programs, and details of safety (exclusion) zones will be published in Notices to Shipping and/or Notices to Mariners, as appropriate. This will allow fishers and other ocean users to plan accordingly and mitigate potential space-use conflicts or environmental effects.

11.0 SUMMARY OF ENVIRONMENTAL EFFECTS

11.1 CHANGES TO THE PHYSICAL ENVIRONMENT

This section summarizes the changes that may be caused by the Project on the components of the environment listed in sections 5(1)(a) and (b) of CEAA, 2012, including those that are directly linked or necessarily incidental to federal decisions that would allow the Project to proceed (refer to Table 11.1.1). Conclusions in this section are summarized from the detailed analyses in Sections 7 through 9 and are categorized as follows:

- Changes to components of the environment within federal jurisdiction;
- Changes to the environment that would occur on federal or transboundary lands; and
- Changes to the environment that are directly linked or necessarily incidental to federal decisions.

An analysis regarding the potential changes to the environment summarized in Table 11.1.1 is provided in Sections 11.1.1 to 11.1.3 below.

Table 11.1.1 Summary of Changes to the Environment

Topic	Changes
Changes to Components of the Environment within Federal Jurisdiction	
Fish and Fish Habitat	• Change in Risk of Mortality or Physical Injury • Change in Habitat Quality and Use
Marine Mammals and Sea Turtles	• Change in Risk of Mortality or Physical Injury • Change in Habitat Quality and Use
Migratory Birds	• Change in Risk of Mortality or Physical Injury • Change in Habitat Quality and Use
Changes to the Environment that Would Occur on Federal or Transboundary Lands	
Special Areas	• Change in Habitat Quality
Commercial Fisheries	• Change in Availability of Fisheries Resources
Current Aboriginal Use of Lands and Resources for Traditional Purposes	• Change in Traditional Use
Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions	
Accord Acts Authorizations (Operations Authorization and Well Approval under the Accord Acts and *Nova Scotia Offshore Petroleum Drilling and Production Regulations*)	• Operations Authorizations and Well Approvals under the Accord Acts sanction offshore exploration drilling projects in their entirety. Therefore, the changes to the environment associated with Project activities and components are directly linked or necessarily incidental to these authorizations.
Authorization under section 35(2)(b) of the *Fisheries Act* (if applicable)	• Change in Risk of Mortality or Physical Injury and/or Change in Habitat Quality and Use that constitutes serious harm to fish that are part of or support a commercial, recreational, or Aboriginal fishery.

11.1.1 Changes to Components of the Environment within Federal Jurisdiction

Section 5(1)(a) of CEAA, 2012 requires consideration of changes that may be caused to the following components of the environment that are within federal jurisdiction (*i.e.*, within the legislative authority of Parliament): fish and fish habitat, as defined in section 2(1) of the *Fisheries Act;* aquatic species, as defined in section 2(1) of SARA; and migratory birds, as defined in section 2(1) of the MBCA.

Changes affecting fish and fish habitat, marine mammals and sea turtles, and migratory birds are summarized below. Greater detail is provided in Section 7.2 (Fish and Fish Habitat), Section 7.3 (Marine Mammals and Sea Turtles), and Section 7.4 (Migratory Birds).

11.1.1.1 Fish and Fish Habitat

Marine benthic, demersal, and pelagic fish species (including SAR and SOCC) and habitat are present in and around the Project Area, LAA, and RAA. Potential environmental effects of the Project on fish and fish habitat include the following:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

Fish habitat includes all aspects of the physical marine environment (including the benthic environment and water quality), and considers spawning, rearing, nursery, food supply, overwintering, migration corridors, and any other area on which fish depend directly or indirectly in order to carry out their life processes.

Fish within the LAA may be subject to increased risk of mortality or physical injury due to underwater sound emissions during certain Project activities (*i.e.*, MODU operation and VSP surveys) and the smothering of marine benthos during the deposition of routine discharges of drill muds and cuttings. Underwater sound emissions from MODU operation, VSP surveys, PSV operations, and well abandonment may also temporarily degrade the quality of fish habitat and result in sensory disturbance that may trigger behavioural responses in fish within the LAA. The localized, temporary reduction of water and sediment quality as a result of routine operational discharges and emissions, including the discharge of drill muds and cuttings as well as drilling and testing emissions, may similarly affect habitat quality and use for fish within the LAA. Marine plants are not located in the Project Area (given water depth) and routine Project activities are not predicted to interact with marine plants which occur in the nearshore. Accidental events (*e.g.*, spills), although unlikely to occur, could alter fish habitat and/or result in species mortality or injury within the affected area. Depending on the type and location of the spill, these effects could potentially be realized beyond the LAA into the RAA, including the nearshore environment.

Habitat altered by the deposition of drill muds and cuttings will become available for use as fish habitat immediately following the completion of drilling operations and is expected to be recolonized by benthic communities in less than five years.

As summarized in Section 7.2.9, in consideration of the extent of the interactions and the planned implementation of known and proven mitigation, the residual environmental effects of routine Project activities and components on Fish and Fish Habitat are predicted to be not significant. With the development and implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), accidental events are unlikely to result in significant residual adverse environmental effects on Fish and Fish Habitat.

11.1.1.2 Marine Mammals and Sea Turtles

Several species of baleen whales (mysticetes), toothed whales (odontocetes), seals (phocids), and sea turtles (including SAR and SOCC) are present in and around the Project Area, LAA, and RAA. Potential environmental effects of the Project on marine mammals and sea turtles include the following:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

Marine mammal and sea turtles within the LAA may be subject to increased risk of mortality or physical injury due to auditory damage from underwater sound emissions during certain Project activities (*i.e.*, MODU operation and VSP surveys) and collisions with transiting PSVs. Underwater sound emissions from MODU operation, VSP surveys, and PSV operations may temporarily degrade the quality of marine mammal and sea turtle habitat and result in sensory disturbance that triggers behavioural responses in marine mammals and sea turtles within the LAA. Sensory disturbance associated with well abandonment and the localized degradation of water quality as a result of routine operational discharges and emissions, including the discharge of drill muds and cuttings as well as drilling and testing emissions, may similarly affect habitat quality and use for marine mammals and sea turtles within the LAA. There is also potential for helicopter transportation to affect habitat quality and use for marine mammals by eliciting temporary diving behaviour. Accidental events (*e.g.*, spills), although unlikely to occur, could alter marine mammal and sea turtle habitat and/or result in species mortality or injury within the affected area, which could extend beyond the LAA into the RAA.

As summarized in Section 7.3.9, with the application of proposed mitigation and environmental protection measures, the residual environmental effects of routine Project activities and components on Marine Mammals and Sea Turtles are predicted to be not significant. A significant adverse residual environmental effect is predicted for marine mammals and sea turtles in event of a well blowout in recognition of the risk of interaction with breeding seals on Sable Island and marine mammal and sea turtle species at risk inhabiting the affected area. However, with the implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects on Marine Mammals and Sea Turtles are unlikely to occur.

11.1.1.3 Migratory Birds

Several species of pelagic (*i.e.*, offshore) and neritic (*i.e.*, inshore) seabirds, waterfowl, shorebirds, and migratory land birds are present in and around the Project Area, LAA, and RAA. Potential environmental effects of the Project on migratory birds include the following:

- Change in Risk of Mortality or Physical Injury; and
- Change in Habitat Quality and Use.

Migratory birds within the LAA may be subject to increased risk of mortality or physical injury due to underwater sound emissions; collisions with the MODU, helicopters, and PSVs; harm from flaring from well test on the MODU; and exposure to other MODU or vessel-based threats. The presence of potential marine bird attractants (*e.g.*, Project-related lights, flares, sanitary wastes) may affect habitat quality and use in such a way that further increases risk of mortality or physical injury. Underwater sound emissions from MODU operation and VSP surveys may temporarily degrade the quality of migratory bird habitat and result in sensory disturbance that may trigger behavioural responses in migratory birds within the LAA. The localized degradation of water quality as a result of routine operational discharges and emissions, including the discharge of drill muds and cuttings as well as drilling and testing emissions, may similarly affect habitat quality and use for migratory birds within the LAA, as could atmospheric sound, artificial night lighting, and other sensory disturbance associated with MODU operation, helicopter transportation, and PSV operations. Accidental events (*e.g.*, spills), although unlikely to occur, could alter migratory bird habitat and/or result in species mortality or injury within the affected area, which could extend beyond the LAA into the RAA.

As summarized in Section 7.4.9, with the application of proposed mitigation and environmental protection measures, the residual environmental effects on Migratory Birds are predicted to be not significant. Under certain circumstances (refer to Section 8.5.3), some accidental event scenarios could potentially result in a significant adverse effect on Migratory Birds. However, with the implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects on Migratory Birds are unlikely to occur.

11.1.2 Changes to the Environment that Would Occur on Federal or Transboundary Lands

Section 5(1)(b) of CEAA, 2012 requires consideration of changes that may be caused to the environment that would occur on federal lands, in another province, or outside of Canada. Project activities and components described within the scope of this EIS have the potential to result in changes to the environment that would occur on federal lands, including federal submerged lands and the federal waters and airspace above those lands. In particular, the PSV route enters Canada's territorial sea and internal waters (Halifax Harbour). The Project Area is located within Canada's EEZ on the Southwest Scotian Slope portion of Canada's continental shelf. The helicopter route occurs in the airspace above these areas. All of these areas constitute federal lands as defined under section 2(1) of CEAA, 2012. Since the scope of the Project does not include any land-based activities or components, changes to the environment from routine Project activities are not anticipated to occur on terrestrial lands belonging to Her Majesty in right of Canada, or reserves, surrendered lands, or other lands that are set apart for the use and benefit of a band and are subject to the *Indian Act*.

A major accidental event (*e.g.*, subsea blowout) could result in transboundary effects outside of Nova Scotian or Canadian offshore areas if left unmitigated (refer to Section 8.4.7.3 and Appendix H). However, with the development and implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), a major accidental event is extremely unlikely to occur and would not be left unmitigated. The Project is therefore not anticipated to result in any changes to the environment that would occur outside of the Nova Scotian or Canadian offshore area.

Changes to Fish and Fish Habitat, Marine Mammals and Sea Turtles, and Migratory Birds will also occur on federal submerged lands and in federal waters; these components have been addressed in Section 11.1.1. Therefore, this section focuses on Special Areas, Commercial Fisheries, and Current Aboriginal Use of Lands and Resources for Traditional Purposes (*i.e.*, Aboriginal fisheries) with greater detail provided in Section 7.5 (Special Areas), Section 7.6 (Commercial Fisheries), and Current Aboriginal Use of Lands and Resources for Traditional Purposes (Section 7.7).

11.1.2.1 Special Areas

The Project Area overlaps spatially with a portion of the Scotian Slope EBSA and a very small portion of the Haddock Box (153 ha of the Haddock Box occurs within the Project Area). The Haddock Box and the Emerald Basin Sponge Conservation Area are within the LAA portion surrounding the PSV route to Halifax Harbour; several other Special Areas are located within the RAA (see Section 5.2.8). The potential environmental effect of the Project on Special Areas is a Change in Habitat Quality. However, given the localized effects of routine Project activities and the distance of the Special Areas from the Project, the Scotian Slope Shelf Break EBSA has the most potential to interact with routine Project activities.

Underwater sound from MODU operation, VSP surveys, PSV operations, and well abandonment may temporarily reduce the quality of habitat in the portions of the Scotian Slope EBSA and the Haddock Box encompassed by the LAA and result in localized sensory disturbance that may trigger behavioural responses in marine species within these areas. Under certain conditions (*e.g.*, winter), continuous sounds from the MODU during drilling may increase ambient noise levels as far afield as the Gully MPA and the Shortland Canyon (both of which are designated critical habitat for the Northern bottlenose whale), potentially resulting in a Change in Habitat Quality of these areas.

The presence of artificial night lighting and other attractants associated with MODU operation, and the localized reduction of water and sediment quality as a result of routine operational discharges and emissions, including the discharge of drill muds and cuttings as well as drilling and testing emissions, may similarly cause localized and temporary effects on habitat quality within the Scotian Slope EBSA. The deposition of drill muds and cuttings may smother marine benthos and cause changes to the composition of the benthic macrofauna community within a highly localized area of the Scotian Slope EBSA. Accidental events (*e.g.*, spills), although unlikely to occur, could temporarily affect habitat in Special Areas within the affected area, which could extend beyond the LAA into the RAA.

As summarized in Section 7.5.9, in consideration of the extent of the interactions and the planned implementation of known and proven mitigation, residual environmental effects on Special Areas are predicted to be not significant. If left unmitigated, and under certain metocean conditions, a major accidental event (*e.g.*, subsea blowout) could potentially result in a significant adverse effect on Special Areas, particularly with regard to the Gully MPA and Sable Island National Park Reserve (refer to Section 8.5.4). However, with the implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects on Special Areas are unlikely to occur.

11.1.2.2 Commercial Fisheries

Commercial fisheries are present in and around the Project Area, LAA, and RAA. The potential environmental effect of the Project on commercial fisheries is a Change in Availability of Fisheries Resources.

The establishment of a 500-m radius safety (exclusion) zone around the MODU may affect the availability of fisheries resources for commercial fishers by excluding commercial fishing activities within that radius. There is also potential for gear loss or damage to affect the availability of fisheries resources. Underwater sound emissions from MODU operation and VSP surveys may affect the availability of fisheries resources for commercial fishers if associated sensory disturbance within the LAA results in behavioural responses in commercially-fished species (*e.g.*, avoidance). However, given the small extent of the affected area, the temporary nature of the activities, the availability of other similar fishing areas, and the Notices to Shipping and Notices to Mariners that BP will provide regarding its operations, the potential for effects is considered low.

The reduction of water and sediment quality as a result of routine operational discharges and emissions, including the discharge of drill muds and cuttings as well as drilling and testing emissions, is unlikely to affect resource availability for commercial fishers given the temporary and localized nature of the potential effects around the wellsite. In addition, the potential smothering of marine benthos within a highly localized area of the Project Area/LAA, including benthic prey species for commercially fished species, as a result of the deposition of drill muds and cuttings is unlikely to affect the availability of fisheries resources for commercial fishers. Accidental events (*e.g.*, spills), although unlikely to occur, could damage fishing gear, result in the imposition of fisheries closures due to contamination of fish species commonly harvested for human consumption through CRA fisheries, alter fish habitat, and/or result in species mortality or injury for commercially important species within the affected area, which could extend beyond the LAA into the RAA.

As summarized in Section 7.6.9, in consideration of the extent of the potential interactions and the planned implementation of known and proven mitigation, residual environmental effects on Commercial Fisheries are predicted to be not significant. However, under certain circumstances, some accidental event scenarios could potentially result in a significant adverse effect on Commercial Fisheries (refer to Section 8.5.5). With the implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects on Commercial Fisheries are unlikely to occur.

11.1.2.3 Current Aboriginal Use of Lands and Resources for Traditional Purpose

Aboriginal communal commercial fisheries are present in and around the Project Area, LAA, and RAA. The potential environmental effect of the Project on Aboriginal communal commercial and FSC fisheries is a Change in Traditional Use. All of the mechanisms for a potential Change in Availability of Fisheries Resources for commercial fisheries, as well as the mitigation measures to reduce this environmental effect on commercial fisheries (refer to Section 11.1.3.2), are also applicable with respect to a potential Change in Traditional Use for Aboriginal communal commercial fisheries and FSC fisheries.

As summarized in Section 7.7.9, in consideration of the extent of the interactions and the planned implementation of known and proven mitigation, residual environmental effects on the Current Aboriginal Use of Land and Resources for Traditional Purposes are predicted to be not significant. Under certain circumstances some accidental event scenarios could potentially result in a significant adverse effect on Current Aboriginal Use of Land and Resources for Traditional Purposes (refer to Section 8.5.6). However, with the development and implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects on the Current Aboriginal Use of Lands and Resources for Traditional Purposes are unlikely to occur.

With respect to Aboriginal peoples, the potential effects of any change that may be caused to the environment on health and socio-economic conditions; physical and cultural heritage; the current Aboriginal use of lands and resources for traditional purposes; or any structure, site or thing that is of historical, archaeological, paleontological, or archaeological significance are summarized in Section 11.2.1 of this EIS, in accordance with section 5(1)(c) of CEAA, 2012.

11.1.3 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 and 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 regulatory approvals necessary to conduct an offshore drilling program are an Operations Authorization (Drilling) and a Well Approval (Approval to Drill a Well) pursuant to the Accord Acts and their regulations. A *Fisheries Act* authorization is not expected to be required in support of the Project, as Project activities and components are not predicted to result in "serious harm to fish" (*i.e.*, the death of fish or any permanent alteration to, or destruction of, fish habitat) for species that are part of or support a CRA fishery. Although drilling discharges will result in localized alteration of benthic habitat, these effects will not be permanent and are not anticipated to affect CRA species. In advance of drilling, seabed surveys at the proposed wellsites will be conducted to confirm the absence of habitat-forming coral and unique benthic habitat at the chosen drilling locations.

This section focuses on changes to the environment other than those referred to under section 5(1)(a) and (b) of CEAA, 2012, which are considered in Sections 11.1.1 or 11.1.2 of this EIS.

11.1.3.1 Atmospheric Environment

Project activities and components authorized by the CNSOPB under these regulatory approvals may cause changes to the environment as outlined above in Section 11.1.1 and 11.2.2. Project activities and components could also result in a change to the atmospheric environment through the release of air emissions and generation of sound emissions associated with operation of the MODU, PSVs, and helicopters.

Project discharges and emissions will be in compliance with the requirements of MARPOL and/or the OWTG, at levels that are intended to be protective of the environment. As noted in Section 6, all nearshore and offshore Project-related vessel operations will take place in Canada's portion of the North American Emission Control Area (ECA), which was established under amendments to the *Dangerous Chemicals Regulations* pursuant to the *Canada Shipping Act* that were adopted in 2013 under Annex VI to MARPOL. New standards have been implemented for the ECA that are designed to progressively reduce allowable emissions of key air pollutants by ships such that, by 2020, emissions of sulphur oxide will be reduced by 96% and nitrogen oxides by 80% (Transport Canada 2013). As noted in Section 2.8.1, the Project is predicted to emit approximately 295.8 tonnes of CO_2 per day, which represents approximately 0.59% of Nova Scotia's average daily emission of CO_2. Atmospheric sound is assessed with respect to the Migratory Birds VC and residual environmental effects are predicted to be not significant (refer to Section 7.4). Underwater sound is assessed with respect to Fish and Fish Habitat (refer to Section 7.2), Marine Mammals and Sea Turtles (refer to Section 7.3) and Migratory Birds (refer to Section 7.4) and residual environmental effects for all VCs are predicted to be not significant.

11.1.3.2 Terrestrial Environment

As per the EIS Guidelines, the EIS must identify any changes related to the terrestrial environment including:

- landscape disturbance;
- migratory bird habitat, including losses, structural changes, fragmentation of habitat and wetlands used by migratory birds;
- critical habitat for federally listed species at risk; and
- key habitat for species important to Aboriginal current use of resources.

Routine Project activities and components are not predicted to interact with the terrestrial environment, including migratory bird habitat, critical habitat for SAR, or key habitat for species important to Aboriginal current use of resources.

The loading and refueling of PSVs in Halifax Harbour will occur at existing industrial facilities and not result in any landscape disturbance, or changes to migratory bird habitat, or critical habitat for SAR, or habitat for species important to Aboriginal current use of resources. Nearshore approaches to the harbor contain migratory bird habitat including habitat for the endangered Piping Plover on the western shore of McNabs Island. Halifax Harbour and its approaches are also within the distribution range of Barrow's Goldeneye (*Bucephala islandica*), and Harlequin Duck (*Histrionicus histrionicus*), both of which are listed as Special Concern on Schedule 1 of SARA (Environment Canada 2015). Section 5.2.7.3 describes areas of significance for migratory birds. PSVs will enter and leave Halifax Harbour using established shipping lanes. Incremental atmospheric sound emitted from the PSVs would be minor and not expected to adversely affect migratory birds (including species at risk) nesting or foraging nearby.

Routine Project activities (including PSV operations) are not predicted to interact with the terrestrial environment and therefore will not affect key habitat for species important to Aboriginal current use of resources.

In the unlikely event of a major accidental event (*e.g.*, subsea blowout), there could potentially be some interaction with the shoreline environment thereby potentially resulting in any or all of the changes to the terrestrial environment listed in the EIS Guidelines and referred above (refer to Section 8.4 and Appendix H). However, with the development and implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), a major accidental event is extremely unlikely to occur and would not be left unmitigated. The Project is therefore not likely to result in any changes to the terrestrial environment.

11.2 EFFECTS OF CHANGES TO THE ENVIRONMENT

This section summarizes the effects of changes that may be caused by the Project on the components of the environment listed in section 5(1)(c) and 5(2)(b) of CEAA, 2012, including those that are directly linked or necessarily incidental to federal decisions that would allow the Project to proceed. Conclusions in this section are summarized from the detailed analyses in Sections 7 through 9 and are categorized as follows:

- effects of changes to the environment occurring in Canada of changes to the environment on Aboriginal people; and
- effects of changes to the environment that are directly linked or necessarily incidental to federal decisions.

11.2.1 Effects of Changes to the Environment on Aboriginal People

Effects of changes to the environment on Aboriginal People as outlined in the EIS Guidelines are presented in Section 7.7 Aboriginal Use of Lands and Resources for Traditional Purposes. This section of the EIS summarizes the effects of changes to the environment on Aboriginal people caused by the Project in accordance with section 5(1)(c) of CEAA, 2012. In particular, changes to the following environmental components are summarized:

- health and socio-economic conditions;
- the current Aboriginal use of lands and resources for traditional purposes; and
- physical and cultural heritage and any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Given its distance offshore, the Project is unlikely to affect any receptors that would be sensitive to atmospheric air or sound emissions from Project activities and components or accidental events. As stated in Section 2.8.1, Project-related air emissions for criteria air contaminants will remain well below the regulatory thresholds for human health effects. Emissions and discharges from routine drilling operations will meet OWTG and will not result in contamination of sediments or marine fish tissues such that consumption of fish species would result in adverse health effects. Thus, the Project is not expected to result in significant residual adverse environmental effects on the health of Aboriginal or non-Aboriginal people.

Accidental events (*e.g.*, spills), although unlikely to occur, could result in contamination of fish species commonly harvested for human consumption through communal commercial or CRA fisheries. However, fisheries closures would be imposed in the event of such an incident, thereby preventing human exposure to contaminated food sources. Similarly, the imposition of an exclusion zone around the affected area(s) would prevent human contact with spilled oil.

The TUS was conducted to characterize traditional use of marine waters in and around the Project Area and to identify potential interactions, issues and concerns with respect to effects on the current Aboriginal use of resources for traditional purposes. The TUS identifies several communal commercial fisheries that are active in and around the Project Area. Based on interviews conducted as of April 2016, the TUS reports that there are no known FSC fisheries currently occurring in the Project Area. Lobster, clams and scallop are fished within the LAA, and several finfish and invertebrate species are fished within the RAA for FSC purposes (MGS and UINR 2016). However, the TUS also acknowledges that this does not imply that FSC fisheries are not occurring in the Project Area or that the Project Area may not be accessed for future FSC fisheries needs. A precautionary approach is therefore taken, assuming that FSC fisheries could potentially occur in the Project Area and LAA, as well as the RAA. BP also acknowledges that species fished for FSC purposes could be harvested outside the RAA but could potentially temporarily interact with the Project during migration activities through the Project Area or LAA.

As described in Section 7.7, the Project may interact with Aboriginal communal commercial and FSC fisheries, potentially resulting in a Change in Traditional Use. The mechanisms for this potential environmental effect on Aboriginal fisheries are similar to those considered with respect to a Change in Availability of Fisheries Resources for commercial fisheries in Section 11.1.2.3. Information regarding traditional Aboriginal fisheries and traditional resource use has been gathered through engagement with Aboriginal groups (refer to Section 4), including the preparation of a TUS (refer to Appendix B). In consideration of the extent of the interactions and the planned implementation of known and proven mitigation (refer to Section 7.7), Project activities and components are not predicted to result in a loss of access to lands and resources for traditional purposes (beyond the 500-m radius safety [exclusion] zone established temporarily around the MODU), a change in availability of fisheries resources, or serious harm to fish that are part of or support a CRA fishery. Residual environmental effects on Current Aboriginal Use of Lands and Resources for Traditional Purposes are therefore predicted to be not significant.

Under certain circumstances, some accidental event scenarios could potentially result in a significant adverse effect on Aboriginal fisheries. However, with the development and implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects on the Current Aboriginal Use of Lands and Resources for Traditional Purposes are unlikely to occur.

Project activities and components are not anticipated to result in any changes to the environment that would have an effect on Aboriginal or non-Aboriginal physical and cultural heritage areas, sites, structures, or other resources (or access to or availability of those areas, sites, structures, or resources). Given the distance offshore, heritage areas sites, structures, or other such resources are not anticipated to be present in the Project Area. BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitives are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.

In the unlikely event of a spill, a temporary exclusion zone may be placed around the affected area which could affect access to heritage sites or resources. No cultural heritage areas, sites, structures, or other such resources have been identified in or around the Project Area during the public, stakeholder, or Aboriginal engagement activities completed to date (refer to Sections 3 and 4).

11.2.2 Effects of Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions

Section 5(2)(b) of CEAA, 2012 requires consideration of the effects of changes 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, if any of the following are affected:

- health and socio-economic conditions; and
- physical and cultural heritage and any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Table 11.2.1 summarizes the changes to the environment that are linked to federal decisions on the Project which are required under the Accord Acts and the *Fisheries Act*.

Table 11.2.1 Summary of Changes to the Environment that are Potentially Contingent on Federal Decisions

Federal Decision	Changes (Potential Environmental Effects)	Affected VCs
Accord Acts Authorizations (Operations Authorization and Well Approval under the Accord Acts and *Nova Scotia Offshore Petroleum Drilling and Production Regulations*)	Change in Risk of Mortality or Physical Injury	• Fish and Fish Habitat • Marine Mammals and Sea Turtles • Migratory Birds
	Change in Habitat Quality and Use	• Fish and Fish Habitat • Marine Mammals and Sea Turtles • Migratory Birds
	Change in Habitat Quality	• Special Areas
	Change in Availability of Fisheries Resources	• Commercial Fisheries
	Change in Traditional Use	• Current Aboriginal Use of Lands and Resources for Traditional Purposes
Fisheries Act Authorization (Authorization for Serious Harm to Fish under section 35(2)(b) of the *Fisheries Act*)	Change in Risk of Mortality or Physical Injury	• Fish and Fish Habitat
	Change in Habitat Quality and Use	• Fish and Fish Habitat

Operations Authorizations and Well Approvals under the Accord Acts sanction offshore exploration drilling projects in their entirety. Therefore, Project activities and components are directly linked or necessarily incidental to these authorizations.

For the same reasons as explained above with respect to the effects of changes to the environment on Aboriginal people (refer to Section 11.2.1), Project activities and components are not expected to result in changes to the environment that would have an effect on health conditions; physical and cultural heritage; or any structure, site or thing that is of historical, archaeological, paleontological or architectural significance for Aboriginal or non-Aboriginal people. However, effects on socio-economic conditions may occur from the following potential changes to the environment:

- Change in Risk of Mortality or Physical Injury for fish;
- Change in Habitat Quality and Use for fish;
- Change in Availability of Fisheries Resources (for commercial and Aboriginal fisheries); and
- Change in Traditional Use for Aboriginal fisheries.

Given that these potential changes to the environment are temporary and localized around the MODU and PSVs, and that other suitable fish habitat and fishing areas are readily available throughout the RAA, these potential changes to the environment are not anticipated to substantially affect socio-economic conditions for commercial or Aboriginal fishers (refer to Sections 7.6 and 7.7).

In consideration of the extent of the interactions and the planned implementation of known and proven mitigation, as described in Sections 7.2, 7.6, and 7.7, residual environmental effects from routine activities on Fish and Fish Habitat, and associated residual environmental effects on socio-economic conditions pertaining to Commercial Fisheries and Current Aboriginal Use of Lands and Resources for Traditional Purposes, are predicted to be not significant.

11.3 SUMMARY OF CHANGES MADE TO THE PROJECT SINCE ORIGINALLY PROPOSED

The Project, as proposed, demonstrates adherence to standard industry and regulatory policies, procedures and best management practices. Through the environmental assessment process, including engagement with public and regulatory stakeholders, and Aboriginal persons, environmental management planning for the Project has generally informed the Project and confirmed the applicability of standard mitigation measures that have been accepted previously for similar offshore exploration drilling projects in the same regional area. A specific example of where engagement resulted in changes to the Project was input provided by government technical experts on the spill dispersion modelling approach. This improved the accuracy of spill modelling results and effects predictions which will also improve emergency response and incident management planning for the Project.

11.4 SUMMARY

The Project has the potential to result in residual adverse environmental effects in relation to the following considerations:

- changes to components of the environment within federal jurisdiction;
- changes to the environment that would occur on federal or transboundary lands;
- changes to the environment that are directly linked or necessarily incidental to federal decisions;
- effects of changes to the environment occurring in Canada of changes to the environment on Aboriginal people; and
- effects of changes to the environment that are directly linked or necessarily incidental to federal decisions.

The residual environmental effects of routine Project activities and components on Fish and Fish Habitat, Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries, and Current Aboriginal Use of Lands and Resources for Traditional Purposes are predicted to be not significant.

In the unlikely event of a Project-related accidental event resulting in the large-scale release of oil (*e.g.*, blowout), effects to Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries, and Current Aboriginal Land and Resource Use for Traditional Purposes have potential to be significant if the spill trajectory overlaps spatially and temporally with sensitive receptors. However, with the implementation of proposed well control, spill response, contingency, and emergency response plans (refer to Section 8.3), significant residual adverse environmental effects are unlikely to occur.

12.0 ENVIRONMENTAL MANAGEMENT AND MONITORING

12.1 ENVIRONMENTAL MANAGEMENT PLANS

As detailed in Section 1.3.1 of this EIS, BP's operating management system includes requirements and guidance for the identification and management of environmental and social impacts. BP's ability to be a safe and responsible operator depends, in part, on the capability and performance of contractors and suppliers. Contractors and subcontractors shall be required to demonstrate conformance with the requirements that have been established, including HSSE standards and performance requirements. Bridging documents are necessary in some cases to define how BP's safety management systems and those of BP's contractors will align to manage risk on a site.

BP will develop environmental management plans to verify that appropriate measures and controls are in place in order to reduce the potential for environmental effects as well as provide clearly defined action plans and emergency response procedures to protect human and environmental health and safety. As part of the CNSOPB authorization process for exploration drilling (refer to Section 1.5.1), BP will submit the following plans to the CNSOPB for review and approval:

- an Environmental Protection Plan (EPP);
- a Safety Plan;
- an Incident Management Plan (IMP);
- a Spill Response Plan (SRP); and
- a Canada-Nova Scotia Benefits Plan.

An EPP will be prepared in accordance with the Environmental Protection Plan Guidelines (C-NLOB *et al.* 2011b) and will serve as a summary and reference document that describes project-specific environment-related processes and documents. The EPP is used as a means to implement and track compliance with applicable regulatory requirements as well as commitments made during the EA process and subsequent approval process with the CNSOPB.

The Safety Plan, to be prepared in accordance with the Safety Plan Guidelines (C-NLOPB *et al.* 2011a), will present BP's plan for managing safety and risk during the proposed Project, and describe responsibilities and expectations for employees as well as contractors. The Safety Plan will describe processes associated with hazard identification and risk management, training and competency of personnel, incident reporting and investigation, and compliance and performance monitoring. The Safety Plan will also describe facilities and equipment critical to safety and describe the system in place for inspection, testing and maintenance.

As described in Section 8.3, an IMP and associated contingency plans will be prepared to define the response to incidents. The IMP will be a comprehensive document including practices and procedures for responding to an emergency event. The IMP will include, or reference, a number of specific contingency plans for responding to specific emergency events. The IMP and supporting specific contingency plans, including the SRP will be aligned with applicable regulations, industry practice and BP standards and will include response strategies, arrangements and procedures. These plans will be submitted to CNSOPB prior to the start of any drilling activity as part of the OA process. The SRP will be finalized in consultation with applicable regulatory authorities.

In accordance with s. 45 of the Accord Act and the Canada-Nova Scotia Benefits Plan Guidelines (CNSOPB 2011b), a Canada-Nova Scotia Benefits Plan will be prepared which will document BP's commitment to providing industrial benefits and employment opportunities on a full and fair basis for residents of Canada, and in particular, Nova Scotia, that arise from Project activities.

12.2 FOLLOW-UP AND MONITORING

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 any mitigation measures." In most cases, the effects of routine exploration drilling activities and effectiveness of mitigation measures are well-understood (refer to Section 7). Where the level of confidence in effects prediction is not high or an interest has been expressed by regulatory, public or Aboriginal stakeholders for additional information, follow-up and monitoring has been proposed.

In particular, BP is proposing to implement the following monitoring programs to address uncertainty and/or confirm effects predictions related to effects on the marine benthos (refer to Section 7.2 Fish and Fish Habitat), marine mammals and sea turtles (refer to Section 7.3), migratory birds (refer to Section 7.4), and Special Areas (refer to Section 7.5). The implementation schedule and program details will be developed in consultation with the appropriate regulatory agencies, including CNSOPB, DFO and Canadian Wildlife Service (CWS) as applicable. In some cases, as noted below, relevant information from other recent monitoring programs will be factored into the design of BP's monitoring program.

Table 12.2.1 Summary of Follow-up and Monitoring Programs for the Scotian Basin Exploration Drilling Project

Follow-up or Monitoring Program	Objective	Applicable VC(s)	Proposed Intervention/Adaptive Management	Schedule	Reporting
Sediment Survey	BP will conduct a visual (using a remote operated vehicle [ROV]) survey of the seafloor to assess the extent of sediment dispersion.	Fish and Fish Habitat	Survey is for data gathering purposes.	Drilling and Post-Drilling	BP will report observations of sedimentation noting radial extent from drill site. Reports will be provided to the CNSOPB within 90 days of well abandonment of the initial well.
Acoustic Monitoring Survey	BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the first phase of the drilling program to collect field measurements to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and the CNSOPB and in consideration of lessons learned from the underwater sound monitoring program that will be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project.	Fish and Fish Habitat Marine Mammals and Sea Turtles Special Areas	Survey is for data gathering purposes.	Drilling	BP will report monitoring results to DFO and CNSOPB within 30 days of data collection.
Marine Mammal and Sea Turtle Monitoring Program	Monitor and report on sightings of marine mammals and sea turtles during VSP surveys. Monitoring will include visual observations and use of passive acoustic monitoring (PAM) to inform decisions related to mitigation actions required during VSP operations when baleen whales, sea turtles, or any marine mammal listed on Schedule 1 of SARA are detected within a minimum 650-m predetermined exclusion zone.	Marine Mammals and Sea Turtles	Shutdown or delay of VSP operations when baleen whales, sea turtles, or any marine mammal listed on Schedule 1 of SARA are detected within a minimum 650-m predetermined exclusion zone	VSP Survey	In the event that a vessel collision with a marine mammal or sea turtle occurs, BP will contact the Marine Animal Response Society or the Canadian Coast Guard to relay incident information. Following the program, copies of the marine mammal and sea turtle observer reports will be provided to DFO and the CNSOPB. Following the program, recorded PAM data will be provided to DFO so that this information can be used to help inform understanding of marine mammals in the area.
Migratory Bird Mortality Monitoring	Carry out routine checks for stranded birds or bird mortality on the MODU and PSVs and compliance with the requirements for documenting and reporting any stranded birds (or bird mortalities) to the CWS during the drilling program.	Migratory Birds	Survey is for data gathering purposes.	Mobilization to Well Abandonment	If a Species at Risk (SAR) is found alive (stranded) or dead on the MODU or PSV, a report will be sent to CWS within 24 hours of identification. Reporting of live migratory seabirds captured and released will be recorded in accordance with a Migratory Bird Permit issued by CWS. A bird monitoring report will be submitted to the CNSOPB within 90 days of well abandonment.

For a complete list of mitigation, monitoring and reporting commitments to be fulfilled, including physical environment monitoring and ongoing consultation and engagement with commercial and Aboriginal fishers, refer to Table 13.2.1.

BP will submit a report to the CNSOPB documenting the implementation schedule (prior to drilling) and the outcome of follow-up and monitoring programs (post-abandonment) of each well, along with any additional conditions of approval, as applicable. The implementation schedule and results will be made available online for public information.

In addition to monitoring and reporting associated with mitigative commitments presented in this EIS, BP will be responsible for reporting to the CNSOPB in accordance with the *Drilling and Production Regulations and Data Acquisition and Reporting Regulations*. The Drilling and Production Guidelines (C-NLOPB and CNSOPB 2011) and Data Acquisition and Reporting Guidelines (CNSOPB 2011c) describe the extensive testing, measurement, monitoring and reporting requirements to be conducted during an exploratory well drilling program. Incidents will be reported in accordance with the *Incident Reporting and Investigation Guidelines* (C-NLOPB and CNSOPB 2012). Examples of CNSOPB reporting requirements for exploration drilling include (but are not limited to):

- Survey Plan to confirm the location of the well on the seafloor;
- daily Drilling Report summarizing drilling and related operations, including completion, workover, well intervention, or any other well operation;
- daily site-specific meteorological forecast and report of ice conditions;
- monthly Compliance Monitoring and Reporting for Waste Discharges, where specific qualitative or quantitative discharge limits are identified in the Environmental Protection Plan;
- annual Chemical Selection Report that outlines each chemical used in the past year, including the hazard rating, quantity used, and its ultimate fate;
- annual Safety Report including a summary of lost or restricted workday injuries, minor injuries and safety-related incidents and near-misses that have occurred during the preceding year; and efforts undertaken to improve safety;
- Well Operations Report (within 30 days after the end of a well operation) that includes details on the well operations such as any problems encountered during well operation, the completion fluid properties, engineering data, impact of the well operation on the performance of the well, and rig release date;
- Well Termination Report (within 30 days of well termination date);
- annual Work Plan Report which includes an understanding of what activities occurred in the previous year, what activities are planned for each upcoming year and how the progress

compares with the initial Work Plan submitted to the CNSOPB at the beginning of the licence term;

- Environmental Report within 90 days of the rig release date for each exploration well including a physical environment report and summary of environmental protection matters; and
- Investigation Report submitted no later than 21 days following the incident or near-miss identifying root causes, casual factors and corrective actions.

13.0 CONCLUSIONS

BP is proposing to conduct an exploration drilling program on ELs 2431, 2432, 2433, and 2434. The Scotian Basin Exploration Drilling Project may involve the drilling, testing and abandonment of up to seven wells between 2018 and 2022. This document has been prepared to meet the requirements of an EIS pursuant to CEAA, 2012 as specified by Project-specific EIS Guidelines (CEA Agency 2015a, refer to Appendix A) as well as EA requirements of the CNSOPB pursuant to the Accord Acts.

13.1 SUMMARY OF POTENTIAL EFFECTS

The assessment methods used in the preparation of this EIS included an evaluation of the potential environmental effects for each valued component (VC) that may arise during routine operations and potential accidental events which may occur as part of the Project. The assessment methods also included an evaluation of potential cumulative effects to consider whether there is potential for the residual environmental effects of the Project to interact cumulatively with the residual environmental effects of other past, present, or future (*i.e.*, certain or reasonably foreseeable) physical activities in the vicinity of the Project.

In support of the EA process, supporting studies were undertaken including a traditional use study (Appendix B), drill waste dispersion modelling (Appendix C), acoustic modelling (Appendix D), and oil spill fate and trajectory modelling (Appendix H).

The scope of the Project evaluated as part of this EIS was selected to align with the EIS Guidelines. Routine and accidental events were assessed against a number of VCs, specifically Fish and Fish Habitat, Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries and Current Aboriginal Use of Lands and Resources for Traditional Purposes. The selected VCs encompassed candidate VCs listed in the EIS Guidelines not included as VCs in their own right. For example, Species at Risk and Species of Conservation Concern were considered as part of Fish and Fish Habitat VC, the Marine Mammals and Sea Turtles VC, and the Migratory Birds VC rather than as a stand-alone VC to eliminate repetition throughout the EIS and Marine Plants were addressed, as relevant, in the Fish and Fish Habitat VC.

Routine operations represent physical activities that would occur throughout the life of the Project and include the presence and operation of the MODU (including light and underwater sound emissions), waste management (including discharge of drill muds and cuttings and other discharges and emissions), VSP, supply and servicing operations (helicopter transportation and PSV operations) and well abandonment. These activities reflect the scope of the Project as outlined in the EIS Guidelines and represent physical activities that would occur throughout the life of the Project forming the basis of the effects assessment.

Accidental events that could potentially occur during exploration drilling and could potentially result in adverse environmental effects were identified and evaluated. Potential accidental events that were identified include small spills which could occur during operations and maintenance activity, small to medium size batch spills which could occur on the MODU and PSVs and a subsea blowout. Accidental events which could give rise to a spill are unlikely and the probability of a large oil spill occurring during an exploration drilling project is very low (refer to Appendix H). However, as discussed in Section 8.5, significant adverse residual environmental effects could potentially occur to Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries, and Current Aboriginal Use of Lands and Resources for Traditional Purposes in the unlikely event of a large accidental spill which could occur as a result of a blowout.

The key environmental factors that may affect the Project include reduced visibility, high winds and waves, and geohazards (such as shallow gas pocket or abnormal pressure zones). However, engineering design, operational procedures, geohazard assessments, and other mitigation measures will reduce the potential adverse effects on, and risks to, the Project. The MODU will be designed for harsh weather conditions. Adverse residual effects of the physical environment on the Project are predicted to be not significant.

Potential interactions between the VCs and Project activities included in the scope of the EIS, which formed the basis for the effects analysis are presented in Table 13.1.1. Proposed mitigation measures are presented in Table 13.2.1 and an overview of the effects analysis is presented in Table 13.3.1.

Table 13.1.1 Potential Project-VC Interactions and Effects

Project Activities and Components	Fish and Fish Habitat		Marine Mammals and Sea Turtles		Migratory Birds		Special Areas	Commercial Fisheries	Current Aboriginal Use of Lands and Resources for Traditional Purposes*
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Habitat Quality	Change in Availability of Fisheries Resources	Change in Traditional Use
Routine Activities									
Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety [exclusion] zone and underwater sound)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)	✓	✓		✓	✓	✓	✓	✓	✓
Vertical Seismic Profiling	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 13.1.1 Potential Project-VC Interactions and Effects

Project Activities and Components	Fish and Fish Habitat		Marine Mammals and Sea Turtles		Migratory Birds		Special Areas	Commercial Fisheries	Current Aboriginal Use of Lands and Resources for Traditional Purposes*
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Habitat Quality	Change in Availability of Fisheries Resources	Change in Traditional Use
Supply and Servicing Operations (including helicopter transportation and PSV operations)		✓	✓	✓	✓	✓	✓	✓	✓
Well Abandonment		✓		✓			✓	✓	✓
Accidental Events									
Small Diesel Batch Spill from the MODU (10 bbl)	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 13.1.1 Potential Project-VC Interactions and Effects

Project Activities and Components	Fish and Fish Habitat		Marine Mammals and Sea Turtles		Migratory Birds		Special Areas	Commercial Fisheries	Current Aboriginal Use of Lands and Resources for Traditional Purposes*
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Habitat Quality	Change in Availability of Fisheries Resources	Change in Traditional Use
Medium Diesel Batch Spill from the MODU (100 bbl)	✓	✓	✓	✓	✓	✓	✓	✓	✓
PSV Diesel Spill	✓	✓	✓	✓	✓	✓	✓	✓	✓
Well Blowout	✓	✓	✓	✓	✓	✓	✓	✓	✓
SBM Spill (surface release [60 m^3 or 337 bbl] and subsea release [573 m^3 or 3,604 bbl])	✓	✓	✓	✓	✓	✓	✓	✓	✓

* Considers Aboriginal and Treaty Rights

13.2 SUMMARY OF MITIGATION, MONITORING AND FOLLOW-UP COMMITMENTS

Mitigation is proposed to reduce or eliminate adverse environmental effects. Most potential environmental effects will be addressed by general design mitigation and best management practices, and by VC-specific mitigation. A summary of mitigation, monitoring and follow-up commitments is provided in Table 13.2.1.

Table 13.2.1 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
General		
1	Contractors and subcontractors shall be required to demonstrate conformance with the requirements that have been established, including HSSE standards and performance requirements.	12.1
2	As part of the CNSOPB authorization process for exploration drilling, BP will submit the following plans to the CNSOPB for review and approval: • an Environmental Protection Plan (EPP); • a Safety Plan; • an Incident Management Plan; • a Spill Response Plan; and • a Canada-Nova Scotia Benefits Plan.	12.1
3	BP will obtain a Certificate of Fitness from an independent third party Certifying Authority for the MODU prior to commencement of drilling operations in accordance with the *Nova Scotia Offshore Certificate of Fitness Regulations*.	9.2
4	The observation, forecasting and reporting of physical environment data will be conducted in accordance with the *Offshore Physical Environment Guidelines* (NEB *et al.* 2008).	9.2
5	BP and contractors working on the Project will regularly monitor weather forecasts to forewarn PSVs, helicopters and the MODU of inclement weather or heavy fog before it poses a risk to their activities and operations. Extreme weather conditions that are outside the operating limits of PSVs or helicopters will be avoided if possible. Captains/Pilots will have the authority and obligation to suspend or modify operations in case of adverse weather or poor visibility that compromises the safety of PSV, helicopter, or MODU operations.	9.2
6	Icing conditions and accumulation rates on PSVs, helicopters, and the MODU will be monitored during fall and winter operations, particularly when gale-force winds may be combined with air temperatures below -2°C (DFO 2012c).	9.2
7	Safe work practices will be implemented to reduce exposure of personnel to lightning risk (*e.g.*, restriction of access to external areas on the MODU or PSV during thunder and lightning events).	9.2
8	Prior to any drilling activity, BP will conduct a comprehensive regional geohazard baseline review (GBR), followed by detailed geohazard assessments for each proposed wellsite.	2.2, 9.2
9	The well design and location for the proposed wells have not yet been finalized. Once confirmed, these details for the wells will be provided for review and approval to the CNSOPB as part of the OA and ADW for each well submitted in association with the Project.	2.3.2

Table 13.2.1 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
10	Prior to installation on the well, the BOP stack will be pressure tested on the MODU deck, and then again following installation on the well to test the wellhead connection with the BOP.	2.5
11	BP will continue to engage commercial and Aboriginal fishers to share Project details as applicable and facilitate coordination of information sharing. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers.	3.4, 4.5, 7.6, 7.7
12	BP will provide details of the safety (exclusion) zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Notices to Shipping and Notices to Mariners. Details of the safety (exclusion) zone will also be communicated during ongoing consultations with commercial fishers.	7.6, 7.7
13	Project-related damage to fishing gear, if any, will be compensated in accordance with the Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2002).	7.6, 7.7, 8.5.5.2, 8.5.6.2
Presence and Operation of MODU		
14	To maintain navigational safety at all times during the Project, obstruction lights, navigation lights and foghorns will be kept in working condition on board the MODU and PSVs. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.	2.4, 7.6, 7.7, 9.2
15	The MODU will be equipped with local communication equipment to enable radio communication between the PSVs and the MODU's bridge. Communication channels will also be put in place for internet access, and enable communication between the MODU and shore.	2.4
16	In accordance with the Nova Scotia Offshore Drilling and Production Regulations, a safety (exclusion) zone (estimated to be a 500-m wide radius) will be established around the MODU within which non-Project related vessels are prohibited.	2.4.1, 8.1.3.1
17	BP will conduct an imagery based seabed survey in the vicinity of wellsites to ground-truth the findings of the GBR. This includes confirming the absence of shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling. If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.	2.2, 7.2, 7.5, 9.2, 11.2
18	No Project well locations will be located within the Haddock Box.	7.2, 7.5
19	Lighting will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.	7.2, 7.4
20	PSV and MODU contractors will have a Maintenance Management System designed to ensure that the vessels and MODU, and all equipment, are well maintained and operated efficiently.	7.3

Table 13.2.1 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
21	Routine checks for stranded birds will be conducted on the MODU and PSVs and appropriate procedures for release will be implemented. If stranded birds are found during routine inspections, they will be handled using the protocol outlined in *The Leach's Storm Petrel: General Information and Handling Instructions* (Williams and Chardine 1999), including obtaining the associated permit from CWS. Activities will comply with the requirements for documenting and reporting any stranded birds (or bird mortalities) to CWS during the drilling program.	7.4
Waste Management		
22	Air emissions from the Project will adhere to applicable regulations and standards including the Nova Scotia *Air Quality Regulations* under the Nova Scotia *Environment Act,* the National Ambient Air Quality Objectives (SO_2, NO_2, total suspended PM, and CO) and the Canadian Ambient Air Quality Standards (fine PM).	2.8
23	Ultra-low sulphur diesel (ULSD) fuel will be used for the Project wherever practicable and available.	2.8.1
24	Offshore waste discharges and emissions associated with the Project (*i.e.*, operational discharges and emissions from the MODU and PSVs) will be managed in accordance with relevant regulations and municipal bylaws as applicable, including the OWTG and International Convention for the Prevention of Pollution from Ships (MARPOL), of which Canada has incorporated provisions under various sections of the *Canada Shipping Act*. Waste discharges not meeting legal requirements will not be discharged to the ocean and will be brought to shore for disposal.	2.8, 7.2, 7.3, 7.4, 7.5
25	Selection of drilling chemicals will be in accordance with the OCSG which provides a framework for chemical selection to reduce potential for environmental effects. During planning of drilling activities, where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds and cements will be preferentially used. Where feasible the chemical components of the drilling fluids will be those that have been rated as being least hazardous under the OCNS scheme and as PLONOR by OSPAR.	2.8, 7.2, 7.3, 7.4, 7.5
26	Discharges of SBM mud and cuttings will be managed in accordance with the OWTG. SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained "synthetic on cuttings" on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG. In accordance with OWTG, no excess or spent SBM will be discharged to the sea. Spent or excess SBM that cannot be re-used during drilling operations will be brought back to shore for disposal.	2.8, 7.2, 7.3, 7.4, 7.5
27	Excess cement may be discharged to the seabed during the initial phases of the well, which will be drilled without a riser. Once the riser has been installed, all cement waste will be returned to the MODU. Cement waste will then be transported to shore for disposal in an approved facility.	2.8, 7.2, 7.3, 7.4, 7.5
28	Small amounts of produced water may be flared. If volumes of produced water are large, some produced water may be brought onto the MODU for treatment so that it can be discharged in line with the OWTG.	2.8, 7.2, 7.3, 7.4, 7.5
29	Deck drainage and bilge water will be discharged according to the OWTG which state that deck drainage and bilge water can only be discharged if the residual oil concentration of the water does not exceed 15 mg/L.	2.8, 7.2, 7.3, 7.4, 7.5

Table 13.2.1 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
30	Ballast water will be discharged according to IMO *Ballast Water Management Regulations* and Transport Canada's *Ballast Water Control and Management Regulations.* The MODU will carry out ballast tank flushing prior to arriving in Canadian waters.	2.8, 7.2, 7.3, 7.4, 7.5
31	Sewage will be macerated prior to discharge. In line with the OWTG and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements, sewage will be macerated so that particles are less than 6 mm in size prior to discharge.	2.8, 7.2, 7.3, 7.4, 7.5
32	Cooling water will be discharged in line with the OWTG which states that any biocides used in cooling water are selected in line with a chemical management system developed in line with the OCSG.	2.8, 7.2, 7.3, 7.4, 7.5
33	BOP fluids and any other discharges from the subsea control equipment will be discharged according to OWTG and OCSG.	2.8, 7.2, 7.3, 7.4, 7.5
34	Any hydrocarbons, such as gas, oil or formation water that are brought to surface as part of well test activity will be flared to enable their safe disposal. All flaring will be via one of two horizontal burner booms, to either a high efficiency burner head for liquids, or simple open ended gas flare tips for gases to minimize fall out of uncombusted hydrocarbons. Flaring will be optimized to the amount necessary to characterize the well potential and as necessary for the safety of the operation.	2.8, 7.2, 7.3, 7.4, 7.5
35	Liquid wastes, not approved for discharge in OWTG such as waste chemicals, cooking oils or lubricating oils, will be transported onshore for transfer to an approved disposal facility.	2.8, 7.2, 7.3, 7.4, 7.5
36	All waste generated offshore on the MODU and PSVs will be handled and disposed of in accordance with relevant regulations and municipal bylaws. Waste management plans and procedures will be developed and implemented to prevent unauthorized waste discharges and transfers.	2.8, 7.2, 7.3, 7.4, 7.5
37	Putrescible solid waste, specifically food waste generated offshore on the MODU and PSVs, will be disposed of according to OWTG and MARPOL requirements. In particular, food waste will be macerated so that particles are less than 6 mm in diameter and then discharged. There will be no discharge of macerated food waste within 3 nm from land.	2.8, 7.2, 7.3, 7.4, 7.5
38	Biomedical waste will be collected onboard by the doctor and stored in special containers before being sent to land for incineration.	2.8
39	Transfer of hazardous wastes will be conducted according to the *Transportation of Dangerous Goods Act.* Any applicable approvals for the transportation, handling and temporary storage, of these hazardous wastes will be obtained as required.	2.8, 7.2, 7.3, 7.4, 7.5
40	Information on the releases, wastes and discharges will be reported as part of a regular environmental reporting program in accordance with regulatory requirements as described in the OWTG.	2.8
Vertical Seismic Profiling		
41	VSP activity will be planned and conducted in consideration of the Statement of *Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP, DFO 2007b).	2.4.3.2, 7.2, 7.3, 7.5
42	BP will use the minimum amount of energy necessary to achieve operational objectives; reduce the energy at frequencies above those necessary for the purpose of the survey; and will reduce the proportion of energy that propagates horizontally.	7.2

Table 13.2.1 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
43	BP will consult with DFO regarding relevant findings from the 2014 CSAS review (DFO 2015a), including additional recommended mitigation that would be appropriate for implementation during VSP prior to Project commencement.	7.3
44	Marine Mammal Observers (MMOs) will be used to monitor and report on marine mammal and sea turtle sightings during VSP surveys to enable shutdown or delay actions to be implemented in the presence of a marine mammal or sea turtle species listed on Schedule 1 of SARA, as well as all other baleen whales and sea turtles (see also Section 7.3.10).	7.3
45	A ramp-up procedure (*i.e.*, gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before any VSP activity begins.	7.2, 7.3, 7.4
46	Shutdown procedures (*i.e.*, shutdown of source array) will be implemented if a marine mammal or sea turtle species listed on Schedule 1 of SARA, as well as all other baleen whales (*i.e.*, mysticetes) and sea turtles are observed within 650 m of the wellsite.	7.3
47	Passive acoustic monitoring (PAM) will be used to detect vocalizing marine mammals during conditions of low visibility (*e.g.*, fog and darkness). The technical specifications and operational deployment configuration of the PAM system will be optimized within the bounds of operational and safety constraints in order to maximize the likelihood of detecting cetacean species anticipated being in the area.	7.3
Supply and Servicing Operations		
48	Helicopters transiting to and from the MODU will fly at altitudes greater than 300 m (with the exception of approach and landing activities) and at a lateral distance of 2 km around active bird colonies when possible. Helicopters will avoid flying over Sable Island (a 2 km buffer will be recognized) except as needed in the case of an emergency.	2.4, 7.3, 7.4, 7.5
49	To reduce the risk of marine mammal vessel strikes, Project PSVs will avoid currently-identified critical habitat for the North Atlantic right whale (Roseway Basin) and northern bottlenose whale (the Gully, and Shortland and Haldimand canyons), during transiting activities within the LAA and outside the Project Area, except as needed in the case of an emergency.	7.3, 7.5
50	PSVs travelling from mainland Nova Scotia will follow established shipping lanes in proximity to shore. During transit to/from the Project Area, PSVs will travel at vessel speeds not exceeding 22 km/hour (12 knots) except as needed in the case of an emergency	7.3, 7.4, 7.6, 7.7
51	In order to reduce the potential for vessel collisions during transiting activities outside the Project Area, vessels will reduce speed in the event that a marine mammal or sea turtle is noted in proximity to the vessel.	7.3
52	In the event that a vessel collision with a marine mammal or sea turtle occurs, BP will contact the Marine Animal Response Society or the Canadian Coast Guard to relay incident information.	7.3
53	PSVs will maintain a 2 km avoidance buffer around Sable Island and associated bird colonies in that area except in the case of an emergency.	7.4
54	Should critical habitat be formally designated for leatherback sea turtle or other SAR within the RAA over the term of the exploration licences, BP will comply with applicable restrictions or mitigations developed for the marine shipping industry to reduce the risks of vessel strikes in these areas.	7.3

Table 13.2.1 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
55	Lighting on PSVs will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.	7.4
56	The PSVs selected for this Project will be equipped for safe all-weather operations, including stability in rough sea conditions and inclement weather. In addition, measures to reduce superstructure icing hazards on PSVs will be implemented as necessary and may include (DFO 2012c): • reducing vessel speed in heavy seas; • placing gear below deck and covering deck machinery, if possible; • moving objects that may prevent water drainage from the deck; • making the ship as watertight as possible; and • manual removal of ice if required under severe icing conditions.	9.2
57	A PSV will remain on standby at the MODU at all times in the event that operational assistance or emergency response support is required.	2.3.3
58	PSVs will undergo BP's internal verification process as well as additional external inspections/audits inclusive of the CNSOPB pre-authorization inspection process in preparation for the Project.	2.4.5.1, 9.2
Well Abandonment		
59	A seabed survey will be conducted at the end of the drilling program using an ROV to survey the seabed for debris.	2.4
60	Once wells have been drilled to TD and well evaluation programs completed (if applicable), the well will be plugged and abandoned in line with applicable BP practices and CNSOPB requirements. The final well abandonment program has not yet been finalized; however, these details will be confirmed to the CNSOPB as planning for the Project continues.	2.4, 7.1, 7.2, 7.3, 7.5, 7.6, 7.7
Accidental Events		
61	Procedures will be put in place to ensure that hoses are inspected and operated correctly to minimize the risk of an unintended release. The vessels, MODU and supply base will be equipped with primary spill contingency equipment to deal with spills in the unlikely event that they occur.	2.4
62	BP will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. The Project will operate under an Incident Management Plan (IMP) which will include a number of specific contingency plans for responding to specific emergency events, including potential spill or well control events. The IMP and supporting specific contingency plans, such as a Spill Response Plan (SRP), will be submitted to the CNSOPB prior to the start of any drilling activity as part of the OA process. The SRP will set out tactical response methods, procedures and strategies for safely responding to different spill scenarios. Tactical response methods that will be considered following a spill incident include: offshore containment and recovery; surveillance and tracking; dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.	8.5.1, 8.5.2, 8.5.3, 8.5.4, 8.5.5, 8.5.6
63	BP will undertake a NEBA as part of the OA process with the CNSOPB to evaluate the risks and benefits of dispersing oil into the water column, and will obtain regulatory approval for any use of dispersants as required.	8.5.1, 8.5.2, 8.5.3, 8.5.4

Table 13.2.1 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
64	In the event that oil does reach the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. A SCAT survey will be conducted to inform shoreline clean-up and remediation as applicable. BP will also engage specialized expertise to deflect oil from sensitive areas, and recover and rehabilitate wildlife species as needed.	8.5.3
65	BP will include procedures for informing fishers of an accidental event and appropriate response within the Fisheries Communication Plan. Emphasis is on timely communication, thereby providing fishers with the opportunity to haul out gear from affected areas, reducing potential for fouling of fishing gear.	8.5.5, 8.5.6
66	In the unlikely event of a spill, specific monitoring (*e.g.*, environmental effects monitoring) and follow up programs may be required and will be developed in consultation with applicable regulatory agencies.	8.5.5, 8.5.6
67	Incidents will be reported in accordance with the Incident Reporting and Investigation Guidelines (C-NLOPB and CNSOPB 2012). BP will submit a report to the CNSOPB documenting the implementation schedule (prior to drilling) and the outcome of follow-up and monitoring programs (post-abandonment) of each well, along with any additional conditions of approval, as applicable. The implementation schedule and results will be made available online for public information.	8.3
Follow-up and Monitoring		
68	BP will submit a report to the CNSOPB documenting the implementation schedule (prior to drilling) and the outcome of follow-up and monitoring programs (post-abandonment) of each well, along with any additional conditions of approval, as applicable. The implementation schedule and results will be made available online for public information.	12.2
69	BP will conduct a visual survey of the seafloor during and after drilling activities to verify drill waste dispersion modelling predictions.	7.2
70	BP will assess in consultation with the appropriate authorities the potential for undertaking an acoustic monitoring program during the drilling program to collect field measurements of underwater sound in order to verify predicted underwater sound levels. The objectives of such a program will be identified in collaboration with DFO and the CNSOPB and in consideration of lessons learned from the underwater sound monitoring program to be undertaken by Shell as part of the Shelburne Basin Venture Exploration Drilling Project in 2016.	7.2, 7.3, 7.5

13.3 RESIDUAL ENVIRONMENTAL EFFECTS

Section 7 of this EIS presents the residual environmental effects for routine operations for each VC. Table 13.3.1 summarizes the residual effect findings for each VC and indicates the significance of these effects. Section 8 of this EIS presents the residual environmental effects for accidental events for each VC. Table 13.3.2 summarizes the residual effect findings for each VC and indicates the significance of these effects. Where an effect is predicted to be significant (refer to Section 7 for significance criteria for each VC), the likelihood of that effect occurring is also presented.

Table 13.3.1 Summary of Residual Effects for Routine Operations

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation Reference (refer to Table 13.2.1)	Residual Effect Characterization					Other Criteria Used to Determine Significance (Ecological/ Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Extent	Duration	Frequency	Reversibility			
Fish and Fish Habitat	s. 5(1)(a)(i)	Change in Risk of Mortality or Physical Injury	Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety zone and underwater sound)	see Section 7.2.8.2 and Table 13.2.1	L	PA	MT	C	R	D	N	N/A
			Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)		L	PA	MT	R	R	D	N	N/A
			Vertical Seismic Profiling		L	LAA	ST	IR	R	D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety zone and underwater sound)		L	LAA	MT	C	R	D	N	N/A
			Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)		L	PA	MT	R	R	D	N	N/A
			Vertical Seismic Profiling		L	LAA	ST	IR	R	D	N	N/A
			Supply and Servicing Operations (including helicopter transportation and PSV operations)		L	LAA	MT	R	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	Change in Risk of Mortality or Physical Injury	Presence and Operation of MODU (including lights, safety zone and underwater sound)	see Section 7.3.8.2 and Table 13.2.1	L	PA	MT	C	R	D	N	N/A
			Vertical Seismic Profiling		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing (PSV Operations)		L	LAA	MT	R	R	D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of MODU (including well drilling and testing operations and associated lights, safety zone and underwater sound)		M	RAA	MT	C	R	D	N	N/A
			Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)		L	PA	MT	IR	R	D	N	N/A
			Vertical Seismic Profiling		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing (including helicopter transportation and PSV operations)		L	LAA	MT	R	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A

Table 13.3.1 Summary of Residual Effects for Routine Operations

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation Reference (refer to Table 13.2.1)	Residual Effect Characterization					Other Criteria Used to Determine Significance (Ecological/ Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Extent	Duration	Frequency	Reversibility			
Migratory Birds	s. 5(1)(a)(iii)	Change in Risk of Mortality or Physical Injury	Presence and Operation of MODU (including drilling and testing operations and associated lights, safety zone and underwater sound)	see Section 7.4.8.2 and Table 13.2.1	L-M	PA	MT	C	R	U	N	N/A
			Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)		N	PA	MT	R	R	U	N	N/A
			Vertical Seismic Profiling		N	PA	ST	IR	R	U	N	N/A
			Supply and Servicing (including helicopter transportation and PSV operations)		L	LAA	MT	R	R	U-D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of MODU (including drilling and testing operations and associated lights, safety zone and underwater sound)		L	PA	MT	C	R	U	N	N/A
			Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)		N	PA	MT	R	R	U	N	N/A
			Vertical Seismic Profiling		L	PA	ST	IR	R	U	N	N/A
			Supply and Servicing Operations (including helicopter transportation PSV operations)		N-L	LAA	MT	R	R	U-D	N	N/A
Special Areas	s. 5(1)(b)(i)	Change in Habitat Quality	Presence and Operation of MODU (including drilling and testing operations and associated lights, safety zone and underwater sound)	see Section 7.5.8.2 and Table 13.2.1	L-M	LAA	ST-MT	C	R	D	N	N/A
			Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)		L	PA	MT	R	R	U	N	N/A
			Vertical Seismic Profiling		L	LAA	ST	IR	R	D	N	N/A
			Supply and Servicing Operations (including helicopter transportation and PSV operations)		L	LAA	MT	R	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	U	N	N/A

Table 13.3.1 Summary of Residual Effects for Routine Operations

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation Reference (refer to Table 13.2.1)	Residual Effect Characterization					Other Criteria Used to Determine Significance (Ecological/ Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Extent	Duration	Frequency	Reversibility			
Commercial Fisheries	s. 5(2)(b)(i)	Change in Availability of Fisheries Resources	Presence and Operation of MODU (including well drilling and testing operations and associate lights, safety zone and underwater sound)	see Section 7.6.8.2 and Table 13.2.1	L	LAA	MT	C	R	U	N	N/A
			Waste Management (including discharge of drill muds and cuttings and other drilling and testing emissions)		L	PA	MT	R	R	U	N	N/A
			Vertical Seismic Profiling		L	LAA	ST	IR	R	U	N	N/A
			Supply and Servicing Operations (including helicopter transportation and PSV operation)		L	LAA	MT	R	R	U	N	N/A
			Well Abandonment		L	PA	ST	IR	R	U	N	N/A
Current Aboriginal Use of Lands and Resources for Traditional Purposes	s.5(1)(c)(i) s.5(1)(c)(iii)	Change in Traditional Use	Presence and Operation of MODU (including well drilling and testing operations and associate lights, safety zone and underwater sound)	see Section 7.7.8.2 and Table 13.2.1	L	LAA	MT	C	R	U	N	N/A
			Waste Management		L	PA	MT	R	R	U	N	N/A
			Vertical Seismic Profiling		L	LAA	ST	IR	R	U	N	N/A
			Supply and Servicing Operations (including helicopter transportation and PSV operations)		L	LAA	MT	R	R	U	N	N/A
			Well Abandonment		L	PA	ST	IR	R	U	N	N/A

Key/Note:
VC specific definitions included for each VC in Section 7.
Environmental Effects under CEAA, 2012:
5(1)
(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:
- (i) fish as defined in section 2 of the *Fisheries Act* and fish habitat as defined in subsection 34(1) of that 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 of [CEAA, 2012];

(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

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

Significance:
S: Significant
N: Not Significant

Likelihood:
U: Unlikely
L: Likely
N/A: Not applicable

Table 13.3.1 Summary of Residual Effects for Routine Operations

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation Reference (refer to Table 13.2.1)	Residual Effect Characterization					Other Criteria Used to Determine Significance (Ecological/ Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Extent	Duration	Frequency	Reversibility			
(iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance. Certain additional 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 Act of Parliament other than CEAA, 2012. 5(2) (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.												

Table 13.3.2 Summary of Residual Effects for Accident Events

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Accidental Event Scenario	Mitigation Reference (refer to Table 13.2.1)	Residual Effect Characterization					Other Criteria Used to Determine Significance (Ecological/ Socio-economic Context)	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Extent	Duration	Frequency	Reversibility			
Fish and Fish Habitat	s. 5(1)(a)(i)	Change in Risk of Mortality or Physical Injury / Change in Habitat Quality and Use	10 bbl Diesel Spill	see Section 8.5.1.2 and Table 13.2.1	L	LAA	ST	S	R	U	N	N/A
			100 bbl Diesel Spill		M	RAA	ST	S	R	U	N	N/A
			PSV Diesel Spill		M	RAA	ST-MT	S	R	U	N	N/A
			Well Blowout		M	RAA*	ST-MT	S	R	U	N	N/A
			SBM Spill		L	LAA	ST	S	R	U	N	N/A
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	Change in Risk of Mortality or Physical Injury / Change in Habitat Quality and Use	10 bbl Diesel Spill	see Section 8.5.2.2 and Table 13.2.1	L	LAA	ST	S	R	U	N	N/A
			100 bbl Diesel Spill		M	LAA	ST	S	R	U	N	N/A
			PSV Diesel Spill		M	LAA	ST-MT	S	R	U	N	N/A
			Well Blowout		H	RAA*	ST-MT	S	R	U	S	U
			SBM Spill		L	LAA	ST	S	R	U	N	N/A
Migratory Birds	s. 5(1)(a)(iii)	Change in Risk of Mortality or Physical Injury / Change in Habitat Quality and Use	10 bbl Diesel Spill	see Section 8.5.3.2 and Table 13.2.1	L	LAA	ST	S	R	U	N	N/A
			100 bbl Diesel Spill		M	RAA	ST	S	R	U	S	U
			PSV Diesel Spill		M	RAA	ST-MT	S	R	U	S	U
			Well Blowout		H	RAA*	ST-MT	S	R	U	S	U
			SBM Spill		L	LAA	ST	S	R	U	N	N/A
Special Areas	s. 5(1)(b)(i)	Change in Habitat Quality	10 bbl Diesel Spill	see Section 8.5.4.2 and Table 13.2.1	L	LAA	ST	S	R	U	N	N/A
			100 bbl Diesel Spill		M	LAA	ST	S	R	U	N	N/A
			PSV Diesel Spill		L-M	LAA	ST-MT	S	R	U	N	N/A
			Well Blowout		H	RAA*	ST-MT	S	R	U	S	L
			SBM Spill		L	LAA	ST	S	R	U	N	N/A
Commercial Fisheries	s. 5(2)(b)(i)	Change in Availability of Fisheries Resources	10 bbl Diesel Spill	see Section 8.5.5.2 and Table 13.2.1	L	LAA	ST	S	R	U	N	N/A
			100 bbl Diesel Spill		M	RAA	MT	S	R	U	S	L
			PSV Diesel Spill		H	RAA	MT	S	R	U	S	L
			Well Blowout		H	RAA*	LT	S	R	U	S	L
			SBM Spill		L	LAA	ST	S	R	U	N	N/A
Aboriginal Use of Lands and Resources for Traditional Purposes	s.5(1)(c)(i) s.5(1)(c)(iii)	Change in Traditional Use	10 bbl Diesel Spill	see Section 8.5.6.2 and Table 13.2.1	L	LAA	ST	S	R	U	N	N/A
			100 bbl Diesel Spill		M	RAA	MT	S	R	U	S	L
			PSV Diesel Spill		H	RAA	MT	S	R	U	S	L
			Well Blowout		H	RAA*	LT	S	R	U	S	L
			SBM Spill		L	LAA	ST	S	R	U	N	N/A

Note:
See Table 13.3.1 for key.
In certain scenarios, effects may extend beyond the RAA as indicated by an "".

Table 13.3.3 summarizes the significance of residual effects identified above in Tables 13.3.1 and 13.3.2 for each VC for routine operations, cumulative effects and accidental events, and, where applicable, the likelihood of significant residual adverse environmental effects occurring.

Table 13.3.3 Summary of Residual Environmental Effects for Routine Operations, Accidental Events and Cumulative Effects

VC	Routine Operations	Accidental Effects		Cumulative Effects
	Significance of Residual Environmental Effect	Significance of Residual Environmental Effect	Likelihood of Significant Effect	Significance of Residual Environmental Effect
Fish and Fish Habitat	N	N	N/A	N
Mammals and Sea Turtles	N	S	L	N
Marine Birds	N	S	L	N
Special Areas	N	S	L	N
Commercial Fisheries	N	S	L	N
Current Aboriginal Use of Land and Resources for Traditional Purposes	N	S	L	N

Key:
N = Not significant residual environmental effect (adverse)
S = Significant residual environmental effect (adverse)
L = Low likelihood
N/A = Not Applicable

Mitigation is proposed to reduce or eliminate adverse environmental effects (Table 13.2.1). Mitigation measures have been proposed to address potential Project and cumulative effects and address all components of the Project scope. They include both general Project mitigation measures and best management practices as well as VC-specific mitigation measures. With the implementation of these proposed mitigation measures, residual adverse environmental effects of routine Project activities and components are predicted to be not significant for all VCs.

In the highly unlikely event of a Project-related accidental event resulting in the large-scale release of oil, effects to Marine Mammals and Sea Turtles, Migratory Birds, Special Areas, Commercial Fisheries, and Current Aboriginal Land and Resource Use for Traditional Purposes have potential to be significant if the spill trajectory overlaps spatially and temporally with sensitive receptors. However, with the implementation of proposed well control, spill response, contingency, and emergency response plans significant residual adverse environmental effects are unlikely to occur.

In summary, the Project is not likely to result in significant residual adverse environmental effects, including cumulative environmental effects, provided that the proposed mitigation is implemented.

BP recognizes the challenge of managing and meeting growing worldwide demand for energy while addressing climate change and other environmental and social issues. The proposed Project will contribute to energy diversification and is expected to generate industrial, employment, and social benefits. The Project is also expected to contribute to technological and scientific knowledge sharing in Canada and Nova Scotia, advancing the understanding of deepwater drilling operations offshore Nova Scotia.

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