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5.0 ENVIRONMENTAL EFFECTS ASSESSMENT SCOPE AND METHODS

5.1 Scope of Assessment

5.1.1 Scope of the Project

The Project under assessment is an offshore exploration drilling program comprising the drilling, testing and abandonment of up to ten exploration wells within a Project Area encompassing Husky's offshore licences on the Grand Banks. The Project Area is located approximately 350 km east of St. John's, NL, in the Northwest Atlantic Ocean (see Figure 2-1).

The scope of the Project to be assessed under CEAA 2012 and pursuant to the *Canada-Newfoundland Atlantic Accord Implementation Act*, and the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* includes the following Project activities and components (refer to Section 2 for details):

- presence and operation of MODU (presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; water management, well testing; cementing and completing wells)
- drilling-associated surveys (VSP and wellsite surveys; geotechnical / geophysical / environmental surveys; diving surveys; ROV surveys)
- waste management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; hazardous waste; oily water treatment; vent and flare system)
- supply and servicing (operation of helicopters and supply / support / standby / tow vessels within the Project Area)
- well abandonment (plugging, suspending, and abandoning of wells)

The assessment in Section 6 focuses on the potential environmental effects associated with these activities, which reflect the scope of the Project as outlined in the Final EIS Guidelines (CEA Agency 2018) (Appendix A) and represent routine physical activities that will occur throughout the life of the Project. Potential environmental effects that could occur in the event of an accident or malfunction are assessed separately in Section 7.

5.1.2 Factors to be Considered

Pursuant to section 19 of CEAA 2012, the federal EA of a designated project must address 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]
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

This EIS addresses all the applicable factors outlined in section 19 of CEAA 2012 and the EIS Guidelines (see Table E.1; Concordance Table).

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 addressed 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
   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
   iii. outside Canada

c) with respect to Indigenous 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
   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 when the carrying out of a designated 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 Husky will require authorizations from the C-NLOPB under the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Act* for the Project to proceed. No other authorizations are known to be required. 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 considered in defining the scope of the assessment, including the scope of factors to be considered. The Final EIS Guidelines (CEA Agency 2018) have been provided to Husky to establish the scope of the EIS (Appendix A).

5.2 Methods

5.2.1 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 ((IAIA) Principles of Environmental Impact Assessment Best Practice (IAIA 1999), and with the method used by Stantec for environmental assessments of projects assessed by the CEA Agency, including Shell's Shelburne Basin Venture Exploration Drilling Project (Shell 2014) and BP's Scotian Basin Exploration Drilling Project (BP 2016). The assessment method is structured to:

- identify the issues and potential effects that are likely to be important
- consider key issues raised by Indigenous peoples, stakeholders, and the public
- 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 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 Indigenous peoples, regulatory agencies, Husky, resource managers, scientists, key stakeholders, and/or the 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 5.2.2).

The potential environmental effects of Project activities and components are assessed in Section 6 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).

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 7 and 8, respectively).

Cumulative environmental effects are assessed in Section 9 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 near the Project. The significance of any identified cumulative environmental effects is also assessed in Section 9.

The results of modelling previously completed for Husky's WREP (Amec 2012; JASCO 2012) are summarized in Sections 2.6.1.1 (drilling waste) and 2.6.2.4 (noise) and cross-referenced where applicable throughout the EA. Results of EEM programs previously completed on the Grand Banks by Husky, Suncor Energy, and Hibernia are used to validate predictions to the extent possible. The results of various spill model scenarios from within the Project Area (Husky's WREP EA), are summarized in Section 7.2 and potential environmental effects associated with an accidental event is discussed in Section 7.3.

The environmental assessment framework used in this EIS is illustrated in Figure 5-1.

5.2.2 Selection of Valued Components

In addition to the Section 5 requirements of CEAA 2012, the selection of VCs was carried out in consideration of:

- regulatory guidance and requirements, including the Project-specific Final EIS Guidelines provided by the CEA Agency (2018) and included in Appendix A;
- technical aspects of the Project (i.e., the nature and extent of Project components and activities) (refer to Section 2);
- issues raised by regulatory agencies, key stakeholders, the public, and Indigenous peoples (refer to Section 3);
- existing environmental conditions in the Project Area and interconnections between the biophysical and socio-economic environment (refer to Section 4);
- experience and lessons learned from assessments for similar offshore projects (e.g., Husky Delineation/Exploration Drilling for Jeanne d'Arc Basin Area (LGL Limited 2007a), Nexen's Flemish Pass Basin Exploration Drilling Project (Nexen 2018), Statoil's Flemish Pass Exploration Drilling Project (Statoil 2017), Shell's Shelburne Basin Venture Exploration Drilling Project (Shell 2014), and BP's Scotian Basin Exploration Drilling Project (BP 2016)) as well as the SEA completed for Eastern Newfoundland (Amec 2014);
- the results of EEM programs previously completed on the Grand Banks by Husky, Suncor Energy, and Hibernia (refer to Section 2.6); and
- the professional judgment of the EA Study Team.

The VCs assessed in this EIS and the rationale for their selection or exclusion are presented in Table 5.1. Relevant sections of the EIS are referenced where applicable.

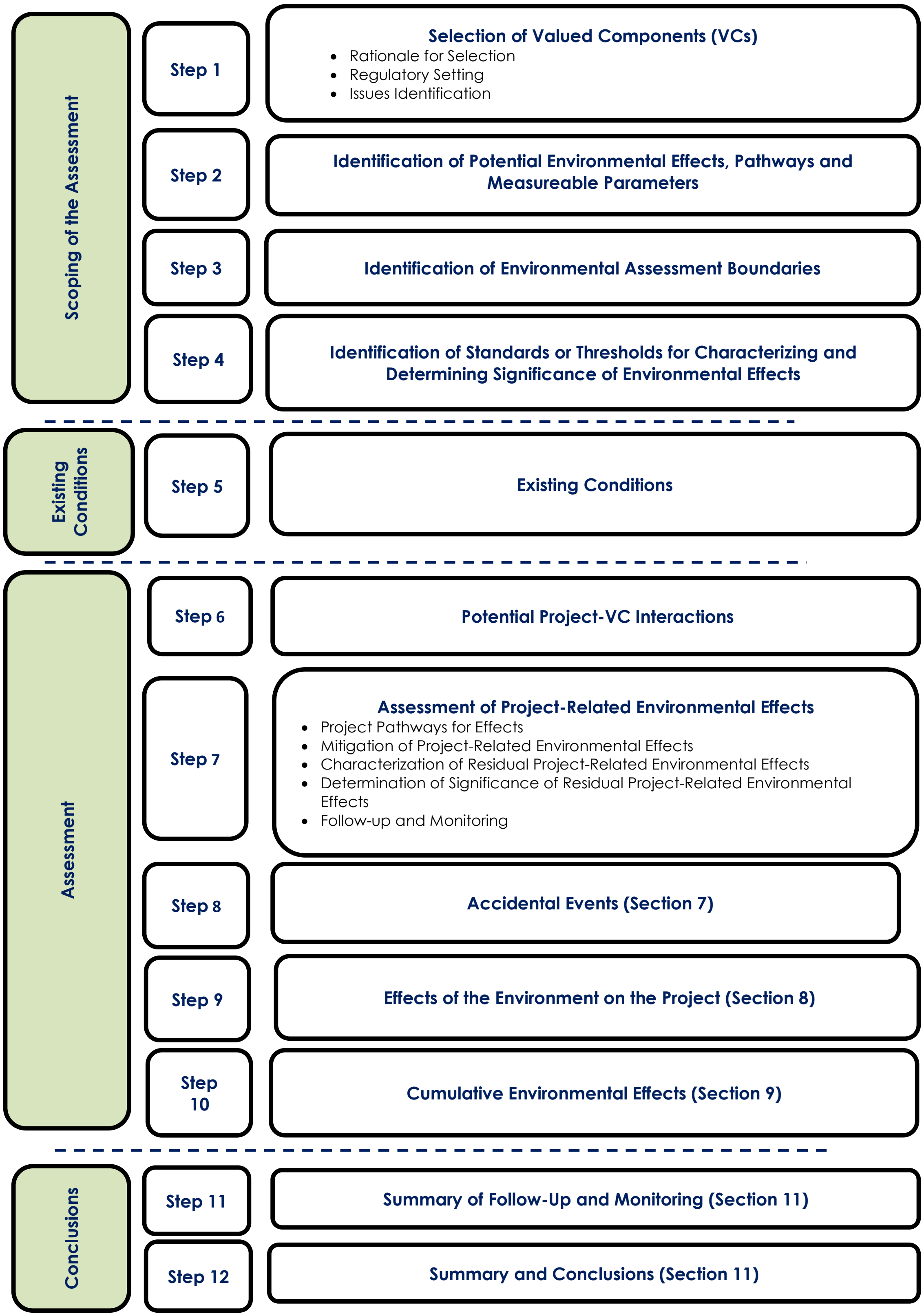


Figure 5-1 Overview of Environmental Assessment Process

Table 5.1 Selected Valued Components

Environmental Components Specified in Final 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, Sound, and Greenhouse Gas Emissions)	No dedicated VC has been selected for the atmospheric environment and climate. In consideration of previous air quality assessments (e.g., Husky Energy 2012a) the magnitude of potential emissions (see Section 2.6.4.1), the environmental setting and existing regulatory standards, that the potential environmental effects on atmospheric environment and climate do not warrant focused assessment. Potential changes to the atmospheric environment are assessed where applicable in the context of other VCs.	• All Project-related vessel operations will take place in Canada's portion of the North American Emission Control Area, 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 Emission Control Area 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% (Government of Canada 2013). • Exhaust emissions will comply with the Newfoundland and Labrador *Air Pollution Control Regulations, 2004*, Ambient Air Quality Objectives under the *Canadian Environmental Protection Act*, and any relevant regulations under MARPOL. Potential flaring will occur in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017). • Given its distance offshore and the limited atmospheric emissions predicted for the Project, as described in Section 2.6.4.1, 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 in the context of the relevant biological VCs (i.e., receptors).	• *Section 2.6.4.1:* Description of Project atmospheric emissions • *Sections 2.6.4.1 and 6.1:* Changes related to ambient sound levels • *Section 4.1:* Existing conditions regarding the atmospheric environment and climate • *Section 6.3:* Project-related changes to atmospheric sound levels and associated effects on the Marine Mammals and Sea Turtles VC • *Section 6.4:* Project-related changes to atmospheric sound and lighting levels and associated effects on the Migratory Birds VC • *Section 6.5:* Project-related changes to atmospheric sound and lighting levels and associated effects on the Special Areas VC • *Section 8:* Effects of the environment on the Project • *Section 10.4:* Summary of changes to the atmospheric environment since the Project requires a federal decision as identified in section 5(2) of CEAA 2012

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Marine Environment	No dedicated VC has been selected for the marine environment. To reduce redundancy and promote EA efficiency, environmental effects on the marine environment are assessed in the context of other marine VCs (i.e., Fish and Fish Habitat, Commercial Fisheries, Marine Mammals and Sea Turtles, Marine Birds, and Special Areas), where the analysis of effects and mitigation can be more specific, rather than as a stand-alone VC.	• Aspects of the marine environment have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Potential changes to the benthic environment are assessed in the context of the Fish and Fish Habitat VC. • Potential changes to marine water quality are assessed in the context of the Fish and Fish Habitat, Commercial Fisheries, Marine Mammals and Sea Turtles, Marine Birds, and Special Areas VCs. • Potential changes to underwater ambient noise and vibration levels are assessed in the context of the Fish and Fish Habitat, Commercial Fisheries, Marine Mammal and Sea Turtles, Marine Birds, and Special Areas VCs. • Potential changes to important and critical habitat for marine species are assessed in the context of the relevant biological VC.	• *Section 4:* Description of biophysical and socio-economic aspects of the marine environment • *Section 6.1*: Project-related environmental effects on the Fish and Fish Habitat VC • *Section 6.2*: Project-related environmental effects on the Commercial Fisheries VC • *Section 6.3*: Project-related environmental effects on the Marine Mammals and Sea Turtles VC • *Section 6.4*: Project-related environmental effects on the Migratory Birds VC • *Section 6.5*: Project-related environmental effects on the Special Areas VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Fish and Fish Habitat	Environmental effects on fish (including applicable species at risk (SAR) and SOCC) and fish habitat are assessed within the Fish and Fish Habitat VC. The scope of this VC includes corals and marine plants. This VC is included in consideration of its ecological importance, the socio-economic importance of commercial 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.	• Commercial fishing of several species within the Study Area • Several species of fish and corals (including SAR and SOCC) are known to occur in the vicinity of the Study 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. • Routine Project activities may result in changes affecting fish and fish habitat due to the following interactions with the environment: - sensory disturbance from underwater noise emissions associated with drilling and VSP activities - localized degradation and disturbance to the benthic environment (including benthic species) due to seabed deposition at drill site(s) (i.e., drill mud/cuttings, cement) - localized effects on marine water quality due to routine ocean discharges (e.g., waste water) • An accidental spill or release during Project activities could result in changes to fish and fish habitat, including: - reduced availability and quality of habitat - degradation and reduction in marine water quality - injury, mortality and/or reduced health for fish and other aquatic species • Project effects on fish and fish habitat have been identified as an issue of concern during	• *Section 4.2:* Existing conditions regarding fish and fish habitat • *Section 6.1:* Project-related environmental effects on the Fish and Fish Habitat VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		Indigenous and stakeholder engagement (refer to Section 3). • 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*, which includes corals, and aquatic species as defined in SARA, which includes marine plants).	
Marine Plants	No dedicated VC has been selected for marine plants. In consideration of the environmental setting and mitigation referred to in the next column, it has been determined that environmental effects on marine plants do not warrant focused assessment. Potential changes to marine plants are assessed where applicable in the context of the Fish and Fish Habitat and Special Areas VCs.	• Much of the Study Area is too deep for marine plants and/or contains soft substrates that are not conducive to marine plants (Amec 2014). However, some areas, such as the Virgin Rocks EBSA, support a relatively high abundance and diversity of marine plants (Amec 2014). • Marine plants are an important component of fish habitat. • Mitigation measures for the protection of fish and fish habitat are also protective of marine plants. It is therefore anticipated that mitigation proposed for the Fish and Fish Habitat VC are sufficient to mitigate environmental effects on marine plants.	• *Section 4.2:* Existing conditions regarding marine plants

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Migratory Birds and their Habitat	Environmental effects on migratory birds (including applicable SAR and SOCC and migratory bird habitat) are assessed within the Marine Birds VC. This VC is included in consideration of its ecological importance, the legislated protection of marine and migratory birds and other applicable SAR and SOCC, and the nature of potential Project-VC interactions.	• Several species of marine birds (including SAR and SOCC) are known to occur in the vicinity of the Study Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Routine Project activities may result in changes affecting marine birds due to the following interactions with the environment: - attraction of marine birds to the lighting (including flares) and discharges (e.g., food wastes) - mortality or stranding of marine birds • An accidental spill or release during Project activities could result in changes to marine birds, including injury, mortality, and/or reduced health for marine bird species. • 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 4.2:* Existing conditions regarding marine birds • *Section 6.4:* Project-related environmental effects on the Migratory Birds VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects
Species at Risk and Species of Conservation Concern	No dedicated VC has been selected for SAR and SOCC. To reduce redundancy and promote EA efficiency, environmental effects on SAR and SOCC are assessed as part of the Fish and Fish Habitat, Marine Mammals and Sea Turtles,	• Several SAR and SOCC are known to occur in the vicinity of the Study Area, including fish, marine mammals, sea turtles and marine birds, and have potential to be affected by routine Project activities as well as accidental events associated with the Project. • SAR and SOCC include the following: - federally protected species listed as "endangered", "threatened", or of	• *Section 4.2:* Summary of marine species at risk and SOCC (including applicable species of fish, corals, mammals, turtles, and birds) with potential to be affected by the Project • *Section 6.1:* Assessment of project-related environmental effects on

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	and Marine Birds VCs, where the analysis of effects and mitigation can be more specific, rather than as a stand-alone VC. Effects and/or mitigation specific to SAR and SOCC will be highlighted as applicable.	"special concern" on Schedule 1 of SARA, and their critical habitat - species assessed as "endangered", "threatened", or of "special concern" by the federal COSEWIC - species listed as "endangered", "threatened", or "vulnerable" under the *Endangered Species List Regulations* pursuant to the NL ESA, which are provincially protected • 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, potential environmental effects and mitigation measures taken to protect SAR and SOCC are also protective of secure species. • With respect to marine mammals and sea turtles, several of the species found in the area are considered SAR or SOCC. As a result, separate VCs to assess secure species and SAR/SOCC would be redundant. Potential changes to SAR/SOCC for these species are therefore assessed in the context of the Marine Mammals and Sea Turtles VC.	fish and coral species at risk and SOCC • *Section 6.3:* Assessment of project-related environmental effects on marine mammal and sea turtle SAR and SOCC • *Section 6.4:* Project-related environmental effects on marine bird SAR and SOCC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects
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	• Several species of marine mammals (including SAR and SOCC) are known to occur in the Study Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Routine Project activities may result in changes affecting marine mammals due to the following interactions with the environment:	• *Section 4.2:* Existing conditions regarding marine mammals • *Section 6.3:* Project-related environmental effects on the

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	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.	- sensory disturbance from underwater noise emissions associated with drilling and VSP activities - localized effects on marine water quality due to routine ocean discharges (e.g., waste water) - potential injury or mortality from vessel collisions • An accidental spill or release during Project activities could result in changes to marine mammals, including: - reduced availability and quality of habitat - degradation and reduction in marine water quality - injury, mortality, and/or reduced health for marine mammal species • 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).	Marine Mammals and Sea Turtles VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects
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-	• Marine turtles (including SAR and SOCC) are known to occur in the Study Area and have potential to be affected by Project activities and components as well as accidental events associated with the Project. • Routine Project activities may result in changes affecting sea turtles due to the following interactions with the environment: - sensory disturbance from underwater noise emissions associated with drilling and VSP activities	• *Section 4.2:* Existing conditions regarding sea turtles • *Section 6.3:* Project-related environmental effects on the Marine Mammals and Sea Turtles VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
	VC interactions. Marine mammals and sea turtles are considered within the same VC due to the similarities in their potential interactions with the Project.	- localized effects on marine water quality due to routine ocean discharges (e.g., waste water) - potential injury or mortality from vessel collisions • An accidental spill or release during Project activities could result in changes to sea turtles, including: - reduced availability and quality of habitat - degradation and reduction in marine water quality - injury, mortality, and/or reduced health for sea turtle species • 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).	
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 such as EBSAs VMEs and NAFO closure areas, including those protected under federal legislation) are known to occur in the vicinity of the Study 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 for certain SAR/SOCC.	• *Section 4.2:* Existing conditions regarding Special Areas • *Section 6.5:* Project-related environmental effects on the Special Areas VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Human Environment			
Indigenous Peoples	Environmental effects are assessed with respect to the Indigenous People and Community Values VC. This VC is included in consideration of its socio-economic, socio-cultural, and/or traditional importance; in recognition of potential or established Indigenous and Treaty rights; and due to the nature of potential Project-VC interactions.	• There are no Indigenous food, social and ceremonial (FSC) fisheries in NAFO Area 3KLMNO. The only FSC fishery in Newfoundland and Labrador is executed by Miawpukek First Nation in Conne River; it is a multi-species coastal fishery (D. Ball, pers. comm.) NAFO Area 3KLMNO, encompasses both the Project Area and the Study Area. • Indigenous commercial communal fishing activity is known to occur in the vicinity of the Study Area and has potential to be affected by Project activities and components as well as accidental events associated with the Project. • Project activities can potentially interact with species traditionally harvested, particularly migratory species. Section 5(1)(c) of CEAA, 2012 requires consideration of project-related environmental effects, with respect to Indigenous peoples, associated with a change to the environment on the current use of lands and resources for traditional purposes.	• *Section 3:* Context for Indigenous organizations (including locations of reserves and communities) • *Section 4.3:* Existing conditions regarding Indigenous resource use • *Section 6.6:* Project-related environmental effects on Indigenous People and Community Values VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects • *Section 11.2:* Effects of changes to the environment on Indigenous peoples • *Section 6.2*: Project-related environmental effects on the Commercial Fisheries VC
	In consideration of the environmental setting and the mitigation referred to in the next column, environmental effects on human health and physical and cultural heritage do not warrant focused assessment.	• Given the distance between the Project and Indigenous communities the Project is unlikely to have any effect on human health or physical and cultural heritage from routine Project activities and components, or from accidental events. • Project activities and components are not anticipated to result in any changes to the environment that would affect human health of Indigenous communities, given the spatial separation. Emissions will be discharged in	• *Section 2.5:* Routine waste discharges and emissions associated with the Project • *Section 4.3:* Existing conditions regarding human health • *Section 7.1:* Spill response measures • *Section 7.3:* Environmental effects of potential accidental events

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		accordance with allowable concentrations stated in the Husky's EPCMP and OWTG. • Accidental events (i.e., spills) associated with the Project could result in an effect on Indigenous commercial communal 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. • Accidental events may also affect traditionally harvested migratory species if they happen to overlap with the spill.	
Commercial Fisheries	Environmental effects on commercial fisheries, including Indigenous commercial communal fisheries, are assessed within the Commercial Fisheries VC. This VC is included in consideration of its economic importance and the potential for Project-VC interactions.	• Commercial fishing activity, including Indigenous commercial communal fishing activity, occurs within the Study Area and has potential to be affected by Project activities and components as well as accidental events associated with the Project. • Routine Project activities may result in the following changes to the environment that may affect commercial fishing activities, in and around the Project Area: o establishment of a safety zone, as required by the C-NLOPB, and associated spatial and temporal restrictions on commercial fish harvesting activity • An accidental spill during Project activities could result in the following changes to the environment that may affect commercial fisheries, including Indigenous communal fishing licences:	• *Section 4.3:* Existing conditions regarding commercial fisheries • *Section 6.2:* Project-related environmental effects on the Commercial Fisheries VC • *Section 7.3:* Environmental effects of potential accidental events • *Section 9.2:* Cumulative environmental effects

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		- contamination-related closure of commercial fishing areas, and associated restrictions on commercial fish harvesting activity - reduced catchability associated with damage to fishing gear (e.g., fouling) - changes in population size and health of individuals among commercial fish species, and associated loss of income through reduced catch value • Project activities can potentially interact with fisheries species harvested offshore, including migratory species.	
Recreational Fisheries and other Areas used for Recreational Activities	No dedicated VC has been selected for recreational fisheries and other areas used for recreational activities. In consideration of the environmental setting and the mitigation referred to in the next column, the environmental effects on recreational fisheries and other recreation do not warrant focused assessment. Changes to the environment potentially affecting species targeted for recreational fishing are assessed in the context of the Fish Habitat VC and Commercial Fisheries VC.	• Recreational fisheries and other forms of recreation are not known to occur in the vicinity of the Project Area. These activities are generally located closer to the nearshore and therefore do not have potential to be affected by Project activities and components or accidental events associated with the Project. • Mitigation measures for the protection of commercial fishing activity (and associated target fish species) are also protective of 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 Fisheries VC are sufficient to mitigate similar environmental effects on recreational fisheries.	• *Section 4.3:* Existing conditions regarding recreational activities • *Section 6.1:* Project-related environmental effects on the Fish and Fish Habitat VC • *Section 6.2:* Project-related environmental effects on the Commercial Fisheries VC • *Section 7.3:* Environmental effects of potential accidental events

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
Other Ocean Use (e.g., shipping, research, oil and gas, military activities, ocean infrastructure)	No dedicated VC has been selected for other ocean use. In consideration of the environmental setting and the mitigation referred to in the next column, environmental effects on other ocean use do not warrant focused assessment.	• 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 4.3:* Existing conditions regarding offshore ocean uses and infrastructure • *Section 9:* Potential interactions between residual Project-related environmental effects and the residual environmental effects of projects or activities carried out by other offshore users
Human Health and Socio-economic Conditions	No dedicated VC has been selected for human health and socio-economic conditions. In consideration of the environmental setting and the mitigation referred to in the next column, environmental effects on human health and socio-economic conditions do not warrant focused assessment.	• Given its distance offshore, the Project is 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 environment that would affect human health. Emissions will be discharged in accordance with allowable concentrations stated in the Husky's EPCMP and OWTG. • Accidental events (i.e., spills) associated with the Project could result in contamination of fish species commonly harvested for human consumption through commercial (including Indigenous commercial communal) and/or recreational fisheries. However, fisheries closures	• *Section 2.5:* Routine waste discharges and emissions associated with the Project • *Section 4.3:* Existing conditions regarding labor and economy • *Section 4.3:* Existing conditions regarding human health • *Section 7.1:* Spill response measures • *Section 7.3:* Environmental effects of potential accidental events • *Section 10:* Benefits of the Project

Environmental Components Specified in Final EIS Guidelines	VC Determination	Basis for Inclusion or Exclusion as a VC	Relevant EIS Section Reference(s)
		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. • The Project is expected to have economic benefits, including economic and contracting opportunities. Socio-economic benefits associated with the Project are discussed in Section 2.2	
Physical and Cultural Heritage (including structures, sites or things of historical, archaeological, paleontological or architectural significance)	No dedicated VC has been selected for physical and cultural heritage. In consideration of the environmental setting and the mitigation referred to in the next column, the environmental effects on physical and cultural heritage do not warrant focused assessment.	• 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. • There are no shipwrecks or legacy sites within the Project Area. • Information gathered during 3D seismic surveys, geotechnical and geohazard surveys, and pre-drill ROV site surveys in the Project Area will confirm the absence of cultural heritage resources on the seabed before any seabed disturbance takes place. • Offshore supply vessel and helicopter transport activities will not result in any ground/seabed disturbance. Therefore, they will not affect heritage resources.	• *Section 2.4.1:* Details regarding site surveys to be undertaken in the Project Area in advance of drilling • *Section 4.3:* Existing conditions regarding physical and cultural heritage • *Section 6.6*: Project-related environmental effects on Indigenous People and Community Values VC
Rural and Urban Settings	No dedicated VC has been selected for rural and urban settings.	• Rural and urban settings along the Newfoundland coastline are outside of the Study Area and therefore do not have potential to be affected by Project activities and components or accidental events associated with the Project.	• *Section 4.3:* Existing conditions regarding land use and nearshore ocean use • *Section 7.3:* Environmental effects of potential accidental events

The following six VCs were selected to facilitate a focused and effective EA process and supports public review:

- Fish and Fish Habitat
- Commercial Fisheries
- Marine Mammals and Sea Turtles
- Migratory Birds
- Special Areas
- Indigenous People and Community Values

Specific candidate VCs identified in the Final EIS Guidelines which were not selected as VCs in this EIS include marine plants, federal species at risk (which are assessed within the Fish and Fish Habitat VC, Marine Mammals and Sea Turtles VC, and Migratory Birds VC), air quality and greenhouse gas emissions, and the human environment. Marine plants are addressed, as relevant, in the fish and fish habitat VC. To eliminate repetition throughout the EIS, species at risk and species of conservation concern (SOCC) 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, and are summarized in Section 10.1.4 of this EIS. Air quality and greenhouse gas emissions are addressed in Section 2.6 of this EIS. Human environment aspects are discussed in Section 4.3. Given the lack of predicted interactions with most aspects of the human environment (as demonstrated in Table 5.1), it was not selected as a VC.

5.2.3 Effects Assessment Framework

The following sections describe the approach and organization of the effects assessment undertaken for each VC in Sections 6.1 to 6.6.

5.2.3.1 Regulatory and Policy Setting

The regulatory context is described for each individual VC, including an overview of applicable regulations, policies, and/or administrative mechanisms. This section helps to establish key aspects of the scope of assessment, including relevant definitions under legislation, measurable parameters, and significance thresholds, where applicable.

5.2.3.2 The Influence of Consultation and Engagement on the Assessment

Any VC-specific issues that have been raised during stakeholder and Indigenous consultation and 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.

5.2.3.3 Potential 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 6. 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.

5.2.3.4 Boundaries

Environmental effects are evaluated within spatial and temporal boundaries. The spatial boundaries, which are consistent for each VC, 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. The temporal boundaries, which may vary among VCs, 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 in consideration of:

- timing/scheduling of Project activities for all Project phases;
- known natural variations of each VC;
- information gathered on land and resource use;
- the time required for recovery from an environmental effect;
- potential for cumulative environmental effects; and
- by oil spill modelling conducted for Husky's White Rose Extension Project.

5.2.3.4.1 Spatial Boundaries

The spatial boundaries for the Project to be assessed are defined below with respect to Project activities and components.

- **Project Area**: The Project Area (Figure 2-1) encompasses the immediate area within which Project activities and components may occur. Well locations have not been identified but will occur within EL 1151, EL 1152 and EL 1155, within the Project Area. The spatial boundary of the Project Area has been delineated to account for all activities related to drilling a well, including transit of OSV and helicopter traffic to/from St. John's and vessel traffic associated with geohazard/environmental surveys. There are other existing ELs, PLs, and SDLs in the Project Area, but these are not part of the Designated Project.
- **Study Area:** The Study Area (Figure 2-1) is the area within which residual environmental effects from operational activities and accidental events may interact cumulatively with the residual environmental effects of other past, present, and future (certain or reasonably foreseeable) physical activities.

5.2.3.4.2 Temporal Boundaries

The temporal boundaries for the Project to be assessed encompass all Project phases, including well drilling, testing and abandonment. Up to 10 exploration wells will be drilled over the term of the ELs (i.e., between 2019 and 2027), and each well is anticipated to take up to approximately

80 days to drill to TVD. It is assumed that Project activities could occur year-round, with one or more wells potentially being drilled simultaneously.

5.2.3.5 Residual Effects Characterization

The following criteria are used to support characterization of the nature and extent of residual environmental effects on each VC.

- **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 or Study Area).
- **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 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 will occur.

5.2.3.6 Significance Definition

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 2015a), 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 section (Section 6). 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.

5.2.4 Existing Conditions

Existing conditions of the marine physical environment, marine biological environment, and socio-economic environment are described in Section 4 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 6, 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.

5.2.5 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 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 Husky will implement;
- identification and characterization of the nature and extent of residual environmental effects (i.e., those environmental effects that remain after the proposed mitigation measures have been applied) through application of the specific criteria (i.e., magnitude, geographic extent, duration, frequency, reversibility, and context) introduced in Section 5.2.3.5; and
- application of VC-specific significance definition thresholds (refer to Section 5.2.3.6) to determine the significance of the residual effects.

The level of confidence is provided for each determination of significance, which is based on published literature, environmental monitoring results, professional judgment and whether there are data gaps. Where a significant effect is predicted to occur, a determination of likelihood based on consideration of probability and certainty is given.

Following the determination of significance, follow-up and monitoring measures are recommended, where necessary, to verify environmental effects predictions or to assess the effectiveness of proposed mitigation measures.

5.2.6 Assessment of Accidental Events

Environmental effects associated with potential accidental events are assessed in Section 7. 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 7 provides further details regarding approach to the assessment for the potential accidental events.

5.2.7 Assessment of Effects of the Environment on the Project

Effects of the environment on the Project are assessed in Section 8. 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. Husky will only hire MODUs fit for purpose and ensure the appropriate certificates of fitness are in place.

5.2.8 Assessment of Cumulative Environmental Effects

Cumulative environmental effects are assessed in Section 9 of this EIS in accordance with the CEA Agency's (2016a) *Operational Policy Statement, 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 near 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 9 provides further details regarding the approach to the assessment of cumulative environmental effects.

6.0 ENVIRONMENTAL EFFECTS ASSESSMENT

6.1 Fish and Fish Habitat

6.1.1 Scope of Assessment

The fish and fish habitat VC includes marine finfish and shellfish their habitat, including benthic habitat, marine plants (including phytoplankton), water and sediment. Under Canada's *Fisheries Act*, 'fish habitat' refers to spawning grounds, nursery grounds and areas used for rearing, food supply and migration. Fish and fish habitat was selected as a VC because of:

- regulatory requirements of the *Fisheries Act*;
- potential for change in habitat quality and use;
- potential mortality, physical injury, or health due to project activities; and
- ecological, social, and economic importance of marine fish and fish habitat.

This VC is particularly important to fishers, fisheries managers, conservation organizations, marine scientists, and other local stakeholders. This VC also includes at risk marine fish species (i.e., at risk species listed on Schedule 1 of SARA or assessed as at risk by COSEWIC).

The definition of "fish" under the *Fisheries Act* is inclusive of marine mammals and sea turtles as marine animals; however, marine mammals and sea turtles are considered as a separate VC in Section 6.3. The Fish and Fish Habitat VC is also closely linked to the Special Areas VC in Section 6.5, as these areas provide important habitat for fish and coral species and the prey upon which fish species depend. Potential environmental effects on commercial and Indigenous fish harvesting are assessed separately in the context of the closely related Commercial Fisheries VC in Section 6.2 and the Indigenous People and Community Values VC in Section 6.6.

6.1.2 Regulatory and Policy Setting

Marine fish and fish habitat in Canada are protected under the *Fisheries Act*, administered by DFO, which focuses on protecting the productivity of commercial, recreational, and Aboriginal (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 2015). Offsetting is required by proponents of projects that cause serious harm to fish to maintain and enhance the productivity of the fishery (DFO 2013c). The deposition of a deleterious substance in waters frequented by fish is prohibited under section 36(3) of the *Fisheries Act*, which is administered by ECCC.

Fish species at risk are protected under the federal SARA, which focuses on protecting species and associated habitat whose populations are not secure. For this assessment, Sections 32, 33, and 58 of SARA are the most relevant, containing 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 marine fish species known to occur in the Study Area, though draft critical habitat does exist for wolffish (DFO 2018a).

Under section 79 of SARA, Ministerial notification is required if a project is likely to affect a listed wildlife species or its critical habitat. The 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, must ensure that measures are taken to avoid or lessen those effects and to monitor them.

6.1.3 The Influence of Consultation and Engagement on the Assessment

Key issues raised during stakeholder consultation and Indigenous people engagement for the Project to date include general concerns related to accidental events in the deep water. Questions and concerns were raised with respect to effects from offshore drilling and exploration on cold water corals, VMEs, and areas in the Flemish Pass inhabited by various commercial (redfish, flounder) and other groundfish.

6.1.4 Potential Effects, Pathways, and Measurable Parameters

Routine Project activities can interact with fish and fish habitat, primarily from approved operational discharges and underwater noise emissions and. In consideration of the potential interaction, and the policies in place to protect fish and their habitat, 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, physical injury, or health; and
- change in habitat quality and use (where habitat alterations are minor/temporary (e.g., drill cutting dispersion) quantity of habitat alteration is discussed).

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 allow for consideration of effects on fish species at risk. The effect pathways and measurable parameters are provided in Table 6.1.

Table 6.1 Potential 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, Physical Injury or Health	• Direct project effects on fish mortality, injury, or health due to direct interactions with individuals or indirectly through a change in habitat quality (degradation of water/sediment quality affecting fish health)	• Likelihood or estimated change in rate of mortality or injury • Concentration of total suspended solids in water column (mg/L) • Increase in silt + clay size fractions (i.e., "fines") in sediment particle size analysis • Chemical uptake in fish from drill cuttings/muds
Change in Habitat Quality and Use	• Change in fish habitat use due to physical disturbance, destruction of benthic habitats or alteration of water quality • Change in fish habitat quality due to a change in the physical/ chemical composition of sediment or water • Increased risk of exposure to underwater sound at levels capable of causing sensory disturbance	• Qualitative loss or alteration of habitat for spawning, rearing, feeding or mitigation • Changes in chemical and/or physical properties of sediment or water from drill cuttings/muds • Water column-total suspended solids (TSS) above published/industry standard thresholds for marine fish

6.1.5 Boundaries

Spatial boundaries and temporal boundaries for the assessment of fish and fish habitat are presented below.

6.1.5.1 Spatial Boundaries

Project Area: The Project Area (Figure 2-1) encompasses the immediate area within which Project activities and components may occur and direct physical disturbance to the marine benthic environment may take place. Well locations have not been identified but will occur within EL 1151, EL 1152, and EL 1155, within the Project Area. The spatial boundary of the Project Area has been delineated to account for all activities related to drilling a well, including transit of OSV and helicopter traffic to/from St. John's and vessel traffic associated with geohazard/environmental surveys, which may originate from Canadian or International waters.

Study Area: The Study Area (Figure 2-1) is the area within which residual environmental effects from operational activities and accidental events may interact cumulatively with the residual environmental effects of other past, present, and future (certain or reasonably foreseeable) physical activities.

6.1.5.2 Temporal Boundaries

The temporal boundaries for potential Project-related environmental effects on fish and fish habitat encompass all Project phases, including well site location surveys, well drilling, testing and abandonment. It is anticipated that exploratory drilling activities would commence in 2019 and continue intermittently throughout the term of the exploration licence, up to 2027. Well testing (if required, dependent upon drilling results) could also occur at any time during the temporal scope of this EA. Wells may be decommissioned and abandoned at any time within the temporal boundaries. The temporal scope of the EA accommodates drilling in EL 1151, EL 1152, and EL 1155 for the full term of each licence (period 1 and period 2). Within the overall temporal scope, well site surveys typically require five to seven days per well, VSPs typically take approximately one day per well and an individual well may take up to 80 days to complete. Drilling operations will not be continuous throughout the entire eight-year scope of the Project and will be dependent partially on rig availability and results from previous wells. If a semi-submersible or drill ship is selected as the preferred MODU option for the Project, then drilling activities have the potential to be conducted at any time of the year. If a jack-up rig is selected as the preferred method, then drilling would only occur during the ice-free season.

Fish can be found year-round near the Project Area carrying out various life cycle processes. Temporal considerations for the assessment of fish and fish habitat include seasonal aspects of their life cycles such as spawning and migration. Refer to Section 4.2.4 for details regarding marine fish species (i.e., species at risk and SOCC and species of importance to CRA fisheries) known to occur in the Study Area.

6.1.6 Residual Environmental Effects Characterization

The descriptors used to characterize residual environmental effects on fish and fish habitat are defined in Table 6.2.

Table 6.2 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 environmental effect relative to baseline	**Positive –** a residual environmental effect that moves measurable parameters in a direction beneficial to fish and fish habitat relative to baseline **Adverse –** a residual environmental effect that moves measurable parameters in a direction detrimental to fish and fish habitat relative to baseline **Neutral –** no net change in measurable parameters for the fish and fish habitat relative to baseline

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	The amount of change in measurable parameters or 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 a residual environmental effect occurs	**Project Area –** residual environmental effects are restricted to the Project Area **Study Area –** residual environmental effects extend into the Study Area
Frequency	Identifies how often the residual effect occurs and how often during the Project	**Single event –** effect occurs once **Multiple irregular event –** effect occurs at no set schedule **Multiple regular event –** effect occurs at regular intervals **Continuous –** effect occurs continuously
Duration	The period required until the measurable parameter or the VC returns to its existing condition, or the residual 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 **Irreversible –** permanent
Ecological and Socio-economic Context	Existing condition and trends in the area where residual 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

6.1.7 Significance Definition

A **significant adverse residual effect** on fish and fish habitat is defined as one that causes:

- a significant decline in abundance or change in distribution of fish populations within the Study Area, 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 2013d).

6.1.8 Summary of Existing Conditions for Fish and Fish Habitat

The following is a summary of the existing marine environment for fish and fish habitat; more detailed information is included in Sections 4.2.1 to 4.2.4.

The Project Area is located on the northeastern edge of the Grand Banks in the Jeanne d'Arc Basin area, including the existing White Rose field. Water depths in the Project Area range from 87 to 211 m. Surficial sediments are comprised of a blanket of fine- to medium-grained Adolphus Sand, which overlies a coarser, irregular substrate of Grand Banks Sand and Gravel (McElhanney 1981, 1982; Nortech Jacques Whitford 1998; FJGI 1999a, 1999b, 2000a, 2000b, 2005).

The Project Area and Study Area are known to support a variety of infaunal and epifaunal benthic species including sand dollars, anemones, clams, sea cucumbers, bryozoans, corals, ascidians, urchins, hydroids, polychaete worms, and three crab species. Dominant species in varying densities are sea stars, brittle stars, and bivalves (FGI 2012, in Husky Energy 2012a). Sampling during the commercial fish surveys of the Husky Environmental Effects Monitoring (EEM) programs since 2002 have found that the northern shrimp was the most abundant epibenthic species, followed by sea urchin and sand dollar (Husky Energy 2009, in Husky Energy 2012a). Less common were soft-shell clam, snow crab, toad crab, Iceland scallop, and sea star (*Asteroidea* sp.). These surveys found minor differences in the benthic communities between the mainly sandy substrate and mainly gravel substrate, particularly for the less abundant taxa. Section 4.2.9 describes several special areas within the Study Area that provide important habitat for corals and sponges, including the NAFO closure areas identified in Section 4.2.9.3 and shown on Figure 4-33. Deep-water corals and sponges located within the Study Area include stony corals, black wire and gorgonian corals, soft corals, sea pens, and sponges. The highest average coral biomass occurs between 600 and 900 m depth along the northeastern slope of the Grand Banks, in the Flemish Pass, and around the Flemish Cap. Within the Study Area, SBAs for sea pens, and large and small gorgonian corals can be found along the northern slope of the Grand Banks, directly north of the Project Area. SBAs for these same species can also be found within the Study Area along the Tail of the Bank area of the Grand Banks. Surveys of the Grand Banks and Newfoundland Shelf indicate a north-south gradient in total zooplankton biomass, with production declining from inshore areas to the shelf edge depending on the year (Dalley and Anderson 1998, in Amec 2014). The main zooplankton taxa found on the Grand Banks from a survey conducted by Dalley et al. (2001) during 1997 were copepods, comprising almost 90% of the total zooplankton. Ichthyoplankton densities along the Northeast Newfoundland Shelf and the Grand Banks can vary by orders of magnitude (Dalley and Anderson 1998, Bradbury et al. 1999, in Amec 2014) and community structure differs by year, season and location (Frank et al. 1992, Dalley et al. 1998, Bradbury et al. 2008, in Amec 2014). Ichthyoplankton assemblages on the Northeast Newfoundland Shelf and Grand Banks are largely dominated by capelin (73.5%), with lower abundances of sand lance (11.3%), lanternfish (5.9%), and Arctic cod (3.4%).

There are two SARA Schedule 1 fish species at risk with a high potential to be present year-round on the Grand Banks and Flemish Cap: northern and spotted wolffish. The northern Grand Banks encompasses an area identified as critical habitat for both northern and spotted wolffish, as it provides the necessary functions and features required to support the life cycle processes for the northern and/or spotted wolffish (DFO 2018a). The critical habitat was delineated using the Area of Occurrence approach based on the number of wolffish present at sea bottom temperature and depth. Approximately 665.80 km^2 (0.9%) of the Project Area overlaps with the spotted wolffish critical habitat. A proposed recovery strategy for northern wolffish and spotted wolffish and a management plan for the Atlantic wolffish have been prepared to promote wolffish population growth and recovery (DFO 2018a). As many as 20 fish SOCC may also be present year-round within the Project Area, with nine having a high potential for occurrence. The SARA status, COSEWIC designation, and information on the potential occurrence and timing of presence are listed in Table 4.24. This information has been compiled for all species at risk and SOCC.

6.1.9 Project Interactions with Fish and Fish Habitat

Physical Project-related activities that might interact with fish and fish habitat are identified in Table 6.3. These interactions are indicated by check marks and are discussed in Section 6.1.10 in the context of effects pathways, mitigation, and residual environmental effects. A justification is provided below for non-interactions where applicable.

Table 6.3 Project-Environment Interactions with Fish and Fish Habitat

Physical Activities	Environmental Effects	
	Change in Risk of Mortality, Physical Injury or Health	**Change in Habitat Quality and Use**
Presence and Operation of MODU (Presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; well testing; cementing and completing wells)	✓	✓
Drilling-associated Surveys (VSP and wellsite surveys; geotechnical/geophysical/environmental surveys; diving surveys; ROV surveys)	✓	✓
Waste Management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)	✓	✓

Physical Activities	Environmental Effects	
	Change in Risk of Mortality, Physical Injury or Health	**Change in Habitat Quality and Use**
Supply and Servicing (operation of helicopters and supply/support/standby/tow vessels within the Project Area)	–	✓
Well Abandonment (plugging and abandoning of wells)	✓	✓
Notes: ✓ = Potential interaction – = No interaction		

Due to a very limited interaction with the marine environment (i.e., very weak underwater sound transmission and no marine discharges) and associated fish and fish habitat, helicopter transportation is not predicted to interact with fish and fish habitat to cause a change in risk of mortality, physical injury, health or change in habitat quality and use.

Underwater sound associated with OSV traffic is not expected to be at levels that would cause health effects, injury, or mortality to marine fish species; therefore, operation of the OSVs (including transit and transfer activities) is not predicted to result in a change in risk of mortality for fish and fish habitat. Fish are also anticipated to temporarily avoid the immediate areas of OSV traffic, thereby reducing the risk of fish mortality or physical injury due to vessel strikes or contact with propeller blades.

6.1.10 Assessment of Residual Environmental Effects on Fish and Fish Habitat

6.1.10.1 Project Pathways

6.1.10.1.1 Change in Risk of Mortality, Physical Injury or Health

A change in risk of mortality to fish may result from waste management activities (particularly the discharging of drill muds and cuttings) smothering or crushing benthic species (e.g., fish, shellfish, sponges, and corals). The toxicity of drill muds and cuttings is also assessed as it relates to benthic species. Mortality may also result from underwater sound associated with the presence and operation of the MODU and drilling-associated surveys. 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. Drilling associated surveys (i.e., wellsite and VSP surveys) will also temporarily (typically less than one day per well) increase sounds levels in the marine environment. Early life stage fish (eggs and larvae) in close proximity to the seismic sound array may result in mortality from acute changes in pressure. Similarly, during abandonment, if shaped charges must be used in wellhead severance, mortality may result nearby from acute changes in pressure. Routine liquid discharges (cooling water, ballast water, bilge and deck water, and grey/ black) will be discharged in accordance with Husky's EPCMP which is based on the Offshore OWTG (NEB et al. 2010), Transport Canada's *Ballast Water Control and Management Regulations* and/or MARPOL as applicable, which are designed to be protective of the marine environment. The routine liquid discharges will not be at levels that would cause mortality or physical injury to fish species.

6.1.10.1.2 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 of the structure (i.e., MODU), noise from drilling, lighting, operation of seawater systems, waste water generation (domestic waste, sanitary waste), operation of helicopters and vessels, cementing and completing wells, surveys (geotechnical, geophysical and environmental), oily water treatment, and presence of no-fishing safety zone. The release of drill fluids and cuttings may result in a change in habitat from an increase in sediment grain-size, organic enrichment in sediments; an increased suspended particulate matter and turbidity in the water column.

The decommissioning and abandonment activities that could potentially interact with marine fish and fish habitat include: removal of the well head; plugging and abandoning of wells; operation of vessels; lighting; surveys (geotechnical, geophysical, and environmental); and the presence of a safety zone.

6.1.10.2 Mitigation

In consideration of the environmental effects pathways noted above, the following mitigation measures will be employed to reduce the potential environmental effects of the Project on fish and fish habitat:

- Lighting on the MODU is designed to comply with requirements stipulated in the Petroleum Occupational Safety and Health Regulations to ensure safe operations. There is no extraneous lighting. All lighting except navigational lighting is pointed downward.
- The loss of fish habitat will be mitigated through compliance with the *Fisheries Act*, including potential requirements for habitat offsetting, if required.
- To mitigate potential environmental effects on fish and fish habitat from discharges in the Project Area during the Project activities, Husky's EPCMP will be implemented based on the following regulations and guidelines:
  - All chemicals used will be screened as per the Offshore Chemical Selection Guidelines (OCSG) (NEB et al. 2009) and Husky's chemical management system and chemical screening program.
  - All routine discharge limits (i.e., deck drainage, bilge water, cooling water) will be in accordance with the OWTG (NEB et al. 2010), *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals* under the *Canada Shipping Act, 2001* and the International Conventions for the Prevention of Pollution from Ships (MARPOL).
  - Sewage will be macerated to a particle size of < 6 mm and discharged as per the OWTG.
  - Waste discharges not meeting OWTG requirements and domestic garbage will be transported to shore for disposal or recycled. Garbage is segregated as required and in compliance with waste disposal requirement and Husky Waste Management Plan.

  - Concentration of synthetic-based mud (SBM) on cuttings will be monitored on the MODU for compliance with the OWTG.
  - All foreign vessels operating in Canadian jurisdiction must comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act, 2001* during ballasting and de-ballasting activities.
- Mechanical means of wellhead severance will be preferential; should blasting be required to sever the wellhead, shape charges will be set below the sediment surface, minimizing the amount of explosive used.
- Adhere to *Canada Shipping Act* and industry best practices and follow marine traffic rules and regulations.
- As required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017a), mitigation measures for geophysical surveys will be consistent with the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP).

6.1.10.3 Characterization of Residual Project-related Environmental Effects

6.1.10.3.1 Change in Risk of Mortality, Physical Injury or Health

Mortality may result from underwater sound associated with the presence and operation of the MODU and drilling-associated surveys. Mortality of sessile invertebrates may also occur near the MODU due to discharge of drilling mud and cuttings (Neff 2010).

6.1.10.3.1.1 Presence and Operation of MODU

It is challenging to establish single sound exposure criteria for marine fish to predict physical or behavioural changes due to the variation in sound characteristics from different types of sound sources and differences in how sound affects different species, generally due to diversity in body type and physiology (Popper et al. 2014). Most research on sound exposure criteria for marine fish has focused on impulsive 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., air guns), in terms of injuries to fish, the US Fisheries Hydroacoustic Working Group proposes the dual criteria of a peak sound pressure level (SPL) of 206 dB re 1 μPa (peak) and cumulative sound exposure (energy) level (SEL) of 187 dB re 1 μPa^2s for fish 2 grams or heavier (Fisheries Hydroacoustic Working Group 2008). In consideration of this general criteria and the acoustic modelling conducted for the White Rose field (Husky Energy 2012a), physical injury effects to fish as a result of MODU operation would be localized to the area within metres of the thrusters. Aggregations of fish surrounding the thrusters are unlikely due to turbulence generated by the thruster propellers. It should also be noted that exposure to sound at these levels would be transient as mobile fish would be expected to react behaviourally at lower sound levels, moving away from these sources. Given that most 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.

Residual environmental effects associated with the presence and operation of the MODU on a change in risk of mortality, physical injury, or health for fish and fish habitat is predicted to be low in magnitude, restricted to the Project Area, medium-term (could persist for the duration of the drilling program) and reversible.

6.1.10.3.1.2 Drilling-associated Surveys

There is potential for mortality of fish and shellfish (particularly egg and larval stages) to occur during seismic surveys associated with drilling (i.e., wellsite survey and VSP). The greatest concern would apply to egg and larval stages of fish that occur near the surface during the survey periods. Dalen and Knutsen (1986, in Davis et al. 1998) studied the impact of air gun arrays on fish stock levels and concluded that mortality and tissue damage in juvenile cod are limited to distances of less than 5 m (16 ft) from the air guns, with most frequent and serious injuries at distances of less than 1.5 m (5 ft).

Under laboratory conditions, mortality or injury to eggs and larvae have only been observed at close range and at high intensity sound. A laboratory experiment by Payne et al. (2009) to determine potential environmental effects of seismic noise on monkfish eggs and larvae found that the difference between eggs and larvae exposed to sound pressure levels at 205 dB peak to peak and that of the control group was not statistically significant 48 to 72 hours after exposure. Payne et al. (2009) concluded that seismic surveys are unlikely to pose any threat to monkfish eggs or larvae that may float in veils at the surface during monkfish spawning. Application of a 'worst-case scenario' mathematical model to investigate the effects of seismic energy on fish eggs and larvae concluded that mortality rates caused by exposure to seismic energy are so low compared to natural mortality, the environmental effect of seismic activity on recruitment to a fish stock would be negligible (Saetre and Ona 1996).

Reviews of studies on the effects of seismic sound on marine life (DFO 2004b, 2004c; Payne et al. 2009; CEF 2011; Alexander 2015) report no direct evidence of mortality of adult fish or shellfish in response to seismic sound exposure at field operating levels. Survey activities will adhere to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*, as appended to the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017a) and will obtain required permits.

Residual environmental effects associated with drilling-associated surveys on a change in risk of mortality, physical injury or health for fish and fish habitat is predicted to be low in magnitude and could affect a portion of the Project Area, but will be infrequent (occurring as one VSP per well), and short-term (no more than a day per well, totaling 10 days over 8 years), and reversible once the underwater sound emissions from the surveys cease.

6.1.10.3.1.3 Waste Management

The OWTG outline recommended practices for the management of waste materials from oil and gas drilling facilities operating in offshore areas regulated by the C-NLOPB. 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 which are then reflected within Husky's EPCMP. Operational discharges during drilling will be in compliance with the EPCMP for the drilling installation. Substances, wastes, residues, or discharges not identified in the EPCMP are not permitted for discharge. In addition to the OWTG, MARPOL and the *Canada Shipping Act* and its regulations will apply to offshore waste discharges from ships associated with the Project.

A combination of WBM and SBM will be used to drill a well. Wastes generated from drilling include drilling mud and cuttings that retain a portion of the drilling muds. WBM is sometimes considered less harmful to the environment, as it contains mainly water and cannot form surface sheens. SBM can form sheens on the surface, but on the other hand, does not disperse as widely as WBMs. The main component of SBM is a synthetic-based oil called Pure Drill IA-35. This fluid has been shown to be non-toxic (acutely or chronically) through both operator testing and government testing (Payne et al. 2000). The main component of WBM is fresh water or seawater. Both WBM and SBM include bentonite (clay) and/or barite. Other chemicals that are used include potassium chloride, caustic soda soda ash, viscosifiers, filtration-control additives and shale inhibitors, added to control mud properties.

Zooplankton generally, do not have high avoidance capability to discharges in water as their horizontal movements are controlled by oceanographic conditions. However, certain taxa of coastal and estuarine copepods have shown an avoidance behavior to hydrocarbon-contaminated water (Seuront 2010). Exposure experiments with *C. finmarchicus* and *C. hyperboreus* to water soluable fractions of hydrocarbons did not affect hatching success. However, nauplii of *C. hyperboreus* showed increased sensitivity to temperature treatments when exposed to polycyclic aromatic hydrocarbons (PAHs) that could cause increased metabolism, resulting in depletion of energy stores before the first feeding stage is achieved (Utne 2017). While many forage fish species are motile and capable of avoidance responses, their early life stages likely have low avoidance abilities similar to other plankton.

Around the area of the well, benthic production may decrease due to smothering under the disposed drilling mud and cuttings. Effects of smothering can include mortality, reduced growth of some species, reduced survival of settling larvae, and a change in fauna composition (Neff 2010). However, this effect is localized and short-term and will occur close to the discharge site, with effects subsiding within one to four years (Bakke et al. 1986; Hurley and Ellis 2004; Renaud et al. 2008; Bakke et al. 2011).

On the surface of the cuttings pile, some infauna will emerge, and a new food source will be available to local benthic predators such as snow crab, skate, and flounder species. At the edges of the deposition, sessile (or slow moving) epifauna (e.g., barnacles, bryozoans, sponge, sea stars, brittlestars, urchins) will be smothered, whereas infaunal species capable of burrowing can be expected to resurface and have little effect from the disposal of cuttings. Neff et al. (2000, 2004) determined there will likely be no net adverse effects to benthic organisms attributable to drilling discharges for an average burial depth threshold of 9.6 mm. This is an average value and is species-dependent. Some sedentary or slow-moving species may experience non-lethal effects at a range of burial depths; for example, Smit et al. (2006a, 2006b) reference a threshold of 6.5 mm where 5% of species are anticipated to be affected. The 50% hazardous level for burial was identified as 54 mm; this value was obtained through a literature review conducted by Smit et al. (2008, in IOGP 2016). For this Project, the burial threshold was identified to be 10 mm or more; this is where 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, 2004). A threshold burial depth for deep-water benthos may be lower (IOGP 2016).

Drill cutting dispersion modelling for Husky's White Rose field (see Section 2.6.1.1) found that a well-defined cuttings patch is found within 100 to 200 m of the wellsite. This patch is generally between 1 and 10 mm thick, with portions that may range between 25 to 50 mm thick.

The chemical attributes of some synthetic-based drilling fluids have been found to have low toxicity to benthic communities, while others appear to cause no or few effects (Khan and Payne 2004). Metals, including barium, and organics in drilling fluids and cuttings, other than aromatic petroleum hydrocarbons, usually are not bioaccumulated from drill cuttings on the sea floor (IOGP 2016). In offshore Newfoundland, Puredrill IA-35LV is used and to date, toxicity studies of plankton, fish larvae, scallop, and winter flounder suggest this drilling fluid has a low potential for acute toxicity (Cranford et al. 2000; Payne et al. 2001; Armsworthy et al. 2005), with extrapolations indicating little or no risk associated with the SBM as close as 1,000 m from the release site. Herring larvae exposed to dispersed PAHs (0.129 to 6.012 µg/L total PAHs) resulted in deformities and impaired growth compared to control groups (Ingvarsdóttir et al. 2012). Early life stages of capelin have also shown sensitivities to hydrocarbons, with lethal effects on larvae at exposures of 1.3 to 7.1 mg/L total PAHs (Paine et al. 1992) and decreased egg mortality rates and hatching success at 40 µg/L crude oil (Frantzen et al. 2012). EEM results to date show that with the exception of five stations (out of 53) in 2010, no PAHs have been at sediment stations in the White Rose field; those five station levels were near the laboratory detection limit of 0.01 mg/kg (Husky Energy 2017).

Results from the ongoing White Rose EEM program have confirmed original assessment and model predictions (Husky Oil Operations Limited 2000; LGL 2007a) of no significant environmental effect on fish and fish habitat due to operational discharges. As Husky's EEM program analyzes the effects of dozens of wells on the receiving environment, DFO suggested (during consultation on the Project Description) the EEM results most comparable to drilling exploratory wells are from the 2004 EEM program (first year after drilling began when 13 upper well sections were drilled) when sediment samples were collected along an eight radials extending from each of the three existing drill centres and around two potential future drill centre locations (Husky Energy 2005). The results of the most recent (2014) EEM Program (Husky Energy 2017) are also summarized below as they illustrate that after 10 years and many wells, the effects of routine Project activities are still consistent with predictions in the 2000 EIS (Husky Oil Operations Limited 2000).

The White Rose EEM program examines potential project effects on sediment chemistry, sediment toxicity and benthic community structure. These three sets of measurements are collectively known as the Sediment Quality Triad (Chapman 1992). The assessment of effects at White Rose is based on the change in relationships between Sediment Quality Triad variables and distance from the development. Distance to the nearest drill centre is used to assess drilling effects at the whole-field level. Occurrence above or below the range of values observed during baseline sampling (2000) is used to assess effects from individual drill centres.

Few project-related effects were noted for the 2004 EEM Program. For sediment, no project-related effects were noted for metals other than barium. As predicted in the initial White Rose EIS (Husky Oil Operations Limited 2000), there was evidence that drilling activity elevated concentrations of hydrocarbons and barium in sediment near the Northern and Southern drill centres and that fines and sulphur concentrations may also have been elevated near these drill centres; no contamination was noted at the Central drill centre (Table 6.4).

Table 6.4 Total Petroleum Hydrocarbons and Barium with Distance from Source at White Rose Development

Location	Year of Study	Distance from Source (m)	TPH (mg/kg)	Barium (mg/kg)
White Rose (Husky Energy 2001, 2005)	2004	300 to 750	8.99 to 275.9	190 to 1,400
		750 to 2,500	<3 to 22.2	120 to 470
		2,500 to 5,000	<3 to 6.9	140 to 230
	2000 (baseline)	300 to 750	<3	140 to 180
		750 to 2,500	<3	140 to 210
		2,500 to 5,000	<3	150 to 210

Source: Husky Energy 2017
Notes:
TPH (total petroleum hydrocarbon) includes C_6-C_{32} hydrocarbons. This range is reported for comparison to other offshore operations.

Sediment contamination at the Northern and Southern drill centres in 2004 was not detected beyond the 9 km zone of influence predicted by drill cuttings modelling (Hodgins and Hodgins 2000). Hydrocarbons were detected between 5 and 8 km from source. Barium concentrations were elevated beyond background levels to approximately 2 km from source. An increase in fine sediment and sulphur concentrations were limited to within 0.7 km from source. None of the sediment samples were toxic to bacteria or marine amphipods.

Overall there was little evidence of mortality effects on benthic invertebrate communities as measured by abundance, biomass, and diversity indices. Total and relative abundance of a sensitive amphipod may have been affected by drilling around the Southern drill centre to within 2 km from source. Evidence of effects on total benthic community abundance, continued to be marginal, with only a few stations affected and no detectable gradient of effects. The radius of detection of water-based drilling fluids (determined by sediment barium concentration) was larger (2 to 20 km) than for synthetic-based fluids (0.2 to 2.0 km). Biological effects on benthic community diversity and abundance ranged from 0.1 to 1.0 km for both water and synthetic fluids. The observed biological changes included reductions in benthic species diversity and abundance and alterations to community structure. Suspension-feeding species were reduced or removed in the zone of influence and deposit feeders and polychaetes increased (Ellis et al. 2012). The range in zone of influence from drilling discharges will depend in large part on water depth, tides and currents in the area. As noted in previous EEM reports, the spatial extent of effects on benthic invertebrates at White Rose is generally consistent with the literature on effects of contamination from offshore oil developments.

In most cases, there is substantial recovery in the megabenthic community within one to a few years after the discharge (IOGP 2016). A literature review conducted by the IOGP on effects of SBM cutting on benthic communities examined seven field monitoring studies and 14 wellsite ranging from 70 to 1,500 m in depth. Observations found the effects of SBM cuttings were usually less severe at greater water depths (>1,000 m) than at shallow depths, and recovery was more rapid (IOGP 2016). These results are echoed in the Terra Nova EEM data analyses, where effects are relatively minor and benthic communities began to recover once drilling activities were reduced (Paine et al. 2014a).

Residual environmental effects associated with waste management on a change in risk of mortality, physical injury and health for fish and fish habitat is predicted to be low in magnitude, restricted to the Project Area, long-term in duration and reversible (i.e., low benthic mortality rates are not predicted to result in irreversible changes to local populations).

6.1.10.3.1.4 Well Abandonment

Well abandonment would include plugging the well with a cement mixture to isolate the wellbore and removing the wellhead and any associated equipment to below the seafloor with mechanical cutters. The plugs are placed at varying depths in the wellbore and the well casing is typically cut just below the surface. The seabed is inspected using a ROV to confirm no equipment or obstructions remain. Husky's preferred method of wellhead severance and recovery is to use a mechanical cutting system, and wellhead designs make provision for this kind of removal. Wellheads mechanically removed by the drill rig or by ROV have low potential for risk of fish mortality. However, circumstances can arise when mechanical cutting cannot effectively perform the task of wellhead severance. In such instances, shaped charges must be used. Husky will employ the smallest effective explosive force and will only be undertaken after the Drilling Superintendent, the C-NLOPB and any of its relevant advisory agencies review the application with approval granted on a case-by-case basis. To reduce the risk of mortality, explosive charges can be lowered into the well and detonated nearly simultaneously or applied to the outside of the casing.

Residual environmental effects associated with well abandonment on a change in risk of mortality, physical injury or health for fish and fish habitat is predicted to be low in magnitude, restricted to the Project Area, occur once per wellhead and reversible (i.e., localized mortality is not predicted to result in irreversible changes to local populations).

6.1.10.3.2 Change in Habitat Quality and Use

6.1.10.3.2.1 Presence and Operation of MODU

Drilling operations will generate light and increased noise which may affect the quality of the underwater environment for marine fish. Lighting has the potential to disturb or alter behaviour of fish close to the site. Increases in light levels and lighting at night may interrupt the normal circadian rhythm of fish, although studies indicate that responses are very species-specific (Nightingale et al. 2006; Brüning et al. 2011). Increased exposure to light can result in changes in fish behaviour, spatial distribution, migration, and reproduction (Nightingale et al. 2006). Physiological stress, due to altered feeding habits from anthropogenic lighting as has been observed during experimental studies of Atlantic cod (Hemre et al. 2002) and rainbow trout (Leonardi and Klempau 2003). Light is also known to attract or repel species and fish distribution may be altered in artificially lighted areas, particularly for pelagic fishes (e.g., herring and sand lance) and squid, which are known to be attracted to light (Pascoe 1990). Many planktonic species are phototaxic and float toward the surface during the day but settle in deeper water at night; this natural vertical movement may be altered by artificial light in localized areas. The environmental effects of light attraction are expected to be temporary and reversible. Extraneous lighting will be minimized to reduce the effect of lighting where practical without affecting safety of operations. Minimum lighting requirements are stipulated in the *Petroleum Occupational Safety and Health Regulations*.

Underwater noise has the potential to affect fish and fish habitat in a variety of ways depending on source levels, duration of exposure, proximity of sound source, species sensitivities and environmental conditions. There are both natural and anthropogenic sources of noise in the marine environment, including storms, wave action, oceanic turbulence, animal communication, vessel traffic and fishing activities. For example, acoustic modelling conducted for the Scotian Basin Exploration Drilling Project assumed broadband source levels for a semi-submersible to be approximately 197 dB re 1 µPa @ 1 m RMS SPL (Zykov 2016). Typical peak levels of ambient noise in shallow water environments are from 110 to 120 dB re 1 µPa; however, this varies depending on shipping traffic, other anthropogenic sources and oceanographic conditions (Richardson et al. 1995).

Fish are generally most sensitive to low-frequency sound (10 to 500 Hz), a range that overlaps with the most intense sound produced by vessels. Some studies suggest noise is thought to be the main cause of vessel avoidance by some fish (Mitson 1995; Mitson and Knudsen 2003; Popper 2003; De Robertis et al. 2008). However, a study by Davis et al. (1998) suggests that most schools of fish show limited avoidance behaviour when in the path of an approaching vessel, as fish may move laterally or to a greater depth as the vessel passes over. A study by Røstad et al. (2006) found that some fish may be attracted to vessels at times. Observed responses to vessels are dependent on species, stage in life cycle, time of day, vessel sound, local conditions and whether fish have fed (Davis et al. 1998). Studies by DFO (2004b) concluded that the most likely response is a startle response, a change in swimming pattern, and/or a change in vertical distribution. For Atlantic cod, a startle response would most likely be observed at ranges of 160 to 188 dB re 1 µPA (Turnpenny and Nedwell 1994). This literature suggests the effect of noise is typically temporary and is not expected to cause biological or physical effects if experienced outside critical reproductive periods.

There is also potential for underwater noise to have effects on communication and environmental sensing by fish (e.g., masking). Over 800 fish species are known to produce sounds, most as broadband signals concentrated at less than 500 Hz. Distinct variation in spectral and temporal characteristics can be related to species, populations and sex (Slabbekoorn et al. 2010), which suggests that sounds can serve as information carriers among fish (Tavolga 1971; Ladich 2004). Fish are known to produce sounds in spawning aggregations (Saucier and Baltz 1993; Aalbers and Drawbridge 2008) and courtship interactions (Myrberg et al. 1986; McKibben and Bass 1998). Sounds could serve in aggregating reproductive groups and may contribute to a synchronized release of eggs and sperm (Myrberg and Lugli 2006). Experimental evidence has shown that sounds can modify mate choice decisions in fish. An acoustic effect on sexual preferences was also inferred for Atlantic cod, in which the male drumming muscle mass was correlated with mating success (Rowe et al. 2008).

Hearing may also be used for prey location and predator avoidance. Although sharks and other cartilaginous fish (skates and rays) have relatively poor hearing sensitivity compared to other fishes, they were reported to approach irregularly pulsed broadband sounds, which could be indicative of struggling prey (Myrberg and Lugli 2006). Surface-feeding fish can localize prey accurately by listening to the surface waves produced when prey fall into the water (Hoin-Radkovsky et al. 1984). Broad hearing bandwidths have been correlated with predator avoidance. Herring (genus *Alosa)* are capable of detecting ultrasound (up to 180 kHz), which could allow detection and avoidance of echo-locating whales (Popper at al. 2014; Doksæter et al. 2009).

Fish have also been observed to congregate, seek shelter or forage for food at places with artificially high sound levels. There are numerous anecdotal observations of fish under noisy bridges or near noisy vessels, indicating that adverse environmental effects are not necessarily overt and obvious. Such observations are unable to indicate whether fish experience any negative consequences related to the noise (Slabbekoorn et al. 2010).

Residual environmental effects associated with the presence and operation of a MODU on the change in habitat quality and use for fish and fish habitat is predicted to be low in magnitude, restricted to the Project Area, medium-term in duration and reversible.

6.1.10.3.2.2 Drilling-associated Surveys

The use of drilling-associated surveys will result in increased noise in the Project Area. Wellsite surveys and VSP activities have a much smaller geographic extent, magnitude and duration than standard exploratory 2D or 3D seismic surveys. Typical wellsite surveys occur over a period of five to seven days, while VSP surveys are often less than a day. A summary of available literature on the potential environmental effects of seismic noise on fish and shellfish is provided below. However, wellsite surveys and VSP activities are much lower in magnitude and extent than the exploratory seismic surveys.

The response to seismic sound by fish can range from no observed change in behaviour, to a startle response (Wardle et al. 2001), a temporary change in movements for the duration of the sound, or larger changes in movements or behaviour that might displace fish from their normal locations (Slotte et al. 2004). There is well-documented evidence of immediate changes in behaviour such as a startle response and avoidance behaviour (e.g., change in swimming direction, movement out of area of sound) of both fish and shellfish (McCauley et al. 2000a, 2000b; LGL 2005b; Løkkeborg et al. 2010). Behavioural effects such as a startle response or change in direction are well-documented in fish exposed to underwater sound (McCauley et al. 2000a, 2000b; Løkkeborg et al. 2010). Such responses most commonly occur within the area of a seismic program but have been observed to occur in fish located tens of kilometres away from the site (Engås et al. 1996). Extended effect areas of this magnitude are not expected from a well site survey or VSP survey. Studies suggest that normal behaviour patterns commonly return within 30 minutes of the seismic response (McCauley et al. 2000a, 2000b); therefore, behavioural effects are expected to be short-term. Adverse effects stemming from behavioural responses could include: leaving preferred feeding and spawning grounds; increased energy expenditure; disruption of migration; suppression of spawning behaviour; or making or blocking of sound reception (CEF 2011). A startle response, change in swimming pattern, or change in vertical distribution are the expected responses of adult marine fish to seismic noise (DFO 2004a). These effects are expected to be short-term and negligible. Although seismic energy is well understood, less is known about marine species in terms of their distribution, life history and potential long-term or sub-lethal effects from seismic noise.

For shellfish, there have been no documented cases of invertebrate mortality due to seismic noise, although there have been accounts of mass giant squid strandings on two occasions that corresponded to periods of seismic activity (Guerra et al. 2004; Worcester 2006; Alexander 2015). Literature reviews and workshops (DFO 2004c; CEF 2011) suggest that information is lacking to evaluate the likelihood of sub-lethal or physiological effects on crustaceans during molting stages, and that the potential for seismic sound to disrupt communication, orientation, locomotion, or detection of predators and prey has not been studied.

Benthic macroinvertebrates are less likely to be affected by seismic activity than pelagic or planktonic invertebrates because few benthic invertebrates have gas-filled spaces that would make them sensitive to changes in pressure, and because benthic species are usually more than 120 m away from the seismic source. Christian et al. (2003) found no apparent effects on adult crab behaviour, health, or catch rates from seismic exposure; but there was an effect on egg development for a female exposed to seismic energy at very close range (2 m). Similarly, reviews by LGL (2005b) also found that mortality of crab eggs and larvae have only been reported when exposed at very close range to seismic sources. A recent review (Alexander 2015) identified snow crab reaction from seismic noise as short term and minor, though additional effects on behaviour were not investigated.

Residual environmental effects associated with drilling-associated surveys on a change in habitat quality and use for fish and fish habitat is predicted to be low in magnitude, restricted to the Study

Area, short-term in duration (no more than a day per well, totaling 10 days over 8 years) and reversible.

6.1.10.3.2.3 Waste Management

Models of the fate of drill cutting deposition within the White Rose field (WBM + SBM) were developed by Amec-Foster Wheeler (Section 2.6.1.1). Despite seasonal variability of currents, wind and waves (Section 4.1.3), the deposition of drilling waste from each well is similar in that a well-defined cuttings patch covering an area approximately 0.03 to 0.06 km² is located up to 300 m of the well. Each patch is of thicknesses generally in the range of 1 to 10 mm, with patches that are as thick as 25 to 50 mm. According to the model, Project-related discharge of drill muds and cuttings may extend up to a maximum distance of 12 km from the release site (modelled to a deposition thickness of 0.1 mm). Cuttings thicknesses are expected to remain below 1 mm beyond 300 m from the Project drill centres.

To test the effects of sedimentation from cuttings on benthic fauna, Trannum et al. (2010) added natural sediment particles and water-based drill cuttings to benthic communities in layer thicknesses of 3 to 24 mm and monitored changes for six months. Observed effects included a substantial reduction in number of taxa, abundance, biomass and diversity of macrofauna with increasing thickness of drill cuttings, which was not observed for the natural sediment particles (Trannum et al. 2010). The drill cuttings were also found to affect oxygen consumption and oxygen penetration depth in the sediment, and an organic compound in the drill cuttings initiated a eutrophication response (Trannum et al. 2010).

Results from the ongoing Husky's White Rose EEM program have confirmed original assessment predictions (Husky Oil Operations Limited 2000; LGL 2007a) of no significant environmental effect on the marine environment from contamination due to operational discharges of more than three dozen production wells. The spatial extent of contamination in 2014 was consistent with original predictions on the spatial extent of the zone of influence of drill cuttings (9 km from source; Hodgins and Hodgins 2000). Hydrocarbon contamination extended to 5.8 km from source, barium contamination extended to 1 km from source, and percent fines extended to 0.7 km from source. All but three (of 53) samples were non-toxic to bacterial bioluminescence, and all but two (of 53) samples were non-toxic to amphipod survival. There was no association with toxicity of samples and distance from active drilling centres. None of the samples assessed were toxic to both bacterial luminescence and amphipod survival. Evidence of effects on total abundance (noted since 2005), was marginal, with only a few stations affected and no threshold distance for effects. As noted in previous EEM reports, the spatial extent of effects on benthic invertebrates at White Rose is generally consistent with the literature on effects of contamination from offshore oil developments. Zones of influence of project contaminants and effects on benthic community indices and taxa have not increased in severity or extent over time; there has been no continued and consistent degradation at White Rose.

Physical recovery of sediment through degradation of the major components of drilling fluids has been shown to occur on the Grand Banks. Deblois et al. (2014b) investigated post-drilling recovery through 10 years of EEM data. The markers for this study were the major constituents of drilling fluid which have potential to result in biological effects (Wang and Chapman 1999, Gray et al. 2002, Randall and Tsui 2002, and Wu 2002, in Deblois et al. 2014b). Post-drilling reductions in the drilling fluid constituents occurs with re-suspension and transport of sediment and biodegradation of organic compounds. Reductions in sediment contamination were identified from 2006 to 2010, which coincided with a reduction in drilling (Deblois et al. 2014b).

Ecological recovery of the sediment around the well occurs by recruitment of new colonists from planktonic larvae and by in-migration from adjacent undisturbed sediments. Recovery begins as soon as the discharge of drilling wastes is completed and is often well advanced within a year (IOGP 2016); however, it may be delayed by oxygen depletion in near-surface sediment pore water from bacteria degrading organic matter. Organic enrichment of the sediment can accumulate from the biodegradable organic matter present in drilling fluids and cuttings. Bacteria and fungi in the sediments degrade the organic matter and, in the process, may deplete the oxygen in surface sediment layers. This suboxic layer may result in increased concentrations of H_2S (IOGP 2016). During the 2004 EEM program, an increase in fine sediment and sulphur concentrations were observed within 1 km from source indicating potential effects from organic enrichment are localized to the wellsite. CSA (2004) monitored sediment oxygen and the values were significantly lower in the near (<100 m) and mid-field (100 to 250 m) than the far field (3,000 to 6,000 m). Macrobenthic communities in the near-field monitored by CSA (2004) had reduced diversity and increased abundance, indicating the progression to a community with few tolerant macrofaunal species.

Once concentrations of biodegradable organic matter decrease through microbial biodegradation to the point where surface layers of sediment become oxygenated, recovery will resume (Neff 2010). Paine et al. (2014a) identified enrichment effects on pollution tolerant species and decreased abundance of sensitive species within 1 to 2 km from the wellsite. The long-term population and ecosystem effects to benthic communities from WBM and SBM and cuttings discharges are generally low (Gates and Jones 2012). The dataset revealed that recovery of the benthic community was observed following a reduction in drilling. Sites previously affected by drill cuttings have shown recovery to occur in as little as four years (Schaanning and Bakke 1997; Bakke et al. 2011). Jones et al. (2012) suggests partial megabenthic recovery 3 to 10 years after drilling in a similar deep-water environment. 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).

If cement reaches the seafloor (after the well section has been drilled), the volume of cement potentially discharged compared to the volume of drill cuttings that already settled on the seafloor is such that the cement will cover the drill cuttings and not affect additional benthic habitat.

Residual environmental effects associated with waste management on a change in habitat quality and use for fish and fish habitat is predicted to be moderate in magnitude, restricted to the Project Area, long-term in duration and reversible (i.e., low benthic mortality rates are not predicted to result in irreversible changes to local populations and ecological recovery is expected).

6.1.10.3.2.4 Supply and Servicing

Supply and servicing operations for the MODU will marginally increase vessel traffic within the Project Area and Study Area. This Project anticipates the OSV responsible for transporting supplies will require one to three trips per week from the supply base to the MODU. Underwater sound associated with OSV traffic will be introduced to the acoustic environment, although the incremental change will be very low.

Sound levels generated from operation of vessels and helicopters were modelled within the White Rose field (Husky Energy 2012a). Sounds levels of 180 to 160 dB re 1 µPA (rms) have been estimated to occur at 5 and 22 m of a typical offshore supply vessel (JASCO 2012). The sound levels of a helicopter at an altitude of 91 m hovering over water were modelled and received underwater sound levels are not expected to exceed 157 dB re 1 µPA at depths greater than 3 m (JASCO 2012). Sound transfer to the marine environment from helicopters during personnel transport is likely minimal.

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 levels of marine traffic and shipping activity throughout the Study Area from the fishing and marine transportation industries.

The change in habitat quality and use from supply and servicing operations would be intermittent throughout the Project as OSVs will be transiting the Study Area only while there is a well being drilled, or a MODU being moved.

Residual environmental effects associated with supply and servicing operations on a change in habitat and use for fish and fish habitat is predicted to be of low magnitude affecting a very small portion of the Project Area at any given time, and persist as medium-term duration (i.e., not extend beyond well abandonment). Effects on habitat quality will be reversible once the underwater sound emissions from the OSV operations cease.

6.1.10.3.2.5 Well Abandonment

The exploratory well will be decommissioned and abandoned according to C-NLOPB requirements and in accordance with *Newfoundland Offshore Petroleum Production and Conservation Regulations*, as well as any other applicable laws and industry standards at the time.

The activities involved in decommissioning and abandonment that may have environmental effects on fish and fish habitat include: removal of the MODU and anchor chains; plugging and abandoning of wells; operation of vessels; lighting; the removal of a safety zone; and conducting surveys (geotechnical, geophysical, and environmental).

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. Wellheads mechanically removed by the drill rig or by ROV will have a negligible effect on habitat quality and use. However, circumstances can arise when mechanical cutting cannot effectively perform the task of wellhead severance. In such instances, shaped charges must be used which will create localized habitat disturbance. To reduce the risk of habitat disturbance, explosive charges can be lowered into the well and detonated nearly simultaneously or applied to the outside of the casing.

Residual environmental effects associated with well abandonment on a change in habitat quality and use for fish and fish habitat is predicted to be low in magnitude. Any effects are likely to be localized to the Project Area, short-term in nature during the abandonment program, and are likely to be reversible once the abandonment program is complete.

6.1.10.4 Summary of Project Residual Environmental Effects

In summary, the Project may result in adverse effects that cause a change in risk of mortality, physical injury or health and a change in habitat quality and use for fish and fish habitat. In consideration of the scientific literature, the effects monitoring programs, implementation of mitigation measures, adherence to industry standards and regulations, the residual effect of a change in risk of mortality, physical injury or health for various Project components and activities is predicted to be low in magnitude. Residual project environmental effects for a change in risk of mortality, physical injury or health will be restricted to the Project Area and localized near the source. The duration of effects will vary from short-term regular events (i.e., one day per well for VSP survey or wellhead removal) to longer-term events such as waste management (i.e., residual effects from WBM/SBM and cuttings discharge). These environmental effects may occur within a disturbed ecological (non-pristine) and socio-economic context (associated with ongoing harvesting of fish species and underwater sound and waste discharge associated with marine shipping and existing oil and gas operations in the Study Area).

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 Study Area (during wellsite surveys), be short to long-term in duration, be reversible at the completion of the Project, and occur within a disturbed ecological (non-pristine) and socio-economic context.

Table 6.5 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 6.3.

Table 6.5 Project Residual Effects on Fish and Fish Habitat

Residual Effect	Residual Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality, Physical Injury and Health							
Presence and Operation of MODU	A	L	PA	MT	IR	R	D
Drilling-associated Surveys	A	L	PA	ST	IR	R	D
Waste Management	A	L	PA	LT	IR	R	D
Well Abandonment	A	L	PA	ST	S	R	D
Change in Habitat Quality and Use							
Presence and Operation of MODU	A	L	PA	MT	IR	R	D
Drilling-associated Surveys	A	L	SA	ST	IR	R	D
Waste Management	A	L	PA	LT	IR	R	D
Supply and Servicing	A	L	PA	MT	R	R	D
Well Abandonment	A	L	PA	ST	S	R	D

KEY:
See Table 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
SA: Study 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

6.1.11 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in risk of mortality, physical injury and health and change in habitat quality and use on fish and fish habitat from Project activities and components are predicted to be not significant. This conclusion has been determined with a high level of confidence based on the documented understanding of the effects of exploration drilling and associated surveys on fish and fish habitat, the effectiveness of mitigation measures discussed in Section 6.1.10.2 and the observed residual environmental effects resulting from the White Rose Project.

6.1.12 Follow-up and Monitoring

To date, Husky has conducted seven post-drilling EEM programs since 2004, with results compared to baseline data collected in 2000 and 2001. The EEM program includes sediment, water and biological (commercial finfish and invertebrate species) components. The environmental effects from exploratory drilling are well understood with nine environmental assessments completed in six years and numerous publications to assess environmental effects from similar drilling activities. As a result, no follow-up monitoring outside of the compliance monitoring and EEM program is required for this Project.

Husky provides an annual EA Update to the C-NLOPB each year, detailing the specific activities that will be conducted within the Project Area in a given year. In that EA Update Husky will include changes (if any) to marine fish species at risk or SOCC and critical habitat and discuss the potential effects of Project activities to marine fish species at risk or SOCC and critical habitat.

6.2 Commercial Fisheries

6.2.1 Scope of Assessment

Commercial fisheries is included as a VC because of the commercial and cultural importance of commercial fisheries to Newfoundland and Labrador, the requirements of the EIS Guidelines, the regulatory protection of fish and fish habitat under the *Fisheries Act*, and the potential for Project-related activities and components to interact with commercial fishing activity.

This VC addresses potential effects on commercial fisheries, focusing on those interactions that could affect the operation and success of commercial fisheries in offshore Newfoundland and Labrador. These are commercial wild fisheries harvested largely by Canadian-registered enterprises inside Canada’s 200 nm EEZ and by both Canadian and non-Canadian vessels outside the EEZ.

Potential Project-related effects on targeted fish species could potentially affect the success of commercial fisheries; therefore, this VC is closely related to the Fish and Fish Habitat VC (Section 6.1).

These fisheries also include commercial fishing pursued under commercial communal licences issued by DFO to certain Indigenous groups. These licences are commonly shared with commercial fishing companies, so are included in aggregate commercial fishing data reported by DFO. Commercial Indigenous fisheries are therefore also closely related to, and specifically discussed in Section 6.6 (Indigenous People and Community Values VC).

6.2.2 Regulatory and Policy Setting

Two regulatory jurisdictions related to marine fisheries exist within the Study Area. The Government of Canada has jurisdiction over commercial fishing activities for sedentary and non-sedentary species within its 200 nm EEZ. Canada also has jurisdiction over commercial fisheries for sedentary species up to the extent of the defined continental shelf. Beyond the EEZ, the NAFO has primary jurisdiction over commercial fisheries for non-sedentary species and has the authority to designate protected areas.

For management purposes, the Northwest Atlantic Ocean is divided into a series of NAFO divisions, subdivisions, and unit areas (refer to Figure 2-1) that are used to regulate and assess fishing activity throughout eastern Canada. The Project Area is within NAFO Area 3L, while the Study Area overlaps with portions of NAFO Areas 3KLMNO.

The federal *Fisheries Act* focuses on protecting the productivity of fish that are part of CRA fisheries. Section 35 of this Act prohibits activities by persons that may cause serious harm to fish that are part of a CRA fishery. The *Atlantic Fishery Regulations, 1985* provide for the management and allocation of fishery resources off the Atlantic coast of Canada, including those off Newfoundland and Labrador. These regulations outline the licence and vessel registration process, and gear requirements in order to allow a person to fish commercially within Atlantic Canada. These regulations are enforced by DFO.

Fishery resources are protected from uncontrolled fishing activity through various measures such as area closures, fishing quotas, fishing seasons, gear, and vessel restrictions. Closures have been established in accordance with the *Fisheries Act* and *Oceans Act*, restricting bottom fisheries activities on the eastern Grand Banks and in areas of the Flemish Pass and Flemish Cap to protect the existing benthic environment, mainly due to the presence of deep-water corals, sponges, and sea pens. Quotas, total allowable catches (TAC) and area closures have historical relevance in the waters of offshore Newfoundland and Labrador, specifically the collapse of groundfish stocks in the 1990s, which resulted in moratoria on a variety of groundfish species, some of which remain in effect (e.g., Atlantic cod and American plaice). DFO has created Integrated Fisheries Management Plans to help monitor and help guide the recovery and management of various commercial fish species throughout the Newfoundland and Labrador region. These plans use scientific knowledge of a species, along with industry data on capacity and harvesting methods for the species, to create management strategies for the fishery (DFO 2016c).

6.2.3 The Influence of Consultation and Engagement on the Assessment

Key issues raised during stakeholder consultation and Indigenous peoples engagement for the Project to date include general concerns related to accidental events in the deep water. Questions and concerns were raised with respect to effects from offshore drilling and exploration on areas in the Flemish Pass inhabited by various commercial (redfish, flounder) and other groundfish. Concern was expressed around the historical cod fishery and the potential for a commercial cod fishery to begin again during the lifetime of the Project. Indigenous engagement also noted the use of Project vessels and the potential to affect commercial fishing.

6.2.4 Potential Effects, Pathways, and Measurable Parameters

Routine Project activities can interact with commercial fisheries resources either directly or indirectly through effects on the species fished and/or fishing activity itself (e.g., through displacement from fishing areas, gear loss or damage). These direct and/or indirect effects may result in a demonstrated financial loss to commercial fishing interests.

In consideration of the potential interactions, 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 effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 6.6. Effects of accidental events are assessed separately in Section 7.3.

Table 6.6 Potential 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) • Damage or loss to fishing gear

6.2.5 Boundaries

Spatial boundaries and temporal boundaries for the assessment of commercial fisheries are discussed in the following sections.

6.2.5.1 Spatial Boundaries

Project Area: The Project Area (Figure 2-1) encompasses the immediate area within which Project activities and components may occur. Well locations have not been identified but will occur within EL 1151, EL 1152 and EL 1155, within the Project Area and represent the actual Project footprint with respect to fisheries resources. The spatial boundary of the Project Area has been delineated to account for all activities related to drilling a well, including transit of OSV and helicopter traffic to/from St. John's and vessel traffic associated with geohazard/environmental surveys.

Study Area: The Study Area (Figure 2-1) is the area within which residual environmental effects from operational activities and accidental events may interact cumulatively with the residual environmental effects of other past, present and future (certain or reasonably foreseeable) physical activities.

6.2.5.2 Temporal Boundaries

The temporal boundaries for potential Project-related environmental effects on commercial fisheries encompass all Project phases, including wellsite surveys, well drilling, testing and abandonment. It is anticipated that exploratory drilling activities would commence in 2019, and continue intermittently throughout the term of exploration licences, up to 2027. Well testing (if required, dependent upon drilling results) could also occur at any time during the temporal scope of this EA. Wells may be decommissioned and abandoned at any time within the temporal boundaries. The temporal scope of the EA accommodates drilling in EL 1151, EL 1152, and EL 1155 for the full term of each licence (period 1 and period 2). Within the overall temporal scope, VSPs typically take approximately one day per well and an individual well may take up to 80 days to complete. Drilling operations will not be continuous throughout the entire eight-year scope of the Project and will depend partially on rig availability and results from previous wells. If a semi-submersible or drill ship is selected as the preferred MODU option for the Project, then drilling activities have the potential to be conducted at any time of the year. If a jack-up rig is selected as the preferred method, then drilling would only occur during the ice-free season.

Although commercial fisheries could potentially interact with the Project year-round, it is understood that peak fishing near the Project Area occurs from April to September. Section 6.2.8 provides a summary of the existing conditions in the Study Area.

6.2.6 Residual Effects Characterization

The descriptors used to characterize residual environmental effects on commercial fisheries are defined in Table 6.7.

Table 6.7 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 environmental effect relative to baseline	**Positive –** a residual environmental effect that moves measurable parameters in a direction beneficial to commercial fisheries relative to baseline **Adverse –** a residual environmental effect that moves measurable parameters in a direction detrimental to commercial fisheries relative to baseline **Neutral –** no net change in measurable parameters for the commercial fisheries relative to baseline
Magnitude	The amount of change in measurable parameters or 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 a residual environmental effect occurs	**Project Area –** residual environmental effects are restricted to the Project Area **Study Area –** residual environmental effects extend into the Study Area
Frequency	Identifies how often the residual environmental effect occurs and how often during the Project	**Single event –** effect occurs once **Multiple irregular event –** effect occurs at no set schedule **Multiple regular event –** effect occurs at regular intervals **Continuous –** effect occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual environmental 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 –** the residual environmental effect is likely to be reversed after Project completion (well abandonment) **Irreversible –** the residual environmental effect is unlikely to be reversed

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Ecological and Socio-economic Context	Existing condition and trends in the area where residual 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

6.2.7 Significance Definition

A **significant adverse residual 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 portions of the areas currently commercially 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) so that resources cannot continue to be used at current levels within the Study Area for more than one fishing season; or
- unmitigated damage to fishing gear.

6.2.8 Summary of Existing Conditions for Commercial Fisheries

A complete description of commercial fishing activity within the Project and Study Areas is provided in Section 4.3.1. Within the boundaries of the Study Area, northern shrimp and snow crab have collectively made up approximately 96% of all landings by weight and 99% by value between 2012 and 2016. The remaining fisheries are primarily groundfish, consisting of flounder and turbot (Greenland halibut), along with smaller quantities of large pelagic species (e.g., swordfish, tunas). There is also some fishing activity for deep-sea clams and bivalves. Surf clam were commercially harvested well outside the Project Area in the Lily Canyon area in 2013. The peak harvesting months in the offshore area are April to September.

Most commercial fish harvesting in NAFO Area 3L currently occurs along the edge of and along the slope of the continental shelf for snow crab, northern shrimp, and other benthic invertebrates and pelagics. The main foreign fisheries in 3L consist of Greenland halibut and roughhead grenadier, which are found in deeper waters of the Flemish Pass, outside the 200 nm limit.

To monitor effects of the White Rose operations (including drilling) on commercial fish species, an EEM program collects American plaice and snow crab within the White Rose field and at four EEM reference areas 27.1 km northwest, northwest, southeast, and southwest of the *SeaRose FPSO*. Tissue is analyzed for body burden and taint (snow crab and American plaice) and fish health (American plaice).

There were no significant differences between the Study Area and Reference Areas crab tissue in 2014 for frequently detected compounds. There were no significant differences in percent fat, moisture, arsenic, iron, mercury, strontium, and zinc content in American plaice fillets between the

Study Area and the Reference Areas in 2014. There were no significant differences between the Study Area and the Reference Areas in trends over time (2004 to 2014) for most frequently detected compounds in American plaice liver. Given the absence of differences between the Study and Reference Areas, many of the metals frequently detected in plaice and crab should be regarded as essential elements rather than contaminants originating from White Rose project activity (or any other anthropogenic source). Hydrocarbons have rarely been detected in edible tissue (crab claws and plaice fillets) at White Rose. Compounds in the $>C_{10}$-C_{21} and $>C_{21}$-C_{32} range frequently detected in plaice liver present as natural compounds, and not as a petrogenic source (Husky Energy 2017).

There was no significant difference in taste (taint test) between the Study and Reference Areas for both plaice and crab and there were no consistent comments from the taste panels identifying abnormal or foreign odour or taste. Results do not indicate the presence of taint in either resource. The health of American plaice is similar between the Study Area and the Reference Areas (Husky Energy 2017). These results are echoed in the Terra Nova EEM data analyses, which indicated no contamination of American plaice liver and fillet tissues and no evidence of taint of edible American plaice tissue (DeBlois et al. 2014a).

Additional detail on commercial fisheries that occur within the Project and Study Areas is provided in Section 4.3.1. Aboriginal fisheries are specifically addressed in Section 6.6 (Indigenous People and Community Values).

6.2.9 Project Interactions with Commercial Fisheries

The physical Project-related activities that have the potential to interact with commercial fisheries are identified in Table 6.8. These interactions are indicated by checkmarks and are discussed in detail in Section 6.2.10 in the context of effects pathways, mitigation, and residual environmental effects.

Table 6.8 Project-Environment Interactions with Commercial Fisheries

Physical Activities	Environmental Effect
	Change in Availability of Fisheries Resources
Presence and Operation of MODU (Presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; well testing; cementing and completing wells)	✓
Drilling-associated Surveys (VSP and wellsite surveys; geotechnical/geophysical/environmental surveys; diving surveys; ROV surveys)	✓
Waste Management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)	✓

Physical Activities	Environmental Effect
	Change in Availability of Fisheries Resources
Supply and Servicing (operation of helicopters and supply/support/standby/tow vessels within the Project Area)	✓
Well Abandonment (plugging and abandoning of wells)	✓
Notes: ✓ = Potential interaction – = No interaction	

6.2.10 Assessment of Residual Environmental Effects on Commercial Fisheries

This section assesses the environmental effects on commercial fisheries resources that may result from Project-related activities identified in Table 6.8. Given the geographic and environmental consistencies, as well as, the analogous Project activities, the WREP EA (Husky Energy 2012a) and the SEA undertaken by the C-NLOPB for Eastern Newfoundland (Amec 2014) have been referenced extensively in this analysis. The information has been updated, as applicable, due to scientific updates and refined EA methods.

6.2.10.1 Project Pathways

6.2.10.1.1 Change in Availability of Fisheries Resources

Commercial fishing activities include deploying, setting, and/or accessing gear on fishing grounds, retrieving/hauling the gear to harvest the fish, and getting the catch back to port where it can be sold. Project interactions resulting in effects that might interrupt or prevent any part of that process, such as having grounds closed to fishing, impediments to or from fishing grounds, lost or damaged fishing gear, or lost or reduced catch, are the focus of this assessment.

A change in availability of fisheries resources for commercial fisheries may occur as a result of the presence and operation of the MODU (fisheries exclusions and underwater sound effects on commercially fished species), discharge of drill muds and cuttings (effects on water and sediment quality on fisheries species), drilling-associated surveys (underwater sound), waste management (effects on water and sediment quality on fisheries species), supply and servicing operations (underwater sound associated with vessel movement potentially causing behavioural effects on fisheries species), and well abandonment (the potential use of shaped charges and their effects on commercial fish health and behaviour).

Damage to fishing gear, and the resulting economic effects from loss of catch, can occur during regular OSV operations or other activities such as drilling-associated surveys. Most gear damage events would primarily include fixed gear (e.g., crab pots); mobile gear (e.g., shrimp trawls) is rarely affected from these activities. In most cases, the owner of gear damaged by offshore petroleum activity is identified and compensated, after submitting a claim to the responsible operator through gear compensation programs. Fishers have stated in the past (Husky Energy 2012a) that there is an increase in the occurrence of "un-attributable" damage incidents, where the incident cannot be directly related to petroleum industry operations. Many of these incidents result in the loss of small items; while these incidents can be viewed as a nuisance, they can contribute to a sense of unease between fishers and the oil and gas industry. Gear loss or damage can also result in lost time and income for affected fishers.

Fishers have also stated that a lack of understanding of oil industry protocols have had a negative economic effect on their operations because fishing vessels are forced around exclusion zones to get from one quota area to the next, rather than being able to transit through the area while maintaining a safe distance (Husky Energy 2012a). This can result in lost fishing time and an increase in fuel costs. The need to maximize time has been identified by fishers as one of the most critical issues faced; preventing lost time is preferable over financial compensation after time has been lost.

6.2.10.2 Mitigation

Given the environmental effects pathways noted above, the following mitigation measures, as well as mitigation measures identified for the Fish and Fish Habitat VC (refer to Section 6.1.10), will be employed to reduce the potential environmental effects of the Project on commercial fisheries resources. These mitigation measures include the following:

- Husky will implement its Vessel Traffic Management Standard (AR-M-99-R-PR-00003-001), which includes procedures for management and communication relevant to the movement of OSVs, survey vessels, and MODU during Project related activities. All communications between Husky, operators, and fishers will adhere to this standard.
- Husky will continue to engage commercial fishers annually to share Project details as applicable and facilitate coordination of information sharing.
- Once the type of MODU is selected, Husky 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. The operator will publish a Canadian Coast Guard "Notice to Mariners" and a "Notice to Fishers" via the CBC (Canadian Broadcasting Corporation) Radio Program Fisheries Broadcast.
- Any Project-related damage to fishing gear will be compensated in accordance with the *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2017). Husky has a gear/vessel damage compensation program, to promptly settle claims for loss and/or damage that may be caused by Project-related activities such as drilling-associated surveys or OSV operations. The scope of the compensation program includes replacement costs for lost or damaged gear and any additional financial loss that is demonstrated to be associated with the incident. Procedures are in place so that any incidents of contact with fishing gear are clearly detected and documented (e.g., time, location of contact, loss of contact, and description of any identifying markings observed on affected gear).

- OSVs travelling between the Project Area and supply base will follow established shipping routes.
- The requirement for a Fisheries Liaison Officer (FLO) during certain offshore Project activities, such as wellsite surveys, will be determined in accordance with the Risk Management Matrix Guidelines developed by One Ocean. The Risk Management Matrix Guidelines provides guidance on the requirements for FLOs and/or Fisheries Guide Vessels based on the level of fishing activity in an area and the activity being undertaken by the oil and gas operator.

6.2.10.3 Characterization of Residual Project-related Environmental Effects

6.2.10.3.1 Change in Availability of Fisheries Resources

6.2.10.3.1.1 Presence and Operation of MODU

A minimum 500 m radius safety zone is expected to be in continuous effect around a MODU to reduce potential interaction with fishing activity. The overall geographic extent of the area lost to fishing activity due to the safety zone will be determined once the preferred MODU type has been identified for each well. For example, a MODU requiring anchors will require a safety zone of 50 m around each anchor, which will extend up to 1,500 m from the MODU, depending on water depth. While a non-anchored MODU, such as a drill ship or jack-up rig will require only a 500 m safety zone.

Biophysical and behavioural effects of underwater sound on fish species, including commercial species are discussed in Section 6.1 (Fish and Fish Habitat VC). This avoidance behaviour is expected to be temporary as fish become conditioned to the continuous sound levels from the MODU and startle responses cease (Chapman and Hawkins 1969; McCauley et al. 2000a, 2000b; Fewtrell and McCauley 2012). Given the temporary and localized nature of this effect, it is not expected to affect commercial fish species to the extent that fishers would be adversely affected. While behavioural responses in fish depend on various factors, including species, it can be anticipated that sound levels would attenuate to a point that they would not affect commercial fishing activities occurring outside the safety zone.

Residual effects associated with the presence and operation of the MODU on change in availability of fisheries resources for commercial fisheries is predicted to be low in magnitude, localized to the Project Area, medium-term in duration, and reversible. Avoidance behaviour 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.

6.2.10.3.1.2 Drilling-associated Surveys

Underwater noise from VSP or wellsite surveys could potentially startle fish, causing them to avoid the ensonified area and thereby reduce catchability. As discussed in Section 6.1, fish species, including commercial species, may move away from an area due to the presence of underwater sound. Underwater noise does not appear to have the same avoidance effects on invertebrate species such as snow crab (Section 6.1), which has been the primary commercial harvest in the Project Area in recent years.

Wellsite and VSP surveys use equipment similar to that used in seismic operations (i.e., a source sound array); however, the associated size and volume of the array are much smaller than a traditional seismic survey. The VSP is focused around a wellbore; therefore, sound effects are localized towards the drill site. Potential effects of sound from Project activities on fish is discussed in Section 6.1.10.3.

In terms of behavioural effects on commercial fisheries from sound, Christian et al. (2003) investigated pre and post-exposure catchability of snow crab during commercial fishing season and found that catch-per-unit-effort (CPUE) did not decrease after snow crabs were exposed to seismic survey sound. Engås et al. (1991) studied the effects of seismic exposure on cod catches off the coast of Norway and found that catch rates decrease by at least 50% within the seismic survey area, lasting for approximately 24 hours within a 10 km radius. Løkkeborg et al. (2010) conducted a similar study and found that fish species exhibit behavioural responses to source array exposure; while gillnet catches increased primarily from increased fish activity, longline catches decreased overall. VSP and wellsite surveys occur over 1 and 5 to 7 days, respectively, and are much more localized than large scale 2D and 3D seismic surveys.

While source array activity could injure fish species if they are within proximity to the sound source, it is likely that motile fish will disperse from the source during array ramp-up or vessel approach and avoid harm. Seismic activity could reduce catches if fish exhibit behavioural changes such as avoidance or a change in distribution.

Residual effects associated with the drilling-associated surveys on change in availability of fisheries resources for commercial fisheries is predicted to be low in magnitude, within the Project Area, short-term in duration (no more than a day per well, totaling 10 days over 8 years), occurring at irregular intervals and reversible following Project completion.

6.2.10.3.1.3 Waste Management

The discharge of drill muds and cuttings, and other discharges and emissions from the MODU and OSVs, have the potential to result in a change in sedimentation and water quality. As discussed in Section 6.1, the effects from these discharges are expected to be low in magnitude and localized within the Project Area. Adherence to Husky's EPCMP, which have been developed to be protective of the marine environment, will help reduce adverse effects on fisheries species.

Results from multiple EEM programs conducted for offshore drilling and production programs on the east coast of Canada (including Husky) have concluded that there have been negligible effects on commercial species such as American plaice and snow crab (Buchanan et al. 2003; Hurley and Ellis 2004). The most recent results from the White Rose EEM show that there continues to be no significant body burden (chemical) differences in plaice fillets or crab tissue collected in the White Rose field and reference areas, and no significant differences were noted in the taste of each species from panellists, compared to the reference area samples (Section 6.1). The EEM results indicate that changes in sediments and benthic community from drill cuttings have not resulted in adverse effects for commercial fisheries.

Other discharges and emissions have the potential to result in temporary and localized effects on water quality. This includes organic matter such as grey or black water, bilge water, deck drainage, BOP fluid, cooling water, and cement. Discharges of fluids into the marine environment will meet the requirements of Husky's EPCMP, which is designed to mitigate potential effects from discharges; therefore, these fluids are not predicted to adversely affect fisheries species in the Project Area or the Study Area. The full assessment of waste discharges on fish and fish habitat is in Section 6.1. As per its EPCMP, Husky will also use an Offshore Chemical Management System, similar to those in use by other producing oil fields in offshore Newfoundland and Labrador. Under this system, all chemicals that are used in the offshore and have the potential to reach the environment, are screened. This screening process will assess the potential toxicity of each chemical. Where chemicals are deemed to have unacceptable toxicity levels, an alternative chemical is sought. This process and this management system is guided by the OCSG (NEB et al. 1999).

Residual effects resulting from waste management on change in availability of fisheries resources for commercial fisheries is predicted to be low in magnitude, localized to the Project Area, medium-term in duration, regularly occurring during Project activities and reversible following Project completion.

6.2.10.3.1.4 Supply and Servicing

The operation of OSVs will increase vessel traffic within the Project Area, marginally. It is anticipated the OSV responsible for transporting supplies will require one to three trips per week from the supply base to the MODU. OSVs and survey vessels traversing the Project Area have the potential to contact and damage fishing gear. The fishing gear most at risk is fixed gear such as snow crab pots, the primary fishery within the Project Area. With relatively lower levels of fishing activity in the Project Area (Section 4.3.1), compared to outside, contact between fishing gear and Project vessels is likely limited to transit between ports and the Project Area.

OSVs will follow established vessel traffic routes between supply base and the Project Area (Section 2.4.3.2). Once near the Project Area, the OSV will select the route most appropriate for reaching the destination. OSVs will adhere to standard at sea protocol and procedures, thereby reducing potential conflicts with commercial fisheries.

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).

Residual effects associated with supply and servicing on change in availability of fisheries resources for commercial fisheries is predicted to be low in magnitude, within the Study Area, medium-term in duration, occurring at regular intervals and reversible following Project completion.

6.2.10.3.1.5 Well Abandonment

The final design and method for well abandonment has not been finalized; however, all activities and methods regarding well abandonment will be conducted in compliance with all C-NLOPB applicable regulations and guidelines, including the Drilling and Production Guidelines. It is anticipated that the well casing will be severed below the seabed and the wellhead removed. This method would result in no infrastructure remaining above the seabed once the well has been removed. In the event that the mechanical device to sever the wellhead should fail, then the potential exists to use shape charges to cut the well casing and decommission the well. To reduce the risk of fish mortality, explosive charges can be lowered into the well and detonated nearly simultaneously or applied to the outside of the casing. Once the charge has been set and detonated, an ROV is sent to inspect the seabed, to confirm that no obstructions remained present on the seafloor. Use of charges will only be undertaken after the Drilling Superintendent, the C-NLOPB and any of its relevant advisory agencies review the application with approval granted on a case-by-case basis.

Residual effects associated with well abandonment on change in availability of fisheries resources for commercial fisheries is expected to be low in magnitude, within the Project Area, short-term in duration (the time it takes to abandon a well), irregular (once per well at no set drilling schedule), and reversible, as any activities surrounding wellhead abandonment would cease once the process is completed.

6.2.10.4 Summary of Project Residual Environmental Effects

In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (e.g., compliance with Husky's EPCMP and applicable C-NLOPB guidelines), the residual environmental effect on a change in availability of fisheries resources is considered low in magnitude for Project components and activities; occur within localized areas of the Project Area; be of short to medium-term in duration, reversible; and occur primarily within an disturbed ecological and socio-economic context. The environmental effects assessment and prediction of residual environmental effects is summarized in Table 6.9. This is a prediction of effects resulting from the interactions between the Project and commercial fisheries that were identified in Table 6.8.

Table 6.9 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	A	L	PA	MT	IR	R	D
Waste Management	A	L	PA	MT	R	R	D
Vertical Seismic Profiling	A	L	PA	ST	IR	R	D
Supply and Servicing Operations	A	L	SA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	D

KEY:
See Table 6.7 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
SA: Study 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

6.2.11 Determination of Significance

With the application of proposed mitigation and environmental protection measures (Section 6.2.10.2), the residual environmental effects of a change in availability of fisheries resources on commercial fisheries from routine 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 Project and Study Areas and the effectiveness of mitigation measures, including those discussed in Section 6.2.10.2.

6.2.12 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 is proposed to be implemented for routine Project activities.

Husky provides an annual EA Update to the C-NLOPB each year, detailing the specific activities that will be conducted within the Project Area in a given year. In that EA Update Husky will include changes (if any) to commercial fisheries and discuss the potential effects of Project activities to commercial fisheries.

6.3 Marine Mammals and Sea Turtles

6.3.1 Scope of Assessment

Marine mammals and sea turtles have been selected as a VC for the following reasons:

- populations of marine mammals and some sea turtle species migrate through, or forage for food in the Study Area;
- there is potential for interaction with Project activities;
- as high-level predators, marine mammals and sea turtles play an ecologically important role by serving as indicators of change in the marine ecosystem; and
- they are a high profile group - important ecologically, culturally and socio-economically.

The Marine Mammal and Sea Turtle VC includes cetaceans (whales, dolphins and porpoises), pinnipeds (seals) and sea turtles. This VC considers secure species as well as species of marine mammals and sea turtles listed under SARA (i.e., species at risk) or considered at risk by COSEWIC (i.e., SOCC). This VC has linkages to the Special Areas VC, which is considered separately in Section 6.5, because special areas are often feeding areas for marine mammals. This VC is also closely linked to the Fish and Fish Habitat VC, as Project activities could result in changes in availability, distribution, or quality of marine mammal and sea turtle prey species and their habitat (refer to Section 6.1). The Indigenous People and Community Values VC (Section 6.6) is also linked to this VC, as routine Project activities may affect marine mammals traditionally harvested.

6.3.2 Regulatory and Policy Setting

Marine mammals and sea turtles are included within the definition of "fish" under the *Fisheries Act*. As noted in Section 6.1, 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 CRA fishery. It also prohibits the deposition of a deleterious substance in waters frequented by fish.

Species at Risk are protected federally under SARA; protection is administered by ECCC, DFO, and Parks Canada. The federal SARA focuses on protecting species whose populations are not secure and their associated habitat. SARA seeks to prevent species from becoming extirpated (i.e., locally extinct) or 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 are the most relevant to this assessment and contain provisions to protect species listed on Schedule 1 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.

Ministerial notification is required under section 79 of SARA if a project "is likely to affect a listed wildlife species or its critical habitat" and must identify the adverse effects of the project on the listed wildlife species and its critical habitat. If the project is carried out, mitigation measures that will be taken to avoid or lessen those effects, along with monitoring commitments, must be provided.

DFO has not yet set regulatory thresholds for levels of underwater sound that should be avoided to reduce potential for injury or behavioural disturbance effects to marine mammals or sea turtles. In the absence of formal Canadian thresholds or guidance, this assessment has been developed in consideration of published literature reviews and US regulatory and interim regulatory thresholds for reducing risk of potential effects from underwater noise. Further details are provided in Section 6.3.10.1.

6.3.3 The Influence of Consultation and Engagement on the Assessment

Key issues raised during stakeholder consultation and Indigenous engagement for the Project to date include general concerns related to accidental events in the deep water. It was also noted through Indigenous engagement around the use of Project vessels and the potential to affect harvestable marine mammal species (particularly seals) that pass through the Project Area and reach the near shore which could be affected.

6.3.4 Potential Effects, Pathways and Measurable Parameters

Routine Project activities have the potential to interact with marine mammals and sea turtles as well as their habitat. The primary pathway of effect is from underwater sound emissions produced by operation of the MODU, OSV and helicopter transport, and drilling-associated surveys. OSV traffic also presents a risk of collision with marine mammals and sea turtles, potentially resulting in physical injury or mortality to individuals. The Project could also result in changes in availability, distribution, or quality of marine mammals and sea turtle prey items (and/or prey habitat) because of underwater sound or operational discharges (refer to Section 6.1. for an assessment of effects on prey species). Routine Project activities may also affect habitat quality of special areas (refer to Section 6.5 for an assessment of special areas).

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 habitat quality and use; and
- change in mortality risk or physical injury.

The effect pathways and measurable parameters used for the assessment of environmental effects is provided in Table 6.10.

Table 6.10 Potential 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 Habitat Quality and Use	• Increased risk of exposure to marine contaminants • Increased risk of exposure to underwater sound at levels capable of causing behavioural disturbance	• Change in chemical composition of water (unit depends on the contaminant) • Extent (km from sound source) of underwater sound above thresholds for marine mammal and sea turtle behavioural disturbance
Change in Mortality Risk or Physical Injury	• Increased risk of vessel collision • Increased risk of exposure to underwater sound at levels capable of causing auditory injury (i.e., permanent threshold shift [PTS])	• Species injury or mortality (qualitative likelihood of species injury or mortality) • Extent (km from sound source) of underwater sound above thresholds for marine mammal and sea turtle auditory injury

Determining if and at what distance an animal can hear a sound is important in assessing effects from introduced underwater noise (Richardson et al. 1995; Popper 2003). This assessment uses expected species presence in the Study Area along with the results of acoustic modelling from the White Rose field (Husky Energy 2012a) (located within the Project Area) 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 assessment 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. Although the WREP modelling results are helpful due to modelling locations for WREP being contained within the current Project Area, there are limitations of direct use of these modelling results in this assessment due to differences in proposed drilling equipment. In such cases, examples are drawn from other sources to help inform the assessment.

6.3.5 Boundaries

6.3.5.1 Spatial Boundaries

Project Area: The Project Area (Figure 2-1) encompasses the immediate area within which Project activities and components may occur. Well locations have not been identified but will occur within EL 1151, EL 1152 and EL 1155, within the Project Area. The spatial boundary of the Project Area has been delineated to account for all activities related to drilling a well, including transit of OSV and helicopter traffic to/from St. John's and vessel traffic associated with geohazard/ environmental surveys.

Study Area: The Study Area (Figure 2-1) is the area within which residual environmental effects from operational activities and accidental events may interact cumulatively with the residual environmental effects of other past, present and future (certain or reasonably foreseeable) physical activities.

6.3.5.2 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 site location surveys, well drilling, testing and abandonment. It is anticipated that exploratory drilling activities would commence in 2019, and continue intermittently throughout the term of exploration licences, up to 2027. Well testing (if required, dependent upon drilling results) could also occur at any time during the temporal scope of this EA. Wells may be decommissioned and abandoned at any time within the temporal boundaries. The temporal scope of the EA accommodates drilling in EL 1151, EL 1152, and EL 1155 for the full term of each licence (period 1 and period 2). Within the overall temporal scope, well site surveys typically require five to seven days per well, VSPs typically take approximately one day per well and an individual well may take up to 80 days to complete. Drilling operations will not be continuous throughout the entire eight-year scope of the Project and will be dependent partially on rig availability and results from previous years. If a semi-submersible or dill ship is selected as the preferred MODU option for the Project, then drilling activities have the potential to be conducted at any time of the year. If a jack-up rig is selected as the preferred method, then drilling would only occur during the ice-free season.

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 4.2.5 and Section 4.2.6 for details regarding the specific marine mammal and sea turtle species known to occur in the Study Area.

6.3.6 Residual Environmental Effects Characterization

The descriptors used to characterize residual environmental effects on marine mammals and sea turtles are defined in Table 6.11.

Table 6.11 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 environmental effect	**Positive –** a residual environmental effect that moves measurable parameters in a direction beneficial to marine mammals and sea turtles relative to baseline **Adverse –** a residual environmental effect that moves measurable parameters in a direction detrimental to marine mammals and sea turtles relative to baseline **Neutral –** no net change in measurable parameters for the marine mammals and sea turtles relative to baseline

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	The amount of change in measurable parameters or 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 **High –** measurable change that exceeds the limits of natural variability and may affect long-term population viability
Geographic Extent	The geographic area in which a residual environmental effect occurs	**Project Area –** residual environmental effects are restricted to the Project Area **Study Area –** residual environmental effects extend into the Study Area
Frequency	Identifies how often the residual environmental effect occurs and how regularly during the Project or in a specific phase	**Single event –** effect occurs once **Multiple irregular event –** effect occurs repeatedly at no set schedule **Multiple regular event –** effect occurs repeatedly at regular intervals **Continuous –** effect occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual environmental 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 residual 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

6.3.7 Significance Definition

In consideration of the descriptors listed above, a **significant adverse residual 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 Study Area, 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 action strategy.

6.3.8 Summary of Existing Conditions for Marine Mammals and Sea Turtles

A total of 22 species of marine mammals, including 6 species of mysticetes (baleen whales), 12 species of odontocetes (toothed whales), and 4 species of phocids (seals) are known to occur in the Study Area. There are also three species of sea turtles known to occur in the Study Area. Of these 25 species, 9 species are designated at risk by SARA or COSEWIC (3 species of mysticetes, 4 species of odontocetes, and 2 species of sea turtles; see Table 6.12). No phocid populations in the Study Area are listed as species at risk or SOCC. Tables 4.26 and 4.27 present information on presence and timing of marine mammals and sea turtles (respectively) known to occur in the vicinity of the Project Area. This information was compiled based on a review of existing literature incorporated within the SEA for Eastern Newfoundland (Amec 2014), the Scotian Basin Exploration Drilling Project (BP 2016), and the White Rose Extension Project (Husky Energy 2012a). There is no designated critical habitat for species at risk within the Project or Study Areas. Marine mammal species of importance for traditional harvesting are described in Section 4.3.2 and assessed in Section 6.6.

Table 6.12 Marine Mammal and Sea Turtle Species at Risk and Species of Conservation Concern Found in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Study Area[1]	Timing of Presence
Mysticetes (Baleen Whales)					
Blue whale (Atlantic population)	*Balaenoptera musculus*	Endangered	Endangered	Low	Year- round (highest concentrations from June to September)
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Special Concern	High	Year- round (highest concentrations from June to October)

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Study Area[1]	Timing of Presence
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered	Low	May to September
Odontocetes (Toothed Whales)					
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Not Listed	Special Concern	Low	Year- round (highest concentration from May to October)
Killer whale	*Orcinus orca*	Not Listed	Special Concern	Low	Year- round (highest concentration from June to October)
Northern bottlenose whale (1: Scotian Shelf population/ 2: Davis Strait-Baffin Bay-Labrador Sea population)	*Hyperoodon ampullatus*	1: Endangered 2: Not Listed	1: Endangered 2: Special Concern	High	Year-round
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Special Concern	Low	Year-round
Sea Turtles					
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered	Moderate	June to November
Loggerhead sea turtle	*Caretta caretta*	Endangered	Endangered	Low	June to October
Source: Modified from Husky Energy 2012a 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 Study Area. Appendix D provides life history information for each species found in the Study Area.					

Four species of mysticetes have the potential to occur in the Study Area year-round: blue, fin, humpback, and minke whales. However, they have the greatest potential to be found in the Study Area, along with North Atlantic right and sei whales, during the summer and fall. While odontocetes are also present in greatest diversity during the summer and fall months, multiple species remain present throughout the year.

In the waters of the Study Area, grey and harbour seals can be found in the area year-round, while harp and hooded seals are less likely to be present in the summer or fall.

Three species of sea turtles can be found migrating through and foraging within the Study Area. Of these, the leatherback sea turtle is the most likely to occur, with the highest likelihood of a sighting in summer or fall. The presence of loggerhead and Kemp's ridley sea turtles in the Study Area is possible but considered unlikely.

Critical habitat was not identified in the 2006 Recovery Strategy for the leatherback sea turtle; however, this recovery strategy is in the process of being updated and a draft version was released for public comment (DFO 2015b). 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 2011). Research has identified important areas for leatherback sea turtles foraging in Atlantic Canadian water (DFO 2013e, DFO 2015b) and it is expected that these areas will be included as critical habitat in the updated Recovery Strategy, once finalized. In general, leatherback sea turtles can be found in high densities in the waters to the south and southeast of Georges Bank, extending to the southwest boundary of the Canadian EEZ, the southeastern Gulf of St. Lawrence and the waters off eastern Cape Breton Island, and waters south and east of the Burin Peninsula, including sections of Placentia Bay, which is approximately 117 km southwest of the Study Area.

6.3.9 Project Interactions with Marine Mammals and Sea Turtles

Table 6.13 identifies the physical Project activities that might interact with marine mammals and sea turtles to result in the identified environmental effect. These interactions are indicated by checkmarks and are discussed in Section 6.3.10 in the context of effects pathways, mitigation measures, and residual effects. A justification is also provided below for non-interactions (no checkmarks).

Table 6.13 Project-Environment Interactions with Marine Mammals and Sea Turtles

Physical Activities	Environmental Effects	
	Change in Habitat Quality and Use	**Change in Mortality Risk or Physical Injury**
Presence and Operation of MODU (Presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; well testing; cementing and completing wells)	✓	✓
Drilling-associated Surveys (VSP and wellsite surveys; geotechnical / geophysical / environmental surveys; diving surveys; ROV surveys)	✓	✓
Waste Management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)	-	-
Supply and Servicing (operation of helicopters and supply / support / standby/ tow vessels within the Project Area)	✓	✓
Well Abandonment (plugging and abandoning of wells)	✓	✓
Notes: ✓ = Potential interaction – = No interaction		

Waste management associated with drilling is expected to have negligible environmental effects on either the habitat quality or use or the change in risk of mortality or physical injury for marine mammals and sea turtles. Discharges at sea will be in accordance with requirements of Husky's EPCMP, which were specifically developed to comply with the OWTG (NEB et al. 2010) to mitigate potential effects on the marine environment. Wastes not identified in the EPCMP will not be discharged to the ocean and will be brought to shore for disposal. Discharges during drilling and completions will result in a temporary and localized reduction in water and sediment quality, although these changes are not anticipated to result in measurable changes in habitat quality for marine mammals and sea turtles.

Organic matter from sanitary wastes will be quickly dispersed (after maceration) and degraded by bacteria, and food waste may be shipped ashore. The environmental effects on marine mammals and sea turtles swimming in the receiving waters containing small amounts of organic matter and nutrients will be minimal to negligible. Domestic garbage will be transported to shore for disposal (garbage is segregated as required or recycled and in compliance with waste disposal requirement and Husky Waste Management Plan).

Drilling waste discharges (e.g., WBM and treated SBM cuttings) are unlikely to produce concentrations of heavy metals in muds and cuttings that are harmful to marine mammals (Neff et al. 1980, in Hinwood et al. 1994). None of the marine mammals that regularly occur in the Study Area are known to feed on benthos in the area. These activities are expected to have negligible environmental effects on marine mammals and sea turtles, including consideration of potential effects on prey species.

Helicopter transportation is not predicted to interact with marine mammals and sea turtles to cause a change in risk of mortality or physical injury. The presence of helicopters, and any associated in-air and underwater sound levels may result in localized behavioural disturbance; however, sound levels are not expected to reach thresholds capable of causing injury or mortality to marine mammals or sea turtles. Localized disturbance from helicopter transportation is assessed under change in habitat quality and use in Section 6.3.10. The second checkmark beside Supply and Servicing Operations in Table 6.13 reflects the potential for change in risk of mortality or physical Injury stemming from potential collision with OSVs, and this effect is carried forward to Section 6.3.10.

6.3.10 Assessment of Residual Environmental Effects on Marine Mammals and Sea Turtles

The following section presents the assessment of potential environmental effects on marine mammals and sea turtles identified as arising from interactions in Table 6.13. Given the geographic and environmental consistencies, as well as the analogous Project description, the WREP EA (Husky Energy 2012a) has been referenced extensively for this analysis, with revisions as applicable due to scientific updates, and refined EA methods.

6.3.10.1 Project Pathways

6.3.10.1.1 Change in Habitat Quality and Use

Changes in habitat quality and use for marine mammals and sea turtles could occur primarily because of underwater noise generated by various Project activities. In particular, underwater noise levels will increase due to the presence and operation of the MODU (e.g., drilling), drilling associated surveys (e.g., VSP surveys and other geophysical and geotechnical surveys), OSV operations, and well abandonment.

6.3.10.1.2 Change in Risk of Mortality or Physical Injury

Increases in underwater noise may also result in a change in risk of mortality or physical injury of marine mammals and sea turtles close to the MODU and other Project-related sound sources (e.g., seismic airguns for geophysical surveys). Exposure to underwater sound of sufficient intensity may result in temporary or permanent hearing loss (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007). There is also the potential risk for mortality or physical injury due to Project vessel collisions with marine mammals and sea turtles during OSV operations.

In consideration of the potential effects on marine mammals and sea turtles attributed to changes in underwater sound levels, the potential effects of these changes are explored further below.

6.3.10.1.3 Potential Effects of Noise on Marine Mammals and Sea Turtles

Marine mammals rely heavily on the use of underwater sounds to communicate and to gain information about their surroundings. Experiments and field studies also show that marine mammals (and to a lesser degree sea turtles) hear and may react to many anthropogenic sounds. The environmental effects of noise on marine mammals (and possibly sea turtles) are highly variable, and can be categorized as follows (based on Richardson et al. 1995):

- The noise may be too weak to be heard at the location of the animal (i.e., lower than the prevailing ambient noise level or the hearing threshold of the animal at relevant frequencies, or both).
- The noise may be audible but not strong enough to elicit any response (i.e., the animal may tolerate it).
- The noise may elicit behavioural reactions of variable conspicuousness and variable relevance to the well-being of the animal; these can range from subtle effects on respiration or other behaviours (detectable only by statistical analysis) to active and observable avoidance reactions.
- Upon repeated exposure, animals may exhibit diminishing responsiveness (habituation), or disturbance effects may persist; the latter is most likely with sounds that are highly variable in characteristics, unpredictable in occurrence and associated with situations that the animal perceives as a threat.

- Any anthropogenic noise that is strong enough to be heard has the potential to reduce (mask) the ability of marine mammals to hear natural sounds at similar frequencies, including calls from conspecifics, echolocation sounds of odontocetes and environmental sounds such as surf noise or (at high latitudes) ice noise.
- Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity, or other physical or physiological effects (and in extreme cases such as close exposure to large explosives, mortality). Received sound levels must far exceed the animal's hearing threshold and/or occur for an extended exposure duration for any temporary threshold shift (TTS) to occur. Received levels must be even higher for a risk of permanent hearing impairment.

To aid in the assessment of potential effects of noise from Project activities on marine mammals and sea turtles, a description of the hearing abilities of marine mammals and sea turtles and a review of noise criteria for assessing effects are summarized below.

6.3.10.1.3.1 Hearing Abilities of Marine Mammals and Sea Turtles

The hearing abilities of baleen whales have not been measured directly. Behavioural and anatomical evidence indicates that they hear well at frequencies below 1 kHz (Richardson et al. 1995; Ketten 2000). For baleen whales as a group, the functional hearing range is thought to be approximately 7 Hz to 22 kHz; therefore, they constitute the "low-frequency" (LF) cetacean hearing group (Southall et al. 2007). The hearing systems of baleen whales are undoubtedly more sensitive to LF sounds than are the ears of the small toothed whales that have been studied directly. Baleen whales are therefore likely to hear LF sounds (like airgun pulses and pile driving) farther away than can small toothed whales; at closer distances, these sounds may seem more prominent to baleen whales than to toothed whales.

The small to moderate-sized toothed whale species whose hearing has been studied, have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at, and above, several kHz. There is very little data on the absolute hearing thresholds of most of the larger, deep-diving toothed whales, such as the sperm and beaked whales. However, Mann et al. (2005) report that a Gervais' beaked whale (*Mesoplodon europaeus*) could detect frequencies of 5 to 80 kHz, with the greatest sensitivity at 80 kHz. Most of the odontocete species have been classified as belonging to the "mid-frequency" (MF) cetacean hearing group, and the MF odontocetes (collectively) have functional hearing from approximately 150 Hz to 160 kHz (Southall et al. 2007). However, individual species may not have quite so broad a functional frequency range. Very strong sounds at frequencies slightly outside the functional range may also be detectable. The remaining odontocetes (porpoises, river dolphins and members of the genera *Cephalorhynchus* and *Kogia*) are distinguished as the "high frequency" (HF) cetacean hearing group. They have functional hearing from approximately 200 Hz to 180 kHz (Southall et al. 2007).

The functional hearing range for pinnipeds in water is considered to extend from 75 Hz to 75 kHz, with aerial hearing between 75 Hz and 30 kHz (Southall et al. 2007). Some individual species (especially the eared seals) do not have as broad an auditory range (Richardson et al. 1995).

There have been limited scientific studies concerning the acoustic sensitivity of sea turtles, the relative importance of their acoustic environment, or the potential effects of introduced underwater noise (Popper et al. 2014). The studies undertaken to date suggest that sea turtles have greatest hearing sensitivity to low-frequency sounds (functional hearing range:100 Hz to 1 kHz; upper frequency limit of 2 kHz), with measurable age and species variations in response (Office of Naval Research 2002; Environment Australia 2003; Ketten and Bartol 2005).

6.3.10.1.3.2 Marine Mammal and Sea Turtle Noise Exposure Criteria

Threshold criteria are commonly used to assess the potential for physical (i.e., auditory) injury in the form of permanent threshold shifts (PTS); however, behavioural responses of marine species to underwater sound are generally more variable, context-dependent and less predictable than potential physical effects (Southall et al. 2007). Therefore, available sound thresholds to predict behavioural responses are considered as a guide to informing the assessment of potential effects of sound on marine mammals and sea turtles 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. Various thresholds have been established using peak sound pressure level (SPL), root-mean-square (rms) SPL, and sound exposure (energy) level (SEL) metrics. In the US, NOAA has recently finalized their guidance document on assessing how marine mammals might respond to sound exposure – NOAA Technical Memorandum: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS 2016). The 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., TTS and PTS). They are intended to be used by NOAA analysts, federal agencies and other user groups and stakeholders to better predict how marine mammals will respond to sound. Thresholds for onset of PTS in marine mammals proposed by NOAA (NMFS 2016) are discussed as applicable in the subsections below. However, 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).

Much of the basis for NOAA's 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. Southall et al. (2007) produced scientific recommendations for marine mammal noise exposure criteria for various marine mammal groups and sound types; they proposed levels above which there is a scientific basis for expecting that noise exposure would cause injury to occur. These exposure criteria incorporate frequency-weighting functions (M-weighting) for assessing the effects of sound on marine mammals, which accounts for the major differences in auditory capabilities across marine mammal groups and species. Minimum exposure criteria for injury are defined as the energy level at which single exposure is estimated to cause onset of permanent hearing loss (PTS); TTS is not considered an 'injury' (Southall et al. 2007; Le Prell 2012). 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 NMFS (2016) are summarized in Tables 6.14 and 6.15, respectively.

Table 6.14 Peak SPL (dB re 1 µPa) and Auditory-weighted Cumulative SEL (dB re 1 µPa2 ·s) Dual Acoustic Thresholds for PTS from Impulsive and Non-impulsive Sounds Proposed by Southall et al. (2007)

Functional Hearing Group	Impulsive Sound		Non-Impulsive Sound	
	Peak SPL	Weighted SEL	Peak SPL	Weighted SEL
Low-frequency cetaceans (LFC)	230	198	230	215
Mid-frequency cetaceans (MFC)	230	198	230	215
High-frequency cetaceans (HFC)	230	198	230	215
Phocid pinnipeds in water	218	186	218	203

Source: Southall et al. 2007
Note:
All criteria in the "Sound Pressure Level" lines are based on the peak pressure known or assumed to elicit TTS-onset, plus 6 dB. Criteria in the "Sound Exposure level" lines are based on the SEL eliciting TTS-onset plus (1) 15 dB for any type of marine mammal exposed to single or multiple pulses, and (2) 20 dB for cetaceans or pinnipeds in water exposed to non-pulses.

Table 6.15 Peak SPL (dB re 1 µPa) and Auditory-weighted Cumulative SEL (dB re 1 µPa2 ·s) Dual Acoustic* Thresholds for PTS from Impulsive and Non-impulsive Sounds Proposed by NOAA Acoustic Guidelines (NMFS 2016)

Functional Hearing Group	Impulsive Sound		Non-Impulsive Sound
	Peak SPL	Weighted SEL	Weighted SEL
Low-frequency cetaceans (LFC)	219	183	199
Mid-frequency cetaceans (MFC)	230	185	198
High-frequency cetaceans (HFC)	202	155	173
Phocid pinnipeds in water	218	185	201

Source: NMFS 2016
Note:
* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
Note: The weightings are not comparable to Southall et al. 2007.

Both the NOAA (NMFS 2016) and Southall et al. (2007) criteria were developed specifically for use with assessing auditory injury in 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 2016).

Under the ANSI-Accredited Standards Committee S3/SC 1, a Working Group on Animal Bioacoustics has established sound exposure guidelines for sea turtles that adopt some of the Southall et al. (2007) approaches for marine mammals. However, the Working Group 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). At this time, the Working Group has only developed numeric thresholds for potential sea turtle mortality and mortal injury in relation to explosions, seismic airguns, and pile driving. This assessment considers the recommended thresholds for seismic airguns in the assessment of potential effects on sea turtles from geophysical surveys.

With respect to behavioural disturbance, NOAA's interim guidelines (NOAA 2015) for marine mammals provide threshold levels for broadband underwater RMS SPLs to avoid risk of behavioural disruption. NOAA's most recent guidelines (NMFS 2016) do not address behavioural disruption or update the interim guidelines. This topic is widely recognized as being a complex and challenging subject and an area of ongoing investigation and analysis. Until this updated guidance is developed, and in the absence of formal Canadian thresholds, NOAA's interim RMS SPLs (NOAA 2015) 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 reviewed publications. These 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 Scotian Basin Exploration Drilling Project (BP 2016); and the Shelburne Basin Venture Exploration Drilling Project (Shell 2014). This approach is also consistent with the DFO acoustic assessment framework 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, there is scientific 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 it has been suggested that the 120 and 160 dB values over-extrapolate results from too few studies and species (Green et al. 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]).

Behavioural and physical effects from underwater sound on marine mammals are described in Section 5.3 of the Eastern Newfoundland SEA (Amec 2014) and include masking, disturbance, hearing impairment, and non-auditory physiological effects.

6.3.10.2 Mitigation

As required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017a), mitigation measures for geophysical surveys will be consistent with the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP) (DFO 2007b).

In consideration of the environmental effect pathways discussed above, the following mitigation measures and standard practices will be implemented to reduce adverse environmental effects of the Project on marine mammals and sea turtles:

- 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
- 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 near the source at the onset of the activity. It assumes 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 500 m of the wellsite.
- Shutdown of the air gun array when a member of the eastern Newfoundland (Sackville Spur) population of northern bottlenose whale is sighted within the safety zone.
- Delay of ramp-up if any marine mammal or sea turtle is sighted within the safety zone.

Project-related vessel traffic will avoid concentrations of marine mammals and sea turtles whenever possible. Vessels will maintain a steady course and safe vessel speed whenever possible, as sudden changes in these factors are known to increase behavioural effects in marine mammals. Helicopters will typically only reduce altitude on approach for landing.

If a vessel strikes a marine mammal or sea turtle the master of the vessel will contact the Canadian Coast Guard (CCG) through the nearest Marine Communications and Traffic Services. The CCG will communicate this information to the appropriate regulatory departments.

The applicable Operator will also inform DFO within 24 hours. As outlined on the DFO website (DFO 2018d), to report a marine mammal or sea turtle emergency there is a 24-hour number to contact – Whale Release and Strandings Newfoundland and Labrador at 1-888-895-3003.

In the unlikely event that shape charges are required to remove the wellhead during well abandonment, a MMO will visually monitor marine mammals and sea turtles in the area of the wellhead and detonation will be delayed until there are no sighting for at least 45 minutes.

Measures to mitigate potential environmental effects on fish in the Project Area during the Project activities (refer to Section 6.1.10.2), will reduce effects on prey for marine mammals and sea turtles.

6.3.10.3 Characterization of Residual Project-related Environmental Effects

6.3.10.3.1 Change in Habitat Quality and Use

6.3.10.3.1.1 Presence and Operation of MODU

This section summarizes the possible environmental effects of noise associated with the presence and operation of the MODU on marine mammals and sea turtles. These activities could occur at any time of the year and would be continuous during the time it takes to drill each well. Up to10 wells may be drilled from 2019 to 2027. Each well may take up to approximately 80 days to complete. Potential reactions of marine mammals and sea turtles to drilling noise range from subtle changes in behaviour to avoidance, although most studies have focused on reactions to impulsive sounds such as those generated by seismic activity rather than continuous drilling noise.

Behavioural reactions of marine mammals and sea turtles to increases in underwater noise are difficult to predict. Responses, if any, can vary by species, state of maturity, experience, activity, reproductive state, time of day and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007). Various authors have noted that even marine mammals that show no obvious avoidance or behavioural changes may still be adversely affected by noise (Brodie 1981; Richardson et al. 1995; Romano et al. 2004; Weilgart 2007; Wright et al. 2009, 2011). For example, some research suggests that animals in poor condition or in an already stressed state may not react as strongly to human disturbance as would more robust animals (e.g., Beale and Monaghan 2004).

If a marine mammal or sea turtle does react to an underwater sound by changing its behaviour or moving a small distance, the effects of the change are unlikely to be critical to the individual, let alone the stock or population. However, if a sound source displaces marine mammals or sea turtles from an important feeding or breeding area for a prolonged period, effects on individuals and populations could be substantial (e.g., Lusseau and Bejder 2007; Weilgart 2007).

Onset of marine mammal behavioural responses to continuous sound may occur at sound levels of 120 dB re 1 µPa RMS SPL (Lawson and Lesage 2013) with more extreme behavioural responses (e.g., long-term displacement from an area) more likely to occur at higher received sound levels over long periods of time. Underwater acoustic modelling undertaken in the White Rose field (Matthews and Zykov 2012) assessed the extent of ensonification resulting from drilling from a concrete gravity structure (CGS). Results of this modelling suggest that sound levels attenuate rapidly with distance, particularly in deep-water environments. CGS source levels of 162 dB re 1 µPa @ 1 m RMS SPL were predicted to decrease to below 120 dB re 1 µPa RMS SPL at distances greater than 677 m in the summer (August) and 584 m in the winter (February). It is recognized that this acoustic modelling for the CGS is not directly comparable to source levels expected for semi-submersibles, jack-up rigs or drillships as these MODUs are likely to have higher source levels and therefore emit more sound into the marine environment than a CGS (Matthews and Zykov 2012). However, this modelling demonstrates how quickly sound levels can attenuate within the Project Area.

Acoustic modelling conducted for the Scotian Basin Exploration Drilling Project in deep waters (2,100 m and 2,790 m) offshore Nova Scotia assumed broadband source levels for a drillship and semi-submersible to be approximately 197 dB re 1 µPa @ 1 m RMS SPL (Zykov 2016) and predicted sound levels from a drillship and a semi-submersible would attenuate to 120 dB re 1 µPa RMS SPL at distances ranging from 23 km (summer) to approximately 150 km (winter) from the source. It is noted that this location featured a strong surface channel, created by water temperature gradients (present year-round, but stronger in winter), which traps acoustic energy at the surface, thereby reducing the amount of transmission loss. This strong surface channel was not predicted by acoustic modelling undertaken for the White Rose field.

Acoustic modeling was also conducted by JASCO for Nexen's Flemish Pass Exploration Drilling Project in deep (1,137 m) and shallow (378 m) waters (JASCO 2018). Considering underwater sound level thresholds associated with injury and behavioural effects to marine life, the longest distance from the drilling platform were for high-frequency cetaceans, with 1.88 km from the deep site and 3.29 km for the shallow site (JASCO 2018). Distances to all other injury threshold rceptors ((low-frequency cetaceans, mid-frequency cetaceans, phocid pinnipeds in water, and otariid pinnipeds in water)) were no longer than 228 m from the drilling platform from wither the deep-water or shallow-water site.

The acoustic assessment undertaken by Statoil suggests that the surface channel in the Flemish Pass is not expected to be as conductive to sound (when compared to the Scotian Basin), and that it would therefore likely yield shorter distances to thresholds (Statoil 2017). Distances to thresholds for behavioural disturbance are also likely to be lower in shallow water sites (Statoil 2017).

Results from acoustic recorders deployed by JASCO Applied Sciences in 2015/2016 indicate that underwater noise from the existing oil and gas platforms (Hibernia, Terra Nova, and White Rose) increases the average received sound levels at recording stations located 35 km away, and that at distances of 100 km, noise from geophysical survey sources were still a dominant noise source (Statoil 2017). JASCO also determined that in the very-low frequency band (10-45 Hz), background sound levels in the Eastern Newfoundland offshore area are in the range of 90-95 dB re 1 µPa and that sound levels are slightly higher in the winter due to the effects of higher winds and sea states, and the presence of singing fin whales, which were a dominant noise source for four to seven months throughout fall, winter, and spring (Statoil 2017). Another dominant noise source recorded in the very-low frequency band in the summer months was anthropogenic seismic survey sounds. Platform and vessel noise were also weakly detectable in this band (Statoil 2017).

One of the key changes in habitat quality and use associated with increased underwater sound levels is a potential change in how marine mammals send and receive acoustic signals for communication. The greatest potential for sound masking exists for marine mammals that produce and perceive sounds within the range of frequencies produced by the anthropogenic source. Baleen whales are likely to be the most susceptible to potential masking associated with the increased ambient sound levels from the MODU as baleen whales vocalize primarily in the lower frequencies (7 Hz to 22 kHz) (Clark 1990; Erbe 2002). Conversely, odontocete communication frequency ranges from 2 to over 100 kHz (Au and Hastings 2008), and only partially overlaps the low frequency range of drilling sounds (10 Hz to 10 kHz). 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, although such alterations may be costly for survival and reproductive success (Wright 2008).

Currently, 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 to compare to acoustic modelling results (Popper et al. 2014). However, studies have proposed that sea turtles (including the species found within the Study Area) have the greatest hearing sensitivity to low-frequency sounds (Office of Naval Research 2002; Environment Australia 2003; Ketten and Bartol 2005). While little scientific data/research is available on the effects of sound on sea turtles, there is also little to suggest that they would be more sensitive to underwater sounds than marine mammals (Popper et al. 2014); therefore, the same types of potential effects discussed above for marine mammals are expected to encompass the range of potential effects on sea turtles.

Residual environmental effects associated with the presence and operation of the MODU on the change in habitat quality and use for marine mammals and sea turtles is predicted to be moderate in magnitude, within the Project Area, medium-term (will not persist beyond the drilling program), irregular over the lifespan of the Project, and reversible.

6.3.10.3.1.2 Drilling-Associated Surveys

In the Study Area, drilling-associated surveys will include VSP and geohazard surveys. Similar to seismic surveys, both VSP and geohazard surveys use air guns, but a key difference is the larger array size and longer duration required during seismic surveys. The potential physical and physiological effects of noise from the geohazards equipment are of less concern than air gun pulses from 2D and 3D surveys given their relatively lower source levels, emission in a narrow beam, short duration of the geohazards program, and that some equipment operates at frequencies outside the range of marine mammal and sea turtle hearing abilities. Although on a relative scale, geophysical surveys may emit the most intense emissions of Project-related sound sources, these would be short term (e.g., approximately one day per well for VSP and five to seven days per well for wellsite surveys). Lee et al. (2011) suggest the energy level from a single VSP pulse could produce a source level of 220 to 245 dB re 1 µPa @ 1 m at frequencies of 5 to 300 Hz. However, this could vary depending on the size of the source array.

Acoustic modelling for the Scotian Basin Exploration Drilling Project assumed a source level of 248 dB re 1 µPa @ 1 m (peak SPL) and predicted the sound from the VSP source would 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 (Zykov 2016). The surface sound channel that exists on the Scotian Shelf is not present to the same extent within the Project Area for the proposed Project. As a result, it would be expected that sound emissions from VSP surveys would likely dissipate at a faster rate than those modelled for the Scotian Basin Exploration Drilling Project. Results from Nexen's acoustic modelling indicated that, considering the injury criteria thresholds, the longest distances from VSP airgun array was for low-frequency cetaceans, with 4.98 km at the deep-water site and 9.66 km at the shallow water site. Distances to all other injury threshold receptors (mid-frequency cetaceans, high-frequency cetaceans, phocid pinnipeds in water, an otariid pinnipeds in water) were no longer than 380 m from the VSP airgun array and distances to behavioural threshold were 6.3–7.9 km for the VSP airgun array (JASCO 2018).

The potential effects of air gun sounds may include one or more of the following: tolerance, masking of natural sounds, behavioural disturbance and, at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Many cetaceans tend to avoid operating air guns, but only slight (if any) avoidance has been shown by pinnipeds and sea turtles.

Some behavioural disturbance is expected, but this would be localized and short-term. Short-term avoidance behaviour does not necessarily provide information about long-term effects, such as reproductive rate or distribution and habitat use in subsequent days or years. Effects likely vary between species, location and past exposure to seismic sounds. Wellsite and VSP surveys are likely to have the greatest effect in or near areas where marine mammals or sea turtles concentrate. However, marine mammals are expected to be widely distributed throughout the Study Area. This area is not a breeding area for sea turtles and there are no known feeding areas or sensitive areas; thus, concentrations of marine mammals, and especially sea turtles, are unlikely.

Short-term avoidance movements and decreased densities of harbour porpoise were observed at 10 km 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), with most harbour porpoise returning to the area within a few hours following seismic activity (Thompson et al. 2013).

Residual environmental effects associated with drilling-associated surveys on the change in habitat quality and use for marine mammals and sea turtles is predicted to be low in magnitude, within the Project Area, short-term (no more than a day per well, totaling 10 days over 8 years), reversible, and with multiple irregular events.

6.3.10.3.1.3 Supply and Servicing

OSV traffic associated with the Project will increase underwater sound levels, which could result in a change of habitat quality or use for marine mammals and sea turtles. Acoustic modelling conducted in the White Rose field (which is located within the Project Area), to predict the propagation of underwater sound from a 5,000 HP tug support vessel, predicted underwater sound levels would attenuate to 120 dB re 1 μPa RMS SPL at distances of approximately 14 km (summer) to 16 km (winter). Therefore, it is reasonable to assume there could potentially be behavioural effects out 16 km from this continuous sound source.

Behavioural responses by marine mammals to vessels are variable and may include approach or avoidance, changes in diving, feeding, or vocalizations. Sea turtles are not found in high densities in the Study Area and typically occur only during late summer or early fall. Generally, sea turtles flee or dive when approached closely by a vessel (e.g., Hazel et al. 2007). The one to three OSVs required for the Project will represent a small increment above existing vessel traffic in the area. Vessel traffic is expected to have a short-term and localized effect on marine mammals and sea turtles.

Vessel traffic will avoid concentrations of marine mammals and sea turtles, whenever possible. As part of routine operations, vessels maintain a steady course and an economical vessel speed, whenever possible, which have the benefit of avoiding sudden changes in factors known to increase behavioural effects in marine mammals.

Helicopter flights over water will introduce some sound to the surrounding marine environment. Matthew and Zykov (2012) described the sound levels of a helicopter hovering over the water at an altitude of 91 m and estimated that the maximum horizontal distance from directly under the helicopter where sounds levels reached 120 dB re 1 μPa was 61 m at a water depth of 128 m below surface. Although transfer of sound from helicopters to the water is likely minimal, marine mammals have shown variable reactions to aircraft, often startling or diving during low-altitude overflights (see Richardson et al. 1995). Baleen whales often react to aircraft overflights by hasty dives, turns, or other changes in behaviour. Whales actively feeding or socializing often seem rather non-responsive, whereas whales in confined waters or with calves sometimes seem more responsive (Richardson et al. 1995). Odontocetes reacting to aircraft may dive, slap the water with flippers or flukes, or swim away. Generally, pinnipeds exhibit a greater response to disturbance when on land than in the water, although overflights at low altitudes may cause some animals in the water to dive (Richardson et al. 1995).

Single or occasional overflights by helicopters would likely only elicit a brief behavioural response by most marine mammals and sea turtles and therefore would be expected to result in a short-term and localized change in habitat quality and use. It is unlikely that large numbers of marine mammals will be overflown, especially at low altitude. Helicopters will typically only reduce altitude on approach for landing which will reduce interactions with marine mammals and sea turtles.

Residual environmental effects associated with supply and servicing on the change in habitat quality and use for marine mammals and sea turtles is predicted to be low in magnitude, occur in the Project Area, be medium-term and reversible, and with multiple irregular events.

6.3.10.3.1.4 Well Abandonment

Well abandonment will be conducted in accordance with C-NLOPB requirements and will involve plugging of wells and removal of the wellhead. This activity, which is expected to take 7 to 10 days per well, will involve above water and underwater activities that could result in changes to habitat quality and use for marine mammals and sea turtles. Removal of the wellhead will be done via mechanical separation where possible, which will result in limited underwater activity and introduced sound, and thus limited interaction with marine mammals and sea turtles.

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. However, in the unlikely event that shape charges are required to remove the wellhead, a MMO will visually monitor marine mammals and sea turtles near the area of the wellhead and detonation will be delayed until there are no sighting for at least 45 minutes.

A charge detonated below the seafloor will have an initial rate of increased pressure that is more attenuated than an explosion in the water column. Much of the initial shock pulse and energy from the charge will be absorbed by the seafloor. Use of charges will only be used after the Drilling Superintendent, the C-NLOPB and any of its relevant advisory agencies thoroughly review the application; approval is granted on a case-by-case basis.

Residual environmental effects associated with well abandonment on the change in habitat quality and use on marine mammals and sea turtles is predicted to be low in magnitude, restricted to the Project Area, be short-term and reversible, and with multiple irregular events.

6.3.10.3.2 Change in Mortality Risk or Physical Injury

6.3.10.3.2.1 Presence and Operation of 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 animals are in and remain within near of the source. Since marine mammals and sea turtles are likely to exhibit behavioural responses at lower thresholds than required to elicit potential injury (e.g., TTS or PTS), it is unlikely that animals would approach the MODU at proximities that could potentially result in injurious effects. 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).

Responses of sea turtles to underwater sound are largely unknown; studies to date have focused on seismic sound sources that are far more intense than the sounds emitted from drilling activities. This assessment assumes that similar to marine mammals, sea turtles will tend to avoid intense sources of sound and are therefore unlikely to approach close enough to the MODU or remain in the vicinity long enough to be exposed to sound levels capable of causing auditory injury.

Residual environmental effects associated with the presence and operation of the MODU on the change in risk of mortality or physical injury for marine mammals and sea turtles is predicted to be low in magnitude, restricted to the Project Area, medium-term (will not persist beyond the drilling program), irregular over the lifespan of the Project, and reversible.

6.3.10.3.2.2 Drilling-Associated Surveys

VSP and geohazard surveys would emit impulsive sounds which could potentially result in physical injury to marine mammals and sea turtles within close proximity of the sound source. NOAA's 2016 Acoustic Guidelines (NMFS 2016) suggest PTS onset from impulsive sounds (e.g., VSP) can occur at cumulative sound exposure levels as low as 155 dB re 1 μPa^2 s for odontocetes (202 dB re 1 μPa peak SPL), with similar effects realized by other marine mammals in lower frequency hearing groups (e.g., baleen whales, phocid pinnipeds) occurring at a threshold of 183-185 dB re 1 μPa^2 s. Assuming the source levels for wellsite and VSP surveys could be on the order of approximately 220 to 248 dB re 1 μPa @ 1 m, there is potential for PTS to occur in close proximity to the sound source. Calculations of cumulative SEL values used to determine sound levels associated with permanent auditory injury assume that the wellsite and VSP source array is activated hundreds of times in a 24-hour period and that the receiver (i.e., marine mammal or sea turtle) is exposed to this level continuously over the entire period (Zykov 2016).

Responses of sea turtles to underwater sound are largely unknown; however, it is assumed that injury levels for sea turtles do not exceed those for cetaceans (LGL 2014). Even though limited data on the effects of seismic airguns on sea turtles exists, Popper et al. (2014) suggested 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. Thresholds for sublethal 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).

While source levels for wellsite and VSP surveys could therefore be high enough to potentially elicit physical effects on marine mammals and sea turtles, these animals are generally expected to temporarily avoid localized areas subject to seismic noise (LGL 2013) and are therefore unlikely to approach close enough to the sound source to be exposed to sound levels capable of causing auditory injury. Adherence to the SOCP will be implemented to further reduce the risk of effects to marine mammals and sea turtles during wellsite and VSP activities (see Section 6.3.10.2).

Residual environmental effects associated with drilling-associated surveys on the change in risk of mortality or physical injury for marine mammals and sea turtles is predicted to be low in magnitude, restricted to the Project Area, short-term in duration, multiple occurring as irregular events (no more than a day per well, totaling 10 days over 8 years), and reversible.

6.3.10.3.2.3 Supply and Servicing

Sound levels from vessel traffic associated with the Project are not expected to be high enough to cause physical or physiological effects on marine mammals or sea turtles (see Richardson et al. 1995). However, there is a risk of vessel collision with marine mammals and sea turtles resulting in serious injury or mortality. Large species of whales and sea turtles that spend extended periods near the surface would be particularly susceptible to ship strikes. Baleen whales such as fin and humpback whales which are common in the Study Area, are the most commonly reported whales to be struck by vessels (Laist et al. 2001).

Sea turtles are also at risk from ship strikes as they regularly surface to breathe and often rest at or near the surface. A study carried out to assess the ability of green sea turtles to avoid vessels in Morton Bay, Queensland, found that the proportion of turtles that displayed a flee response to approaching vessels decreased as speed increased, and that this was most notable for close encounters (Hazel et al. 2007). Turtles were observed to flee from slow moving vessels (approximately 4 km/h) in 60% of observations (Hazel et al. 2007). Thus, sea turtle injury or mortality may also occur due to collisions with vessels, particularly with vessels traveling at speeds greater than 4 km/h (Hazel et al. 2007). This study also indicated that a turtle's ability to detect an approaching vessel was vision-dependent and so directly related to water clarity. The study proposed that the vision-dependence of sea turtles explains their inability to evade fast vessels (Hazel et al. 2007).

The one to three OSVs required for the Project will represent a small increment above existing vessel traffic in the area and Project-related vessel traffic is expected to have a short-term and localized potential for increasing collision risk with marine mammals and sea turtles. The OSV responsible for transporting supplies will require one to three trips per week from the supply base to the MODU. One OSV is always on standby with the MODU if it is operating outside the White Rose field. A third OSV may occasionally be required for ice management. Project activities involving vessel traffic will avoid concentrations of marine mammals and sea turtles whenever possible. Vessels will maintain a steady course and safe speed, reduce speed, or deviate from their course to avoid potentially fatal collisions with marine mammals or sea turtles.

Residual environmental effects associated with supply and servicing on the change in risk of mortality or physical injury on marine mammals and sea turtles is predicted to be low in magnitude, occur within the Project Area, be medium-term in duration (extend the duration of Project activities), with multiple regular events, and reversible.

6.3.10.3.2.4 Well Abandonment

Well abandonment will be conducted in accordance with C-NLOPB requirements and will involve plugging of wells and removal of the wellhead. This activity, which is expected to take 7 to 10 days per well, may involve removal of the wellhead by mechanical means (as a preferred measure) or use of shape charges.

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. However, in the unlikely event that shape charges are required to remove the wellhead, a MMO will visually monitor marine mammals and sea turtles near the wellhead and detonation will be delayed until there are no sighting for at least 45 minutes.

A charge detonated below the seafloor will have an initial rate of increased pressure that is more attenuated than an explosion in the water column. Much of the initial shock pulse and energy from the charge will be absorbed by the seafloor. Marine mammals and sea turtles are not expected to be frequenting the immediate wellhead area during well abandonment activities due to underwater activity and increased sound levels and, as noted above, detonation would be delayed until there are no sightings for at least 45 minutes. Given the depth of the water at the wellhead (i.e., between 85 and 1,000 m), the delay of detonation based on MMO observations, the size of the charge, and its detonation below the sea floor, it is very unlikely that there would be exposure to sound pressure levels that would elicit physical injury to marine mammals and sea turtles.

Residual environmental effects associated with well abandonment on the change in risk of mortality or physical injury on marine mammals and sea turtles is predicted to be low in magnitude, occur within the Project Area, be short-term and reversible, and with multiple irregular events.

6.3.10.4 Summary of Project Residual Environmental Effects

Overall, the Project may result in adverse effects that cause a change in habitat quality and use and a change in risk of mortality or physical injury for marine mammals and sea turtles. Based on the implementation of applicable mitigation measures, best practices, and adherence to industry standards (e.g., compliance with SOCP), the residual effect of changes to habitat quality and use for various Project components and activities is considered to be low to moderate in magnitude. Effects will be restricted to the Project Area, and will be short- to medium-term in duration, continuous or irregular, reversible, and occur within a disturbed ecological and socio-economic context (from current sources of ambient noise [primarily shipping] in the Study Area). Similarly, changes in risk of mortality or physical injury for marine mammals and sea turtles are predicted to be low in magnitude, occur within the Project Area or Study Area, be short- to medium-term in duration, continuous or irregular, reversible, and occur within a disturbed context.

Table 6.16 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 6.13.

Table 6.16 Project Residual Effects on Marine Mammals and Sea Turtles

Residual Effect	Residual Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Habitat Quality and Use							
Presence and Operation of MODU	A	M	PA	MT	IR	R	D
Drilling Associated Surveys	A	L	PA	ST	IR	R	D
Supply and Servicing	A	L	PA	MT	IR	R	D
Well Abandonment	A	L	PA	ST	IR	R	D
Change in Risk of Mortality or Physical Injury							
Presence and Operation of MODU	A	L	PA	MT	IR	R	D
Drilling-Associated Surveys	A	L	PA	ST	IR	R	D
Supply and Servicing	A	L	PA	MT	R	R	D
Well Abandonment	A	L	PA	ST	IR	R	D

KEY:
See Table 6.11 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
SA: Study 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

6.3.11 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in habitat quality and use and change in risk of mortality or physical injury on marine mammals and sea turtles from Project activities and components are predicted to be not significant. This conclusion has been determined with a high level of confidence based primarily on the low likelihood of animals being present within range of physiological effect thresholds continued exposure to those levels and the duration of the Project activities. While there is scientific uncertainty concerning the potential effects of introduced underwater sound on sea turtles and marine mammals and site-specific modelling was not undertaken, there is, however a reasonable understanding of the effects of exploration drilling and VSP operation on marine mammals and the effectiveness of mitigation measures, including those discussed in Section 6.3.10.2. Project activities of relevance to marine mammals and sea turtles are predicted to be of short- to medium-term duration and occur in an area of relatively low marine mammal and sea turtle SOCC abundance, where no critical habitat for species at risk has been designated. As such, confidence is high that residual effects are unlikely to cause a decline in abundance or change in distribution of populations of marine mammal or sea turtle within the Study Area or jeopardize the achievement of self-sustaining population objectives or recovery goals for listed SARA species.

6.3.12 Follow-up and Monitoring

MMOs will be employed to monitor and report on sightings of marine mammals and sea turtles as required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017a) (see Section 6.3.10.2). Mitigation measures, described in Section 6.3.10.3 will be required during wellsite and VSP survey operations when baleen whales, sea turtles, any marine mammal listed on Schedule 1 of SARA, or the eastern Newfoundland (Sackville Spur) population of northern bottlenose whale are detected within a minimum 500 m 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 C-NLOPB.

In the event that a vessel collision with a marine mammal or sea turtle occurs, Husky will contact the Marine Animal Response Society or the Canadian Coast Guard to relay incident information.

Given the low probability of encountering marine mammal and sea turtle SOCC and species at risk, no sound monitoring is required for this Project.

Husky provides an annual EA Update to the C-NLOPB each year, detailing the specific activities that will be conducted within the Project Area in a given year. In that EA Update Husky will include changes (if any) to marine mammal and sea turtle species at risk/SOCC and critical habitat and discuss the potential effects of Project activities to marine mammal and sea turtle species at risk/SOCC and critical habitat.

6.4 Migratory Birds

6.4.1 Scope of Assessment

Migratory birds are selected as a VC because they are abundant within the Study Area, have potential to interact with Project activities, there are regulatory protections in place and because there are requirements in the EIS Guidelines regarding migratory birds. They also have socio-economic value because of their importance to tourism and their use as a food source. The Migratory Birds VC includes pelagic (i.e., offshore) and neritic (i.e., inshore) seabirds, waterfowl, shorebirds, and land birds that are protected under the *Migratory Birds Convention Act* (MBCA); as well as other marine-related birds not protected under the Act (e.g., cormorants). Marine-related birds listed under SARA (Schedule 1), and/or under the NL ESA or are assessed as at risk by COSEWIC are considered in this VC, as are other SOCC. This VC is related to the Fish and Fish Habitat VC (Section 6.1) in recognition of prey species upon which migratory birds may rely and Indigenous People and Community Values (Section 6.6) as some migratory bird species (i.e., turrs (or murres)) are hunted for traditional purposes.

6.4.2 Regulatory and Policy Setting

Species at risk include all species listed under Schedule 1 of the federal SARA as *endangered*, *threatened*, or of *special concern*; or listed in the *Endangered Species List Regulations* under the NL ESA as *endangered*, *threatened*, or *vulnerable*. SOCC include those that are assessed as *endangered*, *threatened*, or of *special concern* by COSEWIC, but not yet listed in Schedule 1 of SARA.

Migratory birds are protected federally under the MBCA and associated regulations. This act provides protection to species listed in the CWS Occasional Paper No. 1, Birds Protected in Canada under the MBCA, including species of waterfowl, shorebirds, seabirds except cormorants and pelicans, and most land birds (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 that are 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". Bird species not protected under the MBCA, such as cormorants, are protected under the provincial *Wildlife Act.*

The NL ESA and the federal SARA provide legislated protection to migratory bird species at risk and important habitat for these species. The NL ESA provides protection to species listed as *endangered*, *threatened*, or *vulnerable* under the Act, and habitat that is critical to their survival or necessary for their recovery. The conservation and recovery of species protected under the NL ESA is coordinated by the Wildlife Division of the Newfoundland and Labrador Department of Environment and Climate Change. The federal 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*. Wildlife species that are protected under SARA are listed in Schedule 1 of the Act; sections 32, 33 and 58 of the Act contain provisions to protect them 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.

6.4.3 The Influence of Consultation and Engagement on the Assessment

Key issues raised during stakeholder consultation and Indigenous people engagement for the Project to date include general concerns related to accidental events in the deep water. It was also noted through Indigenous engagement around the use of Project vessels and the potential to affect harvestable migratory bird species that pass through the Project Area and reach the near shore which could be affected.

6.4.4 Potential Effects, Pathways and Measurable Parameters

Interactions between Project activities and migratory birds may result because of attraction to the lights and flares associated with the presence and operation of the MODU, underwater sound emissions from drilling-associated wellsite and VSP surveys, waste discharges during well drilling and testing operations, and OSV and helicopter activities during supply and servicing. The assessment of the environmental effects of the Project 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 effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 6.17. Effects of accidental events are assessed separately in Section 7.3.

Table 6.17 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., light attraction leading to collisions) or indirect (e.g., predator-prey relations) 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

6.4.5 Boundaries

6.4.5.1 Spatial Boundaries

Project Area: The Project Area (Figure 2-1) encompasses the immediate area within which Project activities and components may occur. Well locations have not been identified but will occur within EL 1151, EL 1152 and EL 1155, within the Project Area. The spatial boundary of the Project Area has been delineated to account for all activities related to drilling a well, including transit of OSV and helicopter traffic to/from St. John's and vessel traffic associated with geohazard/environmental surveys.

Study Area: Is the area within which residual environmental effects from operational activities and accidental events may interact cumulatively with the residual environmental effects of other past, present and future (certain or reasonably foreseeable) physical activities.

6.4.5.2 Temporal Boundaries

The temporal boundaries for potential Project-related environmental effects on migratory birds encompass all Project phases, including well site location surveys, well drilling, testing and abandonment. It is anticipated that exploratory drilling activities would commence in 2019, and continue intermittently throughout the term of licences, up to 2027. Well testing (if required, dependent upon drilling results) could also occur at any time during the temporal scope of this EA. Wells may be decommissioned and abandoned at any time within the temporal boundaries. The temporal scope of the EA accommodates drilling in EL 1151, EL 1152, and EL 1155 for the full term of each licence (period 1 and period 2). Within the overall temporal scope, wellsite surveys typically require five to seven days per well, VSPs typically take approximately one day per well, and an individual well may take up to 80 days to drill. Drilling operations will not be continuous throughout the entire eight-year scope of the Project and will be dependent partially on rig availability and results from previous years. If a semi-submersible or dill ship is selected as the preferred MODU option for the Project, then drilling activities have the potential to be conducted at any time of the year. If a jack-up rig is selected as the preferred method, then drilling would only occur during the ice-free season.

Migratory birds can be found in and around the Project Area year-round carrying out various life cycle processes. An overview of existing conditions for migratory birds is provided in Section 4.2.7 (Existing Environment - Migratory Birds). Further information regarding the specific migratory bird species at risk and SOCC known to occur in the Study Area, including their sensitive periods and relation to the Project Area, is available in Section 4.2.7.5 (Species at Risk and Species of Conservation Concern).

6.4.6 Residual Environmental Effects Characterization

The descriptors used to characterize residual environmental effects on migratory birds are defined in Table 6.18.

Table 6.18 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 environmental effect relative to baseline	**Positive** – a residual environmental effect that moves measurable parameters in a direction beneficial to migratory birds **Adverse** – a residual environmental effect that moves measurable parameters in a direction detrimental to migratory birds **Neutral** – no net change in measurable parameters for migratory birds
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 (e.g., 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 a residual environmental effect occurs	**Project Area** – effect is restricted to the Project Area **Study Area** – effect extends to the Study Area
Frequency	Identifies how often the residual effect occurs and how often during the Project	**Single Event** – effect occurs once **Multiple Irregular Event** – effect occurs more than once at no set schedule **Multiple Regular Event** – effect occurs more than once at regular intervals **Continuous** – effect occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual environmental 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** – effect extends beyond the duration of Project activities and continues after well abandonment (>25 years)
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the Project activity ceases	**Reversible** – measurable parameters will recover to baseline conditions before or after Project completion (well abandonment) **Irreversible** – the residual environmental effect is unlikely to be reversed

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Ecological and Socio-economic Context	Existing condition and trends in the area where residual 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

6.4.7 Significance Definition

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 Study Area, 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 at risk) species; or
- results in permanent and irreversible loss of critical habitat as defined in a recovery plan or an action strategy for a listed (species at risk) species.

6.4.8 Summary of Existing Conditions for Migratory Birds

As described in further detail in Section 4.2.7 (Existing Environment – Migratory Birds), the Grand Banks provide important habitat for millions of migratory birds. Many of these species are pelagic species that could occur in the Project Area, including gannets, phalaropes, gulls, petrels, alcids, and shearwaters (Amec 2014). While there are a large proportion of pelagic seabirds that are resident in the Study Area year-round, summer brings many migratory birds to the Study Area to forage and breed. The peak seabird density is typically from July to September, with the highest densities occurring on the shelf edges where upwelling and nutrients are most abundant (JWEL 2002a, Lock et al. 1994b, in LGL Limited 2008a, 2008b). Seabirds are least abundant during fall months, as species leave to migrate south for the winter (Fifield et al. 2009).

The waters of the eastern Newfoundland offshore area and adjacent coast are known to support approximately 19 species of pelagic seabirds; 17 species of neritic seabirds, 24 species of waterfowl, loons, and grebes; and 24 shorebird species (Table 4.28), 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. Migratory bird species that are likely to occur in the Study Area are listed in Table 6.19.

Table 6.19 Migratory Bird Species Likely to Occur in the Study Area

Family	Species
Alcidae	black guillemot
	dovekie
	common murre
	thick-billed murre
	razorbill
	Atlantic puffin
Laridae	Arctic tern
	black-legged kittiwake
	Caspian tern
	common tern
	ivory gull
	herring gull
	Iceland gull
	laughing gull
	lesser black-backed gull
	ring-billed gull
	Sabine's gull
	glaucous gull
	great black-backed gull
Hydrobatidae	Leach's storm-petrel
	Wilson's storm-petrel
Phalaropdinae	red phalarope
	red-necked phalarope
Procellariidae	Cory's shearwater
	great shearwater
	Manx shearwater
	northern fulmar
	sooty shearwater
Scolopacidae	red phalarope
	red-necked phalarope
Stercorariidae	great skua
	south polar skua
	pomarine jaeger
	parasitic jaeger
	long-tailed jaeger
Sulidae	northern gannet

The only migratory bird species at risk or SOCC likely to occur in the Study Area are the Ivory Gull (listed as *endangered* under Schedule 1 of SARA, by COSEWIC, and under the NL ESA) and the Red-necked Phalarope (listed as a species of *special concern* by COSEWIC). Although land bird species at risk and SOCC have potential to occur in the Study Area during nocturnal migration (i.e., short-eared owl, peregrine falcon, bank swallow, gray-cheeked thrush, olive-sided flycatcher, and bobolink) (Amec 2014), they are unlikely to occur in the Study Area during this time unless blown far offshore during storm events. Other species of land bird species at risk and SOCC that may migrate over the offshore area during the day have not been identified because they are unlikely to interact with Project-related artificial night lighting.

The eastern coast of Newfoundland supports 1,473 seabird colonies and 17 IBA sites (refer to Section 4.2.7.4 and Figure 4-32); however, none of these are located in the offshore environment or overlap with the Project Area or Study Area. The nearest of these sites is located in St. John's (terminus of the Project Area) (IBA NV022: Quidi Vidi Lake).

6.4.9 Project Interactions with Migratory Birds

The physical Project-related activities that might interact with the VC to result in the identified environmental effects are identified in Table 6.20. These interactions are indicated by check marks and are discussed in Section 6.4.10 in the context of effects pathways, mitigation, and residual environmental effects.

Table 6.20 Project-Environment Interactions with Migratory Birds

Physical Activities	Environmental Effects	
	Change in Risk of Mortality or Physical Injury	**Change in Habitat Quality and Use**
Presence and Operation of MODU (Presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; well testing; cementing and completing wells)	✓	✓
Drilling-associated Surveys (VSP and wellsite surveys; geotechnical / geophysical / environmental surveys; diving surveys; ROV surveys)	✓	✓
Waste Management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)	✓	✓
Supply and Servicing (operation of helicopters and supply / support / standby/ tow vessels within the Project Area)	✓	✓
Well Abandonment (plugging and abandoning of wells)	✓	✓
Notes: ✓ = Potential interaction; – = No interaction		

6.4.10 Assessment of Residual Environmental Effects on Migratory birds

This section assesses the environmental effects on migratory birds that may result from Project-related activities identified in Table 6.20. Given the geographic and environmental consistencies, as well as, the analogous Project activities, the WREP EA (Husky Energy 2012a) and the SEA undertaken by the C-NLOPB for Eastern Newfoundland (Amec 2014) has been referenced extensively in this analysis. The information has been updated, as applicable, due to scientific updates and refined EA methods.

6.4.10.1 Project Pathways

6.4.10.1.1 Change in Risk of Mortality or Physical Injury

Of the Project activities, the presence and operation of the MODU and OSVs has the greatest potential to result in changes to risk of mortality or physical injury for migratory birds. In particular, migratory birds are known to aggregate around offshore structures as a result of night lighting, food, and other visual cues; this increases their risk of mortality as a result of physical impacts with structures, predation by other migratory bird species, incineration from flares (Wiese et al. 2001; Ronconi et al. 2015), disorientation, and energy expenditure (Amec 2014). In addition to direct interactions (e.g., collisions) and indirect interactions with the MODU and OSVs, the Project has potential to result in a change in risk of mortality or physical injury to migratory birds as a result of: exposure to underwater sound caused by wellsite and VSP surveys; exposure to hydrocarbon sheens; disturbance from and collisions with transiting helicopters during supply and servicing activities within the Project Area; and interactions with equipment and activities during well abandonment.

6.4.10.1.2 Change in Habitat Quality and Use

A change in habitat quality and use for migratory birds could potentially occur from Project activities. Migratory bird habitat may be particularly influenced by Project activities during operations including: sound, lights, and flaring from the MODU and OSVs; the presence of hydrocarbons and suspended solids within the water column from the discharge of drill muds and cuttings; the release of emissions and other discharges (including cooling water, ballast water, bilge and deck water, grey/black water and small quantities of process water); the exposure of migratory birds to underwater sound during drilling and associate surveys; and disturbance from helicopter transportation. A temporary change in habitat quality could also occur as a result of activities during well abandonment.

6.4.10.2 Mitigation

In consideration of the environmental effects pathways noted above, the following mitigation measures will be employed to reduce the potential environmental effects of the Project on migratory birds:

- Lighting on the MODU is designed to comply with requirements stipulated in the *Petroleum Occupational Safety and Health Regulations* to provide safe operations. There is no extraneous lighting. All lighting except navigational lighting is pointed downward.
- The frequency and duration of flaring events will be restricted to the amount necessary to characterize the well potential (DST) and as required to maintain safe operations. Flaring will occur in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017), which requires a DST not to begin at night. A high-pressure spray of seawater between the MODU and the flare is routinely used as a heat dissipating curtain which will also act as a deterrent to seabirds in the area.
- Routine checks for stranded birds will be conducted on the MODU and OSVs and appropriate procedures for release will be implemented. If stranded birds are found during inspections, they will be handled using the protocol outlined in Best Practices for Stranded Birds Encountered Offshore Atlantic Canada (Environment Canada 2015) and 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.
- 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 wellsite and VSP activity begins.
- Refer to the waste management mitigation measures identified in the fish and fish habitat VC (Section 6.1.10.2).

6.4.10.3 Characterization of Residual Project-related Environmental Effects

6.4.10.3.1 Change in Risk of Mortality or Physical Injury

6.4.10.3.1.1 Presence and Operation of MODU

Many migratory birds navigate by sight and artificial lights 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 seabirds (e.g., shearwaters and storm-petrels), because they feed on bioluminescent prey and are naturally attracted to light (Imber 1975). Small songbirds are commonly attracted to artificial lighting on offshore ships and installations during migration (Gauthreaux and Belser 2006, Poot et al. 2008). Passerines primarily migrate at night and are known to be attracted to artificial light sources, particularly during inclement weather conditions such as foggy conditions (Amec 2014).

Artificial lighting associated with the MODU has potential to result in strandings, collisions, increased opportunities for predation, and exposure to other vessel-based threats. Birds that are attracted to the MODU may experience injury or mortality through direct collision with equipment or may become disoriented by lights and become stranded. Short-duration flaring by the MODU during well testing may attract migratory birds and result in increased mortality risk through incineration or energy reserve depletion. Seabirds have been observed to circle flares for days, eventually dying of starvation (Bourne 1979). 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).

The extent of attraction from artificial lights on drilling vessels and flares, and the potential severity of bird interactions with offshore activities, can vary based on factors such as: meteorological conditions (rain, visibility), season, the lunar phase, light composition, character of the obstacle (location, height, cross-sectional area), and age of the birds (Weir 1976; Wiese et al. 2001). Flaring during exploration drilling is required during a DST. DST are typically required in one in four or five exploration wells. So, in a 10-well program, this Project may conduct 2 DST. Each DST would last at most for two nights each, but rarely, one well may require two DSTs. A seawater spray through a series of high pressure nozzles is used during a DST to dissipate the heat between the flare and the MODU. This seawater curtain is likely to deter birds near the flare.

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), 1,000 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. Attraction is enhanced during conditions of drizzle and fog when moisture droplets in the air refract light and greatly increase the illuminated area. Mortality can also increase during migration when large numbers of birds fly relatively low due to unfavorable weather conditions (Wiese et al. 2001). Mortality risk with flares and 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).

The type and intensity of lighting are expected to be important factors in determining the magnitude of adverse effects on migratory birds. Most studies on the effects of lighting composition (e.g., wavelength, intensity) have found that birds are most likely to be disoriented by longer wavelengths. Steady burning red-coloured lights were shown to result in most bird casualties (Gautreaux and Belser 2006; Gehring et al. 2009, Marquenie et al. 2014). A 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 substantially reduced (Marquenie and van der Laar 2004).

Artificial lighting may indirectly result in increased risk of predation for some species. 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 their exposure to predation (Bruinzeel and van Belle 2010).

Storm-petrels are the most common species to be stranded on vessels in Atlantic Canada. For example, storm-petrels account for approximately 97% of stranded birds recorded from offshore platforms and vessels on the Grand Banks (Environment Canada 2015). Monitoring of pelagic storm-petrels stranded (presumably due to light attraction) on board seismic vessels off Newfoundland and Labrador has been conducted by biologists during 14 seismic programs from 2004 to 2010 (Husky Energy 2012a). Seismic programs were initiated as early as May 7 and terminated as late as November 8; but most were conducted during some portion of the months of June to September. In total, 758 nights were monitored during these seismic programs. Numbers of strandings per-day on seismic vessels ranged from zero early in the season to tens of birds, mostly late in the season after fledging. The largest single stranding event observed by biologists on seismic vessels was 46 birds, all of which were released alive (LGL Limited unpublished data, in Husky Energy 2012a). The number of nights per week with strandings, and the number of individuals stranded per night, was greatest from late August to mid-October. This period coincides with the fledging of Leach's storm-petrels from Newfoundland colonies. Young of this species fledge from Great Island (Witless Bay), Newfoundland, as early as September 10, but the majority fledges from mid-September to late October (Huntington et al. 1996). The mean fledging date is September 25 (Husky Energy 2012a). Juveniles also account for most strandings of Leach's storm-petrels in other areas of the North Atlantic. For example, near a Leach's storm-petrel colony off Scotland, juveniles make up the large majority of birds stranded due to light attraction (Miles et al. 2010). However, adults also strand in wintering areas, probably due to light attraction (Rodríguez and Rodríguez 2009). Visibility during nights when storm-petrels stranded on seismic vessels off Newfoundland and Labrador was usually reduced due to fog, rain, or overcast conditions (Husky Energy 2012a).

Although the vast majority of bird strandings in offshore Newfoundland have been Leach's storm-petrels, a variety of other species may experience increased risk of mortality as a result of the presence and operation of the MODU. For example, strandings of Wilson's storm-petrel (*Oceanites oceanicus*), great shearwater and sooty shearwater have also been recorded from the Newfoundland offshore area (Husky Energy 2012a). Land birds also have potential to interact with offshore vessels or platforms (particularly during migration, when blown offshore by storms, or when disoriented by fog) and account for approximately 1% of strandings recorded on the Grand Banks (Environment Canada 2015). Dovekies have also been observed to circle the lighted Hibernia platform for hours (Wiese et al. 2001) and there have been reports in other regions of strandings involving related species. For example, it was estimated that about 1.5 tons of crested auklets (*Aethia cristatella*) collided and landed in a fishing boat in Alaska as a result of being attracted and disoriented by its bright lights (Dick and Donaldson 1978).

Bird morality rates recorded from offshore platforms are generally considered to be underreported because birds fall into the sea and/or are consumed by scavengers before being detected by observers (Bruinzeel et al. 2009). It is therefore likely that some unknown proportion of individuals entering into contact with flares or otherwise negatively affected by flaring, and lighting in general, would not be recovered during monitoring.

Residual environmental effects associated with the presence and operation of the MODU on the change in risk of mortality or physical injury for migratory birds is predicted to be low to moderate in magnitude. Effects will be irregular in nature and restricted to the Project Area. Effects will be of medium term duration (i.e., will persist throughout the duration of Project activities) and reversible.

6.4.10.3.1.2 Drilling-associated Surveys

Wellsite survey and VSP noise emissions are expected to be the most intense sound generated by the Project, and diving birds are expected to hear a sound pulse if the birds are underwater at the time the pulse arrives. Little is known about underwater hearing sensitivity in birds or the distance at which a bird under water could hear sound from a wellsite survey or VSP. Although there is a scarcity of data on the effects of underwater sound on migratory birds, 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). It is possible however, that migratory birds diving near a loud underwater sound could be injured. Most existing knowledge is based on the effects of seismic surveys, and that information is summarized below. The sound pressure levels produced by wellsite and VSP surveys are expected to be similar to that employed by 2D or 3D seismic surveys but are typically smaller and deployed in a smaller area over a shorter time period.

Seismic sound energy is predominantly directed downward and below the surface of the water. Sound above the water is substantially reduced from that underwater and is likely to have little or no effect on birds that have their heads above water or are in flight. It is possible that birds on the water at close range would be startled by the sound; however, the presence of the ship and associated gear should have already warned any birds of unnatural visual and auditory stimuli. Received sound levels of airgun pulses in the upper few metres of the water column would be reduced due to pressure-release effects and interference phenomena that occur at and near the surface (Richardson et al. 1995).

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 strong 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).

Exposure of migratory birds to potentially harmful underwater noise during wellsite or VSP activity will be limited by the depth they use, time in which they spend underwater, and the mitigating effects of the ramp-up period. Many species of migratory birds that are expected to occur in the Study Area feed at less than 1 m below the surface of the ocean (Husky Energy 2012a), including members of Procellariidae, Oceanitidae, Hydrobatidae, Phalaropodinae, and Laridae. Northern gannets plunge dive to a depth of 10 m but, because they remain submerged for only a few seconds, they would have a low chance at being exposed to underwater seismic sound. Although many species of seabirds that may be present in the Study Area would spend less than one minute underwater during a foraging dive, members of Alcidae (e.g., dovekie, common murre, thick-billed murre, razorbill and Atlantic puffin) spend considerable time submerged under water. Alcids secure food by diving under the water and propelling their bodies rapidly through the water with their wings. They can reach considerable depths and spending prolonged periods of time submerged (Gaston and Jones 1998). Murres regularly dive to a depth of 100 m and have been recorded underwater for up to 202 seconds (Gaston and Jones 1998); common murres are known to dive to a depth of 180 m or deeper (Piatt and Nettleship 1985). However, it is unlikely that these birds will feed underwater when the seismic source is activated because a ramp-up period will be initiated which would deter them from the area and reduce their exposure to potentially harmful underwater sound waves.

Residual environmental effects associated with drilling-associated surveys on a change in risk of mortality or physical injury for migratory birds is predicted to be negligible in magnitude, restricted to the Project Area, short-term in duration (no more than a day per well, totaling 10 days over 8 years) and reversible.

6.4.10.3.1.3 Waste Management

There are several types of discharges that migratory birds may interact with during drilling of the well and operation of the MODUs and OSVs. All operational discharges during drilling will comply with Husky's EPCMP for the drilling installation and will comply with the OWTG and MARPOL, both of which have been established to protect the marine environment. Discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean.

Once treated, drill cuttings associated with SBM use will be discharged to the sea in accordance with Husky's EPCMP. The discharge of cuttings has potential to affect water quality within a localized area as the discharges migrate through the water column, and to result in the formation of small sheens 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 migratory 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 and dovekie (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 because of the discharge of SBM associated cuttings is low because Project activities will be carried out in adherence to the OWTG and drill muds will be selected in accordance with the OCSG. The SBM has a fraction of oil or synthetic oil as a component; when the cuttings are cleaned, there remains only a very small fraction of adhered SBM when discharged (i.e., 6.9 g/100 g or less oil on wet solids, in accordance with OWTG discharge limits). Discharging the cuttings at depth further mitigates the potential for sheen formation. If the wind and wave conditions allowed sheen formation, any sheen would be temporary and limited in size, such that only birds in the immediate area of the discharge would likely be affected. While the risk of mortality for individual birds contacting a sheen would be increased, the potential effects would be expected to be minor given the limited nature of the sheen and the likely number of birds affected. WBM and cuttings released at the seafloor will not interact with surface waters and migratory birds or their prey would be affected.

Discharge of deck drainage and bilge waters have potential to adversely affect migratory bird health if the discharges contain residual hydrocarbons. However, they will be treated onboard the drilling platform via a MARPOL compliant oil-water separator to meet OWTG standards. Bilge water will be treated through the oil-water separator so oil concentrations will meet the 15 mg/L or less oil-in-water content prior to discharge. Sea water used for cooling purposes aboard the MODU will chlorinated and discharged with a residual chlorine level <0.5 ppm, in accordance with OWTG. Residual hydrocarbons in these treated discharges are generally not associated with the formation of a slick and are therefore unlikely to have a measurable effect on migratory birds.

Discharges of sanitary and domestic waste may attract birds and/or prey to the MODU and OSVs, but food and sewage waste will be macerated to maximum particle size (6 mm) prior to disposal in accordance with OWTG standards. 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 OSVs, which may slightly increase risk of mortality or physical injury of migratory bird species, particularly if they interact with a flare or become stranded on the MODU or an OSV. No food or sewage waste will be discharged within 3 nm of the coast, consistent with MARPOL.

Residual environmental effects associated with waste management on a change in risk of mortality or physical injury for migratory birds is predicted to be negligible in magnitude, restricted to the Project Area, medium-term in duration, of multiple regular events, and reversible.

6.4.10.3.1.4 Supply and Servicing

Residual effects of OSV operations within the Project Area are expected to be similar to effects described above in the context of lighting effects from the presence and operation of the MODU, although the lighting on the OSVs will not be stationary and will be lower in magnitude.

Studies have shown that migratory birds react to low-level helicopter flights, but the effects of these responses are short (Stantec 2013). 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). Migratory birds tend to habituate to helicopter transportation over time. One of the greatest potential effects from 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 2013). However, there are no bird colonies or IBAs within the Project Area (or Study Area). Helicopter flights within the Project Area (Figure 2-1) will not overlap with bird colonies or IBAs.

Collisions between birds and helicopters are not currently a major source of injury or mortality for migratory birds in the Project Area. Cougar Helicopters, which logs 4,000 to 5,000 flying hours annually providing helicopter services to Husky and other offshore operators in the Jeanne d'Arc Basin and conducted 1,012 flights in and around the Project Area in 2008 alone, reported a total of five bird strikes during the period from 2005 to 2011 (SMS Aviation Safety Inc. 2012). One bird strike occurred at St. John's Airport, three strikes occurred at MODUs (during take-off, during take-off and climb, and on the helideck, respectively), and one strike occurred during landing on a drill ship (SMS Aviation Safety Inc. 2012). The small, incremental increase in helicopter traffic associated with the Project (i.e., five helicopter trips per week) is not expected to result in a measurable change in risk of mortality or physical injury for migratory birds within the Project Area.

Residual environmental effects associated with supply and servicing operations on a change in risk of mortality or physical injury for migratory birds is predicted to be low in magnitude, restricted to the Project Area, medium-term in duration, consisting of multiple regular events, and reversible.

6.4.10.3.1.5 Well Abandonment

Well abandonment will involve both above water and underwater activities that could result in interactions with migratory birds but will follow industry standard abandonment procedures and practices in accordance with C-NLOPB regulations. Potential for interactions with surface activities during well abandonment are similar as those described for the OSVs and will be mitigated similarly. Underwater well abandonment activities will occur at depths where interaction with migratory birds is unlikely except perhaps for the deepest diving species: 50 m for black guillemots; 60 m for Atlantic puffins; more than 120 m for razorbills, and approximately 180 m or deeper for common murres (Piatt and Nettleship 1985). In the unlikely event that shape charges are required to remove the wellhead, the charge will be set below the sea floor. A charge detonated below the seafloor will have an initial rate of increased pressure that is more attenuated than an explosion in the water column. Much of the initial shock pulse and energy from the charge will be absorbed by the seafloor. As a result of well depths and the nature of well abandonment activities, underwater well abandonment activities are not expected to result in a measurable change in risk of mortality or physical injury for migratory birds within the Project Area.

Residual environmental effects associated with well abandonment on a change in risk of mortality or physical injury for migratory birds is predicted to be low in magnitude, restricted to the Project Area, short-term in duration, consisting of a single event, and reversible.

6.4.10.3.2 Change in Habitat Quality and Use

6.4.10.3.2.1 Presence and Operation of 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). Some species may be attracted to artificial night lighting and flares on the MODU, while others may be deterred (e.g., ducks and other birds that prefer to sleep at night in the dark).

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 from the presence and operation of the MODU is expected to be minimal. Flaring will only be conducted during well tests, which are conducted for 20% to 25% of wells (i.e., approximately two wells within the Project Area). Flaring for these wells is likely to be conducted at night because each well test is expected to take between 1.5 and 2 days. Exposure of migratory birds to artificial lighting will be mitigated by reducing extraneous light and moderating exposure to lighting required for accommodation (e.g., deadlights, curtains) and navigation, as required by regulation.

Residual environmental effects associated with the presence and operation of the MODU on a change in habitat quality and use for migratory birds is predicted to be low in magnitude, restricted to the Project Area, medium-term in duration, of an irregular nature, and reversible.

6.4.10.3.2.2 Drilling-associated Surveys

Drilling-associated surveys have the potential to disturb migratory birds and adversely affect their habitat quality, particularly for alcids (e.g., dovekie, common murre, thick-billed murre, razorbill, and Atlantic puffin), which spend relatively high amounts of time underwater during forage dives. However, studies have failed to document a strong response of migratory birds to seismic testing (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 on the effects of underwater seismic surveys on moulting long-tailed ducks in the Beaufort Sea also showed no effects on movement or diving behaviour (Lacroix et al. 2003). However, the authors suggested caution in interpretation of these data because they were limited in their ability to detect subtle disturbance effects and recommended studies on other species to fully understand the effects of seismic sounds.

As noted above, the emission of noise from wellsite surveys and VSPs is expected to be the most intense sound generated by the Project, and it is unlikely that diving birds will feed underwater when the seismic source is activated due to the initiation of a ramp-up period which would deter migratory birds from the area and reduce their exposure to potentially harmful underwater sound waves. The sound pressure levels produced by wellsite and VSP surveys are expected to be similar to that employed by 2D or 3D seismic surveys but are typically smaller and deployed in a smaller area over a shorter time period (five to seven days for a wellsite survey and approximately one day for VSP).

The Project could also indirectly affect habitat quality and use for migratory birds through potential effects on prey species. However, as discussed in Section 6.1, the residual environmental effects on fish and fish habitat are predicted to be not significant.

Residual environmental effects associated with drilling-associated surveys on a change in habitat quality and use for migratory birds is predicted to be low in magnitude, restricted to the Project

Area, short-term in duration (no more than a day per well, totaling 10 days over 8 years) and reversible.

6.4.10.3.2.3 Waste Management

There are several types of discharges during drilling of a well and from the MODU and the OSV that may interact with migratory bird habitat and use (Section 2.6). However, these discharges will comply with the Husky's EPCMP and OWTG and MARPOL and will be temporary, localized, non-toxic, and subject to high dilution in the open ocean. Residual hydrocarbons in wastewater discharges are usually 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 and migratory birds or their prey would not be affected. The potential for sheen formation as a result of the discharge of cuttings and SBM use is low because drill cuttings associated with SBM use will be treated in accordance with the Husky's EPCMP prior to discharge. Larger particle sizes of discharged drill cuttings will settle rapidly to the seabed and have a negligible interaction with migratory birds. Fines, silts, and clays will take longer to settle but will disperse in the open ocean. 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 (Section 2.6.1.1). Temporary elevated TSS levels in the water column could result in short-term avoidance of a localized area by migratory birds during discharge of SBM cuttings at the surface.

As outlined in Section 2.6.2, bilge water and deck drainage will be treated onboard the drilling platform via an oil-water separator and cooling water associated with the drilling program will be chlorinated and discharged overboard with a residual chlorine level <0.5 ppm, in accordance with the EPCMP. Discharges of sanitary and domestic waste may attract birds and/or prey to the MODU and OSVs but will be macerated to maximum particle size (6 mm) prior to discharge. This waste is expected to be quickly dispersed and degraded by physical and biological processes.

Residual environmental effects associated with waste management on a change in habitat quality and use for migratory birds is predicted to be negligible in magnitude, restricted to the Project Area, medium-term in duration and reversible.

6.4.10.3.2.4 Supply and Servicing

Residual effects of OSV operations within the Project Area are expected to be similar to those described above with respect to the presence and operation of the MODU; although the lighting intensity on the OSVs is lower in magnitude and mobile. The presence of an approaching OSV or helicopter may alert birds and flush some species from the area. Migratory birds can react to low-level helicopter flights, but their reactions are often temporary in nature. Although migratory birds near the MODU may be disturbed during helicopter take-off and landing, they are likely to become habituated to the activity.

OSVs and helicopters will not interact with any bird colonies or IBAs while conducting supply and servicing operations within the Project Area, as no such areas are located within the Project Area or surrounding Study Area (Figure 4-32). OSV activities in support of the Project (i.e., one to three OSV trips per week from the supply base to the MODU for transporting supplies) are expected to be minimal compared to ongoing shipping activity in the region, and helicopter activities in support of the Project (i.e., five helicopter trips per week) will only account for a small, incremental increase in overall helicopter traffic within the Project Area.

Residual environmental effects associated with supply and servicing operations on a change in habitat quality and use for migratory birds is predicted to be low in magnitude, restricted to the Project Area, medium-term in duration and reversible.

6.4.10.3.2.5 Well Abandonment

Well abandonment will involve both above water and underwater activities that could result in changes to the quality of migratory bird habitat but will follow industry standard abandonment procedures and practices in accordance with C-NLOPB regulations. Residual effects of above-surface well abandonment activities within the Project Area are expected to be similar to those described above with respect to OSVs. Underwater activities, including the use of shape charges if required, during well abandonment may result in sensory disturbance to migratory birds, leading to behavioural responses such as temporary habitat avoidance. However, as a result of well depths and the nature of well abandonment activities, underwater activities are not expected to result in a measurable change in habitat quality and use migratory birds within the Project Area. In the unlikely event that shape charges are required to remove the wellhead, the charge will be set below the sea floor. A charge detonated below the seafloor will have an initial rate of increased pressure that is more attenuated than an explosion in the water column. Much of the initial shock pulse and energy from the charge will be absorbed by the seafloor.

Residual environmental effects associated with well abandonment on a change in habitat quality and use for migratory birds is predicted to be low in magnitude, restricted to the Project Area, short-term in duration, consisting of a single event, and reversible.

6.4.10.4 Summary of Project Residual Environmental Effects

In summary, the Project will result in adverse effects on migratory birds by causing a change in risk of mortality or physical injury and a change in habitat quality and use. In consideration of the implementation of applicable mitigation measures, best practices, and adherence to industry standards (e.g., compliance with Husky’s EPCMP), the residual effect of a change in risk of mortality or physical injury is considered to vary from negligible to moderate in magnitude for various Project components and activities, will be restricted to the Project Area, will be short to medium-term in duration, reversible, and will primarily occur within an undisturbed ecological and socio-economic context. Similarly, changes to habitat quality and use for migratory birds are predicted to be negligible to low in magnitude, restricted to the Project Area, short to medium-term in duration, reversible, and to primarily occur within an undisturbed context. Table 6.21 summarizes the environmental effects assessment and prediction of residual environmental effects resulting from interactions between the Project and migratory birds that were identified in Table 6.20.

Table 6.21 Project Residual Effects on Migratory Birds

Residual Effect	Residual 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	A	L-M	PA	MT	IR	R	D
Drilling-associated Surveys	A	N	PA	ST	IR	R	D
Waste Management	A	N	PA	MT	IR	R	D
Supply and Servicing	A	L	PA	MT	IR	R	D
Well Abandonment	A	L	PA	ST	S	R	D
Change in Habitat Quality and Use							
Presence and Operation of MODU	A	L	PA	MT	IR	R	D
Drilling-associated Surveys	A	L	PA	ST	IR	R	D
Waste Management	A	N	PA	MT	IR	R	D
Supply and Servicing	A	L	PA	MT	IR	R	D
Well Abandonment	A	L	PA	ST	S	R	D

KEY:
See Table 6.18 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
SA: Study 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

6.4.11 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of the Project on migratory birds (i.e., a change in risk of mortality or physical injury and a change in habitat quality and use) are 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.

6.4.12 Follow-up and Monitoring

Follow-up and monitoring will include routine checks for stranded birds on the MODU and OSVs (with handling as per the Environment Canada (2015) and 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 and Leach's storm-petrel, photographs depicting their differences will be provided to crew members trained to check for and handle stranded birds.

Husky provides an annual EA Update to the C-NLOPB each year, detailing the specific activities that will be conducted within the Project Area in a given year. In that EA Update Husky will include changes (if any) to migratory bird species at risk/SOCC and critical habitat and discuss the potential effects of Project activities to migratory bird species at risk/SOCC and critical habitat.

6.5 Special Areas

6.5.1 Scope of Assessment

The special areas VC considers areas noted for their biological and ecological importance within the Study Area. These areas are important or essential habitat for several marine species. Special areas have been designated as Ecologically and Biologically Significant Areas (EBSAs), Vulnerable Marine Ecosystems (VMEs), NAFO Coral-Sponge areas, and marine refuges. There are no designated Marine Protected Areas within the Study Area. Special areas are selected as a VC because of their presence within the Study Area, and the ecological function they provide to the marine environment as well as their social-cultural value.

Special areas within the Study Area may offer unique habitat features, high biodiversity, provide aggregation areas for feeding or mating, or important nursery areas. The assessment of special areas is therefore closely linked to the Fish and Fish Habitat VC (Section 6.1), Marine Mammals and Sea Turtles VC (Section 6.3), and Migratory Birds VC (Section 6.4). These sections are cross-referenced below.

6.5.2 Regulatory and Policy Setting

Regulatory protection of marine sensitive areas is provided by Canada's *Oceans Act*, which authorizes DFO to provide enhanced protection to marine areas of ecological or biological importance (DFO 2004a, 2007a).

In addition to the *Oceans Act*, many special areas are sites that may provide habitat for species identified as threatened or endangered. Therefore, special areas may be regulated under SARA. 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. While there has been no official critical habitat identified within the Study Area, a DFO draft recovery strategy for northern and spotted wolffish has identified potential critical habitat that has the potential to achieve protection under SARA during the temporal scope of the Project.

A Ministerial notification is required under section 79 of SARA if a project "is likely to affect a listed wildlife species or its critical habitat", which includes identification of the adverse effects of the project on the listed wildlife species and its critical habitat. The notification must also identify, if the project is carried out, mitigation measures that will be implemented to avoid or lessen those effects, and monitoring commitments.

Sections of the *Fisheries Act* also provide context on the regulation/protection of special areas within Canadian jurisdiction. The Act defines serious harm to fish as the death of fish and the destruction or permanent alteration to fish habitat. Section 35(1) of the *Fisheries Act* states that no person shall undertake any activity that may result in serious harm to fish that are part of, or support a commercial, recreational, or Aboriginal fishery, unless authorized by the appropriate authority. Section 37 (1.1) requires any person proposing to carry out any work in an ecologically significant area to provide, at the Minister's request, any material or information regarding the work and any areas that are likely to be affected as a result of the work or activity.

Outside of Canada's 200 nm EEZ, NAFO has identified VMEs, as well as areas with high densities of intact coral and/or sponge habitat (coral-sponge closure areas), in the offshore environment within the context of deep-sea fisheries management. NAFO regulates VMEs through their Conservation and Enforcement Measures, which were created to monitor and regulate bottom fishing activities by all member states of NAFO. These conservation and enforcement measures include carrying scientific observers on board to report any encounters with VME indicator species, and NAFO's vessel monitoring system that tracks flag state ships via global positioning system (GPS) to determine if they are within a closed area.

6.5.3 The Influence of Consultation and Engagement on the Assessment

Key issues raised during stakeholder consultation and Indigenous people engagement for the Project to date include general concerns related to accidental events. Questions and concerns were raised with respect to effects from offshore drilling and exploration on cold water corals and VMEs.

6.5.4 Potential Effects, Pathways and Measurable Parameters

Routine Project-related activities can affect the ability of the special area to maintain an important biological and ecological function as well as potential effects to their social-cultural importance. Therefore, in consideration of the potential interactions, the assessment of Project-related environmental effects on special areas is focused on a change in habitat quality. The assessment of social-cultural importance is qualitatively assessed based on the magnitude of the biological and ecological effects. Potential effects on a change in risk of mortality or physical injury to marine species within special areas are addressed in Sections 6.1, 6.3 and 6.4.

The effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 6.22. Effects of accidental events are assessed separately in Section 7.3.

Table 6.22 Potential 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 could result in direct loss or alteration of habitat • Change in use of special areas due to physical disturbance, destruction of benthic habitats or deposition of cuttings/drill muds • Increase of underwater sound at levels capable of causing behavioural disturbance for species that use special areas	• Area of habitat altered or lost(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

6.5.5 Boundaries

Spatial boundaries and temporal boundaries for the assessment of special areas are discussed in the following sections.

6.5.5.1 Spatial Boundaries

Project Area: The Project Area (Figure 2-1) encompasses the immediate area within which Project activities and components may occur. Well locations have not been identified but will occur within EL 1151, EL 1152 and EL 1155, within the Project Area. The spatial boundary of the Project Area has been delineated to account for all activities related to drilling a well, including transit of OSV and helicopter traffic to/from St. John's and vessel traffic associated with geohazard/environmental surveys.

Study Area: The Study Area (Figure 2-1) is the area within which residual environmental effects from operational activities and accidental events may interact cumulatively with the residual environmental effects of other past, present and future (certain or reasonably foreseeable) physical activities.

6.5.5.2 Temporal Boundaries

The temporal boundaries for potential Project-related environmental effects on special areas encompass all Project phases, including wellsite surveys, well drilling, testing and abandonment. It is anticipated that exploratory drilling activities would commence in 2019, and continue intermittently throughout the term of exploration licences, up to 2027. Well testing (if required, dependent upon drilling results) could also occur at any time during the temporal scope of this EA. Wells may be decommissioned and abandoned at any time within the temporal boundaries. The temporal scope of the EA accommodates drilling in EL 1151, EL 1152, and EL 1155 for the full term of each licence (period 1 and period 2). Within the overall temporal scope, well site surveys typically require five to seven7 days per well, VSPs typically take approximately one day per well and an individual well typically may take up to 80 days to complete. Drilling operations will not be continuous throughout the entire eight-year scope of the Project and will depend partially on rig availability and results from previous wells. If a semi-submersible or dill ship is selected as the preferred MODU option for the Project, then drilling activities have the potential to be conducted at any time of the year. If a jack-up rig is selected as the preferred method, then drilling would only be able to occur during the ice-free season.

Special areas provide important habitat year-round, although some areas are more sensitive or commonly used by species during specific times of the year. Refer to Section 4.2.9 for information on species use of special areas.

6.5.6 Residual Environmental Effects Characterization

The descriptors used to characterize residual environmental effects on special areas are defined in Table 6.23.

Table 6.23 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 environmental effect relative to baseline	**Positive –** a residual environmental effect that moves measurable parameters in a direction beneficial to special areas relative to baseline **Adverse –** a residual environmental effect that moves measurable parameters in a direction detrimental to special areas relative to baseline **Neutral –** no net change in measurable parameters for the special areas relative to baseline
Magnitude	The amount of change in measurable parameters or 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

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Geographic Extent	The geographic area in which a residual environmental effect occurs	**Project Area –** residual environmental effects are restricted to the Project Area **Study Area –** residual environmental effects extend into the Study Area
Frequency	Identifies how often the residual environmental effect occurs and how often during the Project	**Single event –** effect occurs once **Multiple irregular event –** effect occurs at no set schedule **Multiple regular event –** effect occurs at regular intervals **Continuous –** effect occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual environmental 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 –** the residual environmental effect is likely to be reversed after Project completion (well abandonment) **Irreversible –** the residual environmental effect is unlikely to be reversed
Ecological and Socio-economic Context	Existing condition and trends in the area where residual 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

6.5.7 Significance Definition

A **significant adverse residual effect** for 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.

6.5.8 Summary of Existing Conditions for Special Areas

Special areas located within or in the vicinity of the Study Area are described in Section 4.2.9 and shown in Figure 4-33. Special areas include EBSAs, VMEs, and NAFO closure areas; there are no designated Marine Protected Areas within the Study Area.

The distances of each special area from the Project Area are presented in Table 6.24. Portion of the Northeast Shelf and Slope EBSA overlaps with the Project Area. The Northeast Shelf and Slope EBSA is recognized for supporting spotted wolffish and Greenland halibut populations, as well as providing a feeding area for marine mammals, particularly harp seals, hooded seals, and pilot whales (CPAWS 2009).

Table 6.24 Special Areas within the Study Area and their Proximity to the Project Area

Special Area	Distance to the Project Area* (km)
EBSA	
Northeast Shelf and Slope	0
Virgin Rocks	41
Lilly Canyon-Carson Canyon	87
The Southeast Shoal and Tail of the Banks	155
Orphan Spur	209
VME	
Beothuk Knoll	107
Seamount Closures	
Newfoundland Seamounts	284
Orphan Knoll	275
Coral and Sponge Closures	
Flemish Pass / Eastern Canyon	23
Northwest Flemish Cap	65
Northwest Flemish Cap	78
Beothuk Knoll	107
Beothuk Knoll	112
Sackville Spur	100
Northwest Flemish Cap	129
Northern Flemish Cap	164
Bonavista Cod Box	153
Northern Flemish Cap	164
Northern Flemish Cap	176

Special Area	Distance to the Project Area* (km)
Tail of the Bank	220
Northeast Flemish Cap	244
Eastern Flemish Cap	147
3O Coral Closure	333
Marine Refuge Area	
Northeast Newfoundland Slope	63
Note: * Those areas with a distance of 0 km to the Project Area indicate that portions of those areas overlap with the Project Area. These distances are approximations based on distances between area boundaries.	

While there is a special area that overlaps with the Project Area, a large portion of the Project Area does not include any special areas. The total coverage of special areas within the Project Area is approximately 1,706 km². This constitutes approximately 8.8% of the Project Area (19,366 km²).

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 Northeast Shelf and Slope EBSA.

6.5.9 Project Interactions with Special Areas

The physical Project-related activities that have the potential to interact with special areas are identified in Table 6.25. These interactions are indicated by checkmarks and are discussed in detail in Section 6.5.10 in the context of effects pathways, mitigation, and residual environmental effects.

Table 6.25 Project-Environment Interactions with Special Areas

Physical Activities	Environmental Effects
	Change in Habitat Quality
Presence and Operation of MODU (Presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; well testing; cementing and completing wells)	✓
Drilling-associated Surveys (VSP and wellsite surveys; geotechnical / geophysical / environmental surveys; diving surveys; ROV surveys)	✓
Waste Management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)	✓

Physical Activities	Environmental Effects
	Change in Habitat Quality
Supply and Servicing (operation of helicopters and supply/support/standby/tow vessels within the Project Area)	✓
Well Abandonment (plugging and abandoning of wells)	✓
Notes: ✓ = Potential interaction – = No interaction	

6.5.10 Assessment of Residual Environmental Effects on Special Areas

This section assesses the environmental effects on special areas that may result from Project-related activities identified in Table 6.25. Given the geographic and environmental consistencies, as well as the analogous Project activities, the WREP EA (Husky Energy 2012a) and the SEA undertaken by the C-NLOPB for Eastern Newfoundland (Amec 2014) has been referenced extensively in this analysis. The information has been updated, as applicable, due to scientific updates and refined EA methods. Effects on species (including species at risk and SOCC) that may occur within the special areas, and how species use these areas, are assessed within their respective VC chapters including: Section 6.1 (Fish and Fish Habitat); Section 6.3 (Marine Mammals and Sea Turtles); and Section 6.4 (Migratory Birds).

6.5.10.1 Project Pathways

Change in Habitat Quality

A change in habitat quality, and associated effects to social-cultural aspects, for special areas could potentially occur as a result of Project activities affecting the marine environment. The primary pathway for Project-related activities to affect the physical quality of special areas is the presence and operation of the MODU (sound emissions, presence of anchors or legs on the sea floor), the discharging of drill muds and cuttings (effect on water and sediment quality), and other emissions and discharges (effects on water quality), drilling-associated surveys (sound emissions), support vessel activities (sound emissions), and well abandonment (change in benthic habitat).

6.5.10.2 Mitigation

Based on the environmental effects pathways noted above, the following mitigation measures, as well as mitigation measures identified for the Fish and Fish Habitat VC (Section 6.1.10), Marine Mammals and Sea Turtles VC (Section 6.3.10), and Migratory Birds VC (Section 6.4.10), will be employed to reduce the potential environmental effects of the Project on special areas. These mitigation measures include the following:

- Lighting on the MODU is designed to comply with requirements stipulated in the *Petroleum Occupational Safety and Health Regulations* to provide safe operations. There is no extraneous lighting. All lighting except navigational lighting is pointed downward.
- The waste management mitigation measures included for the Fish and Fish Habitat VC (Section 6.1.10.2) are also applicable to special areas, and are listed below:
  - All chemicals used will be screened as per the OCSG (NEB et al. 2009) and Husky's chemical management system and chemical screening program.
  - All routine discharge limits (i.e., deck drainage, bilge water, cooling water) will be in accordance with the OWTG (NEB et al. 2010), *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals* under the *Canada Shipping Act, 2001* and the International Conventions for the Prevention of Pollution from Ships (MARPOL).
  - Sewage will be macerated to a particle size of <6 mm and discharged as per the OWTG.
  - Waste discharges not meeting OWTG requirements and domestic garbage will be transported to shore for disposal or recycled. Garbage is segregated as required and in compliance with waste disposal requirement and Husky Waste Management Plan.
  - Concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG.
  - All foreign vessels operating in Canadian jurisdiction must comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act, 2001* during ballasting and de-ballasting activities.
- VSP activity will be conducted in consideration of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP) (DFO 2007b), according to Husky Procedure EC-M-99-X-PR-00121-001 Vertical Seismic Profiles and Well Site Surveys - Environmental Requirements.

6.5.10.3 Characterization of Residual Project-related Environmental Effects

6.5.10.3.1 Change in Habitat Quality

6.5.10.3.1.1 Presence and Operation of MODU

A portion of EL 1151 overlaps the Northeast Shelf and Slope EBSA (see Figure 4-33 in Section 4.2.9.1).

Drilling operations and dynamic positioning to keep the MODU in place, will generate underwater sound that has the potential to affect the habitat quality of some special areas. This may result in species avoiding the areas (see Sections 6.1 and 6.3 for effects of MODU on fish and fish habitat and marine mammals and sea turtles, respectively). The effects of underwater noise on fish, marine mammals, and sea turtles depends on a variety of factors, including ocean conditions, species, stage of life, reproductive stage, etc. (Davis et al. 1998; Southall et al. 2007; Weilgart 2007).

Anchored MODUs produce less noise during drilling than the cavitating propellers of supply boats during loading and offloading of materials onto the MODU. Available noise levels for a MODU range between 115 to 128 dB re 1 µPa @ 1m (Blackwell et al. 2004; Moore and Clarke 2002) compared to a supply ship sound level of 182.5 dB re 1 µPa @ 1m (Matthews and Zykov 2012). Sounds produced by a MODU are therefore unlikely to interfere with echolocation by marine mammal (Gales 1982). Animals will tolerate a stimulus they might otherwise avoid if the benefits in terms of feeding, mating, migrating to traditional habitat, or other factors outweigh the negative aspects of the stimulus (Richardson et al. 1995).

Therefore, a change in habitat quality of special areas could occur in the Northeast Shelf and Slope EBSA. These areas provide habitat to fish species such as spotted wolffish and Greenland halibut, and an aggregation area for a variety of marine mammals such as harp and hooded seal species. However, this change would be temporary, localized close to the wellsite, and is not predicted to result in permanent or irreversible loss of habitat for fish, or marine mammals and sea turtles.

There are no special areas for marine birds or IBAs near the Project Area, potential effects of light on migratory birds is discussed in Section 6.4. As discussed in Section 6.4.10, the presence and operation of lights on the MODU have the potential to affect a portion of the visual environment, which could lead to the attraction of fish and migratory bird species. With the implementation of mitigation (Section 6.4.10.2), the presence and operation of the MODU is expected to be low to moderate in magnitude, irregular in nature and restricted to the Project Area.

In the shallower areas of the Grand Banks, typically, 8 to 12 anchors are used to moor a semi-submersible rig. As anchors are set into place, they may drag across the seabed, leaving physical "scars" and increasing suspended sediment. Ulfsnes et al. (2013) estimated a corridor of influence from anchor placement to be approximately 100 m wide (in Cordes et al. 2016). The Continental Shelf Associates (2006) undertook a study to look at physical impacts from oil and gas exploration activity in the Gulf of Mexico. In the sites that were sampled, anchor scars were observed in all sites, ranging from 100 m to 3 km in length (Continental Shelf Associates 2006). It has been suggested that anchor scars from drilling activities can last for up to 14 years (IOGP 2016). It is anticipated that effects from anchors on special areas will be low in magnitude, restricted to the Project Area, irregular in occurrence as it depends on the number of wells drilled long-term in duration, reversible, and occurring in a relatively undisturbed ecological area.

Residual environmental effects associated with the presence and operation of the MODU on a change in habitat quality, and associated social-cultural effects, for special areas is predicted to be low-medium in magnitude, restricted to within the Project Area, medium-term in duration, and occurring irregularly as there is no set drilling schedule. These effects are expected to be reversible once Project activities cease.

6.5.10.3.1.2 Drilling Associated Surveys

The potential effects of drilling associated surveys from the Project on fish and fish habitat, and marine mammals is discussed in Sections 6.1 and 6.3, respectively, and will be cross-referenced in the assessment of this VC.

The potential effects of air gun sounds may include one or more of the following: tolerance, masking of natural sounds, behavioural disturbance and, at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Many cetaceans tend to avoid operating air guns, but only slight (if any) avoidance has been shown by pinnipeds and sea turtles.

Some behavioural disturbance is expected but would be localized and short-term. Short-term avoidance does not necessarily provide detail about longer term effects such as reproductive rate, or species distribution and habitat use, however, effects likely vary between species, location, and life stage. Pre-drilling surveys in or near areas with larger aggregations of fish, marine mammals, or sea turtles would likely have the largest effect. However, marine mammals are expected to be widely distributed throughout the Study Area.

There is potential for an effect from drilling-associated surveys within a portion of the Northeast Slope and Shelf EBSA, which could temporarily affect the habitat quality of that area to support fish and mammal species using the area. This effect is anticipated to be low in magnitude, short-term and continuous for the duration of the survey, and reversible. Wellsite and VSP survey activities will adhere to the Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment, as appended to the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017a) (see Section 6.3.10.2).

Residual environmental effects associated with drilling-associated surveys on a change in habitat quality, and associated social-cultural effects, for special areas is predicted to be low in magnitude and short-term (no more than a day per well, totaling 10 days over 8 years), restricted to the Project Area, occurring irregularly, and reversible, with no predicted lasting effects once the VSP survey is completed.

6.5.10.3.1.3 Waste Management

Discharges from drilling activities such as muds and cuttings, have the potential to alter water and sediment quality within a portion of special areas that overlap or are adjacent to the boundaries of Husky's ELs. Slow moving or sessile organisms, such as benthic fauna, have the potential to be smothered by drilling wastes if they are located close to the wellsite. Sediment quality also has the potential to be altered in terms of oxygen depletion and nutrient enrichment, which may reduce species diversity and abundance (Neff et al. 2000, 2004). Noticeable effects on benthic macrofauna are most often confined to within a 250 m radius and seldom detected beyond 500 m of the drill site (Olsgård and Gray 1995; Bakke et al. 2011). Water depth also affects the dispersion and thickness of drill cuttings in a given area. Effects on benthic communities from drilling wastes are typically more pronounced in waters less than 600 m. Laboratory experiments indicate the potential for polyp mortality caused by drill cuttings (Larsson and Purser 2011) as well as alterations in feeding behaviours, coral physiology and disruption of calcification (Dodge and Szmant-Froelich 1985). The tolerance of individual species to the constituents of drill cuttings has also been found to be highly variable (Rogers 1990).

Smit et al. (2008, in IOGP 2016) determined a threshold level of approximately 6.5 mm of sediment burial is required to cause mortality to benthic macrofauna. This is similar to the 6.3 mm threshold that has been used in Norwegian environmental risk assessment models for drilling activity on the

Norwegian Continental Shelf (Teh and Koh 2016). Drill cutting dispersion modelling for Husky's White Rose field (see Section 2.6.1.1) found that a well-defined cuttings patch is found within 100 to 200 m of the wellsite. This patch is generally between 1 and 10 mm thick, with portions that may range between 25 to 50 mm thick. Approximately 500 m from the drill centre, there are approximately a dozen additional thin patches of cuttings of thicknesses up to 0.2 mm. These patches are all approximately 1 km in radius and are scattered out to approximately 8 to 12 km from the drill centre.

The results of Husky's EEM programs for White Rose are summarized in Section 6.1.10.3 and note that there have been few effects on benthic invertebrate communities and their habitats as a result of offshore drilling operations. The spatial extent of contamination measured in the 2014 EEM was within original EA predictions in that hydrocarbon contamination extended to 5.8 km from source, barium contamination extended to 1 km from source, and the percent of fines in sediment extended to 0.7 km from source. Note that these are based on 38 well drilled since 2004. These results are similar to those of the Terra Nova EEM, which indicated the highest levels of barium and hydrocarbon contamination extended to 1 to 2 km from source (DeBlois et al. 2014b). Of the 53 samples taken during this program, all but two samples were determined to be non-toxic to amphipod survival. The spatial extent of effects on benthic invertebrates at White Rose is generally consistent with the literature on effects of contamination from offshore oil developments. Zones of influence of project contaminants and effects on benthic community indices and taxa have not increased in severity or extent over time; there has been no continued and consistent degradation at White Rose.

Ecological recovery of benthic macrofauna communities from effects associated with offshore drilling activities has been found to occur relatively quickly in most cases (IAGOP 2016). In areas such as deep water (greater than 600 m) where drilling muds and cuttings are more widely dispersed, ecological recovery begins soon after drilling and can be well advanced within a year (IOGP 2016). Hurley and Ellis (2004) and Garcia et al. (2011) also confirmed in separate studies of the effects of drill cuttings on benthic communities that the recovery of benthic communities return close to pre-drill conditions within a year after drilling had taken place.

Other discharges associated with routine Project activities, such as organic matter, deck drainage, bilge water, produced water, etc., are regulated by the C-NLOPB under the OWTG, to reduce the potential effects of discharged wastes on the marine environment from offshore oil and gas activities. Discharges at sea will be in accordance with requirements of Husky's EPCMP, which comply with the OWTG to mitigate potential effects on the marine environment. Waste not identified in the EPCMP will not be discharged to the ocean and will be brought to shore for disposal. Discharges into the marine environment may result in a temporary and localized reduction in water or sediment quality within special areas that overlap with the Project Area. However, these changes are not anticipated to result in a measurable change of habitat quality for marine species that use these areas.

If cement reaches the seafloor (after the well section has been drilled), the volume of cement potentially discharged compared to the volume of drill cuttings that already settled on the seafloor is such that the cement will cover the drill cuttings and not affect additional benthic habitat.

Given the evidence from the relevant models and scientific literature, and current findings from Husky's ongoing EEM program for White Rose, drilling cuttings and mud discharges are expected to be localized near the drill site.

Residual environmental effects associated with waste management on a change in habitat quality, and associated social-cultural effects, for special areas is predicted to be low to moderate in magnitude, occurring irregularly as there is no set drilling schedule and medium to long-term in duration (continuous over the length of the drilling program), and reversible (baseline conditions are anticipated to return once the drilling program is completed).

6.5.10.3.1.4 Supply and Servicing Operations

Sound disturbance effects on marine mammals and sea turtles are discussed in Section 6.3. Noise modelling completed within the White Rose field (summarized in Section 2.6.3.2) found that sound levels of 182.5 dB re 1 μPa @ 1m) from a 5,000 HP tug support vessel would attenuate to 120 dB re 1 μPa (rms) or lower at distances of approximately 14 km in the summer, and 16 km during the winter. Behavioural responses by marine mammals to vessels are variable and may include approach or avoidance, changes in diving, feeding, or vocalizations. As discussed in Section 6.1, 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.

The area that may cause adverse hearing effects to marine mammals and sea turtles (180 and 190 dB re 1 μPa (rms)) were found to occur in an area less than 5 m from an OSV. Sound levels above the threshold for behavioural effects (160 dB re 1 μPa (rms)) were found to occur within 22 m of an OSV. For fish species, a sound level behavioural threshold of 160 to 180 dB re 1 μPa (rms) was predicted within less than 5 to 22 m of a vessel; a helicopter flying 91 m above the surface did not exceed that threshold at depths greater than 3 m (Husky Energy 2012a). The risk for collision of marine mammals associated with OSV transit and marine mammals and seas turtles is discussed in Section 6.3.

The one to three OSVs required for the Project will represent a small increment above existing vessel traffic in the area. Vessel traffic is expected to have a short-term and localized effect on marine mammals and sea turtles.

Residual environmental effects associated with supply and servicing on a change in habitat quality, and associated social-cultural effects, for special areas is predicted to be low in magnitude, localized to a portion of the Project Area at any one time, medium-term in duration, occurring at an irregular frequency, and reversible once supply and servicing operations for the Project are finished.

6.5.10.3.1.5 Well Abandonment

All wells drilled during the life of the Project will be plugged and abandoned upon well completion. All abandonment activities will be conducted in compliance with all C-NLOPB applicable regulations and guidelines, including the Drilling and Production Guidelines. It is anticipated that the well casing will be severed below the seabed and the wellhead removed. This method would result in no infrastructure remaining above the seabed once the well has been removed. In the unlikely event that shape charges are required to remove the wellhead, the charge will be below the sea floor. A charge detonated below the seafloor will have an initial rate of increased pressure that is more attenuated than an explosion in the water column. Much of the initial shock pulse and energy from the explosion will be absorbed by the seafloor. Should shape charges be required, the MMO will track any marine mammals and sea turtles in area of wellhead and detonation will be delayed until there are no sightings for at least 45 minutes.

Residual environmental effects associated with well abandonment on a change in habitat quality, and associated social-cultural effects, for special areas is predicted to be negligible in magnitude, localized to the wellsite in the Project Area, short-term in duration, irregular (once per well with no set schedule), and will be reversible.

6.5.10.4 Summary of Project Residual Environmental Effects

As a result of characterizing the above potential interactions between Project activities and special areas, the Project has potential to result in adverse residual effects through a change in habitat quality, and associated social-cultural effects, for special areas that exist within the Project Area, including the Northeast Shelf and Slope EBSA. With the implementation of applicable mitigation measures and adherence to industry standards for offshore oil and gas activities in Newfoundland and Labrador, the residual adverse environmental effects are considered to be negligible to low in magnitude for most Project components and activities, short to medium-term in duration, reversible (with the exception of well abandonment), and primarily occur within an undisturbed ecological and socio-economic setting (Table 6.26).

Table 6.26 Project Residual Effects on Special Areas

Residual Effect	Residual Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Habitat Quality							
Presence and Operation of MODU	A	L-M	PA	MT-LT	IR	R	D
Drilling-associated Surveys	A	L	PA	ST	IR	R	D
Waste Management	A	N	PA	MT	IR	R	D
Supply and Servicing	A	L	PA	MT	IR	R	D
Well Abandonment	A	L	PA	ST	IR	R	D

KEY
See Table 6.23 for detailed definitions

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
SA: Study 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

6.5.11 Determination of Significance

With mitigation and environmental protection measures in place and implemented, residual environmental effects on special areas are not significant. This conclusion has been determined with a high level of confidence based on extensive scientific literature and EEMs within the Study Area, and discharge modelling. Literature outlining the recovery of the benthic environment post-drilling dictates that recovery begins relatively quickly after drilling stops.

6.5.12 Follow-up and Monitoring

Given the high level of confidence around a prediction of no significant adverse environmental effects on special areas, and the implementation of standard mitigation, no follow-up is proposed to be implemented for routine Project activities.

Husky provides an annual EA Update to the C-NLOPB each year, detailing the specific activities that will be conducted within the Project Area in a given year. In that EA Update Husky will include changes (if any) to special areas and discuss the potential effects of Project activities to special areas.

6.6 Indigenous People and Community Values

6.6.1 Scope of Assessment

Indigenous People and Community Values was selected as a VC in recognition of the cultural, social, and economic importance of marine life and fishing to Indigenous peoples, the requirements of the EIS Guidelines, and in recognition of potential or established Aboriginal and Treaty rights. As the Project Area does not intersect with any claimed Indigenous traditional territory, this VC includes consideration of social, cultural, or spiritual value to the Indigenous communities, with a focus on commercial communal fisheries, food, social, and ceremonial (FSC) fishing, and hunted migratory bird species, marine mammals and other species (e.g., Atlantic salmon) with potential to occur in or migrate through the Study Area.

This VC is closely related to Commercial Fisheries VC (Section 6.2) with respect to commercial communal fisheries as well as Fish and Fish Habitat VC (Section 6.1) with respect to potential Project-related effects on fishery species targeted by commercial communal fisheries. This VC is also related to the Migratory Birds VC (Section 6.4) and Marine Mammals and Sea Turtles VC (Section 6.3) with respect to potential Project-related effects on traditional use species.

6.6.2 Regulatory and Policy Setting

Two regulatory jurisdictions related to marine fisheries apply to the Study Area. The Government of Canada has jurisdiction over commercial fishing activities for sedentary and non-sedentary species within its 200 nm EEZ. Canada also has jurisdiction over commercial fisheries for sedentary species up to the extent of the defined continental shelf. Beyond the EEZ, the NAFO has primary jurisdiction over commercial fisheries for non-sedentary species and has the authority to designate protected areas.

The federal *Fisheries Act* focuses on protecting the productivity of fish that are part of CRA fisheries. These regulations are enforced by DFO. DFO also issues communal licences pursuant to the *Aboriginal Communal Fishing Licences Regulation* to provide for the harvest of fish for FSC fisheries purposes. There are no identified FSC fisheries within the Study Area. The only FSC fishery on the Island of Newfoundland is executed by Miawpukek First Nation in Conne River; it is a multi-species coastal fishery (D. Ball, pers. comm.).

The *Technical Guidance for Assessment the Current Use of Lands and Resources for Traditional Purposes under CEAA 2012* and *Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site or Thing that is of Historical, Archeological, Paleontological or Architectural Significance under CEAA, 2012*, influenced the EA process including the scoping and assessment of this VC.

6.6.3 The Influence of Consultation and Engagement on the Assessment

Key issues raised during stakeholder consultation and Indigenous peoples engagement for the Project to date include general concerns related to accidental events in the deep water and the potential effects an accidental event would have on migratory species and Indigenous activites in their traditional territory. Questions and concerns were raised with respect to effects from offshore drilling and exploration on areas in the Flemish Pass inhabited by various commercial (redfish, flounder) and other groundfish. Concern was expressed around the historical cod fishery and the potential for a commercial cod fishery to begin again during the lifetime of the Project. It was also noted through Indigenous engagement around the use of Project vessels and the potential to affect commercial fishing as well as a concern for harvestable species that pass through the Project Area and reach the near shore that could be affected. Potential impacts on migratory species of interest to the Indigenous groups, such as Atlantic salmon, American eel, and North Atlantic right whale, that are harvested for FSC purposes was raised along with the cumulative effects of numerous exploration projects and activities from other ocean users.

6.6.4 Potential Effects, Pathways and Measurable Parameters

As with commercial fisheries (Section 6.2), routine Project activities can interact with commercial communal fisheries resources either directly or indirectly through effects on the species fished and/or fishing activity itself (e.g., through displacement from fishing areas, gear loss or damage). Although there is no known FSC fishing occurring in the Project Area, routine Project activities may interact with migratory species, including marine fish, marine mammals, and marine birds traditionally and currently harvested by Indigenous communities at their traditional harvesting sites. While Indigenous groups have expressed an interest in all marine species and habitat, specific concerns have focused on the potential Project interaction with American eel and Atlantic salmon. Routine Project activities may also interact with migratory bird species traditionally and currently hunted by Indigenous communities. As noted in Section 6.4 – Migratory Birds, there are predicted Project interactions with migratory birds because of potential attraction to the lights and flares associated with the presence and operation of the MODU and underwater sound emissions from drilling-associated VSP surveys. Indigenous people in Labrador primarily hunt harp seals, ringed seals, and harbor seals. The harp seal is the only one of these species known to occur within the Study Area during the winter months. Although potentially present within the Project Area, no effects on the harp seal are anticipated from routine Project activities. Potential effects on harp seal from accidental events are discussed in Section 7.3.

In consideration of the potential interactions, the assessment of Project-related environmental effects on Indigenous people and community values is focused on the following potential environmental effect:

- change in commercial communal fisheries
- change in current use of lands and resources for traditional purposes

Routine Project-related activities will occur in the marine environment; therefore, effects from routine activities are unlikely to directly affect the physical or social health and well-being of Indigenous persons or communities except potentially indirectly as a result of effects on commercial communal or FSC fishing. There are no known physical and cultural sites, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance within the Project Area. Therefore, there are no pathways of effects from routine Project activities to changes in structures, sites or things of historical, archaeological, paleontological or architectural significance due to the offshore location of the Project and localized extent of routine Project interactions.

The effect pathway and measurable parameters used for the assessment of the environmental effect presented is provided in Table 6.27. Effects of accidental events are assessed separately in Section 7.3.

Table 6.27 Potential Effects, Effects Pathways and Measurable Parameters for Indigenous People and Community Values

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in Commercial Communal Fisheries	• Direct or indirect loss in availability of commercial communal fisheries resources arising from Project activities •	• Change in access to area used for commercial communal fisheries (ha) • Change in catch rates (qualitative) • Area of fish habitat permanently affected (m²) • Mortality of commercially important species (qualitative) • Damage to fishing gear (qualitative) • Employment and business activity and income levels / revenues (qualitative) • Change in community revenues (qualitative)
Change in Current Use of Lands and Resources for Traditional Purposes	• Direct or indirect loss in availability of FSC fisheries resources arising from Project activities	• Change in availability of culturally important species (i.e., through mortality or change in migration patterns) (qualitative) • Degree of reduced access to FSC resources, and associated effect to social, spiritual, or cultural value (qualitative)

6.6.5 Boundaries

Spatial boundaries and temporal boundaries for the assessment of Indigenous people and community values are discussed in the following sections.

6.6.5.1 Spatial Boundaries

Project Area: The Project Area (Figure 2-1) encompasses the immediate area within which Project activities and components may occur and direct physical disturbance to the marine benthic environment may take place. Well locations have not been identified but will occur within EL 1151, EL 1152 and EL 1155, within the Project Area. The spatial boundary of the Project Area has been delineated to account for all activities related to drilling a well, including transit of OSV and helicopter traffic to/from St. John's and vessel traffic associated with geohazard/environmental surveys.

Study Area: The Study Area (Figure 2-1) is the area within which residual environmental effects from operational activities and accidental events may interact cumulatively with the residual environmental effects of other past, present and future (certain or reasonably foreseeable) physical activities.

6.6.5.2 Temporal Boundaries

The temporal boundaries for potential Project-related environmental effects on Indigenous people and community values encompass all Project phases, including well site location surveys, well drilling, testing and abandonment. It is anticipated that exploratory drilling activities would commence in 2019, and continue intermittently throughout the term of exploration licence, up to 2027. Well testing (if required, dependent upon drilling results) could also occur at any time during the temporal scope of this EA. Wells may be decommissioned and abandoned at any time within the temporal boundaries. The temporal scope of the EA accommodates drilling in EL 1151, EL 1152, and EL 1155 for the full term of each licence (period 1 and period 2). Within the overall temporal scope, well site surveys typically require five to seven days per well, VSPs typically take approximately one day per well and an individual well may take up to 80 days to complete. Drilling operations will not be continuous throughout the entire eight-year scope of the Project and will depend partially on rig availability and results from previous wells. If a semi-submersible or drill ship is selected as the preferred MODU option for the Project, then drilling activities have the potential to be conducted at any time of the year. If a jack-up rig is selected as the preferred method, then drilling would only occur during the ice-free season.

Temporal boundaries also consider periods of enhanced biological sensitivity for resource species and times used for resource harvesting with respect to current use for traditional purposes (e.g., fishing, hunting).

6.6.6 Residual Environmental Effects Characterization

The descriptors used to characterize residual environmental effects on Indigenous people and community values are defined in Table 6.28.

Table 6.28 Characterization of Residual Environmental Effects on Indigenous People and Community Values

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual environmental effect relative to baseline	**Positive –** a residual environmental effect that moves measurable parameters in a direction beneficial to Indigenous people and community values relative to baseline **Adverse –** a residual environmental effect that moves measurable parameters in a direction detrimental to Indigenous people and community values relative to baseline **Neutral –** no net change in measurable parameters for the Indigenous people and community values relative to baseline
Magnitude	The amount of change in measurable parameters or 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 a residual environmental effect occurs	**Project Area –** residual environmental effects are restricted to the Project Area **Study Area –** residual environmental effects extend into the Study Area
Frequency	Identifies how often the residual environmental effect occurs and how often during the Project	**Single event –** effect occurs once **Multiple irregular event –** effect occurs at no set schedule **Multiple regular event –** effect occurs at regular intervals **Continuous –** effect occurs continuously
Duration	The period of time required until the measurable parameter or the VC returns to its existing condition, or the residual environmental 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 –** the residual effect is likely to be reversed after Project completion (well abandonment) **Irreversible –** the residual effect is unlikely to be reversed

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Ecological and Socio-economic Context	Existing condition and trends in the area where residual 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

6.6.7 Significance Definition

A **significant adverse residual effect** on Indigenous people and community values is defined as a Project-related environmental effect that results in one or more of the following outcomes:

- Loss of access to areas relied on for traditional use practices or the permanent loss of traditional use areas within a large portion of the Study Area for a season
- Adverse effects on socio-economic and cultural conditions of affected Indigenous communities, such that there are associated, detectable, and sustained decreases in the quality of life of a community
- A decrease in established employment and business activity in commercial communal fisheries (e.g., due to fish mortality and/or dispersion of stocks, or restriction or loss of access) such that there is a detectable adverse effect upon the economy of the affected Indigenous community
- unmitigated damage to fishing gear

6.6.8 Summary of Existing Conditions for Indigenous People and Community Values

A detailed discussion on Indigenous use of resources is provided in Section 4.3.2. This section provides a summary of Indigenous use in the Study Area and which harvested species could potentially interact with the Project.

Indigenous communities have a long-established respect for and reliance on the resources of the land and water including fish, sea mammals, birds, and caribou. As described in detail in Section 4.3.2, commercial communal fisheries, hunting for migratory bird species, and seal hunting are the only three activities associated with resources of interest to Indigenous groups potentially affected by the proposed Project.

The EIS Guidelines, as revised May 31, 2018, identified five Indigenous groups in Newfoundland and Labrador, 13 groups in Nova Scotia, 16 groups in New Brunswick, 2 groups in Prince Edward Island and 5 groups in Quebec that have the potential to be affected by Project activities. Some communities hold commercial communal licences in or near the Study Area, and have FSC licenses in the Study Area or for species that may migrate through the Study Area.

Species harvested for commercial communal purposes in the Study Area include capelin, groundfish, herring, mackerel, seal, shrimp, snow crab, swordfish, tuna, and whelk. Commercial fishing gear used in offshore Newfoundland and Labrador are unique to the species that is being harvested, except for groundfish, which typically uses a combination of stern otter trawls, mobile or fixed gillnets, or longlines (e.g., baited hooks). Crab pots are used in the snow crab fishery and shrimp trawls for northern shrimp. Most harvesting occurs between the months of April and August, with some activity occurring year around. In addition to species commercially fished by the Newfoundland and Labrador Indigenous groups, Indigenous groups within the Maritime provinces hold commercial communal licences which are located within the Study Area. This includes commercial communal licences for swordfish and tuna.

Very few of the species harvested during a FSC fishery or a traditional migratory bird harvest have the potential to occur within the Husky Exploration Drilling Environmental Assessment Study Area. Harvested species that may transit through the Project and Study Areas include:

- Atlantic salmon
- American eel
- harp seal
- murres (turrs)

6.6.8.1 Salmon

North American Atlantic salmon breed and spend the early part of their life cycle in freshwater systems throughout Atlantic Canada, eastern Québec, and the northeastern seaboard of the United States. Salmon have been an important food source for many Indigenous groups in Atlantic Canda. The subsistence salmon fishery in Labrador harvested an estimated 13,236 fish (39.5 t) in 2016 (Veinott et al. 2018) This is similar to the previous generation mean (2010-2015) of 14,264 salmon (38.3 t). Subsistence fishery harvests have been increasing since 2000 (DFO 2016g), and salmon harvested in the Labrador subsistence fishery originate primarily in Labrador (DFO 2015e). Salmon native to rivers in Labrador typically migrate north and are therefore not likely to interact with the Project. Bradbury et al. (2015) analyzed the genetic makeup of the Labrador subsistence fishery. They found that 96% to 97% of the contributing fish were from adjacent stocks, and any stocks from Quebec or Newfoundland were rare, primarily in southern Labrador via pathways through the Strait of Belle Isle. The subsistence salmon fishery in other regions in the Atlantic are currently closed.

6.6.8.2 American Eel

The American eel (*Katew)* is a catadromous (i.e., migrating down rivers to the sea to spawn) fish that lives primarily within freshwater and estuarine environments and has a broad distribution throughout the northwest Atlantic Ocean, stretching from Venezuela to Greenland and Iceland (COSEWIC 2012). There is little information available on specific migration patterns of American eel. If American eel were to occur within the Project Area, it is likely that they would be carried by currents on their way to either Greenland, Iceland, or Newfoundland and Labrador. The American eel is assessed by COSEWIC as threatened because of dramatic declines over a substantial portion of its distribution (COSEWIC 2012). Various factors have been identified as threats to the

American eel including habitat loss, dams, overfishing, disease, and possibly global warming (COSEWIC 2012; UNIR 2015a; Parks Canada 2017). A relatively new threat is an exotic swim bladder nematode parasite, which may also be adversely affecting the eel (COSEWIC 2012; Parks Canada 2017).

6.6.8.3 Harp Seal

The Jeanne d'Arc Basin and adjacent areas overlap with regions where harp seals have been observed during January and February (Lacoste and Stenson 2000, in Husky Energy 2012a). During years when pack ice extends to the Northern Grand Banks, harp seals may use the region for spring pupping, mating and moulting.

The harp seal is found throughout the North Atlantic and Arctic Ocean, from the Gulf of St. Lawrence to Russia (Jefferson et al. 2008, in Husky Energy 2012a). Harp seals are the most abundant seal in the Northwest Atlantic, with an estimated population size of 8 million in 2008 (DFO 2011d, in Husky Energy 2012a). The Northwest Atlantic population of harp seal summers in the eastern Canadian Arctic and Greenland and undergo an annual southward migration in the fall to Atlantic Canadian waters to birthing (whelping) locations in the Gulf of St. Lawrence or off northern Newfoundland, where they give birth on pack ice during late February or March (DFO 2016h). Dedicated at-sea surveys and data from satellite-tagged animals indicate that harp seals spend most of their time in offshore areas of southern Labrador and eastern Newfoundland during the winter (Stenson and Sjare 1997, in Husky Energy 2012a; Lacoste and Stenson 2000, in Husky Energy 2012a). Older seals also aggregate to moult off northeastern Newfoundland and in the northern Gulf of St. Lawrence in April and May before migrating northward (DFO 2000, in Husky Energy 2012a).

This population of harp seals are hunted for commercial and subsistence purposes by Inuit in Labrador, Arctic Canada, and Greenland. Most of the approximately 80,000 subsistence animals are harvested in Greenland. A five-year (2014 to 2018) management plan regulates the commercial harvest, which removes less than 100,000 seals per year since 2009, using 12,000 licences (DFO 2016h).

6.6.8.4 Murres

Most murres harvested off the coast of Labrador north of Groswater Bay are Thick-billed Murre which breed in the Arctic and migrate either to or from breeding grounds along the coast of Labrador (S. Wilhelm, CWS, pers. comm., 2016). Most birds are harvested during this migration. The Canadian Arctic is estimated to host 1,080,000 breeding Thick-billed Murres, of which 178,399 (16.5%) may over-winter on the Grand Banks (Frederiksen et al. 2016).

For murres harvested south of Groswater Bay, in addition to the Arctic Thick-billed Murre breeders, murres taken in a traditional harvest may originate from Common and/or Thick-billed Murre colonies in Groswater Bay and the Gannet Islands. While tracking data for birds breeding in Groswater Bay are not available (S. Wilhelm, CWS, pers. comm., 2016), tracking data of Thick-billed and Common murres from the Gannet Islands show that they primarily over-winter on the Grand Banks (McFarlane Tranquilla et al. 2014, 2015). CWS is currently studying the species composition of the migratory bird harvest along the Labrador coast, but results are not expected to be available for three to five years (R. Wells, CWS, pers. comm., 2016).

6.6.9 Project Interactions with Indigenous People and Community Values

The physical Project-related activities that have the potential to interact with Indigenous people and community values are identified in Table 6.29. These interactions are indicated by checkmarks and are discussed in Section 6.6.10 in the context of effects pathways, mitigation, and residual effects.

Table 6.29 Project-Environment Interactions with Indigenous People and Community Values

Physical Activities	Environmental Effects	
	Change in Commercial Communal Fisheries	**Change in Current Use of Lands and Resources for Traditional Purposes**
Presence and Operation of MODU (Presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; well testing; cementing and completing wells)	✓	✓
Drilling-associated Surveys (VSP and wellsite surveys; geotechnical / geophysical / environmental surveys; diving surveys; ROV surveys)	✓	✓
Waste Management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)	✓	✓
Supply and Servicing (operation of helicopters and supply / support / standby/ tow vessels within the Project Area)	✓	✓
Well Abandonment (plugging and abandoning of wells)	✓	✓
Notes: ✓ = Potential interaction – = No interaction		

Harp seals have been observed in the Project Area, but potential effects from routine activities are not anticipated and therefore have not been carried through the assessment. Potential effects to harp seals related to accidental events in discussed in Section 7.3. Potential effects of routine Project activities on commercial communal fisheries and migratory birds is provided in the following sections.

6.6.10 Assessment of Residual Environmental Effects on Indigenous People and Community Values

This section assesses the environmental effects on Indigenous people and community values that may result from Project-related activities identified in Table 6.29. Given the geographic and environmental consistencies, as well as the analogous Project description, the WREP EA (Husky Energy 2012a) has been referenced extensively in this analysis with revisions as applicable, due to scientific updates and refined EA methods.

6.6.10.1 Project Pathways

6.6.10.1.1 Change in Commercial Communal Fisheries

Commercial communal fishing activities include deploying, setting, and/or accessing gear on fishing grounds, retrieving/hauling the gear to harvest the fish, and getting the catch back to port where it can be sold. Project interactions resulting in effects that might interrupt or prevent any part of that process, such as having grounds closed to fishing, impediments to or from fishing grounds, lost or damaged fishing gear, or lost or reduced catch, are the focus of this assessment. Revenue generated from commercial communal fishing activity is also a main source of revenue for many Indigenous communities; therefore, indirect socio-economic impacts are also qualitatively considered in this assessment.

A change in commercial communal fisheries may occur as a result of:

- the presence and operation of the MODU (fisheries exclusions and underwater sound effects on commercially fished species)
- drilling-associated surveys (underwater sound potentially causing behavioural effects on fisheries species)
- waste management (effects on water and sediment quality on fisheries species)
- supply and servicing operations (underwater sound associated with vessel movement potentially causing behavioural effects on fisheries species)
- well abandonment (the potential use of shaped charges and their effects on fish health and behaviour)

6.6.10.1.2 Change in Current Use of Lands and Resources for Traditional Purposes

Current use of lands and resources for traditional purposes includes those harvesting activities to collect resources that provide nourishment, or for use in traditional ceremonies and social events. Although there are no known FSC fisheries in the Project Area, some species that are traditionally harvested closer to Indigenous traditional territories, have the potential to migrate through the Project Area. These include some species of marine fish, marine mammals, and migratory birds. Routine Project activities that might interact with these migratory species are the focus of this assessment. It also considers the social, spiritual, and cultural value of the FSC fishery to the Indigenous communities; however, it is difficult, if not impossible, to express the importance of this fishery as a monetary value, because it reflects the very nature of Indigenous culture. A qualitative assessment of social and cultural value is provided based on the potential impacts to the current use of lands and resources for traditional purposes.

A change in current use of lands and resources for traditional purposes may occur as a result of:

- the presence and operation of the MODU (fisheries exclusions and underwater sound effects on FSC species)
- drilling-associated surveys (underwater sound potentially causing behavioural effects on FSC species)
- waste management (effects on water and sediment quality on FSC species)
- supply and servicing operations (underwater sound associated with vessel movement potentially causing behavioural effects on FSC species)
- well abandonment (the potential use of shaped charges and their effects on fish health and behaviour

6.6.10.2 Mitigation

Given the environmental effects pathways noted above, the following mitigation measures, as well as mitigation measures identified for the Fish and Fish Habitat VC (refer to Section 6.1.10) will be employed to reduce the potential environmental effects of the Project on Indigenous people and community values. These mitigation measures are consistent with measures proposed to reduce potential environmental effects on commercial fisheries (including commercial communal fishing activities) (refer to Section 6.2.10.2). These mitigation measures include the following:

- Husky will implement its Vessel Traffic Management Standard (AR-M-99-R-PR-00003-001), which includes procedures for management and communication relevant to the movement of OSVs, survey vessels, and MODU during Project related activities. All communications between Husky, operators, and fishers will adhere to this standard.
- Husky will continue to engage Indigenous fishers on an ongoing basis to share Project details as applicable and facilitate coordination of information sharing.
- Once the type of MODU is selected, Husky 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. The operator will publish a Canadian Coast Guard "Notice to Mariners" and a "Notice to Fishers" via the CBC Radio Program Fisheries Broadcast.

- Any Project-related damage to fishing gear will be compensated in accordance with the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017). Husky has a gear/vessel damage compensation program, to promptly settle claims for loss and/or damage that may be caused by Project-related activities such as drilling-associated surveys or OSV operations. The scope of the compensation program includes replacement costs for lost or damaged gear and any additional financial loss that is demonstrated to be associated with the incident. Procedures are in place so that any incidents of contact with fishing gear are clearly detected and documented (e.g., time, location of contact, loss of contact, and description of any identifying markings observed on affected gear).
- OSVs travelling between the Project Area and supply base will follow established shipping lanes in proximity to shore.
- The requirement for a Fisheries Liaison Officer (FLO) during certain offshore Project activities, such as any wellsite surveys, will be determined in accordance with the Risk Management Matrix Guidelines developed by One Ocean. The Risk Management Matrix Guidelines provides guidance on the requirements for FLOs and/or Fisheries Guide Vessels based on the level of fishing activity in an area and the activity being undertaken by the oil and gas operator.

Mitigation measures identified for the Migratory Birds VC (refer to Section 6.4.10) will also serve to reduce the potential environmental effects of the Project on Indigenous peoples and community values as it pertains to hunting of migratory birds.

6.6.10.3 Characterization of Residual Project-related Environmental Effects

6.6.10.3.1 Change in Commercial Communal Fisheries

6.6.10.3.1.1 Presence and Operation of MODU

A minimum 500 m radius safety zone is expected to be in effect around the work vessels and MODU at all times to eliminate potential interaction with fishing activity. The overall geographic extent of the area lost to fishing activity due to the safety zone will be determined once the preferred MODU type has been determined for each well. For example, a MODU requiring anchors will require a safety zone of 50 m around each anchor, which will extend up to 1,500 m from the MODU, depending on water depth. A non-anchored MODU, such as a drill ship or jack-up rig will require only a 500 m safety zone. Although fishing effort may be prevented within this safety zone, it is anticipated to be a temporary and localized fishing exclusion and is not likely to have a substantial effect on commercial communal fishing activities and fisheries resources.

Biophysical and behavioural effects of underwater sound on fish species, including commercial species are discussed in Section 6.1 (Fish and Fish Habitat). This avoidance behaviour is expected to be temporary as fish become conditioned 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 commercially fished species to the extent that fish harvesters would be adversely affected.

Since most activities producing sound will be limited to the safety zone during construction and operations, where commercial communal fishing will be prohibited, effects of sound on targeted fish species outside of this zone are anticipated to be minimal. Underwater noise modelling from the WREP predicted noise levels of 160 dB re 1 μPA (the threshold for a startle response in Atlantic cod (Turnpenny and Nedwell 1994)) within 5 m of a drill site in both the winter and summer scenarios. Underwater sound attenuated to 120 dB re 1 μPA within 100 m of the drilling source in both cases. While behavioural responses in fish depend on various factors, including species, it can be anticipated that sound levels would attenuate to a point that they would not affect commercial fishing activities occurring outside the safety zone. Given the temporary and localized nature of this effect, it is not expected to affect fisheries species to the extent that commercial communal fishers would experience a measurable change in availability of fisheries resources (through species mortality or dispersion of stocks) and therefore Indigenous communities would not experience adverse socio-economic effects.

As discussed in Section 4.3.2, Indigenous communities hold commercial communal licenses for several species, including groundfish, halibut, mackerel, herring, capelin, seal, lobster, scallop, snow crab, shrimp, swordfish, tuna, and Arctic char. Swordfish and tuna, are two species known to occur in the Study Area that were noted in recent offshore environmental assessments as being of commercial communal importance and therefore are the focus in the assessment for this VC.

Swordfish are a migratory species that are distributed widely throughout the Atlantic Ocean and can occur in waters offshore Newfoundland and Labrador. Indigenous groups hold commercial communal fishing licences for swordfish in NAFO Areas that overlap with the Project Area and the Study Area. The potential exists for swordfish to be found in areas that overlap with the Project Area; however, the overall distribution and migration patterns for swordfish is a large area, including most of the North Atlantic Basin (Dewar et al. 2011; Trenkel et al. 2014 in Nexen 2018). As tuna are a highly migratory species, and they have been found in the offshore waters of Newfoundland and Labrador, the species could migrate through the Project Area in search of prey species. Given the overall migration range for swordfish and tuna, it is unlikely that large numbers of these species would interact or be adversely affected by the presence and operation of the MODU. Therefore, this activity is not predicted to decrease the availability of swordfish or tuna as a resource for commercial communal fishing and result in associated adverse socio-economic impacts to the Indigenous communities.

A change in commercial communal fisheries for Indigenous people and community values, including associated socio-economic effects, is predicted to be low in magnitude, localized to the Project Area, medium-term in duration, and reversible. Avoidance behaviour exhibited by fisheries species, as well as the establishment of the safety zone associated with the presence of the MODU, will not have a permanent, irreversible effect on commercial communal fisheries.

6.6.10.3.1.2 Drilling-associated Surveys

Underwater sound from VSP or wellsite surveys could potentially startle fish, causing them to avoid the ensonified area and thereby reduce catchability. As discussed in Section 6.1, fish species, including commercial communal species, may move away from an area due to the presence of underwater sound. Underwater sound does not appear to have the same avoidance effects on invertebrate species such as snow crab (Section 6.1), which has been the primary commercial communal harvest in the Project Area in recent years.

Wellsite and VSP surveys use equipment similar to that used in seismic operations (i.e., a source array); however, the associated size and volume of the array are much smaller than a traditional seismic survey. The VSP is focused around a wellbore; therefore, sound effects are localized towards the drill site. VSP and wellsite surveys occur over one and five to seven days, respectively and are much more localized than large scale 2D and 3D seismic surveys.

As noted in Section 6.1, seismic airgun sound pulses can result in variable effects on fisheries species and catchability. While source array activity could injure fish species if they are within proximity to the sound source, it is likely that motile fish will disperse from the source during array ramp-up or vessel approach and avoid harm. Seismic activity could reduce trawl and longline catches if fish exhibit behavioural changes such as avoidance or a change in distribution. Physical and behavioral changes in commercial communal fisheries species resulting from drilling-associated surveys would be expected to be low and associated socio-economic effects are also anticipated to be low (refer to Section 6.1 Fish and Fish Habitat).

Residual effects associated with the drilling-associated surveys on a change in commercial communal fisheries, and associated socio-economic effects, for Indigenous people and community values is predicted to be low in magnitude, within the Project Area, short-term in duration (no more than a day per well, totaling 10 days over 8 years), occurring at irregular intervals and reversible following Project completion.

6.6.10.3.1.3 Waste Management

All operational discharges during drilling will comply with Husky's EPCMP for the drilling installation and will comply with the OWTG and MARPOL, both of which have been established to protect the marine environment. Discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean.

The discharge of drill muds and cuttings, and other discharges and emissions from the MODU and OSVs, have the potential to result in a change in sedimentation and water quality. As discussed in Section 6.1.10, the effects from these discharges are expected to be low in magnitude and localized within the Project Area. Adherence to Husky's EPCMP, which have been developed to be protective of the marine environment, will help reduce adverse effects on fisheries species.

As discussed in detail in Section 6.1.10.3, results from multiple EEM programs conducted for offshore drilling and production programs on the east coast of Canada (including Husky) have concluded that there have been negligible effects on commercial species that are resident in the Project Area, such as American plaice and snow crab (Buchanan et al. 2003; Hurley and Ellis 2004). The most recent results from Husky's White Rose EEM show that there continues to be no significant body burden (chemical) differences in plaice fillets or crab tissue collected in the White Rose field and reference areas, and no significant differences were noted in the taste of each species from panellists, compared to the reference area samples (Section 6.1.10.3). The EEM results indicate that changes in sediments and benthic community from drill cuttings have not resulted in adverse effects for any fisheries, including commercial communal.

Although recovery time varies because of the local environmental conditions (e.g., water depth, currents, temperature) and change in sediment particle size, the long-term population and ecosystem effects to benthic communities from WBM and SBM and cuttings discharges are generally low (Gates and Jones 2012). Sites previously affected by drill cuttings have shown recovery to occur in as little as four years (Schaanning and Bakke 1997; Bakke et al. 2011). However, studies of deep-water megafaunal assemblages have shown recovery taking longer as reported by Jones et al. (2012) following deepwater drilling showing 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).

Other discharges and emissions have the potential to result in temporary and localized effects on water quality. Discharges will meet the requirements of Husky's EPCMP, which is designed to mitigate potential effects from discharges; therefore, these discharges are not predicted to adversely affect fisheries species in the Project Area or the Study Area.

Residual effects associated with waste management on a change in commercial communal fisheries, and associated socio-economic effects, for Indigenous people and community values is predicted to be low in magnitude, localized to the Project Area, medium-term in duration, regularly occurring during Project activities and reversible following Project completion.

6.6.10.3.1.4 Supply and Servicing

The operation of OSVs will increase vessel traffic within the Project Area, marginally. It is anticipated the OSV responsible for transporting supplies will require one to three trips per week from the supply base to the MODU. OSVs and survey vessels traversing the Project Area have the potential to contact and damage fishing gear. With relatively lower levels of fishing activity in the Project Area (Section 4.3.1), compared to outside, contact between fishing gear and Project vessels is likely limited to transit between ports and the well site.

OSVs will follow established vessel traffic routes between supply base and the Project Area (Section 2.4.3.2). OSVs will adhere to standard navigation procedures, thereby reducing potential conflicts with commercial communal fisheries.

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).

Residual effects associated with supply and servicing operations on a change in commercial communal fisheries, and associated socio-economic effects, for Indigenous people and community values is predicted to be low in magnitude, within the Study Area, medium-term in duration, occurring at regular intervals and reversible following Project completion.

6.6.10.3.1.5 Well Abandonment

Well abandonment would include plugging the well with a cement mixture to isolate the wellbore and removing the wellhead and any associated equipment to below the seafloor with mechanical cutters. The plugs are placed at varying depths in the wellbore and the well casing is typically cut just below the surface of the seal. The seabed is inspected using a ROV to confirm no equipment or obstructions remain. Husky's preferred method of wellhead severance and recovery is to use a mechanical cutting system, and well head designs make provision for this kind of removal. However, circumstances can arise when mechanical cutting cannot effectively perform the task of wellhead severance. In such instances, shaped charges must be used. As discussed in the assessment of fish and fish habitat (Section 6.1), to reduce the risk of mortality charges will be properly sized and lowered into the well or applied to the outside of the casing. Charges will only be used after the Drilling Superintendent, the C-NLOPB and any of its relevant advisory agencies thoroughly review the application. Approval is granted on a case-by-case basis.

As discussed in Section 6.2.10, well abandonment is not expected to interact with commercial fishing activities (including commercial communal fishing activities) in the Jeanne d'Arc Basin, given the small footprint of the wellhead, the marking of wellheads on nautical charts for mariners and commercial fishers, and the lower amount of fishing activity that takes place in the area.

Residual effects associated with well abandonment on a change in commercial communal fisheries, and associated socio-economic effects, for Indigenous people and community values is predicted to be low in magnitude, within the Project Area, short-term in duration (the time it takes to abandon a well), irregular (once per well at no set drilling schedule), and reversible, as any activities surrounding wellhead abandonment would cease once the process is completed.

6.6.10.3.2 Change in Current Use of Lands and Resources for Traditional Purposes

6.6.10.3.2.1 Presence and Operation of MODU

Biophysical and behavioural effects of underwater sound on fish species, including species harvest for FSC purposes, are discussed in Section 6.1 (Fish and Fish Habitat). This avoidance behaviour is expected to be temporary as fish become conditioned 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 migratory fish species to the extent that FSC fish harvesters would be adversely affected.

Although there is no known FSC fishing occurring in the Project Area, there is potential for species to migrate through the Project Area that are harvested elsewhere for FSC purposes. Two species were noted in recent environmental assessments to be of importance from a cultural or spiritual perspective: the Atlantic salmon and the American eel. Both species are known to occur in the Study Area and therefore are a focus in the assessment for this VC.

The largest area of potential interaction with Atlantic salmon is from noise transmission from these various activities. However, most mobile fish species are generally expected to avoid underwater sound at lower levels than those at which injury may occur; therefore, any potential impact causing injury on any salmon population is highly unlikely. Any behavioural effect would be of limited duration due to the short-term nature of the activities and the migratory nature of the salmon.

If the American eel is present in the Project Area, it is not expected that a localized potential area of avoidance would substantially affect their behaviour during migration through a relatively wide corridor (e.g., kilometres). It is possible that eels migrating from southern waters would attempt to avoid the MODU, although it is not expected this small area will interfere with migration such that the species at a population level distributed over a much wider geographic area would be affected. Therefore, potential effects on American eel population from the presence and operation of the MODU is unlikely.

Migratory birds harvested elsewhere for FSC purposes, may also migrate through the Project Area. Many migratory birds navigate by sight and artificial lights 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). Artificial lighting associated with the MODU has potential to result in strandings, collisions, increased opportunities for predation, and exposure to other vessel-based threats.

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), 1,000 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. Attraction is enhanced during conditions of drizzle and fog when moisture droplets in the air refract light and greatly increase the illuminated area.

Underwater and atmospheric sound from the MODU may also 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). Some species may be attracted to artificial night lighting and flares on the MODU, while others may be deterred (e.g., ducks and other birds that prefer to sleep at night in the dark). Birds that are attracted to the MODU may experience injury or mortality through direct collision with equipment 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 through incineration or energy reserve depletion. Flaring during exploration drilling is required during a drill stem test (DST). DST are typically required in one in four or five exploration wells. So, in a 10-well program, this Project may conduct two DST. Each DST would last at most for two nights each; on a rare occasion one well may require two DSTs. A seawater spray through a series of high pressure nozzles is used during a DST to dissipate the heat between the flare and the MODU. This seawater curtain is likely to deter birds near the flare.

Because the MODU will remain on-site at the drilling location during Project activities, the spatial extent for migratory birds from the presence and operation of the MODU is expected to be minimal. Mitigation measures to limit flaring and exposure of migratory birds to artificial lighting will reduce potential effects.

Residual effects associated with the presence and operation of the MODU on a change in current use of lands and resources for traditional purposes for Indigenous people and community values, including associated impacts to social and cultural values, is predicted to be low in magnitude, localized to the Project Area, medium-term in duration, and reversible. Avoidance behaviour exhibited by fisheries species, as well as the establishment of the safety zone associated with the presence of the MODU, will not have a permanent, irreversible effect on change in current use of lands and resources for traditional purposes. With the implementation mitigation described in Section 6.4.10.2, including efforts to reduce flaring and exposure to artificial lighting, the change in traditional use on salmn, eel, and migratory bird species as a result of the presence and operation of the MODU is expected to be low in magnitude.

6.6.10.3.2.2 Drilling-associated Surveys

Underwater sound from VSP or wellsite surveys could potentially startle migratory fish, causing them to avoid the ensonified area and thereby reduce catchability elsewhere. As discussed in Section 6.1, fish species, including migratory species, may move away from an area due to the presence of underwater sound. However, behavioural changes to FSC fisheries species resulting from drilling-associated surveys are expected to be low, and potential impacts to social and cultural values are also anticipated to be low. Effects on the potential presence of salmon and eel migrating to either feeding or breeding grounds is anticipated to be transient in nature and low if interactions occur. These species, if present in the Project Area, would likely display avoidance behaviour to 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 these species is highly unlikely from routine activities.

Although short-term in duration, VSP noise emissions are expected to be the most intense sound generated by the Project, and diving birds (including murres, which are the only traditionally harvested species within the Project Area) are expected to hear a sound pulse if the birds are underwater at the time the pulse arrives. Exposure of migratory birds to potentially harmful underwater noise during VSP activity will be limited by the depth they use, time in which they spend underwater, and the mitigating effects of the ramp-up period. Although many species of seabirds that may be present in the Study Area would spend less than one minute underwater during a foraging dive, members of Alcidae (including the common murre and thick-billed murre) spend considerable time submerged under water. Alcids secure food by diving under the water and propelling their bodies rapidly through the water with their wings. Murres regularly dive to a depth of 100 m and have been recorded underwater for up to 202 seconds (Gaston and Jones 1998); common murres are known to dive to a depth of 180 m or deeper (Piatt and Nettleship 1985). However, it is unlikely that these birds will feed underwater when the seismic source is activated because a ramp-up period will be initiated which would deter them from the area and reduce their exposure to potentially harmful underwater sound waves.

Residual effects associated with the drilling-associated surveys on a change in current use of lands and resources for traditional purposes, including associated impacts to social and cultural values, for Indigenous people and community values is predicted to be low in magnitude, within the Project Area, short-term in duration (no more than a day per well, totaling potentially 10 days over 8 years), occurring at irregular intervals and reversible following Project completion.

6.6.10.3.2.3 Waste Management

The discharge of drilling waste and other discharges and emissions may result in temporary and localized effects on water quality and/or sediment quality and therefore could potentially affect FSC species within a localized area. All operational discharges during drilling will comply with Husky's EPCMP for the drilling installation and will comply with the OWTG and MARPOL, both of which have been established to protect the marine environment. Discharges and emissions are expected to be temporary, localized, non-toxic, and subject to high dilution in the open ocean. Results of environmental effects monitoring programs undertaken for various drilling programs in Atlantic Canada (Hurley and Ellis 2004) concluded that effects on the health of migratory fish species including Atlantic salmon and eels are negligible given brief exposure due to the transitory nature of these species.

There are several types of discharges that migratory birds may interact with during drilling of the well and operation of the MODUs and OSVs. However, as noted in Section 6.4.10, discharges and emissions are expected to be temporary, localized, non-toxic and subject to high dilution in the open ocean and will not have significant adverse environmental effects on migratory birds.

Residual effects associated with waste management on a change current use of lands and resources for traditional purposes, including associated impacts to social and cultural values, for Indigenous people and community values is predicted to be low in magnitude, localized to the Project Area, medium-term in duration, regularly occurring during Project activities and reversible following Project completion.

6.6.10.3.2.4 Supply and Servicing

The operation of OSVs will increase vessel traffic in the Project Area and may therefore locally affect migratory species habitat quality and use around the OSV. It is anticipated the OSV responsible for transporting supplies will require one to three trips per week from the supply base to the MODU. Potential environmental effects on fish attributable to PSV would represent only a small incremental increase over similar effects currently associated with existing high levels of marine traffic and shipping activity throughout the Study Area. Therefore, the potential for supply and servicing to interact with traditional fisheries and associated socio-economic impacts is anticipated to be low.

Residual effects on migratory birds from OSV operations within the Project Area are expected to be similar to effects described above in the context of lighting effects from the presence and operation of the MODU, although the lighting on the OSVs will not be stationary. Studies have shown that migratory birds react to low-level helicopter flights, but the effects of these responses are short in duration (Stantec 2013). One of the greatest effects from 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 2013). However, there are no known bird colonies or IBAs within the Project Area (or Study Area).

Residual effects associated with supply and serving operations on a change in current use of lands and resources for traditional purposes, including associated impacts to social and cultural values, for Indigenous people and community values is predicted to be low in magnitude, within the Study Area, medium-term in duration, occurring at regular intervals and reversible following Project completion.

6.6.10.3.2.5 Well Abandonment

Well abandonment would include plugging the well with a cement mixture to isolate the wellbore and removing the wellhead and any associated equipment to below the seafloor with mechanical cutters. The plugs are placed at varying depths in the wellbore and the well casing is typically cut just below the surface of the seal. The seabed is inspected using a ROV to confirm no equipment or obstructions remain. Husky's preferred method of wellhead severance and recovery is to use a mechanical cutting system, and well head designs make provision for this kind of removal. However, circumstances can arise when mechanical cutting cannot effectively perform the task of wellhead severance. In such instances, shaped charges must be used. As discussed in the assessment of fish and fish habitat (Section 6.1), to reduce the risk of mortality charges will be properly sized and lowered into the well or applied to the outside of the casing. Charges will only be used after the Drilling Superintendent, the C-NLOPB and any of its relevant advisory agencies thoroughly review the application; approval is granted on a case-by-case basis.

As discussed in Section 6.4.10, underwater well abandonment activities will occur at depths where interaction with migratory birds is unlikely except perhaps for the deepest diving species which includes the common murres at approximately 180 m or deeper (Piatt and Nettleship 1985). In the unlikely event that shape charges are required to remove the wellhead, the charge will be set below the sea floor and will have an initial rate of increased pressure that is more attenuated than an explosion in the water column.

Residual effects associated with well abandonment on a change in current use of lands and resources for traditional purposes, including associated impacts to social and cultural values, for Indigenous people and community values is predicted to be low in magnitude, within the Project Area, short-term in duration (the time it takes to abandon a well), irregular (once per well at no set drilling schedule), and reversible, as any activities surrounding wellhead abandonment would cease once the process is completed.

6.6.10.4 Summary of Project Residual Environmental Effects

In summary, the Project may result in adverse environmental effects to a change in traditional use for Indigenous people and community values. In consideration of the implementation of applicable mitigation measures (including mitigation measures identified for fish and fish habitat, commercial fisheries, and migratory birds), best practices, and adherence to industry standards (e.g., compliance with OWTG and applicable C-NLOPB guidelines), the residual environmental effect on a change in traditional use is considered low in magnitude for Project components and activities; occur within localized areas of the Project Area; of short to medium-term in duration; reversible; and occur primarily within a disturbed ecological and socio-economic context. The environmental effects assessment and prediction of residual environmental effects is summarized in Table 6.30. This is a prediction of effects resulting from the interactions between the Project and traditional resources that were identified in Table 6.29.

Table 6.30 Project Residual Effects on Indigenous People and Community Values

Residual Effect	Residual Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Commercial Communal Fisheries							
Presence and Operation of MODU	A	L	PA	MT	IR	R	D
Drilling-associated Surveys	A	L	PA	ST	IR	R	D
Waste Management	A	L	PA	MT	IR	R	D
Supply and Servicing Operations	A	L	SA	MT	IR	R	D
Well Abandonment	A	L	PA	ST	IR	R	D
Change in Current use of Lands and Resources for Traditional Purposes							
Presence and Operation of MODU	A	L	PA	MT	IR	R	D
Drilling-associated Surveys	A	L	PA	ST	IR	R	D
Waste Management	A	L	PA	MT	IR	R	D
Supply and Servicing Operations	A	L	SA	MT	IR	R	D

Residual Effect	Residual Effects Characterization						
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological and Socio-economic Context**
Well Abandonment	A	L	PA	ST	IR	R	D

KEY:
See Table 6.28 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
SA: Study 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

6.6.11 Determination of Significance

With the application of proposed mitigation and environmental protection measures, the residual environmental effects of a change in traditional use on Indigenous people and community values 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 communal fisheries species and migratory birds species inhabiting the Project and Study Areas and the effectiveness of mitigation measures, including those discussed in Section 6.6.10.2.

6.6.12 Follow-up and Monitoring

Given the high level of confidence around a prediction of no significant adverse environmental effects on Indigenous people and community values, and the implementation of standard mitigation, no follow-up is proposed to be implemented for routine Project activities.

7.0 ACCIDENTAL EVENTS

This section provides an overview of Husky's procedures to assess and manage the risk of accidental events and the oil spill response plan, should an incident occur (Section 7.1). A summary of oil spill risk and probabilities is provided, as well as a description of models used to determine the fate, behaviour and trajectory of spilled oil (Section 7.2). Also included in this chapter is an assessment of the environmental effects of accidental events on each of the VCs (Section 7.3).

7.1 Spill Prevention and Response

As outlined in Section 2.7, Husky's Environmental Management System is embedded within the HOIMS is applied to all of Husky's projects and operations to manage operational integrity through the life-cycle of assets. Risk Management is Element 3 within HOIMS. The objective of this Element is to identify and manage risks by performing comprehensive risk assessments and to develop and implement plans to manage significant risks and impacts to As Low As Reasonably Practicable (ALARP) levels. Risk is managed by identifying hazards and major accident scenarios, assessing their consequences and probabilities, and evaluating and implementing prevention, detection, control and mitigation measures to ensure that residual risk levels are tolerable and are ALARP. Risk assessments are conducted to identify and address potential hazards to personnel, environment, assets, and the public. Risk assessments are performed by qualified personnel within the business unit or from specialized contractors, as necessary. A clear process is established by procedures to prioritize risks to personnel, environment, assets, and the public to enable appropriate management of the risk. A follow-up process is in place to ensure that risk management decisions and mitigation measures are implemented. Risk assessments are documented, auditable, and appropriate for the complexity of the activity.

Husky's plans, policies and procedures are assessed against the regulations and the guidance during the review of the OA application. An OA is required before an operator can undertake any activity in the offshore Newfoundland and Labrador jurisdiction. Approval for a drilling operation involves an OA and an Approval to Drill a Well. These applications are reviewed by the C-NLOPB's technical staff to ensure they meet all regulatory requirements. The regulatory approval process for drilling programs therefore requires a two-tier approval process.

Relevant regulatory approvals within the context of the OA include a Project-Specific EA, a Certificate of Fitness, an Operator 's Declaration of Fitness, a Letter of Compliance from Transport Canada, Safety Plans, an EPCMP and Contingency Plans.

Safety Plans are an important component of regulatory requirements. Operators must provide a detailed report specifying how safety-related items will be managed and mitigated. These plans include hazard identification, risk management, training and competency of personnel, details of systems and equipment (including maintenance, inspection and testing), operating procedures and processes, a Joint Occupational Health and Safety Committee (JOHSC), incident reporting and investigation, management oversight and monitoring.

In addition to Safety Plans, a Contingency Plan is required to act as a preliminary plan of action in the event of a spill or significant incident. The contingency plan covers numerous areas of concern with respect to safety. Several of the plans covered within the scope are Offshore and Onshore Emergency Preparedness and Response Plans, Oil Spill Response Plans, Ice Management Plans and Relief Wells Plans.

During normal operations, the following spill prevention devices are used:

- all fuel vents have fixed spill containment
- bunker stations have fixed spill containment
- all oil storage facilities have fixed spill containment
- during fuel/oil transfers, all associated overboard scuppers, if installed, are closed
- spills that occur onboard will be cleaned up using spill kits located in various areas around the vessel

Risk assessment of an installation for potential major accident hazards can include both qualitative and quantitative assessment techniques to ensure that all the relevant hazards are addressed. The risk assessment for each installation will:

- assess the likelihood of occurrence of a hazardous event
- assess the severity of the consequences of the hazardous event
- evaluate the risk
- ensure that all aspects of the work activity are covered including non-routine operations
- ensure all groups of employees are covered and identify groups of workers or individuals who may be exposed to additional hazards identify where further assessment work is required
- be carried out by competent members of the onshore and offshore management, the installation workforce and safety representatives
- take into account existing preventative and mitigating control measures
- identify further control measures

Husky is prepared to effectively respond to an oil spill in offshore Newfoundland and Labrador in the event that one should occur, and is equipped with various response tools and strategies. Contingency plans are in place to detail the associated practices and procedures for responding to different emergency scenarios. All plans surrounding response to accidental events such as an oil spill are submitted for review and approval by the C-NLOPB as part of regulatory authorizations to conduct drilling activities.

Husky has a robust emergency response program. The Incident Coordination and Response Management Plan outlines the necessary resources, personnel, logistics and actions to implement a prompt, coordinated response to any emergency. The Plan provides Husky and its associated contractors with a clear description of duties, practices, and procedures to be employed in the onshore component of a response to any emergency occurring during Husky Atlantic Region operations. It offers an efficient and balanced approach to dealing with the issues resulting directly from an incident as generally defined below.

For the purposes of this plan, an incident is defined as those events or situations which result in:

- concern for current or forecast conditions that cause an operational alert
- direct threats to human safety, or actual injury or death
- substantial unintentional discharge of materials to the natural environment
- threatened or actual damage to facilities or major equipment
- terrorism, sabotage, or criminal acts
- public or regulatory concern for Husky operations

The intent of the plan is to mobilize personnel onshore as soon as possible in the event of an offshore or onshore incident to provide the necessary support and coordination required by an On-Scene Incident Response Team (Emergency Response Team) and the longer duration management of consequences, stabilization and restoration.

Husky has also instituted an environmental management system that includes goals and processes focused on eliminating spills into the marine environment. Any unintentional discharge of a hydrocarbon is considered to be an oil spill requiring an appropriate level of response, potentially including activation of the Oil Spill Response Plan (EC-M-99-X-PR-00125-001) (Appendix E). Husky - Atlantic Region's Oil Spill Response Plan provides specific guidance to personnel who are involved in a spill response related to exploration, development or production operations. Specifically, it supplies Husky's onshore and offshore emergency response teams with the tactical (reactive and proactive) response strategies, main procedures, guidance and information required during an oil spill response. The Plan details the response actions to be taken by Husky in the event of an oil spill while operating in the Newfoundland and Labrador Offshore Area. These procedures are responsive to regulatory requirements for oil spill contingency planning.

The plan provides comprehensive direction and instructions on:

- Implementation of oil spill countermeasures
- Organization of Husky's response efforts, and the evolution of those efforts with the increasing scale of spill response activities
- Arrangements for assistance from contractors and other operators
- Environmental issues, potential impacts and fate/effects of oil resulting from an offshore spill
- Husky's policies concerning safety, oil spill waste management, and training

7.1.1 Regulatory Requirements

Under the Accord Acts, the C-NLOPB is responsible for the regulation of spill prevention measures at all offshore drilling and production operations. Risk assessment processes are carried out in accordance with the requirements of *Newfoundland Offshore Petroleum Drilling and Production*

Regulations (SOR 2009-316) (D and P Regulations). The D and P Regulations also require the development and approval of an EPP which, using the Environmental Protection Plan Guidelines (NEB et al. 2011), is to include identification of potential environmental emergencies and hazards (including spills) and provide reference to spill response plans and/or emergency plans and procedures to be implemented in the case of an environmental emergency. All operational discharges during drilling will follow Husky's EPCMP which is based on the OWTG. Any substances, wastes, residues, or discharges not identified in the EPCMP are not permitted for discharge.

If the source of the spill is a supply vessel, the vessel operator will be the Responsible Party under the *Canada Shipping Act, 2001*. The *Canada Shipping Act, 2001* requires that these vessel or facility operators have response plans, designated and trained spill response personnel, and contract arrangements with a Response Organization certified by Transport Canada. In every applicable case, Eastern Canada Response Corporation (ECRC) is the Response Organization retained by Husky contractors. While *Canada Shipping Act, 2001* regulations do not apply directly to Husky drilling or production activities, Husky's spill capability meets *Canada Shipping Act, 2001* standards.

7.1.2 Spill Management

For response planning purposes, oil spill events are classified in tiers. This scheme is an international planning standard for the pre-development of response actions, resource placement and strategy options based on risk assessment (event parameters, probability/ frequency and impact/outcome severity). The risk parameters to be considered in selecting the appropriate level of response include:

- oil volume at risk of release
- oil type and properties and spill situation details
- environmental and operational conditions at the time of the spill
- event priorities, resource availability/location and safety hazards present

The risk assessment culminates in the establishment and development of three tiers of response capability; defined as follows:

- Tier 1 - spill poses the least threat of impact, and can be managed using resources available at site
- Tier 2 - spill response requires local shore-based management support and resources in addition to those already at site or
- Tier 3 - spill requires resources and support beyond the established capability available in the region (based on applicable regulatory guidelines and accepted probabilities) and will require considerable resources, drawn from national and international sources

7.1.2.1 Management Structure

Because of the dynamic nature of offshore spills, the installation impacted or in direct control of the spill source may quickly cease to be the scene of the resulting oil slick. Tier 1 countermeasures are therefore generally initiated and managed offshore (using supplied guidance), and Tier 2 and 3 countermeasures and assessment are initiated and managed onshore by the Husky Regional Response Management Team (RRMT) with assistance from certified response organizations and specialty service providers (i.e., ECRC, Oil Spill Response Limited (OSRL), PAL, Oceans Ltd.).

7.1.2.2 Management Philosophy

Five principles are considered paramount in all aspects of a spill response:

- the health and safety of all personnel must not be compromised;
- response to an emergency situation that threatens personnel safety, or the integrity of the facility will take precedence over response to the oil spill;
- identifying and protecting sensitive environmental and human resources;
- response countermeasure implementation and planning decisions should be based on net environmental benefit considerations to the maximum extent that is practical; and
- operational response countermeasures address a wide range of effectiveness based on the nature of the spill.

7.1.3 Response Strategy

7.1.3.1 Situation Assessment

No action should be taken in response to a marine oil spill without an understanding of the nature of the problem. This appreciation will help incident commanders and response team members (on scene and onshore) to decide:

- What response actions are necessary?
- How to implement the response in the safest and most effective manner?

The decision process requires ongoing collection and assessment of information from the spill site, including:

- nature and type of spill
- trajectory and weathering of oil
- weather and sea state conditions

- environmental sensitivities in the area at the time of the spill
- logistics, equipment and personnel availability
- effectiveness (monitored/reported) of the countermeasures initiated or planned

7.1.3.2 Net Environmental Benefit

Each spill response option, or combination of options, can have some effect on the environment beyond that of the spill itself. The Husky response strategy is based on the principle of net environmental benefit. Net environmental benefit considers advantages and disadvantages of response actions and their effect on the environment. Some response methods have the potential to cause adverse environmental effects but may be justifiable because of overriding benefits and/or the avoidance of further, more serious, effects.

Following the Deepwater Horizon oil spill in the Gulf of Mexico in 2010, the Department of Natural Resources, Government of Newfoundland and Labrador required an independent review of the legislative and regulatory regimes, capabilities, and practices in place in NL for oil spill prevention and remediation offshore NL (Turner et al. 2010). Prevention is considered to be the highest priority; however, spill response is also critical, with response decision-making varying case-by-case based on the type and amount of oil spilled, the environment where the spill occurred, and response tools required (Turner et al. 2010). To evaluate spill response options, a net environmental benefit analysis (NEBA) is conducted. A NEBA is a mechanism that balances the potential effects of an oil spill against the effects of the available response options (Turner et al. 2010). 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. A NEBA was submitted jointly by Husky, Suncor and ExxonMobil to the C-NLOPB in December 2013 (SL Ross and LGL Limited 2013). The operators are currently preparing a response to review comments received from the C-NLOPB in 2016 (refer to Section 7.1.10.3.3).

7.1.4 Response Operations

7.1.4.1 Response Options

In any spill response, Husky's objective will be to reduce the effects of the spill. While every spill response will be unique, there are basic strategies that can be considered. Husky's oil spill response plan identifies the response options available (current and under development based on regulatory changes) during an offshore spill. These include the following:

- surveillance and monitoring
- testing and application of a spill treating agent (approved oil dispersant)
- mechanical dispersion
- containment and recovery
- wildlife measures

7.1.4.2 Capability

Husky's spill response capability includes:

- a first response capability (Tier 1) utilizing Husky supplied equipment and contracted vessels
- mutual aid assistance through other Grand Banks operators (Tier 1 and 2)
- ECRC Operational Spill Management Services – provided on contract to Husky (Tier 1,2 & 3)
- ECRC personnel and equipment for larger spill response operations – provided on contract to Husky (Tier 2 and 3)
- resources available through Oil Spill Response Limited (Tier 3), including access to the Global Response Network (see Section 7.1.10)
- additional regional spill response resources acquired under cost recovery or rental agreements (i.e., CCG environmental response personnel and equipment)

7.1.4.3 Initial Response Actions

The initial actions to be taken in the event of a spill may be severely restricted or impossible if the installation is in an emergency situation. During an emergency, the spill will be a secondary priority to the emergency that caused the general platform alarm.

7.1.4.4 Countermeasures

Husky is able to use a considerable pool of spill response resources. With the combined resources of Husky, Hibernia, and Suncor for dealing with Tier 1 spills, and the additional capabilities of ECRC for Tier 2 spills, the inventory of offshore spill response equipment in St. John's is currently the largest in Canada. Contract arrangements with ECRC allow Husky to access this equipment, along with trained personnel, in the event of a spill.

7.1.4.4.1 Shoreline Protection

If there was a risk to shorelines from a spill resulting from Project associated activities, countermeasures to divert hydrocarbons from potentially impacting environmentally sensitive coastal shorelines and socio-economic sensitive coastal areas will be initiated. Compliance to Canadian marine oil spill response regulations is maintained by all installations and ships. As required under these regulations each installation and ship maintains an agreement with a certified oil spill response organization (OSRO). Once engaged, the OSRO will recommend and initiate shoreline protection strategies. OSRO's maintain a database of shoreline inventory, segmented and classified by environmental and socio-economic sensitivities. OSROs also maintain an inventory of equipment and trained responders that can be used for shoreline protection countermeasures, including:

1. Deflection booming, which is used to divert oil to suitable collection points on the shoreline or at sea
2. Protection booming, which is used to hold oil back from environmental or socio-economic sensitivities

OSROs will also identify and support the implementation of additional response countermeasures like sand, sand bags and earth barriers to prevent the ingress of oil to specific areas if necessary.

7.1.4.4.2 Shoreline Clean Up

If situations arise where Project associated hydrocarbon reach shorelines, response countermeasures will be initiated. Shoreline cleanup assessment teams will be engaged to perform systematic surveys of any impacted shoreline areas and recommend the appropriate cleanup tactics to employ. Regulatory representatives and stakeholders are engaged in assessment teams to ensure consensus on clean-up endpoints is established, and recommendations are based on net environmental benefit. Recommendations may identify a wide range of cleanup options based on the shoreline type and will also consider the potential for natural factors (i.e., wind/wave energy, ice scour, etc.) to successfully clean shorelines with potentially greater net benefit to environmental health. Response tactics that may be used in shoreline cleanup include:

- low pressure, high volume flushing with seawater
- mechanical collection/gross oil collection
- manual cleaning of shoreline
- plowing/surf washing
- soil washing

7.1.4.4.3 Oiled Wildlife Response

During oil spill response operations for all tiers, seabird monitoring is initiated from the outset. Assigned personnel on charter vessels are trained to conduct seabird surveys and document observations. Survey methods established by the Canadian Wildlife Service will be used to determine population densities in the area and the potential risk. If warranted, the engagement of specialized contractors to support oiled wildlife response efforts will occur. Oiled wildlife response operations will progress through three stages:

1. Primary response: surveillance to determine the location and extent of wildlife at risk; and deflecting oil away from areas of high sensitivity where countermeasures can be effective.
2. Secondary response: deterring fauna from affected or potentially affected areas.
3. Tertiary response: capture and stabilization of oiled wildlife (using boats, or on the shoreline); transport to treatment facilities and treatment of affected fauna.

Husky maintains an oiled-seabird treatment facility, along with a number of trained responders and a wildlife veterinarian. For longer-term rehabilitation, Husky sponsors a local rehabilitation facility.

7.1.5 ECRC Role

Husky has contracted ECRC to provide operational preparedness and response services. ECRC can also provide management support for Tier 1, 2 and 3 events.

ECRC is a full-time spill response organization certified by Transport Canada under the *Canada Shipping Act, 2001*. ECRC, as a specialty service provider, will take the lead in developing tactical and strategic plans and in coordinating spill response operations. Prior to implementation, Husky must approve all response activities and plans.

7.1.5.1 ECRC and the Incident Command System

ECRC's Spill Management System is based on the principles of the Incident Command System and is compatible with the Husky response management process.

7.1.5.2 ECRC Oil Spill Response Centre

During a spill response, both the Husky RRMT and the ECRC Oil Spill Response Centre will be mobilized. All spill response operations will be managed on shore from the dedicated ECRC Oil Spill Response Centre. The Husky RRMT will serve as lead centre for all non-spill related components of the response, as well as for the provision of advice, information, and approvals necessary for the spill response.

7.1.6 Waste Management

Procedures for handling waste will be in place before it is collected or stored. When initiating an oil spill response, a comprehensive waste management plan will be developed as soon as possible to limit the amount of waste generated and to maximize efficiency of the ultimate disposal of that waste. Husky maintains contractual arrangements with waste management service providers who will be called upon to assist in the development of the waste management plan for a spill, based on the countermeasures being used in the spill response and available local and national waste management options.

7.1.7 Tier 1 Response

Oil spill response equipment that can be deployed quickly in the event of an oil spill has been positioned at site (Table 7.1). The capability at site for any of these options is limited in response to small spills or the initial response to larger spills. Tier 1 countermeasures can be deployed rapidly with favorable weather conditions. Times will vary based on the equipment deployed from minutes for the tracker buoy to several hours for the Single Vessel Side Sweep (SVSS). Actual deployment time will vary based on the observed meteorological and oceanographic conditions.

Table 7.1 Tier 1 Oil Spill Response Equipment

Equipment	Storage Location
8" Sorbent boom	• Stored on all Husky supply vessels
Offshore Single Vessel Side-Sweep system	• Outrigger arms stored on Husky supply vessels • Booms and skimmers stored in containers on *SeaRose FPSO*
Oil and oiled bird sampling kit	• Sampling kits are stored on all Husky supply vessels
Global Positioning Systems (GPS)/ Satellite oil spill tracker buoys	• MetOcean iSphere buoys are on all Husky supply vessels and the *SeaRose FPSO*

7.1.7.1 Sorbent Boom

The side sweep sorbent boom system is a single-vessel oil recovery system used by all offshore support vessels chartered by Husky, in response to small oil spills at an offshore facility. Unlike a conventional boom, which acts as an impenetrable barrier that collects floating oil, the side sweep sorbent boom system is constructed of multiple 10-foot sections of 8-inch sorbent boom, which will absorb oil on contact.

The system uses the ship's crane as an outrigger arm, extending perpendicular to the side of the vessel, to tow the boom (Figure 7-1). One end of the boom is attached to the crane (winch cable hook is lowered to the water surface) and the other end is tied to the side of the vessel. As the vessel steams ahead at slow speed (1.8 to 3.7 km/hr (1 to 2 knots)), a V-shaped boom is formed along the side of the vessel.

Figure 7-1 Sorbent Boom System

7.1.7.2 Single Vessel Side-sweep System

While in the White Rose field, the *SeaRose FPSO* has been equipped with the SVSS oil spill containment and recovery system. The philosophy of this system is to ensure that resources are available at the production site that can be deployed and operated in open ocean conditions by a single vessel. The system consists of a side-deployed outrigger arm and float, an inflatable containment boom and a skimmer for oil recovery (Figure 7-2).

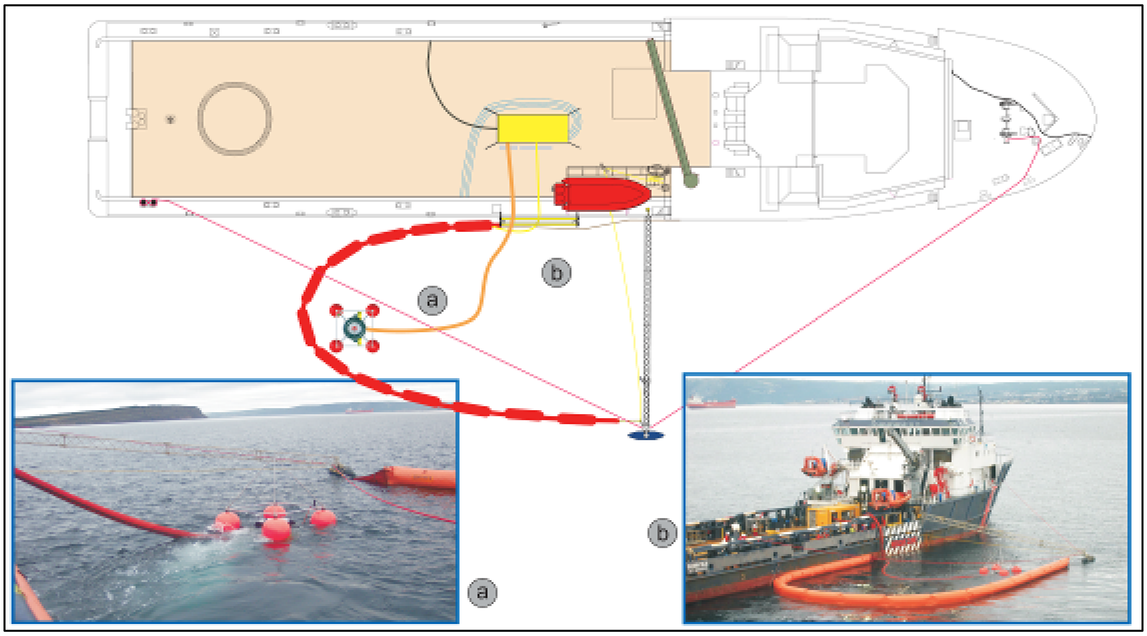


Figure 7-2 Third Generation Single Vessel Side Sweep

The system was designed to be suitable for offshore conditions. The skimmer has been built on a broad flotation base and is very stable in a seaway. Its powerful thrusters ensure that the skimmer can be maneuvered into any part of the boom apex. The sea state rating for Husky's NOFI 800 SVSS boom is approximately 2 to 2.5 m significant wave height (Hs), or Beaufort 5.

Each SVSS system consists of:

- Stored on *the SeaRose FPSO* - A customized 20-foot DNV-class offshore container housing an inflatable oil containment boom, offshore oil skimmer, boom and hose deployment winches (reels), hydraulic control system, sweep arm rigging, hydraulic and discharge hoses and miscellaneous supplies.
- Stored on designated supply vessels - An outrigger arm assembly and boom deployment fairlead. The 20-m outrigger arm assembly keeps the oil containment boom positioned on the side of the vessel during oil recovery operations. The boom fairlead is designed to aid in the over-the-side deployment and recovery of the containment boom. Each vessel is equipped with dedicated SVSS hydraulics.

7.1.7.3 Oil and Wildlife Sampling Kits

Husky maintains seabird observation as well as oil and oiled wildlife sampling capabilities that can be initiated during oil spill situations. Initiating these processes during spills supports the overall response effort. Completing regular seabird observations identifies the potential environmental impact the spill may have over time. Collecting samples of oil and seabirds (captured or found deceased) from the spill area will identify/confirm the spill source and mortality.

7.1.7.4 Satellite Tracker Buoys

MetOcean satellite tracker buoys are available offshore on the vessels and platforms. The buoys are designed to float with the oil slick (same trajectory) and are deployed in order to track the oil slick. An onboard GPS receiver transmits the buoy's position every 30 minutes. GPS positions are received onshore via the Iridium satellite system. Buoy positions are processed and quality-controlled by the host website (JouBeh) and then plotted on a chart to show the buoy trajectory in the slick. This is a powerful tool for oil slick monitoring and aerial surveillance during response operations.

7.1.8 Tier 2 Response

There are three local sources of oil spill response equipment that might be considered for use when an offshore oil spill response escalates to the Tier 2 level:

- Producing operator-owned equipment - SVSS and Norwegian Standard System (Section 7.1.9.2)
- ECRC equipment stored in Donovan's
- Equipment caches owned/managed by private and public entities (i.e., Oil Handling Facilities or CCG)

Equipment in this pool is owned by offshore producing operators, ECRC, regulated oil handling facilities, commercial oil transporters (bulk) or the CCG.

Deployment times for Tier 2 equipment will vary. Expected times are from 6 to 36 hours based on several conditions, such as:

- meteorological and oceanographic conditions;
- recovery vessel locations; and,
- amount of equipment to be mobilized and number of vessels to be outfitted.

7.1.8.1 Key Resources

The most suitable local resources available for an escalating offshore spill response include:

- Operators' SVSS systems;
- Operator's Norwegian Standard System;
- ECRC NOFI 1000 boom;
- various ECRC, private or publicly owned inflatable booms for sea states up to 1.5 m; and
- ECRC, private or publicly owned oil skimmers available for deployment, NL.

7.1.8.2 Norwegian Standard System

Producing operators in NL own and maintain Tier 2/3 offshore oil spill containment system suitable for use in offshore Newfoundland conditions. The systems consist of Framo Transrec 150s with weir and high-viscosity skimmer heads, and 400 m Norlense 1200-R self-inflating boom. The systems are identical to the NOFO Norwegian Standard System.

The Norwegian Standard System, with dedicated trailers and permanent deck mounts on designated response vessels, greatly improves oil collection capability because:

- mobilization time is reduced to a few hours with deck mounts installed
- increased safety as fewer personnel are required and boom self-inflates
- oil recovery operations will be possible in greater sea states (3 to 3.5 m significant wave height)
- skimmer efficiency is improved (oil capture, pumping rates and overall control)

The producing operators have entered a preparedness agreement with ECRC that includes the continued system maintenance and training.

7.1.9 Tier 3 Response

If an offshore oil spill response escalates to the Tier 3 Level, Husky will arrange to mobilize equipment from outside of Newfoundland and Labrador. Sources of this equipment will be:

- ECRC offshore-grade equipment stored in mainland depots
- suitable offshore equipment owned by OSRL
- equipment available through OSRL and ECRC membership in the Global Response Network (GRN) for surface spill response

Tier 3 equipment for surface spill response would be expected to start arriving on site approximately 18 to 24 hours from initial activation.

7.1.9.1 ECRC Canadian Resources

ECRC maintains a cache of suitable resources available for an escalating offshore spill response. This cache is distributed throughout Eastern Canada at ECRC depots in Dartmouth, Sept Isles, and Quebec City. The most suitable equipment in this pool includes:

- ECRC NOFI Ocean Buster boom (7.4 to 9.3 km/hr (4 to 5 knots) towing) stored at ECRC, Quebec
- ECRC RoBoom and Oil Stop inflatable booms for sea states up to 1.5 m
- GT 185 and Desmi 250 Skimmers
- 50 m^3 tanker barges that could be used on deck for storage of recovered waste

7.1.9.2 Global Response Network

Several international surface oil spill cooperatives have formed an alliance, the GRN, to provide a Tier 3 mutual aid opportunity. The GRN also provides a framework between member organizations that allows all to improve benchmarking and knowledge-sharing. Members of the GRN include:

- OSRL
- Marine Spill Response Corporation
- Alaska Clean Seas
- Australian Marine Oil Spill Centre
- Clean Caribbean and Americas
- ECRC
- Western Canada Marine Response Corporation

7.1.9.3 Tier 3 Response to a Well Blowout

In the case of a subsea blowout, as a current member of the subsea well intervention service through OSRL Husky can avail of subsea dispersant systems and a capping stack. In the case of a subsea blow out within the Project Area, the capping stack could be mobilized from Norway to the wellsite within 13 to 24 days from initiation (Figure 7-3).

Responding to an incident that results in complete loss of well control requires the systematic and sequential implementation of operational missions that encompass six distinct prioritized objectives. These objectives (and associated missions) in order of execution include:

1. <u>Emergency Response</u> - complete loss of well control is the result of a system failure that will have consequences impacting life safety. The primary emergency response focus will be to execute missions that re-establish life safety (i.e., fire suppression, evacuation, and MODU relocation).
2. <u>Subsea Survey</u> – identifying the actual blowout location (e.g., well casing, well head, BOP, riser) and the condition of the subsea infrastructure (e.g., well head, BOP and Lower Marine Riser Package, riser/drill string) will determine what further countermeasures are required.
3. <u>BOP Intervention</u> – actuating the shear rams/choking off well fluids to stem the flow using subsea controls and ports on the BOP. If incident circumstances prohibited surface activation of the BOP, subsea activation may still be possible and eliminate source releases.
4. <u>Debris Clearance</u> – removing obstacles, clearing obstructions and creating space for the placement/setup of subsea tools is necessary. Vertical access and safe working conditions directly above the well are required to execute capping stack installation.
5. <u>Establish Surface Safe Work Zone</u> - the elimination/reduction of toxic and explosive gas concentrations released at the surface in the work zone must be accomplished in order to execute capping missions. The injection (subsea) and application (surface) of spill treating agents (oil dispersant) into well fluid and its surface expression, respectively, is necessary to

enable personnel, ships, and equipment to operate directly above the well without exposure to toxic and volatile atmospheres.

6. Capping Stack Installation – hold vertical position over the well, lift and lower capping stack over top of BOP, actuate coupling lock/seal, and begin shut in of well flow through stack chokes and valves.

The sequence of missions to achieve these response objectives is developed, detailed and resourced concurrently, mobilizing and using different technical expertise. The timeline for the implementation and sequential execution of these objectives is provided in Figure 7-3.

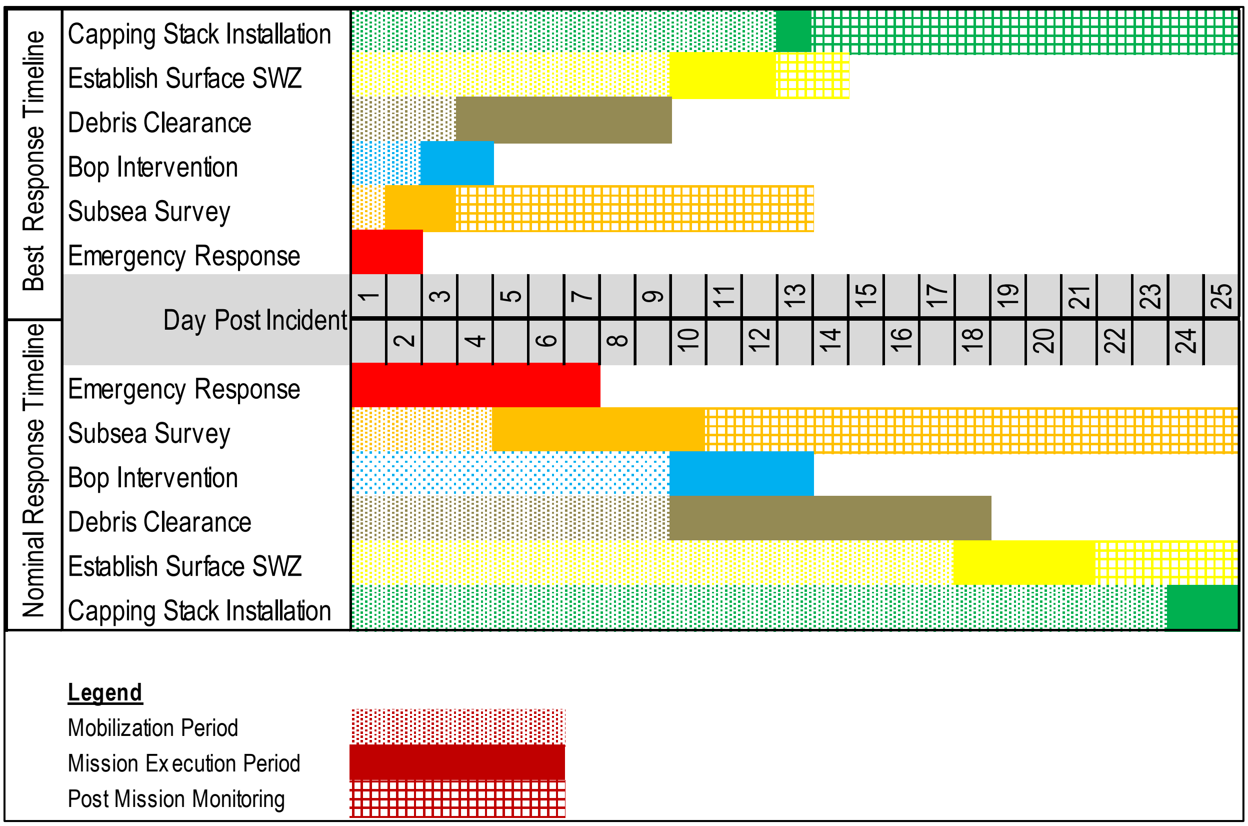


Figure 7-3 Capping Stack Installation Timeline

7.1.9.4 Dispersants

Amendments to the *Oil and Gas Operations Act* (SOR/2016-108) outline provisions for the approval and use of dispersants (Spill Treating Agents) by the Chief Conservation Officer of the C-NLOPB. Net Environmental Benefit Analysis (Section 7.1.3.2) demonstrates the conditions under which dispersant application offers net environmental benefit over more other countermeasures.

Husky has commissioned independent testing to confirm that White Rose field crudes can be dispersed using Corexit 9500 using dispersant spray application technologies. These tests have confirmed that White Rose Crude can be dispersed using spray applicators and Corexit 9500A in tier 1, 2 and 3 situations. Schedule 1 of the *Regulations Establishing a List of Spill-treating Agents* (*Canada Oil and Gas Operations Act*) (SOR/2016-108) lists Corexit® EC9500A and Corexit® EC9580A as accepted spill-treating agents. Corexit® EC9500A is an open-ocean dispersant whereas Corexit® EC9580A is used as a shoreline cleaner.

7.1.9.4.1 Dispersant Effects

The use of a spill treating agent in response to an offshore crude oil spill is an effective countermeasure. Crude oil on the sea surface remains at a toxic concentration until natural degradation, removal operations or dispersant application change that concentration. Unlike natural degradation or mechanical removal, dispersants, when applied to crude oil slicks, immediately begin to change the concentration, quickly lowering the toxic concentration and thus the net impact to the environment.

As described in Dispersants: Subsea Application Good Practice Guidelines for Incident Management and Emergency Response Personne*l* prepared by International Petroleum Industry Environmental Conservation Association (IPIECA) and the International Association of Oil and Gas Producers (IOGP) (2015), dispersants are used to minimize the overall ecological and socio-economic damage by reducing the probability of the released oil from reaching nearshore or coastal habitats and onto the shore. Dispersants cause a greater amount of the released oil to break into small oil droplets that will be dispersed, diluted and biodegraded in the water column, unlike the larger oil droplets that will float up to the sea surface. By dispersing the oil into the water as small oil droplets, it allows rapid colonization by petroleum degrading microorganisms that naturally occur in ocean environments and microorganisms therefore will substantially biodegrade the majority of the oil within days and weeks (IPIECA and IOGP 2015).

Effective dispersant use involves transferring more of the oil into the water column than would otherwise be the case. The oil droplets entering the water will be smaller in size, enhancing the rate of transfer of the water-soluble compounds from the oil into the water because the oil/water surface area is increased with smaller oil droplets resulting in higher concentrations of dispersed oil (very small oil droplets) and water-soluble compounds in the water in close proximity to the release (IPIECA and IOGP 2015).

The potential risk of dispersant use is the increased exposure of marine organisms in the water column to dispersed oil droplets and water-soluble oil compounds released from these oil droplets (IPIECA and IOGP 2015). At many subsea oil and gas blowouts, a substantial proportion of the released oil volume may already have been produced in the form of a plume of very small oil droplets in the water by the turbulence created by the high-velocity flow of oil and gas into the water. Adding dispersant to the oil being released will increase the proportion of oil dispersed as very small oil droplets, but from an already high value, not from zero (IPIECA and IOGP 2015). The smaller oil droplets (<70 µm) can facilitate microbial biodegradation, resulting in a potential reduced dissolved oxygen levels (<1.4 mL/L or 2.0 mg/L) to hypoxic conditions harmful to marine life (Joint Analysis Group, Deepwater Horizon Oil Spill 2012). Tjeerdema et al. (2013) also reported that smaller droplets, available to hydrocarbon-degrading microbes, can also contribute to hypoxic conditions.

The ingestion of food provides marine organisms with a potential route of exposure to higher molecular weight polycyclic aromatic hydrocarbons (PAHs). Filter feeding organisms that prey on plankton can ingest naturally- or chemically-dispersed oil droplets when they are of a similar size to some plankton (IPIECA and IOGP 2015). Relatively simple organisms, such as bivalves, cannot biochemically process the higher molecular weight PAHs in the oil, therefore PAHs can bioaccumulate in some organs (Neff and Burns 1996). Predators that consume oil-contaminated bivalves may therefore be exposed to elevated concentrations of the higher molecular PAHs by this ingestion route. However, organisms such as fish which possess livers, can quickly metabolize PAH, although some of these metabolites may be harmful. It is, however, unlikely that bivalves will be exposed to subsea dispersed oil, as they are benthic organisms and are more likely to be exposed to naturally dispersed surface slicks in shallow waters. Plankton and copepods may be found in the mid or deeper water column and are therefore at increased risk of exposure. The low concentration of dispersed oil, coupled with the abundance and rapid recovery of their populations, is likely to limit impacts on these organisms (IPIECA and IOGP 2015).

SL Ross and LGL Limited (2013) completed a draft NEBA of using dispersants on Grand Banks spills that included the analysis of one summer batch spill and three blowout scenarios (winter and summer) on a representative cross section of VC populations, including a total of 19 species marine birds, mammals and turtles, finfish, and shellfish, as well as the commercial fisheries for five species.

In general, results showed that in an event of an accidental event, the use of dispersants offered a clear net environmental benefit in all cases (SL Ross and LGL Limited 2013). An untreated spill in the Grand Banks pose a substantial risk to globally important populations of a number of marine bird species and commercially important fisheries, as well as some risk to marine mammals and very limited risk to local finfish and shellfish populations. In summary, the risks to bird, mammal, turtle species, and in certain cases commercial fisheries can be greatly reduced by using dispersants; and dispersant use increases the exposure of segments of finfish and shellfish populations to oil, but the segments of these populations actually exposed are small and as a result the overall effect to the fish and shellfish populations from dispersant use is correspondingly small (SL Ross and LGL Limited 2013).

As described in the NEBA report (SL Ross and LGL Limited 2013), there is benefit from dispersants use in summer, with the benefit even greater in winter because although bird populations are at risk in both summer and winter, different species are at risk from the untreated spill in winter versus summer because of the seasonal habits of the different species. Also, the fishery disruption appears to play less of a role in winter versus summer, because catches in local areas are large in midsummer and small in winter. The risks to seals from the untreated spill (and hence the benefit of dispersant use) are greater in winter than summer, because of the seasonal habits of the harp and hooded seals (SL Ross and LGL Limited 2013).

7.1.10 Offshore Training – Spill Response Operations

Key offshore personnel receive practical instruction in oil spill operations. Emphasis is on response to small spills or the initial response to a larger spill.

Husky has entered a preparedness agreement with ECRC that includes the provision of the following services:

- management and maintenance of Tier 1 equipment (sorbents, tracker buoys, SVSS)
- management and maintenance of Tier 2 equipment
- initial and recurrent training for vessel crews
- oil spill contingency planning and exercises

7.1.10.1 Tier 1 Oil Spill Response Orientation

Offshore personnel are given an overview of Tier 1 oil spill response operations. Topics covered include: the nature of offshore oil spills; notification procedures; a review of available oil spill response resources; and determining first response strategies.

7.1.10.2 Oil Spill Response Techniques

All supply vessel crews become familiar with on-water techniques applicable to their roles in a response.

Operational training includes sessions covering the following:

- oil on water observations
- use of the sorbent boom
- oil sampling procedures
- wildlife handling
- basic seabird observation techniques

On vessels that may be assigned to standby duties for exploration in the Project Area, crews are trained in the use of the sorbent boom equipment and tracker buoy deployment. Designated vessels receive additional training on the deployment of the SVSS oil containment and recovery system.

7.1.11 Continuous Improvement

Husky is committed to continuous improvement in all areas of operations, including emergency response. New technologies and ideas are identified through participation in industry conferences and through relationships with service providers such as ECRC and OSRL. Examples of recent initiatives include:

- The development of a NEBA for the use of dispersants as an oil spill response countermeasure;
- The development of a comprehensive Source Control Response Plan
- Re-testing the effectiveness of dispersant on White Rose crude oil
- Daily seabird observations performed by supply vessel crews, providing enhanced competencies of the vessel crews and improved capability for incident response
- Transitioned Husky's response process to the internationally recognized and utilized Incident Command System
- Restructured contingency plans using a risk-based approach

7.2 Accidental Event Probabilities and Models

As outlined in Section 7.1, a rigorous risk assessment process is in place to identify and manage potential accidental events that are activity-specific. During exploration drilling, there are several accidental event scenarios that could occur, which may or may not result in hydrocarbons discharged to the environment. Based on a review of international and Canadian spill statistics, two categories of accidental events are assessed within this assessment of explorations drilling; batch spills and blowouts as they represent the most consequential scenarios. The assessment of batch spills applies to several scenarios where instantaneous or short-duration discharges of hydrocarbons result from accidents where hydrocarbons are stored and handled. Blowouts are continuous spills that can last hours, days or weeks, if uncontrolled, and involve the discharge of large volumes of associated gas into the atmosphere and discharge of crude oil and certain amounts of gas condensate (a very low viscosity, highly volatile type of liquid petroleum oil) into surrounding waters. Low probability and low consequence spill scenarios were not considered in this effects assessment.

7.2.1 Oil Spill Risk and Probabilities

Given the range of possible scenarios, spill probabilities are discussed separately for blowouts and batch spills. Following the approach used by Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) definitions of oil spill sizes are provided in Table 7.2.

Table 7.2 Definition of Hydrocarbon Spill Sizes

Hydrocarbon Spill Type	Spill Size (1)	
	bbl (2)	m³
Extremely Large	>150,000	>23,850
Very Large	>10,000	>1,590
Large	>1,000	>159
Small	<1	<0.159

(1) The top three categories are cumulative; for example, the large spill category (>1,000 bbl) includes the very large and extremely large spills, and the very large category includes extremely large spills. For the small category, more detailed statistics are available, and a further breakdown is made with discrete size ranges, specifically: 50 to 999 bbl; 1 to 49 bbl; 1 L to 1 bbl (159 L); and less than 1 L

(2) The petroleum industry usually uses the oil volume unit of petroleum barrel (bbl), which is different than a US bbl and a British bbl. There are 6.29 bbl in 1 m³ and there are approximately 7.5 bbl per tonne. Most spill statistics used here are taken from publications that use the oil volume units of bbl, and bbl are used in the subsequent statistical analysis. The statistics relating to small spills uses litres (L); 1 bbl = 159 L.

7.2.1.1 Extremely Large and Very Large Oil Spills from Blowouts

Blowouts can happen during exploration, development, production, workovers and well completion activities. In Canada, there have been no large petroleum spills from blowouts. In the US, since offshore drilling began in the mid-1950s, there have been three offshore oil-well blowouts involving hydrocarbon spills greater than 50,000 bbl. Using the definition of "extremely large" spills (i.e., hydrocarbon spills greater than 150,000 bbl), there have been six such spills in the history of offshore drilling; one occurring during development drilling, three during production or workover activities; and two during exploration drilling (Table 7.3).

Table 7.3 Historical Extremely and Very Large Spills from Offshore Oil Well Blowouts During Exploration

Area	Reported Spill size (bbl)	Year	Operation underway	Durations (days)	Intervention Method
Extremely Large Spills (>150,000 bbl)					
Macondo (US Gulf of Mexico)	5,000,000	2010	Exploratory Drilling	91	Relief Well
Mexico (*Ixtoc-1*) (1)	3,000,000	1979	Exploratory Drilling	293	Relief Well
Iran (2)	See note	1983	Production	--	
Mexico	247,000	1986	Workover	??	
Nigeria	200,000	1980	Development Drilling	14	Bridged
North Sea/Norway	158,000	1977	Workover	7	Capped
Very Large Spills (>10,000 bbl)					
Iran	100,000	1980	Development Drilling	8	Unknown
US, Santa Barbara	77,000	1969	Production (platform)	11	Capped

Area	Reported Spill size (bbl)	Year	Operation underway	Durations (days)	Intervention Method
Saudi Arabia	60,000	1980	Exploratory Drilling	8	Capped
Mexico	56,000	1987	Exploratory Drilling	51	
US, S. Timbalier 26	53,000	1970	Wireline	138	Relief Well and Capping
US, Main Pass 41	30,000	1970	Production (platform)	49	Capped (three relief wells also initiated)
Australia	30,000	2009	Development Drilling (primarily gas)	74	Relief Well
US, Timbalier Bay/Greenhill	11,500	1992	Production	11	Unknown
Trinidad	10,000	1973	Development Drilling	4	Unknown

Source: Husky Energy 2012a
(1) Spill volume widely believed to be significantly underestimated.
(2) The Iranian Norwuz oil well blowouts in the Gulf of Arabia, which started in February 1983, were not caused by exploration or drilling accidents, but were a result of military actions during the Iran/Iraq war.

7.2.1.2 Blowouts During Drilling

Spill frequencies are best expressed in terms of a risk exposure factor such as number of wells drilled. On a world-wide basis, approximately 35,000 exploration wells were drilled as of 2008 (LGL 200a8), with approximately 7,200 exploration wells drilled between 2009 and 2016 (Oil and Gas International 2016). There have been two extremely large spills (>150,000 bbl) during offshore exploration drilling, resulting in a frequency of 4.7×10^{-5} blowouts per exploration well drilled (2/42,200). There have been four very large spills (>10,000 bbl), resulting in a frequency of 9.5×10^{-5} spills per exploration well drilled (4/42,200).

The most recent large blowout event occurred on April 20, 2010; a fire and explosion occurred on Transocean's Deepwater Horizon drilling rig while drilling an exploration well on BP's Macondo prospect, approximately 66 km offshore Louisiana in the US Gulf of Mexico (US GOM). The total spill volume over the 91-day event was estimated at up to 5,000,000 bbl. Despite this event, the overall trend of spills and blowouts is decreasing world-wide. A spill of the magnitude of the Macondo blowout in recent years is unprecedented. The investigation has resulted in lessons learned in terms of improved technology, operational, safety and environmental procedures. However, in spite of improvements and advancements in spill prevention technology and practices, there still remains an element of safety and environmental risk in any drilling operation.

Gas blowouts from offshore wells that do not involve a discharge of liquid petroleum are generally believed to be relatively innocuous to the marine environment. However, such blowouts may represent a threat to human life and property because of the possibility of explosion and fire. Two sources are used for historical statistics on blowouts involving only gas or small hydrocarbon discharges. A source for US blowouts is the BOEMRE web page (www.boemre.gov), because BOEMRE keeps track of spills down to 1 bbl in size (only data to 2006 data are available) (BOEMRE

2012, in Husky Energy 2012a). Scandpower (2000, in Husky Energy 2012a) provides a report on blowouts in the North Sea and in the US GOM, although the report provides no information if hydrocarbon spills were involved in the reported blowouts. The United Stated Outer Continental Shelf (US OCS) data on exploration drilling blowouts, representing the 34-year period from 1972 to 2006, are provided in Table 7.4. There are no large spills in the entire database. The 2010 blowout in the US GOM would fit into the extremely large category.

Table 7.4 Exploration Drilling Blowouts and Spillage from US Federal Offshore Wells, 1972 to 2006

Year	Well Starts	Drilling Blowouts		US OCS Production (MMbbl)
		No	Bbl	
1972	845	2	0	396.0
1973	820	2	0	384.8
1974	816	1	0	354.9
1975	372	4	0	325.3
1976	1,038	1	0	314.5
1977	1,064	3	0	296.0
1978	980	3	0	288.0
1979	1,149	4	0	274.2
1980	1.307	3	0	274.7
1981	1,284	1	0	282.9
1982	1,035	1	0	314.5
1983	1,151	5	0	350.8
1984	1,386	3	0	385.1
1985	1,000	3	0	380.0
1986	1,538	0	0	384.3
1987	777	2	0	358.8
1988	1,007	1	0	332.7
1989	911	2	0	313.7
1990	987	1	0	304.5
1991	667	3	0	326.4
1992	943	3	100	337.9
1993	717 [(c)]	1	0	352.7
1994	717 [(c)]	0	0	370.4
1995	717 [(c)]	1	0	429.2
1996	921	1	0	433.1
1997	1,333	1	0	466.0
1998	1,325	1	0	490.5
1999	364	1	0	534.6

Year	Well Starts	Drilling Blowouts		US OCS Production (MMbbl)
		No	Bbl	
2000	1,061	5	200	551.6
2001	1,007	1	0	591.5
2002	828	1	0	602.1
2003	835	1	0	594.7
2004	861	2	16	567.0
2005	1,232	3	0	497.4
2006	1,586	0	0	503.1
Total	**34,576**	**67**	**316**	**13,963.9**
Source: Modified from Husky Energy 2012a				

7.2.1.3 Shallow Gas versus Deep-well Blowout

A blowout is an incident where hydrocarbons flow from the well to the surface, all barriers are non-functional and well control can only be regained by means that were not available when the incident started. A shallow gas blowout is a release of gas prior to the BOP being set. A deep blowout is defined as one that occurs after the BOP is set (Scandpower 2000, in Husky Energy 2012a).

A blowout might occur if shallow gas is encountered unexpectedly during drilling operations, which may be of concern from the mudline to approximately 914 m and below. Gas that is trapped in the shallow sediments can originate from deeper gas reservoirs but can also come from biogenic activity in the shallow sediments. The vast majority of blowouts and well releases are of the shallow gas variety. Shallow gas blowout frequencies in the North Sea and in the US GOM have been on the decline in the most recent years of the record (Table 7.5).

Table 7.5 Shallow Gas Exploration and Development Drilling Blowout Frequencies over Time, 1980 to 1997

Time Period	No. of Blowouts	Number of Exploration and Development Wells Drilled	Blowout Frequency
18 years (1980 to 1997)	53	22,084	24.0×10^{-4}
10 years (1988 to 1997)	53	13,870	16.6×10^{-4}
5 Years (1993 to 1997)	5	7,581	6.6×10^{-4}
3 Years (1995 to 1997)	1	4,924	2.0×10^{-4}
Source: Scandpower 2000, in Husky Energy 2012a			

Regulations in Canada are similar to those in the North Sea, where operators are required by law to always have two barriers during exploration and development drilling (this is not the case in the US). A more recent analysis by IOGP (2010) is based on the 20-year record to 2005 and indicates a deep-well blowout frequency of 4.8×10^{-5}. Using this figure results in a probability of one blowout for every 21,000 wells drilled. For a drilling program involving 10 wells, this statistic yields a deep-well blowout probability of 0.05%.

7.2.1.4 Platform Spills Involving Small Discharges

Small spills are the most probable spill events that could occur during a drilling program. These spills could include crude oil, hydraulic oil, SBM, diesel, diesel and formation fluids and mixed oil. Production in Newfoundland and Labrador waters commenced in 1997 at the Hibernia location, with Terra Nova coming on stream in 2001, White Rose in 2005 and North Amethyst in 2010. The C-NLOPB data for spills in NL (from both production and exploration) begin in 1997. An overview of spill statistics from exploration platforms (MODU) for the Newfoundland and Labrador Offshore area is provided in Tables 7.6 to 7.8. The spill incidents involving 1 bbl or more of hydrocarbon during that period are listed in Tables 7.6 and 7.7. These spills include spills of SBM, crude, diesel, and other hydrocarbons. Half of the1 to 49.9 bbl spills occurred in the first three years that spills were recorded.

Table 7.6 Frequency of Exploration Platform Spills from 1 to 49.9 bbl, 50 to 99 bbl, and 99.1 to 500 bbl (Newfoundland and Labrador Waters, 1997 to 2016)

Spill Size Range	Number of Spills
1 to 49.9 bbl	14
50 to 99 bbl	1
99.1 to 500 bbl	2
As of April 27, 2016	
Source: Husky Energy 2012a; C-NLOPB 2016b	

Table 7.7 Frequency of Exploration Platform Spills from 1 to 49.9 bbl, 50 to 99 bbl, and 99.1 to 500 bbl (Newfoundland and Labrador Waters, 2000 to 2016)

Spill Size Range	Number of Spills
1 to 49.9 bbl	7
50 to 99 bbl	1
99.9 to 500 bbl	2
As of April 27, 2016	
Source: Husky Energy 2012a; C-NLOPB 2016b	

Table 7.8 Very Small Spills during Exploration in Newfoundland and Labrador Waters, 1997 to 2016

Year	Spills Greater than 1 L and Less than 159 L (1 bbl)		Spills of 1 L and Less [1]	
	Number	**Total Volume (L)**	**Number**	**Total Volume (L)**
1997	1	40.0	0	0
1998	1	45.0	3	1.6
1999	16	385.9	9	4.72
2000	0	0	2	1.1
2001	0	0	8	4.2
2002	0	0	19	5.2
2003	3	147.0	9	2.5
2004	0	0	30	9.0
2005	0	0	28	9.0
2006	3	16.0	27	9.2
2007	0	0	34	4.3
2008	0	0	23	3.9
2009	2	8.1	30	9.15
2010	1	2.7	15	3.42
2011	5	98.1	7	4.26
2012	0	0	4	1.004
2013	0	0	5	0.250
2014	0	0	7	3.154
2015	0	0	1	0.100
2016	1	2.0	1	1.00
Total	**33**	**744.8**	**262**	**77.058**

Source: Husky Energy 2012a; C-NLOPB 2016b
1 includes all spills (exploration and production) 1 L or less

Just over half of the spills of greater than 1 L but less than 1 bbl (159 L) occurred in the first three years of operations. The average spill frequency is 1.5 spills per year in the 1 to 159 L category, and 13.1 spills per year less than 1 L (although Table 7.7 indicates a trend that has fewer spills/smaller volume in the past half-decade).

Spill frequency and volume by type from 1997 to 2015 during exploration drilling is provided in Table 7.9. The spill frequency and volume annual summary related to exploration activities are provided in Table 7.10.

Table 7.9 Exploration Drilling Spill Frequency and Volume by Type (Percentages) in Newfoundland and Labrador Waters, 1997 to 2015

Exploration Drilling Spills, 1997 to 2015	Spill Frequency (percentage of incidents)	Spill Volume (percentage of volume)
Crude	37.9%	2.1%
Hydraulic and Lubricating Oil	22.4%	0.1%
Synthetic Oils/Fluids	19.0%	95.6%
Diesel and Jet Fuel	10.3%	2.1%
Other Hydrocarbon	10.3%	0.1%
Source: Husky Energy 2012a; C-NLOPB 2016b		

Table 7.10 Exploration Spill Frequency and Volume in Newfoundland and Labrador Waters, 1997 to 2015

Year	Synthetic-based Drilling Fluid		All Other Hydrocarbons	
	Number	Total Volume (L)	Number	Total Volume (L)
1997	0	0.00	1	40.00
1998	0	0.00	4	3,195.00
1999	0	0.00	24	1,965.00
2000	0	0.00	1	160.00
2001	0	0.00	0	0.00
2002	0	0.00	1	1.00
2003	1	4,400.00	3	147.00
2004	0	0.00	0	0.00
2005	0	0.00	0	0.00
2006	1	600.00	3	16.00
2007	1	74,000.00	0	0.00
2008	0	0.00	1	0.02
2009	1	1.00	4	1.10
2010	0	0.00	3	3.84
2011	4	28,742.00	2	40.00
2012	1	27.70	0	0.00
2013	0	0.00	0	0.00
2014	1	860.00	0	0.00
2015	1	14,750.00	1	0.01
Total	**11**	**123,380.70**	**48**	**5,578.39**
Source: Husky Energy 2012a; C-NLOPB 2016b As of January 7, 2016				

7.2.2 Synthetic-based Whole Mud Spill Trajectory Modelling

To characterize possible accidental SBM releases, a review was conducted of the latest scientific literature and industry spill databases from Atlantic Canada and the United States Outer Continental Shelf (OCS) to determine the most probable modes of accidental release. Four potential release spill scenarios were selected:

- surface tank discharge
- riser flex joint failure (two scenarios, two fall velocities)
- BOP disconnect

A l dispersion study was conducted for the WREP EA (Husky Energy 2012a) to predict the potential seasonal footprints of SBM spills on the seafloor for each of the four scenarios. The numerical model used a full-year time series derived from ADCP current measurements at White Rose from 2008 to the end of 2010, with approximately 13,000 model realizations being simulated in each seasonal scenario per release mode. The total SBM spill footprint area, length and distance from release site, as well as projected initial SBM layer thickness on the seafloor, were estimated for each simulated event, and seasonal median, maximum, and average values were derived.

The interpretation of the predicted footprint areas and thicknesses considered that these are only preliminary dimensions of the projected landing area for the SBM droplets, and the estimated SBM layer thickness if the full spill volume landed in each model cell and was equally distributed within that cell. The subsequent fate and the footprint are likely to evolve in a less predictable fashion, as the negatively buoyant SBM droplets are expected to coalesce into streams or pools, and flow under the influence of gravity and the local bathymetric features. As there is a tradeoff between the area covered by the spill and the thickness of the SBM spill, it can be expected that an area of the seafloor that is relatively flat and with few roughness features is likely to result in a thinner and more widely distributed SBM layer, while a localized depression in the seafloor could retain the received SBM as a thicker layer within a smaller area.

While the weathering properties for the SBM considered in the Amec (2012) study are not precisely known, it is expected that the biodegradation of the SBM on the seafloor would take place over periods on the order of several weeks. This timescale far exceeds the duration of the spill and settling of SBM to the floor; therefore, the SBM is considered to be stable during the entire duration of the physical dispersion of the droplets in all modelled scenarios.

The WREP EA model originated near the middle of the current Project Area. The WREP spill model used the White Rose field as the hydrocarbon release point is located adjacent to EL 1152 (diagonal to the lower southwest corner of EL 1151), with a water depth of 120 m. The centroid for EL 1152 is only approximately 17 km southwest from the modelled spill source near the middle of the exploration Project Area. The centroid for EL 1155 is only approximately 48 km northwest and the centroid for EL 1151 is only approximately 43 km northeast from the modelled spill source. As all ELs in this assessment are on the Grand Banks in similar water depths as the WREP, the likely dispersion of whole SBM from an accidental release is applicable to the ELs in this assessment. The full WREP SBM modelling report is provided in Amec (2012; https://www.cnlopb.ca/wp-content/uploads/whiterose/dispersassess.pdf) (Appendix F).

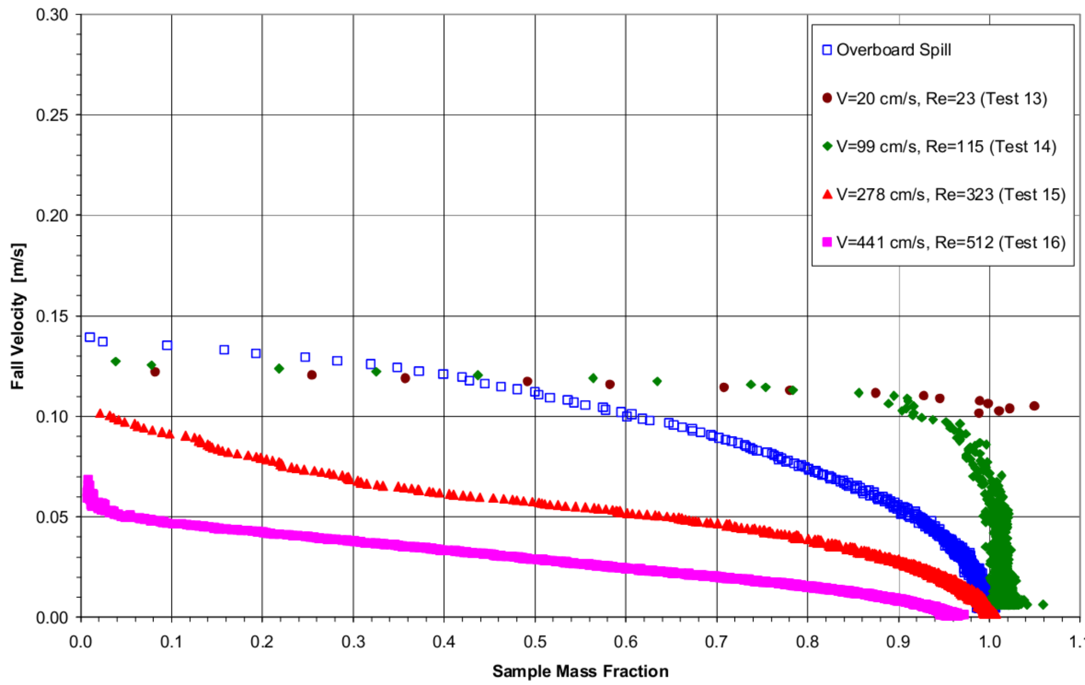
7.2.2.1 Model Inputs

The scenario details are listed in Table 7.11 as they apply to the SBM dispersion model. Two main SBM flow regimes are considered in the modeled scenarios: the wide, low-speed jet that produces relatively uniform fall velocity distributions (approximately 11 cm/s); and a narrow, high-speed jet that produces droplets with a wider range of fall velocities (mostly within 1 to 5 cm/s). In order to capture the wide range of fall velocities expected for the subsea release mode resulting in a high-speed jet flow (e.g., a flex joint failure), this scenario was modelled separately at the two ends of the fall velocity range (plotted with pink markers in Figure 7-4). The four release scenarios were modelled for each of the four seasons, resulting in a total of 16 scenarios.

The settling times shown in Table 7.11 are a function of the fall velocity, as well as the location of the release above the seafloor. It is expected that the SBM droplets would reach the seafloor within a period from 3 to 30 minutes.

Table 7.11 Synthetic-based Mud Model Input Parameters for Each Release Scenario

Release Scenario	Total Volume (m^3)	Duration of Release (hours)	SBM Flow Type	Fall Velocity (cm/s)	Location of Release	Settling Time (seconds)
Surface Tank Discharge	60	0.5	Wide, low-speed jet	11	120 m above seafloor	1,091
Flex Joint Failure I	49	3	Narrow, high-speed jet	1	20 m above seafloor	2,000
Flex Joint Failure II	49	3	Narrow, high-speed jet	5	20 m above seafloor	400
BOP Disconnect	49	1	Wide, low-speed jet	11	20 m above seafloor	182



Source: Southwest Research Institute 2007

Figure 7-4 Fall Velocity Distributions for Synthetic-based Mud Droplets under Different Flow Regimes

7.2.2.2 Model Output

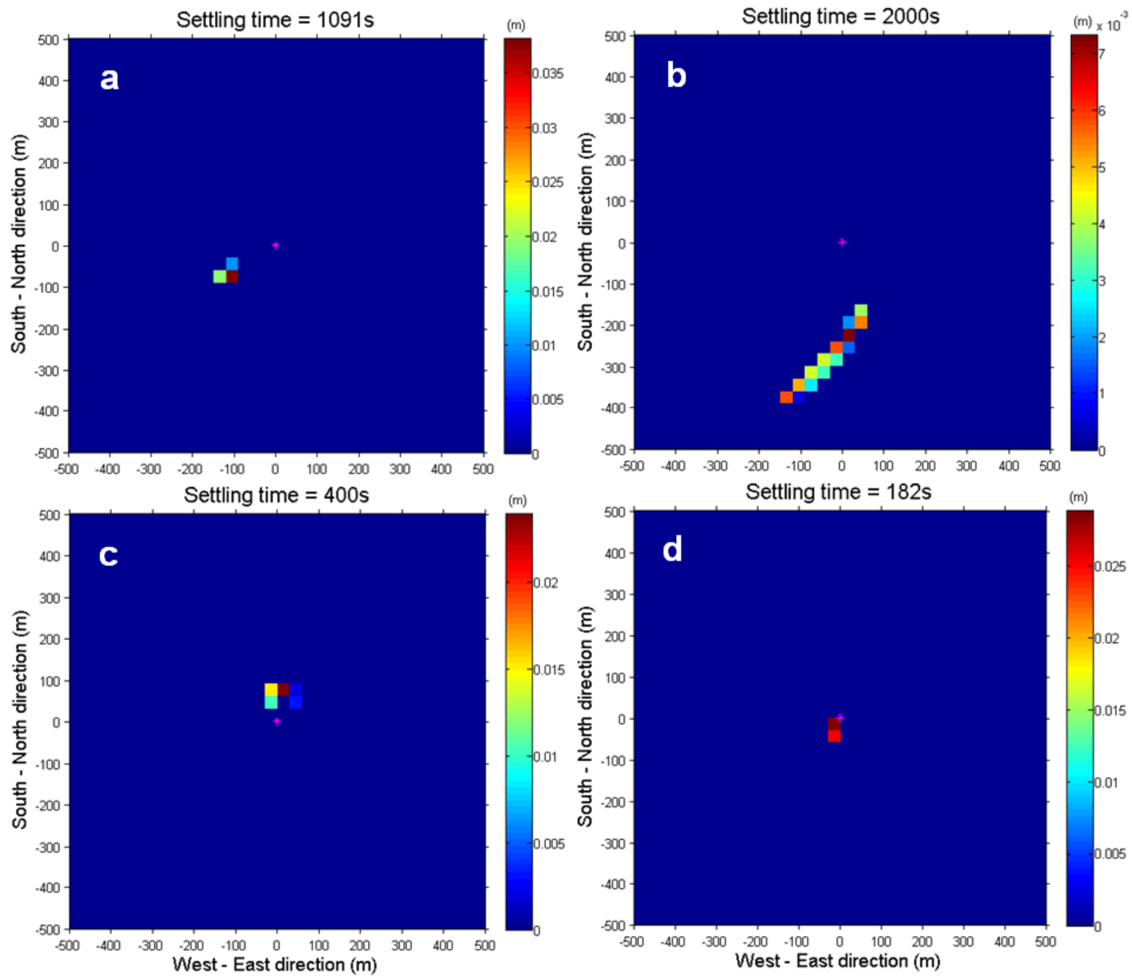
The outcomes of the modelled scenarios reveal several ways in which the mode of release and the ocean current conditions influence the spill footprint. The results for the modelled scenarios are presented in Table 7.12. These include the maximum and median seasonal values for the area of the predicted spill footprints, as well as the maximum and average values of the thickness of SBM within the projected spill area. In addition to the size of the spill area, it was important to characterize the location of the spill relative to the position of the release. This distance was calculated in each model realization as the location of the model cell that received the highest fraction of the spilled SBM volume. In the majority of the scenarios, the spill footprints exhibited an elongated shape, which was measured and recorded as the length of the footprint, and it represents the longest horizontal dimension of the area in which the SBM droplets land.

Table 7.12 Synthetic-based Mud Dispersion Modelling Results for All Scenarios

SBM Dispersion Scenario		Distance from Release Site (m)		Footprint Length (m)		Footprint Area (m^2)		SBM Layer Thickness (cm)	
		max	med	max	med	max	med	max	mean
Surface Tank Rel.	Winter	1,061	201	101	47	4,500	1,800	6.7	4.4
	Spring	458	162	81	47	3,600	1,800	6.7	4.5
	Summer	677	134	106	47	4,500	1,800	6.7	4.4
	Fall	834	212	133	51	5,400	1,800	6.7	4.1
Riser Flex Joint I	Winter	1,008	192	579	161	23,400	6,300	5.4	0.9
	Spring	443	175	465	164	18,900	6,300	5.4	0.9
	Summer	836	150	839	166	34,200	6,300	5.4	0.9
	Fall	757	234	826	206	32,400	8,100	5.4	0.7
Riser Flex Joint II	Winter	201	42	140	56	5,400	1,800	5.4	2.9
	Spring	108	30	117	57	5,400	1,800	5.4	2.8
	Summer	190	30	192	57	9,000	1,800	5.4	2.8
	Fall	175	60	189	65	8,100	2,700	5.4	2.4
BOP Disc.	Winter	108	30	46	34	2,700	900	5.4	4.9
	Spring	67	30	44	34	3,600	900	5.4	4.9
	Summer	108	30	53	34	3,600	900	5.4	4.8
	Fall	85	30	55	35	3,600	900	5.4	4.8

The distance from the release site at which most of the SBM droplets will land appears to be largely dependent not only on the height of release above the sea bottom and the droplet fall velocity, but also on the seasonal currents. Overall, there was no strong tendency for the spills to land in a particular direction from the spill site in any given season. The maximum predicted distances from the release site are those for the winter surface dispersion scenario and the first riser flex joint scenario (high-speed jet, low fall velocity), where the maximum concentrations of the footprint were found at 1,061 and 1,008 m from the release site, respectively. For the other dispersion scenarios, the spill footprints remain within a maximum distance of 201 m (second riser flex joint scenario, high fall velocity), and 108 m (BOP disconnect scenario). These maximum distances are expected to occur during periods when the current magnitudes are at the seasonal maximum. However, this does not necessarily imply that the spill footprint is larger than normal, only that the footprints are shifted horizontally with respect to the release location.

The largest footprint areas were found for the first riser flex joint scenario, which had the lowest fall velocity and the longest release period of 3 h. The single largest spill area in this scenario was observed in the winter season, and represented an area spanning approximately 579 m long by 40 m wide. Since the SBM was dispersed over a large area, the average layer thicknesses were much lower for this dispersion scenario compared to the other three. The majority of the spill footprints were 1,800 m² or smaller, corresponding to spill areas measuring 30 m by 60 m. The smallest footprints (30 m by 30 m) were predicted for the BOP disconnect scenarios, which exhibited a combination of low height above sea bottom, relatively quick release time (1 hr), and high fall velocities. Typical realizations of the spill footprints for the four selected modes of release are shown for the winter season in Figure 7-5.



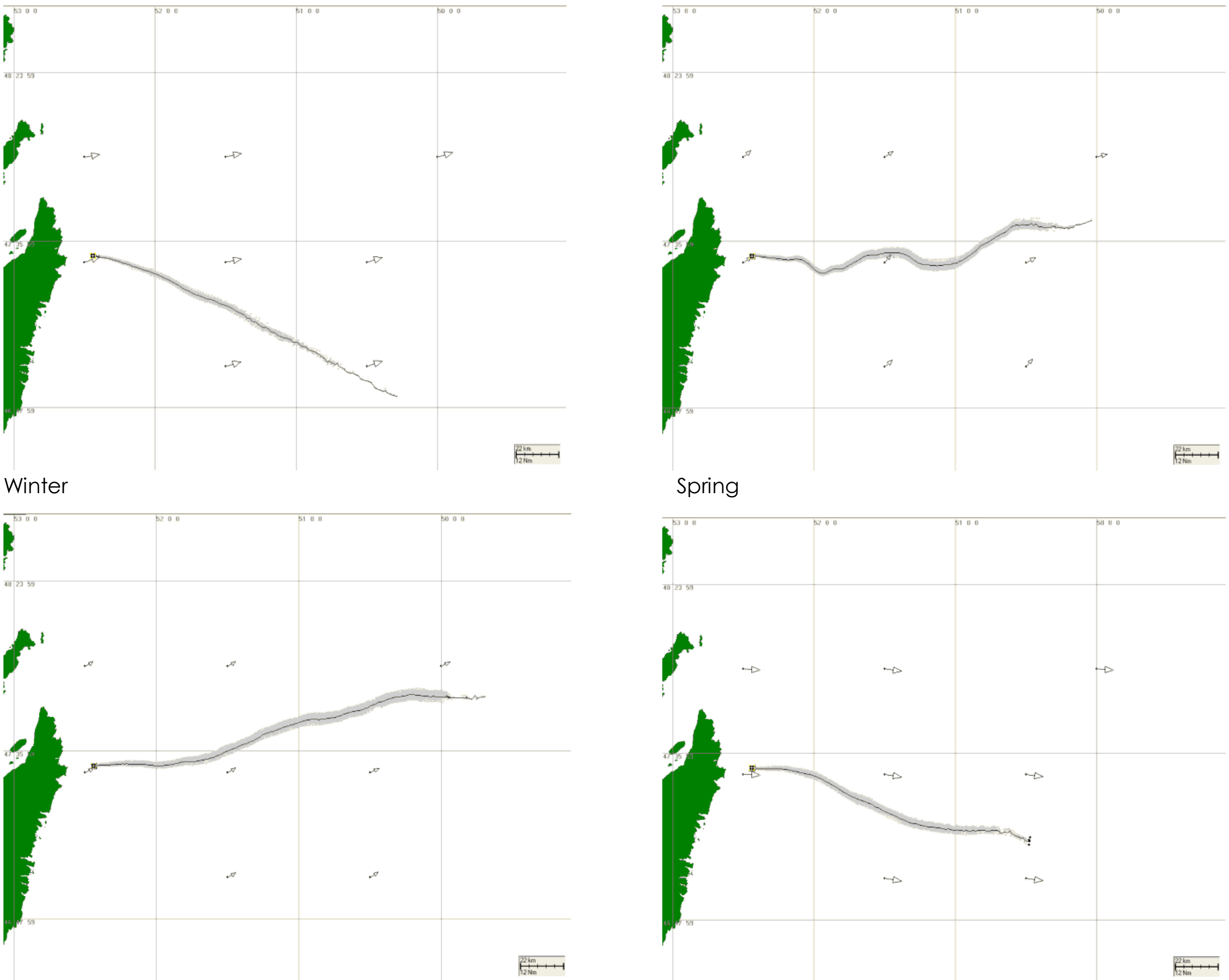
Note: a) surface low-speed jet release; b) subsea high-speed jet – low fall velocity; c) subsea high-speed jet – high fall velocity; d) subsea low-speed jet (BOP disconnect)

Figure 7-5 Example Realizations for the Four Modelled Release Scenarios in Winter

7.2.3 Nearshore Marine Diesel Spill Model

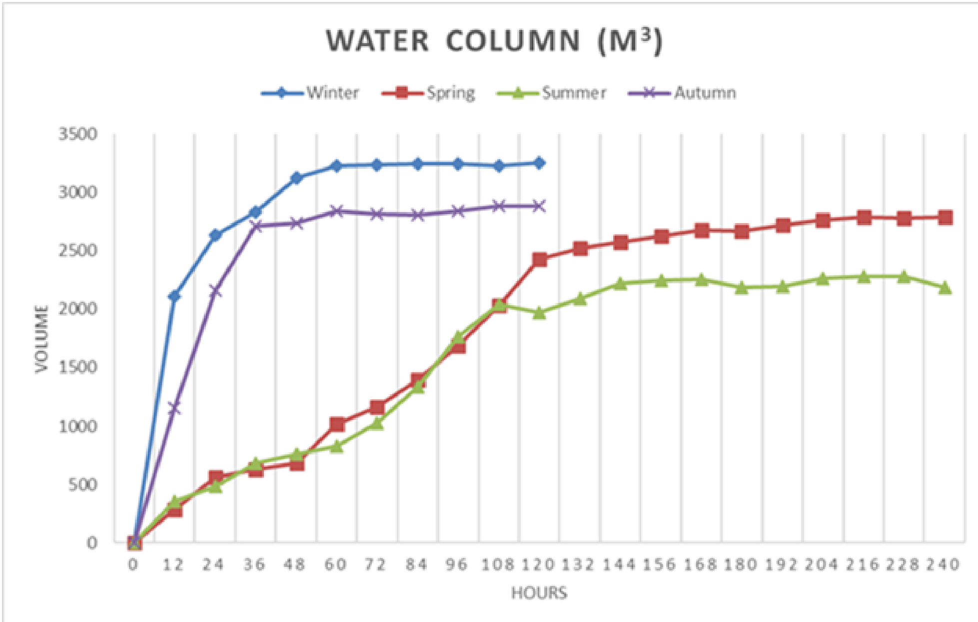
A worst-case scenario of a nearshore spill associated with this project is between two OSVs colliding and both losing all their diesel fuel. Trajectory modelling (Oceans Ltd. 2017; Appendix G) has determined that a nearshore spill of 5,000 m^3 of marine diesel will move in a predominantly easterly direction year-round from a spill location 10 nm from St. John's (Figure 7-6). The amount of oil mixing through the water column (Figure 7-7) is much higher in autumn and winter than it is during spring and summer. This is most likely due to higher wind speeds (and hence wave heights) during autumn and winter, causing the diesel to mix through the water column more. The rate of evaporation (Figure 7-8) is greater in summer than winter, but the differences are much smaller than mixing through the water column, so diesel spills during the autumn and winter are estimated to dissipate within 120 hours (five days), while spills during the spring and summer are predicted to take 240 hours (10 days) to dissipate.

A spill in the winter tracks east-southeast; the final measurable amount of hydrocarbon is projected to be approximately 96.6 nm from the original spill location. A spill in the spring, summer and autumn tracks east, with the final measurable amount of hydrocarbon projected to be located approximately 97.8, 113.0 and 83.0 nm, respectively, from the original spill location. Information on the weathering and fates for the diesel spills is presented in Tables 7.13 to 7.16.



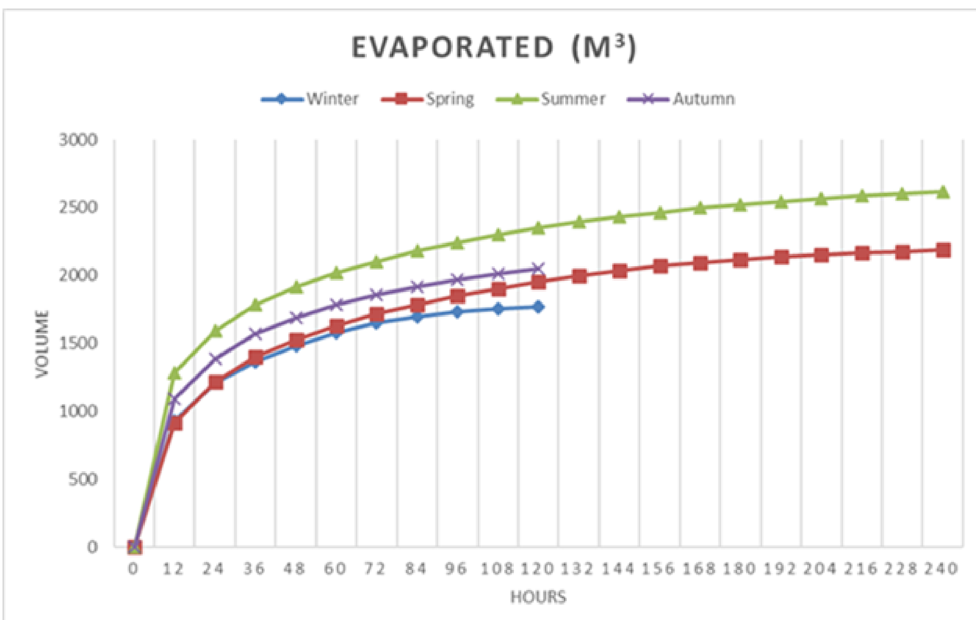
Source: Oceans Ltd. 2017
Note: Arrows on each trajectory plot represent the direction and magnitude of the wind speed.

Figure 7-6 Nearshore Spill Trajectories



Source: Oceans Ltd. 2017

Figure 7-7 Diesel Mixing Through the Water Column in the Nearshore



Source: Oceans Ltd. 2017

Figure 7-8 Diesel Evaporated in the Nearshore

Table 7.13 Hourly Diesel Spill Weathering and Fates Information for Winter

Time (hours)	Surface (m^3)	Water Column (m^3)	Ashore (m^3)	Evaporated (m^3)	Radius (m)	Viscosity (cP)	Thickness (m)
0	0.0	0.0	0.0	0.0	333333.4	19.3	0.01500
12	2026.0	2104.4	0.0	931.0	929859.8	23.2	0.00215
24	1223.4	2630.0	0.0	1208.0	1043231.0	24.5	0.00116
36	863.2	2831.7	0.0	1366.4	1109641.0	25.3	0.00077
48	452.5	3122.5	0.0	1486.3	892935.6	25.9	0.00045
60	259.8	3221.9	0.0	1579.7	501905.9	26.4	0.00033
72	178.1	3232.5	0.0	1650.8	284021.8	26.8	0.00029
84	117.2	3244.1	0.0	1700.1	49607.5	27.1	0.00033
96	83.2	3245.0	0.0	1733.2	27290.6	27.4	0.00033
108	82.5	3223.0	0.0	1755.9	6977.3	27.7	0.00039
120	39.4	3248.6	0.0	1773.4	0.0	0.0	0.00000

Table 7.14 Hourly Diesel Spill Weathering and Fates Information for Spring

Time (hours)	Surface (m^3)	Water Column (m^3)	Ashore (m^3)	Evaporated (m^3)	Radius (m)	Viscosity (cP)	Thickness (m)
0	0.0	0.0	0.0	0.0	333333.4	13.7	0.015
12	3847.4	286.5	0.0	915.5	1040214	16.4	0.00366
24	3269.1	559.5	0.0	1220.8	1335882	17.4	0.00242
36	3020.4	627.0	0.0	1402.1	1539798	18	0.00194
48	2838.0	682.4	0.0	1529.0	1705062	18.5	0.00165
60	2402.7	1014.7	0.0	1632.0	1838436	18.9	0.00129
72	2168.1	1165.3	0.0	1716.1	1938520	19.2	0.00111
84	1869.4	1393.1	0.0	1787.0	2019770	19.5	0.00092
96	1514.5	1686.1	0.0	1848.9	2083897	19.7	0.00072
108	1114.0	2031.2	0.0	1904.3	2128677	19.9	0.00052
120	671.1	2424.9	0.0	1953.4	2152963	20.1	0.00031
132	532.6	2520.9	0.0	1995.9	2168019	20.3	0.00024
144	443.2	2572.3	0.0	2033.9	2180000	20.4	0.0002
156	358.1	2622.5	0.0	2068.9	2096224	20.6	0.00017
168	276.4	2676.2	0.0	2096.9	1065351	20.7	0.00019
180	267.6	2663.3	0.0	2118.5	888635.4	20.8	0.00019
192	193.4	2717.9	0.0	2138.2	197897.6	20.9	0.00017

Time (hours)	Surface (m^3)	Water Column (m^3)	Ashore (m^3)	Evaporated (m^3)	Radius (m)	Viscosity (cP)	Thickness (m)
204	130.3	2763.1	0.0	2156.2	44216.3	21	0.00021
216	94.2	2786.5	0.0	2168.7	0	0	0
228	94.6	2776.3	0.0	2178.6	0	0	0
240	76.8	2785.6	0.0	2187.1	0	0	0

Table 7.15 Hourly Diesel Spill Weathering and Fates Information for Summer

Time (hours)	Surface (m^3)	Water Column (m^3)	Ashore (m^3)	Evaporated (m^3)	Radius (m)	Viscosity (cP)	Thickness (m)
0	0.0	0.0	0.0	0.0	333333.4	4.1	0.015
12	3361.4	357.7	0.0	1286.6	992922	5.3	0.00338
24	2927.3	483.3	0.0	1595.2	1258608	5.6	0.00232
36	2536.3	685.9	0.0	1783.7	1443591	5.8	0.00176
48	2330.3	759.0	0.0	1916.5	1582764	6	0.00147
60	2160.3	827.1	0.0	2018.4	1699684	6.1	0.00127
72	1874.5	1027.6	0.0	2103.7	1797185	6.2	0.00104
84	1488.5	1338.3	0.0	2179.0	1868174	6.3	0.0008
96	998.4	1762.3	0.0	2245.1	1915517	6.4	0.00052
108	660.7	2042.5	0.0	2302.5	1940956	6.5	0.00034
120	685.8	1969.8	0.0	2350.2	1959725	6.5	0.00035
132	525.7	2087.7	0.0	2392.5	1978321	6.6	0.00027
144	354.3	2220.5	0.0	2431.0	1988967	6.6	0.00018
156	290.9	2249.6	0.0	2465.4	1936568	6.7	0.00015
168	253.7	2255.4	0.0	2496.7	960254.4	6.7	0.00015
180	298.4	2185.6	0.0	2521.8	1413380	6.8	0.00019
192	265.8	2194.6	0.0	2545.5	800145.4	6.8	0.0002
204	176.7	2260.2	0.0	2568.9	0	0	0
216	140.5	2277.2	0.0	2588.1	0	0	0
228	125.7	2275.9	0.0	2604.2	0	0	0
240	198.6	2188.8	0.0	2618.4	0	0	0

Table 7.16 Hourly Oil Spill Weathering and Fates Information for Autumn

Time (hours)	Surface (m^3)	Water Column (m^3)	Ashore (m^3)	Evaporated (m^3)	Radius (m)	Viscosity (cP)	Thickness (m)
0	0.0	0.0	0.0	0.0	333333.4	9.7	0.015
12	2794.5	1151.8	0.0	1091.2	964181.8	12.1	0.00288
24	1484.9	2163.5	0.0	1389.1	1140930	12.8	0.00129
36	759.9	2708.1	0.0	1569.5	1198650	13.3	0.00063
48	613.9	2731.9	0.0	1691.8	1193734	13.6	0.0005
60	414.0	2839.2	0.0	1784.4	1005320	13.9	0.00037
72	365.2	2812.7	0.0	1859.7	827473.1	14.1	0.00036
84	309.8	2807.6	0.0	1920.2	734239.7	14.3	0.00032
96	229.5	2835.8	0.0	1972.2	459919.1	14.4	0.0003
108	139.5	2883.5	0.0	2014.6	32161.6	14.5	0.00032
120	112.2	2877.2	0.0	2048.1	36285.9	14.6	0.0004

7.2.1 Offshore Spill Model Scenarios

At the exploration stage it is not possible to define all possible factors needed to calculate blowout rates, blowout duration, and expected release volume. To calculate expected release rates and volumes one needs a specific well design and expected reservoir and fluid properties. Such detail is generally not available at the outset of an exploration program. Standard practice to assess potential release volumes for a multi-year exploration program is to compare likely field and reservoir parameters in the area to be explored to analogous areas where reservoir propoerities are known from previous drilling programs.

Of the 18 oil spill models conducted for exploration drilling and production projects in the Newfoundland offshore area, ten have originated from within the current Project Area. Each has consistently demonstrated a tendency to disperse in a northeasterly to southern direction, regardless of point of origin. This tendency has also been predicted in the oil spill trajectory models conducted for three exploration drilling assessments (ExxonMobil 2017; Statoil 2017; Nexen 2018) recently submitted for offshore NL.

The primary accidental event model used for the assessment of effects from a blowout was originally presented in the WREP EA (Husky Energy 2012a). The WREP EA model originates near the middle of the current Project Area, using measured oil properties and reservoir parameters from the White Rose field. The WREP spill model used the White Rose field as the hydrocarbon release point. The centre for EL 1152 is just 45 km northwest from the modelled spill source. The centroid for EL 1155 is only approximately 48 km northwest and the centroid for EL 1151 is only approximately 43 km northeast from the modelled spill source. Shifting the spill source by a distance of only 45 km would not demonstrably affect the spill trajectories and would have no effect on the weathering behaviour. There would be no change in the conclusions of the modelling if the spill source were moved to an adjacent EL. Modelling for other projects in the region also predict slick trajectories to be predominantly to the east (e.g., Statoil 2017). Given the proximity and similar water depths and oceanography between the White Rose field and adjacent ELs, the model inputs would not change for a new model. As a worst-case accidental event scenario, a subsea and surface blowout rate of 40,476 bopd for 120 days was used based on reservoir data from the White Rose field. A duration of 120 days was selected as the worst-case scenario since it is the estimated time required to drill a relief well, in the event that all other attempts to shut in the well have failed. This blowout rate is considered worst-case for adjacent exploration licences. The flow rate of a surface blowout may differ from the subsurface blowout rate by type of drilling unit used, but in all cases would not exceed the subsurface rate; therefore, the subsurface rate is a conservative worst-case. The WREP EA model uses the maximum worst case flow rate for each scenario. Oil properties were determined from lab analysis of crude samples from the White Rose field and used as inputs to the model (Table 7.17). These oil property data remain the most current and relevant characteristics for modelling oil spill trajectories in adjacent ELs.

Trajectories were run for 120 days or until the oil evaporated and dispersed from the surface, or the average oil concentration on the surface dropped below 1 gram per 25 m². This level of contamination of highly weathered crude is considered innocuous to wildlife (French-McCay 2004). The WREP EA modelling report (SL Ross 2011) is available in Appendix H.

Table 7.17 Oil Property Parameters Used in Spill Modelling

Oil Property	White Rose Crude	Diesel Fuel
Initial Density (kg/m³)	867.9	827.0
Standard Density Temperature (°C)	288.7	288.0
Density Constant 1	128.5	200.0
Density Constant 2	1.010	0.733
Initial Viscosity (cP)	38.7	5.0
Standard Viscosity Temperature (°C)	288.16	313.0
Viscosity Constant 1	7.14	8.755
Viscosity Constant 2	15,833.7	1,607.0
Oil Water Interfacial Tension (dynes/cm)	19.4	37.0
Water Interfacial Tension Constant	0.836	0.0
Oil Air Interfacial Tension (dynes/cm)	27.2	22
Air Interfacial Tension Constant	0.543	0.0
Initial Pour Point (°C)	275.72	243.0
Pour Point Constant	0.314	0.139
ASTM Distillation Constant A (slope)	609.98	285.0
ASTM Distillation Constant B (intercept)	425.4	473.0
Emulsification Delay	30,000	99,999,999,999
Fv Theta A	6.7	6.3
Fv Theta B	13.0	10.3

Given the geographic scale and duration of a blowout scenario, the water currents used in the model are seasonal mean current fields developed by the Ocean Sciences Division, Maritimes Region (Atlas of Ocean Currents in Eastern Canadian Waters, Wu and Tang 2011) and by the Biological and Physical Oceanography Section, Northwest Atlantic Fisheries Centre (Han 2012). The DFO water currents available in 2012 covered the area bounded by longitude -42.6° E, latitude 41.9° N in the southeast, -42.6° E 54.5°N in the northeast and -69.3° E, 40.4° N in the southwest. The water currents to the north and west extend to the land masses of Canada to the mouth of the St. Lawrence River. These longitudes and latitudes define the full extent of the modelling area (Figure 7-9). The modelled area covers an area of approximately 2.4 million km². These water currents were combined with 3% of the average winds to determine the surface water currents influencing the initial formation and movement of the oil slicks. Water currents below the surface layer have a negligible effect on the spill model given the directional force of oil from a shallow water blowout.

The WREP EA model used 57 years of wind data, dating from 1954-2010. Six-hourly wind speed and direction data were extracted from the full MSC 50 data set at grid points with 0.5 degree spacing over the entire Study Area. The model results show a relatively consistent movement of the oil to the east and southeast out into the Atlantic Ocean over the 120 days. The persistent oil slicks generally travel to the east and southeast from the offshore spill site due to the prevailing winds and surface water currents. Another five or so years of data would not demonstrably alter the results or conclusions of the modelling. Recent modelling completed by RPS ASA for Statoil Canada Ltd. (Statoil 2017) used wind and current data from 2006-2010. It was stated that "currents and winds in the study area are very similar to those from 5-10 years ago." In the unlikely event of an actual spill in the area, real-time wind data would be used to track the actual movement of the surface oil, which can be expected to fall within the bounds of the spill trajectory probabilities.

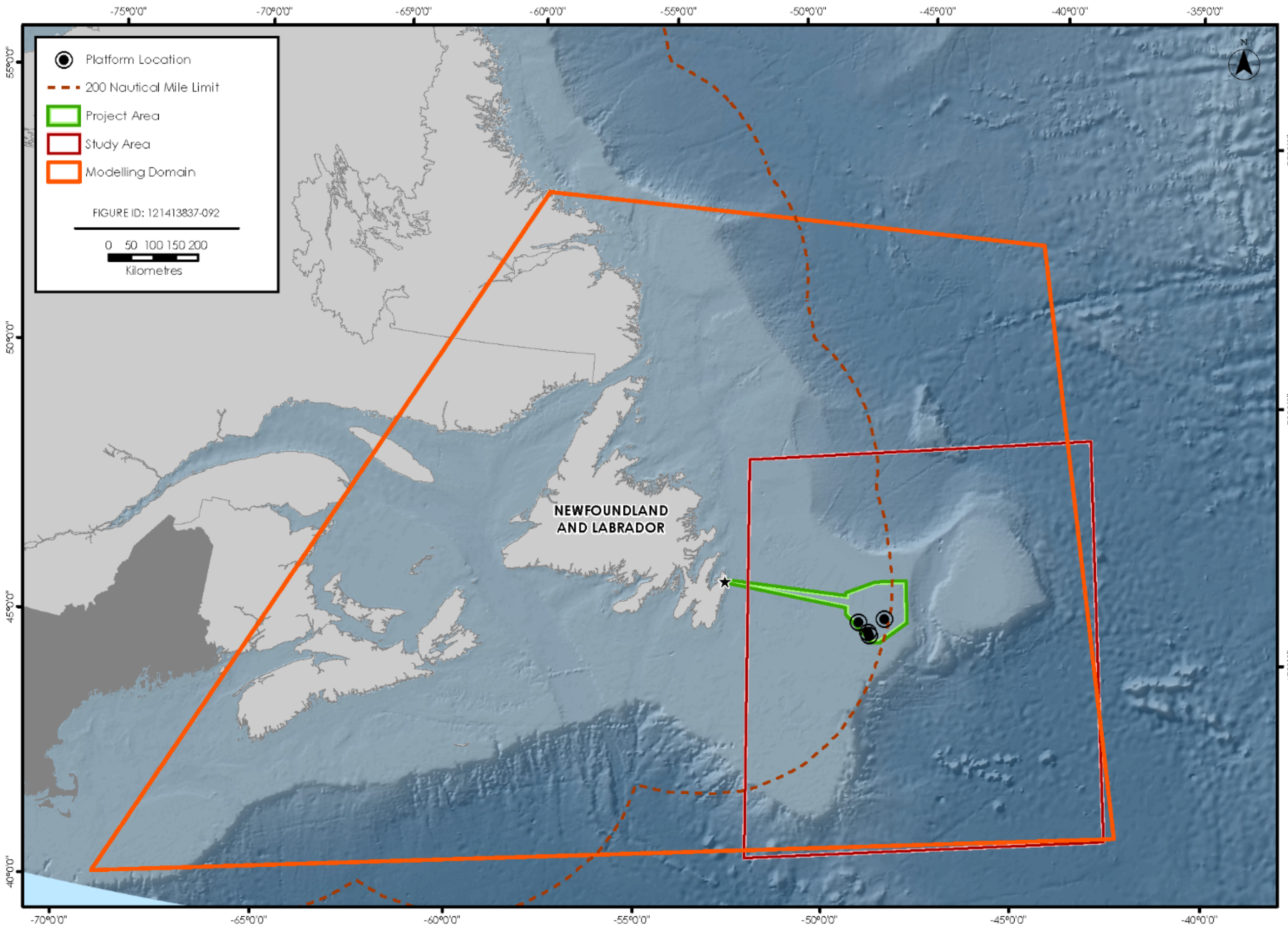


Figure 7-9 Project Area and Study Area in Relation to the White Rose Extension Project Oil Spill Modelling Domain

7.2.1.1 Model Inputs and Spill Scenarios

The spill scenario modelled for offshore activities are fuel oil batch spills from vessels or the platform as well as subsea and above surface crude oil blowouts.

Instantaneous batch spills of 1.6 m³ (10 bbl), 16 m³ (100 bbl), 100 m³ (630 bbl) and 350 m³ (2,200 bbl) have been modelled for marine diesel. The two smallest spill sizes were chosen as they are representative of small and medium sized platform spills based on historical records. The modelling of the continuous releases of gas and oil from well blowouts has been completed using the gas and oil flow rates shown in Table 7.18.

Table 7.18 Spill Flow Rates and Volumes Used in Modelling

Spill Type	Source	Flow	Gas-to-Oil Flow Ratio (m³/m³)
Crude Oil Well Blowout	Subsea	6,435 m³/day (40,476 bopd)	138
	Platform	6,435 m³/day (40,476 bopd)	138
Batch Oil Spills	Transfer	1.6 m³ (100 bbl)	na
	Transfer	0.16 m³ (10 bbl)	na
	Vessel Accident	100 m³ (630 bbl)	na
	Vessel Accident	350 m³ (2,200 bbl)	na
Source: Husky Energy 2012b na = not applicable			

7.2.1.2 Metocean Inputs

Surface water current fields developed by the Ocean Sciences Division, Maritimes Region DFO (Wu and Tang 2011, in Husky Energy 2012a) were used in the spill trajectory modelling in the Study Area. Seasonal mean surface water velocities were provided by DFO and these were converted to a map format used by the SL Ross Oil Spill model. Surface water current maps for spring (April to June), summer (July to September), fall (October to December) and winter (January to March) seasons were used in the modelling. Coarse representations of the summer and winter vector fields for the Study Area are provided in Figures 7-10 and 7-11, respectively. These water currents were combined with 3% of the average winds to determine the surface water currents influencing the initial formation and movement of the oil slicks.

The monthly average air and water temperatures used in the fate modelling for the detailed fate and trajectory modelling for the offshore are shown in Table 7.19. Summer and winter average air temperatures of 12.9°C and 0.1°C, respectively, were used in the seasonal oil fate modeling. Summer and winter average water temperatures of 12.3°C and 0.5°C were used in the seasonal oil fate modelling.

Source: Husky Energy 2012a

Figure 7-10 Summer Surface Water Current Vectors

Source: Husky Energy 2012a

Figure 7-11 Winter Surface Water Current Vectors

Table 7.19 White Rose Extension Site: Average Monthly Air and Water Temperatures

	Average Temperatures (°C)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Air	0.1	-0.4	0.3	1.9	4.1	7.1	11.9	14.3	12.6	8.8	5.1	2.1
Water	1.0	0.3	0.3	1.0	3.0	5.9	10.5	13.7	12.7	9.1	5.5	2.7
Source: Oceans Ltd. 2011, in Husky Energy 2012a (ICOADS air and surface water temperatures)												

7.2.1.3 Subsea Crude Oil Blowout Fate and Behaviour Modelling

The fate of crude oil from winter and summer subsea blowout scenarios has been modeled and the results are summarized below. Oil properties of White Rose crude oil sampled and analyzed in the fall of 2011 have been used in this modelling.

Oil flow rates of 6,435 and 3,963 m^3/day (with gas-to-oil ratios of 138 and 275 m^3/m^3) were used in the modelling. These flows represent the maximum oil flow rate estimated from the reservoir and the reduced flow expected after a 120-day release period (Husky Energy 2012a). At the beginning of a blowout the oil fate will most closely match the results provided for the higher flow rate. By the end of a 120-day release, the results presented for the lower flow rates will be more representative.

In this scenario, the fluids are assumed to erupt from the seabed with the formation of small oil droplets in the turbulent jet region of the discharge. The oil drops are then quickly carried to the surface with entrained water and gas. At the surface, the oil drops spread to form a slick in the summer since the ambient temperature is above the fresh oil's initial pour point. In the winter the oil is assumed to remain in the form of small drops of about 1 mm in diameter because the ambient water temperature is well below the oil's pour point. Because the oil drops are essentially semi-solid spheres it is assumed that they will not mix and coalesce into a traditional oil slick. The small drops have a larger surface area than a traditional slick and this allows for a more rapid evaporation and further increase in the oil's pour point and viscosity. If high concentrations of these droplets were to form offshore during a sunny day with calm conditions, then solar radiation could warm the oil to the point where the drops might coalesce and form a more traditional oil slick. The entrained water flow from the blowout creates a hyperbolic-shaped oil distribution at the surface that extends several hundred metres up-current of the gas boil zone, and between about 1.7 to 2.8 km wide down-current of the gas boil depending on the season (see initial slick width in Table 7.20).

Table 7.20 Subsea Crude Oil Blowout Spill Characteristics

Spill Flow Rate m³/day (bopd)	Season	Initial Slick Width (m)	Initial Slick Thick (mm)	Slick Survival Time (days)	% Evap after 1day	Total Evap. %	Peak Disp. Oil Conc. (ppm)	Time to 0.1 ppm Disp. Oil Conc. (hr)	Initial oil Viscosity (cP)	Time to Oil Viscosity of 10,000 cP (hrs)	Maximum Oil Viscosity cP
6,435 (40,476)	winter	1670	1.0[2]	>30	18	31	<0.001	na[1]	712	na[1]	7,400[1]
6,435 (40,476)	summer	2600	0.18	>30	19	36	<0.001	na	65	15	39,350
3,963 (24,927)	winter	1790	1.0[2]	>30	18	33	<0.001	na	712	na[1]	7,400[1]
3,963 (24,927)	summer	2760	0.1	>30	21	33	<0.001	na	65	9.7	45,600

1 Water temperature more than 15°C lower than oil pour point – no natural dispersion and no emulsification assumed
2 Oil remains as 'solid' drops with a 1 mm diameter due to high pour point and low water temperature in winter

The oil slicks are predicted to be very persistent due to the formation of water-in-oil emulsions in the summer and because the water is colder than the oil's pour point in the winter. The oil therefore does not naturally disperse and will remain on the surface for an extended period.

After approximately one day of exposure on the water surface, the oil will have lost between 18% to 21% of its volume to evaporation. The maximum amount expected to be removed through evaporation over the life of the surface oil is 31% to 36%.

In the winter, the water temperature is more than 15°C lower than the oil's pour point, so the oil will remain in the form of drops, will not coalesce to form a slick and will not form water-in-oil emulsions. The maximum viscosity of the drops is estimated to be about 7,500 centipoise (cP).

Natural dispersion will be minimal in all the subsea blowout scenarios either due to emulsion formation or the high oil pour point and cold water. In-water oil concentrations from these spills will remain below 0.001 ppm. The NEBA conducted for the Grand Banks determined that injurious concentrations of oil would occur only in the upper 10 m of the column (SL Ross and LGL Limited 2013 (draft)). Subsea discharges of oil released in shallow water (i.e., <400 m) will rapidly progress to the surface. The portion of oil that is not dispersed, evaporated, or biodegraded will comprise compounds similar to bitumen or asphalt. These are largely biologically inert and of low toxicity. Some of these compounds may eventually be deposited on the seabed at extremely low concentrations over a large area, posing no risk to marine life (IPIECA-IOGP 2015). Impacts from a subsea petroleum blowout to benthic communities are expected to be confined to the immediate vicinity of the well.

7.2.1.4 Historical Spill Trajectory Assessment

7.2.1.4.1 Introduction

The modelling in this section looks at which surface areas on the Grand Banks are more likely to be swept by surface oil and the likelihood of crude oil slicks released from within the Project Area reaching Newfoundland shorelines. Because the oil is very persistent, the mode of release (subsea or surface blowout or batch spill) is not a critical factor in determining the long-term trajectory of spills. Long term releases from the site is therefore represented as discrete batches of oil released at six-hour intervals. Each batch of oil contains the full quantity of oil that would have been released during the six-hour period by a blowout flowing at the maximum discharge rate. This ensures that all the oil spilled is accounted for and provides a reasonable separation between batches (six hours) for the assessment of variations in trajectory because of variations in wind speed and direction.

A total of 83,220 trajectories were run in this analysis from a spill release site within the White Rose field. For months with 30 days, a total of 6,840 individual slick trajectories were followed, one released every 6 hours starting at the beginning of the first day in the month. For months with 31 days, a total of 7,068 trajectories were modelled and 6,384 spills were modelled for February. The surface blowout slick and dispersed oil characteristics are provided in Table 7.21.

Table 7.21 Surface Blowout Slick and Dispersed Oil Characteristics

Oil Characteristic	Summer	Winter
In-Air Evaporation (%)	12.8	14.9
Initial Slick width (m)	97	82
Initial Slick Thickness (mm)	1.6	3.8
Slick Survival Time (hours)	134	97
Final Evaporation (%)	23	23
Final Dispersal (%)	77	77
Initial Dispersed Oil Concentration (ppm)	0.81	0.57
Time to 0.1 ppm (hours)	9	12
Cloud Width at 0.1 ppm (m)	740	960
Distance to 0.1 ppm (km)	12	8
Source: Husky Energy 2012		

7.2.1.4.2 Shoreline Contact

Shoreline contact statistics from these hypothetical spills is provided in Table 7.22. A small number of slicks came to shore only in the months of March (9 slicks), October (29 slicks) and November (1 slick). This amounts to only 0.04% of the 83,220 oil slicks tracked that reached shore. The slicks arrived at shore between 45 and 92 days after release.

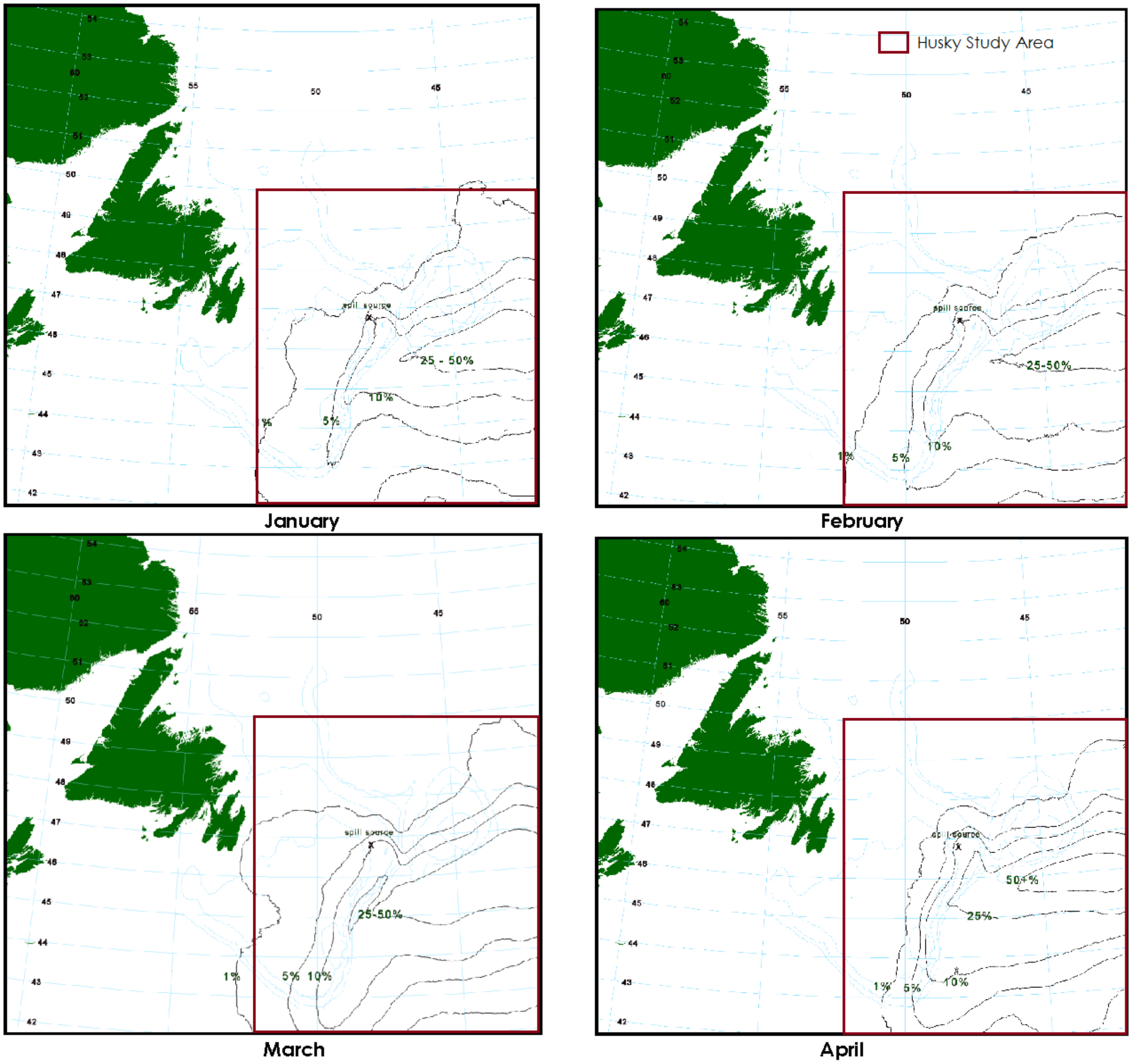
Table 7.22 Slick Shoreline Contact from White Rose Offshore Releases

Month	Number of Slicks Tracked	# of Slick's Centres Reaching Shore	% of Slick's Centres Reaching Shore	Minimum Time to Shore		Maximum Time to Shore	
				Hours	Days	Hours	Days
January	7,068	0	0	-	-	-	-
February	6,384	0	0	-	-	-	-
March	7,068	9	0.13	1638	68	2220	92.5
April	6,840	0	0	-	-	-	-
May	7,068	0	0	-	-	-	-
June	6,840	0	0	-	-	-	-
July	7,068	0	0	-	-	-	-
August	7,068	0	0	-	-	-	-
September	6,840	0	0	-	-	-	-
October	7,068	26	0.37	1080	45	1746	73
November	6,840	1	0.01	1410	59	1410	59
December	7,068	0	0	-	-	-	-
Source: Husky Energy 2012a							

7.2.1.4.3 Spill Trajectory Probabilities

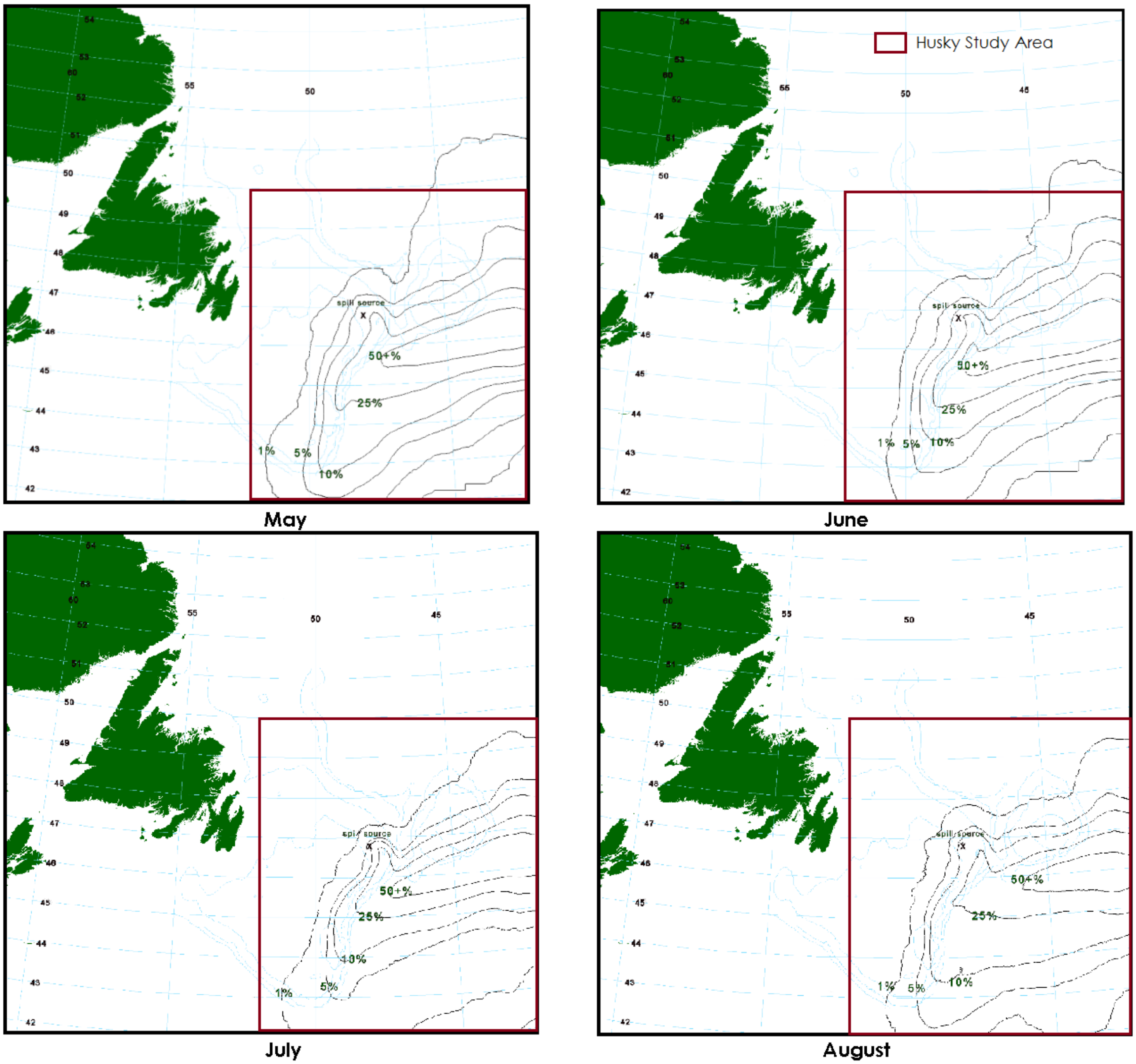
The data haves been further processed to identify the probability of a slick reaching specific areas in the offshore. The slick movements for all spills released in each month of the year, for the 57 years of data, have been processed to identify the percent of the spills released in the month that enter each cell in a 1 km x 1 km grid placed. The results are shown in Figures 7-12 to 7-14. The total sweep area of the slicks (as defined using an oceanic diffusion model, Okubo 1971, in Husky Energy 2012a) has been used in this assessment. The contours on the following graphs represent the boundaries where less than 1% of the slicks will pass, 1% to 5%, 5% to 10%, 10% to 25%, 25% to 50%, and 50% to 100%. These graphs provide insight into the most likely path of oil when spilled in each month based on the 57 years of available wind data.

Trajectories have been run for 120 days or until the oil evaporates and disperses from the surface or the average oil concentration on the surface has dropped below 1 g/25 m^2. This level of contamination of highly weathered crude is considered innocuous to wildlife (French-McCay 2004, in Husky Energy 2012a)



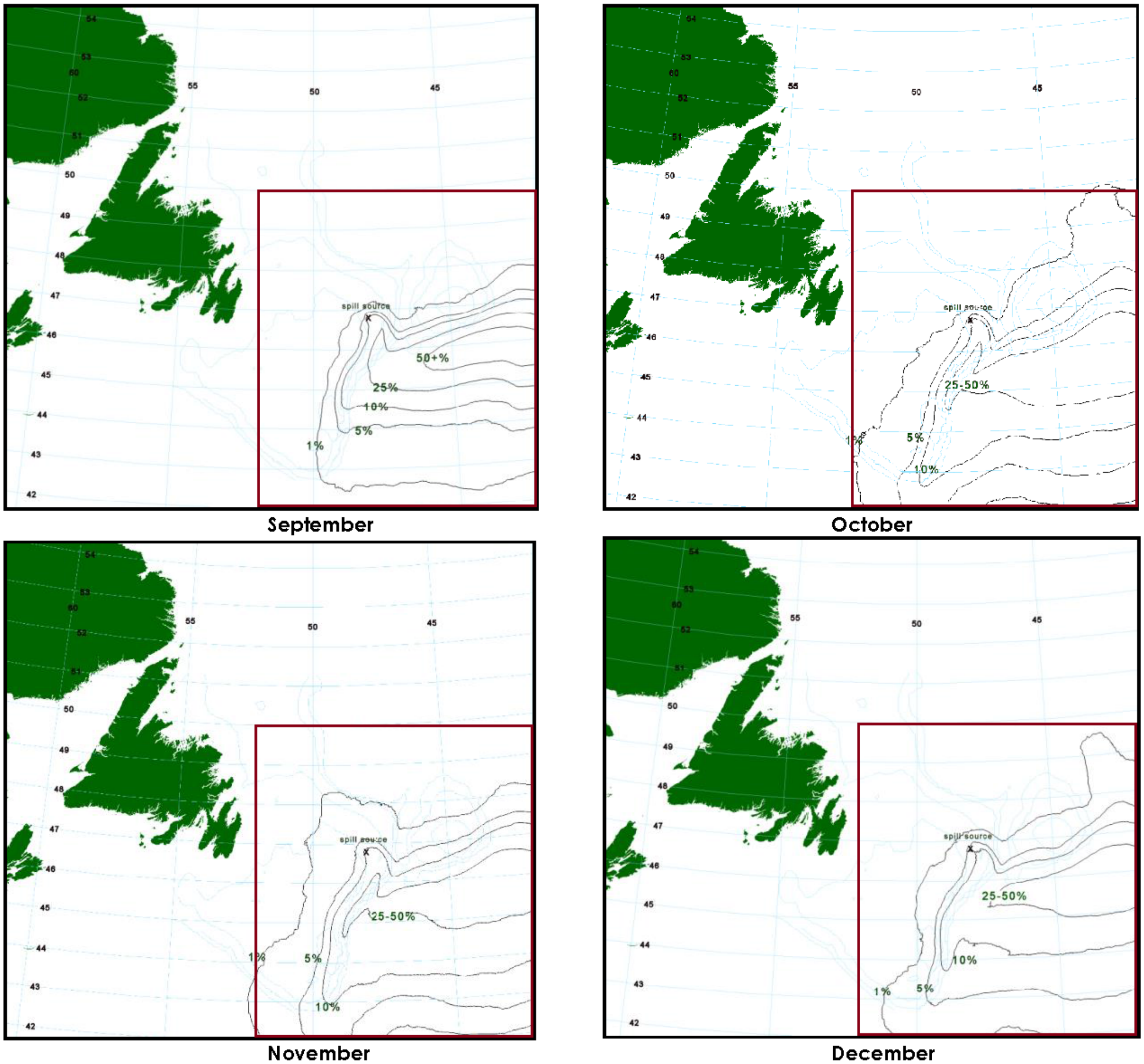
Source: Husky Energy 2012a

Figure 7-12 Spill Trajectory Probabilities for Releases from White Rose: January to April



Source: Husky Energy 2012a

Figure 7-13 Spill Trajectory Probabilities for Releases from White Rose: May to August



Source: Husky Energy 2012a

Figure 7-14 Spill Trajectory Probabilities for Releases from White Rose: September to December

The present state of the art in oil spill modelling is not advanced enough to model the behaviour and trajectory of oil in an open ocean environment with any degree of certainty past even a few weeks. Very little data has ever been collected on the long-term fate of different oil types in the offshore (past even one-week of exposure). A study completed for the US Minerals Management Service reviewed the worldwide data on the persistence of crude oil spills on open water (SL Ross et al. 2003). The study found that the persistence of large spills (>1,000 bbl) was predicted best with the following equation: $PD= 0.0001S-1.32T+33.1$

where:

- PD = spill persistence in days
- S = spill size in bbl
- T = Water temperature in degrees Celsius

If the single day's release of oil is considered as a unique slick with a volume of 40,500 bbl then its long-term persistence would be about 34 days in the winter and about 20 days in the summer. These estimated surface slick persistence values (based on the equation above) are somewhat shorter than those predicted in the detailed spill modelling prepared for WREP and are presented only to provide additional insight into the possible survival time of surface slicks based on historical records.

7.2.1.5 Batch Fuel Oil Spills

Small batch spills of diesel fuel from hose ruptures during transfer operations from a supply vessel or from platform storage facilities are a possibility during drilling operations. Ship collisions could conceivably result in larger batch spills of fuel oil up to a maximum volume of the size of the vessels fuel tanks. Batch spills are considered instantaneous events and are modelled by considering the surface spreading, evaporation, dispersion, emulsification and drift of a single patch or slick of oil.

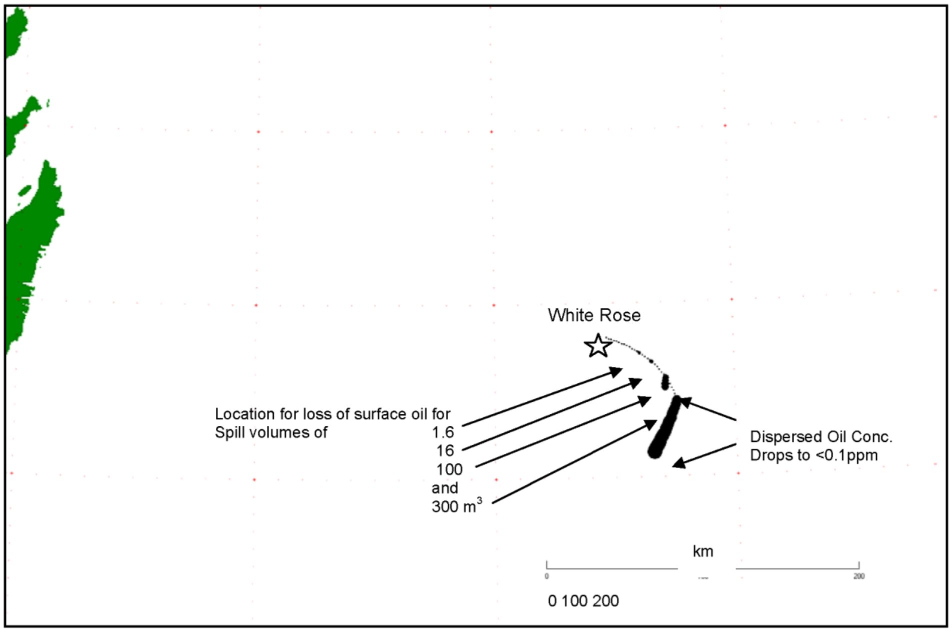
Four diesel fuel spill scenarios have been considered, with spill volumes of 1,600, 16,000, 100,000 and 350,000 L. Table 7.23 shows the fate of the "batch" spills for the winter and summer seasons for the different spill volumes. The winter and summer scenarios were modelled using the average seasonal air and water temperatures and wind speeds provided in sections 7.2.1.2. The summer discharges lose 36% to 38% of the diesel to evaporation, while the winter scenarios lose approximaely 25% to 27% by evaporation; this is due to a combination of the warmer summer temperatures and the more energetic winter conditions that disperse the oil more quickly, thus reducing the opportunity for evaporation. The slicks in the winter are lost from the surface more quickly (13 to 37 hours in winter versus 25 to 62 hours in summer, depending on initial volume spilled) due to the higher winds and thus more energetic wave action. Surface oil will persist for 16 to 49 km from the source in the winter versus 22 to 62 km in the summer; the shorter distance in winter is due to the more rapid natural dispersion. The faster dispersion in winter results in higher peak in-water oil concentrations (0.6 to 3 ppm in winter versus 0.24 to 1.2 ppm in summer). The naturally dispersed oil in the water column is assumed to mix to a conservative depth of 30 m. The clouds of dispersed oil from the winter spills will grow to widths of 0.3 to 10.2 km at the point where the oil has diffused to below 0.1 ppm oil concentration. The winter dispersed oil clouds will sweep distances of 10 to 130 km prior to diffusing to a 0.1 ppm in-water oil concentration. The size of the summer spill clouds will be somewhat smaller (0.3 to 9.7 km) and they will sweep smaller distances (5 to 102 km). The in-water concentration of 0.1 ppm of total petroleum hydrocarbon is the exposure concentration below which no significant biological effects are expected (French-McCay 2004, in Husky Energy 2012a).

Table 7.23 Batch Diesel Spill Characteristics

Spill Volume m^3 (bbl)	Season	Initial Slick Width (m)	Slick Survival Time (hr)	Max. Slick Width (m)	Total Evap. %	Max Oil Viscosity (cP)	Dist. to Loss of Slick (km)	Peak Disp. Oil Conc. (ppm)	Time to Peak Conc. (hr)	Time to 0.1 ppm (hr)	Cloud Width at 0.1 ppm (m)	Distance to 0.1 ppm (km)
1.6 (10)	Winter	10	13	50	26	1350	16	0.6	2	8	315	10
1.6	Summer	10	25	54	38	3700	22	0.24	2	4	275	5
16 (100)	Winter	32	19	120	27	1340	24	1.13	2	26	2,210	30
16	Summer	32	35	130	36	3070	31	0.5	2	18	1,490	17
100 (630)	Winter	80	28	247	25	1660	36	2.0	4	58	5,630	65
100	Summer	80	48	264	36	3075	45	0.8	4	54	5,210	55
350 (2200)	Winter	150	37	402	26	1320	49	3.0	6	98	10,400	130
350	Summer	150	62	430	36	2890	62	1.2	6	92	9,720	102

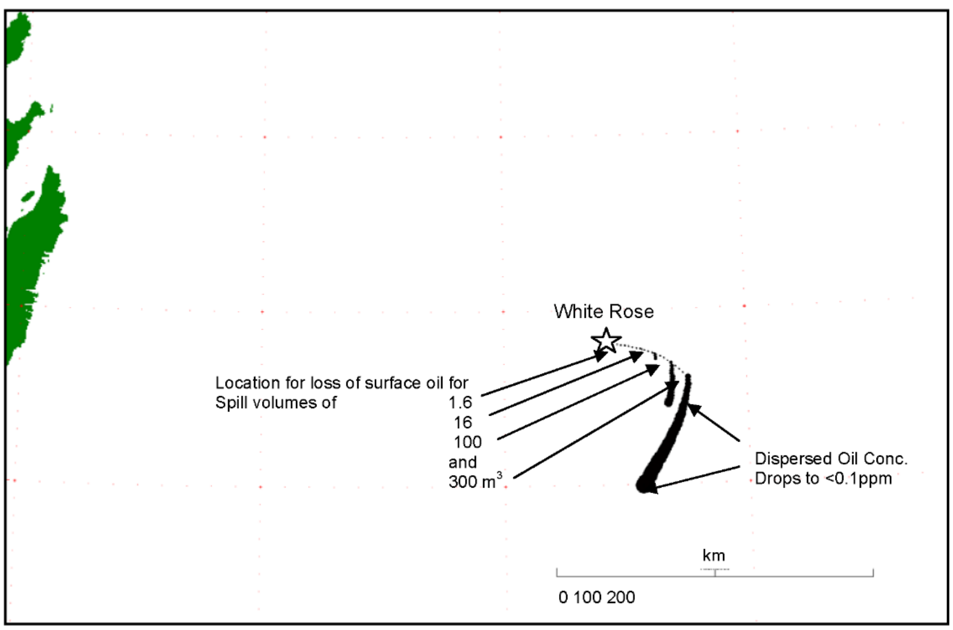
The maximum viscosity that the surface oil will reach in these batch spills is approximately 1,700 cP in the winter and 3,700 cP in the summer. The higher summer viscosity is due to the higher evaporation that results in a greater increase in viscosity than that caused by the colder winter water temperatures.

Spill trajectories have been run from the White Rose field using average summer and winter wind speeds and prevailing water currents for the four diesel fuel spill volumes. The summer and winter trajectory results are shown in Figures 7-15 and 7-16.



Source: Husky Energy 2012a

Figure 7-15 Offshore Summer Diesel Spill Trajectories: Average Environmental Conditions



Source: Husky Energy 2012a

Figure 7-16 Offshore Winter Diesel Spill Trajectories: Average Environmental Conditions

7.3 Accidental Events Environmental Effects Assessment

The following section provides an assessment of the environmental effects of accidental event scenarios described above, on the VCs:

- Fish and Fish Habitat (including SOCC)
- Commercial Fisheries
- Marine Mammals and Sea Turtles (including SOCC)
- Migratory Birds (including SOCC)
- Special Areas
- Indigenous People and Community Values

As discussed above, accidental event modelling of multiple scenarios has been conducted for several EAs within the Project Area. The primary models used for the assessment of this Project originated within the White Rose field, which is within the Project Area. As worst-case accidental event scenarios, subsea and surface blowout rates of 40,476 bopd were modelled for 120 days or until the oil evaporated and dispersed from the surface, or the average oil concentration on the surface dropped below 1 gram per 25 m². This level of contamination of highly weathered crude is considered innocuous to wildlife (French-McCay 2004).

For each VC, the assessment considers the following accidental spill scenarios:

- diesel batch spill from the MODU and OSV; and
- subsea and surface hydrocarbon blowouts from two locations, one shallow and one deep.

Batch spills are considered instantaneous events. As noted in Section 7.2.3.1, instantaneous batch spills of 1.6 m³ (10 bbl), 16 m³ (100 bbl), 100 m³ (630 bbl) and 350 m³ (2,200 bbl) have been modelled for marine diesel for the winter and summer seasons. Diesel batch spills from an OSV are also included for assessment given the potential for a spill to occur because of OSV collision during transit to/from the MODU. The OSV spill scenario includes a nearshore diesel spill of 5000 m³. Accidental spills from a MODU or OSV are collectively referred to as "batch spills" in this section.

A subsea or surface blowout scenario has the greatest potential for environmental effects; however, the extent of effects depends in large part upon the duration and volume of the spill, as well as the environmental conditions at the time of the spill. Subsea blowouts are classified as shallow or deep water, depending on water depth. Water depths less than about 400 m are considered shallow from the perspective of subsea blowout plume behaviour. Water depths greater than about 600 to 700 m would be required before conversion of gas to solid hydrates and reduced plume buoyancy would become an issue.

Although serious accidental events are considered unlikely, such an event could occur at any time of year, throughout the life of the proposed Project. Therefore, a conservative approach has been taken and the assessment will consider the potential environmental effects of a credible worst case accidental event (i.e., large hydrocarbon spill).

7.3.1 Fish and Fish Habitat

7.3.1.1 Project Pathways for Effects

Potential effects on plankton including phytoplankton and zooplankton, vary by species. Potential effects on phytoplankton include a change in community structure from adverse effects of contamination, and increases in biomass due to decreased predation by zooplankton (Teal and Howarth 1984; Abbriano et al. 2011). Phytoplankton near a hydrocarbon spill may experience limited or inhibited air-sea gas exchange and light penetration and may experience reduced productivity and growth (González et al. 2009; Abbriano et al. 2011). The PAHs within oil may also affect phytoplankton growth, with growth stimulation possibly occurring at low concentrations (1 mg/L) and growth inhibition occurring at higher concentrations (100 mg/L) (Harrison et al. 1986). A study on the short-term effects of oil on phytoplankton using crude oil obtained from the Deepwater Horizon oil spill and a mixture of Texas crude oils found that the total phytoplankton biomass (as measured by chlorophyll a concentrations) declined with increasing concentration of crude oil (Gilde and Pinckney 2012). The phytoplankton community was also altered as phytoplankton taxa had varying responses to crude oil, with diatoms, cyanobacteria, euglenophytes and chlorophytes being relatively resistant to contamination, while cryptophyte abundance decreased (Gilde and Pinckney 2012).

Zooplankton responses to hydrocarbons vary by species, with mortality being more dependent on exposure time than the concentration of oil at the site (Lee et al. 1977; Abbriano et al. 2011). Copepods in direct contact with oil have been observed to experience increased mortality, decreased feeding and decreased reproduction (Suchanek 1993; Seuront 2011). Copepods also show some ability to sense and avoid oil spills, which may reduce contact and mortality rates (Seuront 2010). Full recovery of zooplankton communities is expected to occur soon after a spill due to their short generation time, high fecundity and ability to avoid oil patches (Seuront 2010). In previous oil spills such as the Prestige spill, zooplankton abundance and community structure returned to former levels within days to several weeks of the spill (Johansson et al. 1980; Varela et al. 2006).

Diesel is known to have an immediate toxic effect on many organisms, including periwinkle, limpet, gastropods, amphipods and many meiofaunal organisms (Stirling 1977; Simpson et al. 1995; Cripps and Shears 1997, Hjermann et al., 2007), with exposed eggs and larvae most at risk since they are not able to actively avoid the fuel. If marine diesel is released into the environment (e.g., in the unlikely event of an OSV accident resulting in oiling of the nearshore), coastal habitats that fish and shellfish depend on as part of their life cycle could be affected and result in a decrease in habitat quality in the surface layers. Oil spill models in Section 7.2.2 demonstrate that a diesel spill is not likely to affect coastal areas.

The release of hydrocarbons also has the potential to affect the quality of benthic habitat and affect invertebrates in the immediate area of the spill. Hydrocarbons have been found to be able to persist in marine sediments for several years in the absence of disturbance and even low levels of hydrocarbons may have sub-lethal effects on invertebrates. Crustaceans appear to be the most sensitive taxa to hydrocarbons among benthic communities (Sanders et al. 1980; Jewett et al. 1999). A study of arthropod communities in salt marshes in Louisiana and Mississippi following the Deepwater Horizon oil spill (McCall and Pennings 2012) found that during 2010 surveys, intertidal crabs and terrestrial arthropods (insects and spiders) were suppressed by oil exposure, whereas Littoraria snails were unaffected. Within a year, crab and terrestrial arthropods had recovered to former levels (McCall and Pennings 2012). However, this did not preclude potential long-term effects experienced by fishes because of chronic exposure and delayed indirect effects (Fodrie and Heck 2011). In another study following the Deepwater Horizon oil spill, commercial fish and invertebrates (crab, shrimp, oyster) species were collected from the closed fishing grounds along the Mississippi Gulf Coast. Higher levels of PAHs were detected in all four taxa groups (fish, crab, shrimp and oyster) during the early period of sampling in comparison to later months. The PAH levels in the tested seafood samples were like those detected in commonly consumed processed foods and overall, the levels of PAHs in all the tested seafood samples collected within the one-year period were far below allowable levels (Levels of Concern) (Xia et al. 2012).

Deep-water coral communities in the Gulf of Mexico were examined at 11 sites three to four months after the well was capped following the Deepwater Horizon spill (White et al. 2012). Healthy coral communities were observed at all sites more than 20 km from the spill site. Seven of the 11 sites visited had been studied in September 2009 and appeared unchanged since that time (White et al. 2012). However, at one site 11 km southwest of the spill site, coral was found to exhibit signs of physiological stress, including tissue loss, sclerite enlargement, excess mucous production and bleached ophiuroids (commensal species), and were covered by brown flocculent material. Of the 43 coral colonies photographed at the affected site, 46% showed evidence of effects on half the colony, and nearly 25% of the colonies were observed to have greater than 90% damage (White et al. 2012).

The fate of soluble and non-soluble hydrocarbon releases was analyzed using data compiled from recent spills including the Deepwater Horizon blowout. For a deep-water seafloor release, water-soluble hydrocarbons were generally entrained in the water column leading to increased dissolved hydrocarbon concentrations, whereas relatively insoluble compounds were transported to the seafloor or sea-surface (Reddy et al. 2011; Tjeerdema et al. 2013). For surface releases, soluble compounds that are generally highly volatile, such as BTEX, quickly volatilize and are lost to the atmosphere over hours to days following the release (Tjeerdema et al. 2013). Due to the limited penetration of a surface spill, the water column dissolved hydrocarbon concentrations are less (Reddy et al. 2011; Valentine et al. 2014). Dissolved (from a subsea blowout at depth) or dispersed oil (from chemical treatment during a surface release) concentrations will be highest in the initial days after the spill or in close proximity to the wellhead if the release is continuous. The microbial response to a marine oil spill is dependent on numerous factors, including the oil composition and degree of weathering, as well as environmental conditions, particularly temperature and nutrient concentrations. During biodegradation of the oil oxygen is used by bacteria, fungi, and microalgae, which can reduce oxygen levels in the plume (McGenity et al. 2012). Both particulate and dissolved hydrocarbons may have adverse effects to fish and fish habitat, but the dissolved fraction is generally more bioavailable (NRC 2005), as the particulate fraction would require ingestion or absorption from surface coating.

Natural dispersion will be minimal in all the subsea blowout scenarios either due to emulsion formation or the high oil pour point and cold water. In-water oil concentrations from these spills will remain below 0.001 ppm. The NEBA conducted for the Grand Banks determined that injurious concentrations of oil would occur only in the upper 10 m of the column (SL Ross and LGL Limited 2013). Subsea discharges of oil released in shallow water (i.e., <400 m) will rapidly progress to the surface. The portion of oil that is not dispersed evaporated or biodegraded will comprise compounds similar to bitumen or asphalt. These are largely biologically inert and of low toxicity. Some of these compounds may eventually be deposited on the seabed at extremely low concentrations over a large area, posing no risk to marine life (IPIECA-IOGP 2015). Impacts from a subsea petroleum blowout to benthic communities are expected to be confined to the immediate vicinity of the well.

Oil-mineral-aggregates (OMAs) can be formed if oil droplets adhere to suspended particles, which stabilizes dispersed oil droplets in the water column and enhances their biodegradation rate (Niu et al. 2011). Sediments within 6 km of the Deepwater Horizon spill indicated clear signs of biodegradation (due to biological degradation and dissolution) of the oil deposited in the sediment; however, the degradation rate in sediments was quite slow. Low temperature and available dissolved oxygen were the limiting factors on the biodegradation rate. Most low molecular weight compounds were absent relative to the crude oil, primarily due to weathering from dissolution and biodegradation within the water column. Low molecular weight compounds were also moderately weathered from the oil mousses by evaporation (Liu et al. 2012).

As oil components on the OMAs age (from weathering or microbial activity), they can increase in density and sink to the substrate faster (Passow et al. 2012), thus potentially affecting benthic organisms. Such risks are dependent on factors such as water depth and hydrodynamics, amount spilled, and sediment properties. Nui et al. (2011) studied various scenarios and determined that the risks are generally low and not persistent. Lee et al. (2008) experimented on the effects of chemical dispersants and mineral fines on partitioning of petroleum hydrocarbons in natural seawater and found that chemical dispersants can overcome OMA sinking by dispersing oil into smaller droplets and increasing the suspension of the dispersed oil drops in the water column.

The formation of OMAs from a blowout within Husky's Project Area is not likely; OMA formation occurs in shoreline and river environments with high suspended sediment concentrations. Suspended sediment concentrations in the water column around the proposed drilling area would be too low to substantially interact with a subsurface oil plume.

If fine-grained sediment had built up around the subsurface release point, some of it could be re-suspended in the immediate aftermath of a blowout event (MMS 2008). It is conceivable that there could be some OMA formation in this situation; however, this scenario would only exist in the very early moments of a blowout and would transition to a regular blowout scenario once the sediment around the well was cleared. Benthic impacts, if any, would be localized given the upward pressure of a shallow water blowout. In laboratory studies, adult fish were able to detect petroleum at low concentrations (Hellstrøm and Døving 1983; Dauble et al. 1985; Beitinger 1990; Farr et al. 1995). Adult fish would have lower exposure risk because they are highly mobile, and able to detect and avoid oiled surface waters (Irwin 1997; Law et al. 1997). The potential effect of hydrocarbons on fish eggs and larvae is more of concern because they primarily reside in the upper water column and are sensitive life stages and are not able to actively avoid polluted areas (Rice 1985). The risk to eggs and larvae from effects of hydrocarbon releases is generally limited to species which spawn in or around the Project Area, such as the common species observed during the meroplankton surveys (Atlantic cod, American plaice, sand lance, redfish, capelin, lanternfish, alligatorfish, sculpin, snailfish, white hake, haddock, wolffish, witch flounder, yellowtail flounder, and Greenland halibut [Dalley et al. 2000]).

Studies of Pacific herring (*Clupea pallasi*) larvae following the 1989 *Exxon Valdez* oil spill in Alaska found larvae that hatched from demersal adhesive eggs at oil-affected sites had statistically significantly higher incidences of morphological deformities and cytogenetic abnormalities than those at unaffected sites (Hose et al. 1996). Bue et al. (1996) also found higher levels of mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos. Experimental studies of the effects of hydrocarbons on early life stages for a variety of other fish species (e.g., herring, salmon, minnow, mummichog) have demonstrated toxic effects, including pericardial and yolk sac oedema, small jaws, hemorrhages, spinal deformities, body axes defects and inhibited growth in response to exposure to petroleum products (Marty et al. 1997; 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). Much of the more recent research on the environmental effects of blowouts has resulted from the Deepwater Horizon incident. The Deepwater Horizon blowout occurred at a water depth of approximately 1,500 m. At those depths, the pressure causes gas to dissolve in the water and/or form gas hydrates, which deprives the plume of buoyancy and substantially slows the rate of plume surfacing, which allows more time for hydrocarbon dissolution. Differences in water depth and temperature between the Gulf of Mexico and offshore Newfoundland must be considered when determining the applicability of this research within the current assessment.

7.3.1.2 Mitigation

As outlined in Section 7.1, Husky will implement several measures and preventative actions into the daily operation and maintenance of a MODU to mitigate the risk of a hydrocarbon spill. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to minimize the likelihood of an accident or malfunction. As noted in Section 7.1, Husky has an established corporate Incident Coordination and Response Management Plan (EC-M-99-X-PR-00003-001) and an Oil Spill Response Procedure - East Coast Oil Spill Response Plan (EC-M-99-X-PR-00125-001). These plans include a number of different options and contingencies to address responding to emergency events, including potential spills and well control events. All relevant plans are submitted to the C-NLOPB prior to the start of any drilling activities in offshore Newfoundland and Labrador. The oil spill response procedure will outline response methods and strategies for addressing different levels of oil spills. Response methods for oil spills that will be considered include but are not limited to: offshore containment and recovery; surveillance and tracking of spills; dispersant application, and wildlife response measures.

In the unlikely event of an accidental event such as a large spill or a blowout, specific monitoring programs (e.g., environmental effects monitoring and follow up) may be required for the Project. In such case, these programs will be developed and implemented in consultation with the appropriate regulatory agencies.

7.3.1.3 Assessment of Residual Environmental Effects on Fish and Fish Habitat

7.3.1.3.1 Diesel Batch Spill from MODU and OSV

A batch spill will create a temporary and reversible degradation in habitat quality; however, based on modelling for the White Rose Project, diesel spills from the MODU and OSV are not likely to result in biological effects on fish (including fish SAR and SOCC) over a large area. With respect to a change in habitat quality, most of the diesel from a MODU or OSV spill will evaporate (the winter scenarios lose approximately 25% to 27% and summer discharges lose 36% to 38% to evaporation) from the surface within 13 to 37 hours in winter and 25 to 62 hours in summer, depending on initial volume spilled. A diesel fuel spill was estimated to have a slick survival time of 48 hours (SL Ross 2012). This will create a temporary and reversible degradation in habitat quality. Proposed critical habitat has been identified for the wolffish in the Study Area; however, any effects from a diesel spill is expected to be minimal. The winter dispersed oil clouds will sweep distances of 10 to 130 km prior to diffusing to a 0.1 ppm in-water oil concentration where the summer spill clouds will sweep smaller distances (5 to 102 km). The in-water concentration of 0.1 ppm of total petroleum hydrocarbon is the exposure concentration below which no significant biological effects are expected (French-McCay 2004, in Husky Energy 2012a).

With respect to a change in risk of mortality, physical injury or health, diesel is known to have immediate toxic effects on many benthic organisms (Stirling 1977; Simpson et al. 1995; Cripps and Shears 1997). Sessile and early life stages (eggs, larvae) are the most at risk given they are unable to actively avoid the diesel and/or are during sensitive life-stage development periods. Benthic invertebrates 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). Dissolved hydrocarbons from spilled diesel would be limited to the surface and mixed layer of the water column, therefore the potential for deeper corals and sponges to be exposed is considered low. The implementation of oil spill containment and recovery operations will reduce residual effects on fish (including fish SAR and SOCC) and fish habitat (including proposed critical habitat for the wolffish) associated with total dissolved hydrocarbons.

While 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 limited to a localized area. Adult fish species (including fish SAR and SOCC) will largely be unaffected because of avoidance mechanisms; bottom dwelling species are unlikely to be exposed to harmful concentrations of dissolved total hydrocarbons would be limited to the surface and mixed layer of the water column.

In the unlikely event there is a spill of marine diesel fuel in the nearshore, oil spill response plans will be initiated to contain and clean-up the spill to mitigate potential environmental effects. Residual effects from a nearshore diesel spill from the OSV could include localized mortality and sub-lethal effects to fish eggs, larvae, and juveniles. As discussed in Section 7.2.2, a nearshore spill is not predicted to reach the shoreline and will dissipate within 120 hours (during the autumn and winter) and 240 hours (during spring and summer).

7.3.1.3.2 Subsea and Surface Blowout

The oil from a subsea or surface blowout is predicted to be persistent under both summer and winter conditions due to formation of water-in-oil emulsions during summer, and because the water is colder than the oil's pour point in winter. Consequently, the natural dispersion would be low, and the oil would remain at the surface for an extended period. After approximately one day of exposure at the water surface, the oil will have lost between 18 and 21% of its volume due to evaporation, with the maximum anticipated amount of evaporation over the life of the surface oil estimated to be 31 to 36% (SL Ross 2011).

There is a risk of mortality to phytoplankton, zooplankton, larval and juvenile fish species that maybe entrained within the plume during a subsea blowout (both shallow and deep-water blowouts), or present in the mixed surface layer of the water column, during a surface blowout.

Following a blowout scenario, the geographic extent of residual effects on change in habitat quality could extend into the Study Area. The winter zone of influence is smaller than in summer due to strong, persistent westerly winds in the winter, creating a tighter trajectory. The summer wind direction is more variable, and the modelled slick moves over a wider area. Overall, a release of crude oil from the Project Area would persist and surface slicks would remain for several weeks. Just 0.04% of slicks were predicted to reach the shore between 45 to 92 days after the hydrocarbon release. Details on the oil spill fate and behaviour modelling can be found in Section 7.2 and Appendix H. Though the modelling shows a potentially large affected area, it is important to note that many of the areas defined through the modelling have low probabilities of occurrence and that results are based on an unmitigated release. In an actual incident, spill 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 described in Section 7.1.9.3, in the unlikely event of a hydrocarbon blowout, the use of dispersants will be considered as a spill countermeasure. The potential risk of dispersant use is the increased exposure of marine organisms in the water column to dispersed oil droplets and water-soluble oil compounds released from these oil droplets (IPIECA and IOGP 2015). The bioavailability in relation to oil dispersion has recently become a focus based on the mechanical and chemical dispersion methods used during the Deepwater Horizon response.

The chemically dispersed oil is present in the water column as stabilized droplets which are smaller than oil globules and more readily available for uptake in fish. Initially the oil droplets are contained within surfactant-enclosed micelles and generally unavailable for diffusion, over time the surfactant will dissolve (Tjeerdema et al. 2013). Dispersed or dissolved oil was observed to promote a higher rate of microbial activity than observed at baseline, which results in microbial degradation of the release (Hazen et al. 2010, Valentine et al. 2010). This increase in microbial degradation has the potential to deplete oxygen within the plume, Valentine et al. (2010) estimated that 70% of the oxygen depletion was due to increased microbial activity.

The exposure of oil to fish, either naturally or chemically dispersed, following a spill has the potential to affect the development, structure, and function of the cardiac system in fish embryos leading to impaired swimming stamina (Lee et al. 2015). Studies have indicated that dispersed oil is more toxic to fish than surface oil slicks, from the increase in availability and subsequent exposure to hydrocarbons (Tjeerdema et al. 2013, Adams et al. 2014,). At the Macondo well site concentrations of dissolved hydrocarbons were detectable up to 35 km from the release (Camilli et al. 2010), this would be a worst-case scenario as the release of oil was located on the seafloor and dispersants were used to diffuse oil into the water column.

The ingestion of food provides marine organisms with a potential route of exposure to higher molecular weight PAHs. Filter feeding organisms that prey on plankton can ingest naturally- or chemically-dispersed oil droplets when they are of a similar size to some plankton (IPIECA and IOGP 2015). Relatively simple organisms, such as bivalves, cannot biochemically process the higher molecular weight PAHs in the oil; therefore, PAHs can bioaccumulate in some organs (Neff and Burns 1996). Predators that consume oil-contaminated bivalves may therefore be exposed to elevated concentrations of the higher molecular PAHs by this ingestion route. However, higher level organisms such as fish, can quickly metabolize PAH, although some of these metabolites may be harmful. Bivalves and other benthic invertebrates may be exposed if dispersed oil settles on the seafloor. Plankton and copepods in the surface to mid-water column are at increased risk of exposure. The low concentration of dispersed oil, coupled with the wide distribution of populations, is likely to limit impacts on these organisms (IPIECA and IOGP 2015). During the Deepwater Horizon spill, toxicity tests were conducted during subsurface application of dispersants and results indicated little toxicity to *Brachionus plicatilis* (a marine rotifer) and *Vibrio fischeri* (a marine bacteria) (Tjeerdema et al. 2013).

7.3.1.3.3 SBM Spill

In the event of an unintended bulk release of SBM, effects would likely be restricted to smothering of habitat and of highly immobile invertbrate species within tens of metres from the spill site. The acute toxicity of SBMs is considered relatively low and therefore is not expected to cause contamination of marine biota or habitats (C-NLOPB 2011). There are potential health effects associated with chronic exposure to SBM associated cuttings (Jagwani et al. 2011; Gagnon and Baktyar 2013; Vincent-Akpu 2013, in BP 2016); however, effects from an SBM spill would likely be temporary, reversible and highly localized around the wellsite.

7.3.1.3.4 Summary

Table 7.24 provides a summary of predicted residual environmental effects of accidental events on fish and fish habitat.

Table 7.24 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 of Physical Injury/Change in Habitat and Use							
Diesel Batch Spill from OSV and MODU (10 bbl and 100 bbl scenarios)	A	M	SA	ST	S	R	D
Subsea and Surface Hydrocarbon Blowout (blowout rates of 40,476 bopd)	A	M	SA	ST-MT	S	R	D
SBM Spill	A	L	PA	MT	S	R	D

KEY:
See Table 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
SA: Study 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

7.3.1.4 Determination of Significance

In consideration of the information presented above, the predicted residual environmental effects from any of the accidental event scenarios on fish and fish habitat is not significant such that a significant decline in abundance or change in fish population is unlikely within the Study Area, does not jeopardize the achievement of self-sustaining population objectives for listed species, unlikely to result in permanent and irreversible loss of critical habitat, or result in serious harm to fish as defined by the *Fisheries Act*. An accidental event is predicted to be reversible and is not expected to cause an adverse effect on fish and fish habitat resulting in a decrease in abundance or alteration in distribution of the population over more than one generation or so that natural recruitment would not reestablish the populations(s) to baseline conditions within one generation. Husky will adhere to safety and risk management systems, management of change procedures and global standards. This includes the implementation of spill prevention that will be incorporated into the design and operations for all Project activities as part of contingency planning. Spill response planning is described in detail in Section 7.1.

7.3.2 Commercial Fisheries

7.3.2.1 Project Pathways for Effects

Accidental events that might affect commercial fisheries in the Study Area are mostly related to the unplanned release of hydrocarbons, whether refined or crude product. Section 7.3.1 concludes that biophysical effects on fish from a batch spill or blowout will be not significant. However, a change in availability of fisheries resources might still occur if a spill prevented or impeded a harvester's ability to access fishing grounds (because of areas temporarily excluded during the spill or spill clean-up), caused damage to fishing gear (through oiling), or resulted in a negative effect on the marketability of fish products (because of market perception resulting in lower prices).

The uptake of oil and PAHs by exposed fish poses a potential threat to human consumers and affects the marketability of catches. Although results may show safe exposure levels for consumption, market perceptions of poor product quality (e.g., tainting) can persist. The hydrocarbon concentrations at which tainting can occur (i.e., when a food product has an usual odour or flavor), may be very low (no reliable chemical threshold has been established) with the presence of taint determined by sensory testing (ITOPF 2011). Depressed market prices may be the result of reduced demand for seafood that is perceived to be tainted as was demonstrated following the Deepwater Horizon oil spill. 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).

The implications of an oil spill for the commercial fishery can be difficult to assess as the spill location, seasonal timing, and how much oil reaches the fisheries resource can vary the effect on change in availability of fisheries resources as well as other factors such as the natural fluctuations in species levels, variation in fishing effort, climatic effects, or contamination from other sources (ITOPF 2011).

7.3.2.2 Mitigation

As per HOIMS, Husky will implement several measures and preventative actions into the daily operation and maintenance of a MODU. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to reduce the likelihood of an accident or malfunction. As noted in Section 7.1, Husky has an established corporate Incident Coordination and Response Management Plan (EC-M-99-X-PR-00003-001) and an Oil Spill Response Procedure - East Coast Oil Spill Response Plan (EC-M-99-X-PR-00125-001). These plans include a number of different options and contingencies to address emergency response, including potential spills and well control events. All relevant plans are submitted to the C-NLOPB prior to the start of any drilling activities in offshore Newfoundland and Labrador. The oil spill response procedure will outline response methods and strategies for addressing different levels of oil spills. Response methods for oil spills that will be considered include but are not limited to: offshore containment and recovery; surveillance and tracking of spills; dispersant application, and wildlife response measures.

Specific mitigation to reduce effects from an accidental spill on fisheries includes compensation for gear loss or damage caused by the spill. Husky's fishing gear and vessel compensation program will include spill related damage (such as fouling) to mitigate for gear damage that may result from an accidental event. Compensation for damage to gear will be in accordance with Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017). Husky will continue to engage commercial fishers annually to share Project details as applicable and facilitate coordination of information sharing.

7.3.2.3 Assessment of Residual Environmental Effects on Commercial Fisheries

7.3.2.3.1 Diesel Batch Spill from OSV and MODU

Modelling results for the WREP indicate that diesel batch spill from the platform (MODU) are not likely to result in effects on fish over a large area (described in Section 7.2.3), and therefore potential effects on a change of availability of fishery resources is unlikely. Diesel fuel may result in a moderate to high risk of seafood contamination given the relatively high content of water-soluble aromatic hydrocarbons (Yender et al. 2002). However, because of the high evaporation rates (see Section 7.2.3), exposure of fisheries resources to the diesel would be short-term, thereby reducing risk of contamination of fisheries resources.

In the case of a vessel (OSV) diesel spill, this risk of exposure and subsequent contamination could be greater where there could be a higher density of fisheries resources. As discussed in Section 7.2.2, a nearshore spill is not predicted to reach the shoreline and will dissipate within 120 hours (during the autumn and winter) and 240 hours (during spring and summer). Spill response measures discussed in Section 7.1 would be implemented in the event of a diesel spill. Exposure of fisheries resources to diesel would be short-term, thereby reducing risk of contamination of fisheries resources. As discussed in Section 7.2.2, a nearshore spill is not predicted to reach the shoreline and will dissipate within 120 hours (during the autumn and winter) and 240 hours (during spring and summer).

7.3.2.3.2 Subsea and Surface Blowout

As described in Section 7.3.1.3.2, the oil from a subsea or surface blowout is predicted to be persistent under both summer and winter conditions, natural dispersion would be low, and the oil would remain at the surface for an extended period. In the case of an unmitigated subsea or surface blowout, a slick would likely reach an active fishing area, especially during the spring and summer). In that case, it is likely that fishing would be halted because of the possibility of fouling gear and fishing vessels. If the release site is some distance from snow crab fishing grounds, there would be time to notify fishers of the occurrence and prevent the setting or hauling of gear and thus prevent or reduce gear damage.

Fishery closure in the spill area would be expected to be short-term, as typical sea and wind conditions in the Project Area would promote evaporation and weathering of the slick. If fishers had to cease fishing, harvesting might be disrupted (though, depending on the extent of the slick, alternative fishing grounds might be available in a nearby area). An interruption could result in reduced catches, or extra costs associated with relocating set gear.

Effects due to market perceptions of poor product quality (no buyers or reduced prices, etc.) are more difficult to predict, since the actual (physical) effects of the spill might have little to do with these perceptions.

As described in Section 7.1.9.3, in the unlikely event of a hydrocarbon blowout, the use of dispersants will be considered as a spill countermeasure. As noted in Section 7.3.1.3.2, the use of chemical dispersants has the potential to affect fish and fish habitat and therefore has potential to affect commercial fisheries. The US Food and Drug Administration conducted laboratory tests on the effects of a commonly used dispersant on Eastern oyster, blue crab, and red snapper and found little to no bioaccumulation; the dispersant was depurated from the organisms' tissues with 24 to 72 hours (Tjeerdema et al. 2013). Seafood species collected during the Deepwater Horizon spill detected dioctylsulfosuccinate sodium salt, a highly water-soluble component of dispersants, in 4 of 299 tissue samples and determined that it was unlikely to pose a risk to aquatic receptors due to low tissue concentrations, low bioaccumulation, and rapid depuration (Tjeerdema et al. 2013). Nevertheless, the risk of effects on public perception and the marketability of potentially affected products remain.

7.3.2.3.3 SBM Spill

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). A fisheries closure and fouling of gear would be unlikely given the relatively small spatial and temporal footprint of the spill event.

7.3.2.3.4 Summary

Table 7.25 provides a summary of predicted residual environmental effects of accidental events on commercial fisheries.

Table 7.25 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 Fishery Resources							
Diesel Batch Spill from OSV and MODU (10 bbl and 100 bbl scenarios)	A	L	SA	ST	S	R	D
Subsea and Surface Hydrocarbon Blowout (blowout rates of 40,476 bopd)	A	H	SA	ST-MT	S	R	D
SBM Spill	A	L	PA	MT	S	R	D

KEY:
See Table 6.7 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
SA: Study 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

7.3.2.4 Determination of Significance

In consideration of the information presented above, the predicted residual environmental effects from a diesel batch spill on commercial fisheries is not significant, where local fishers are unlikely to be displaced or unable to use portions of the areas currently commercially fished for all or most of a fishing season; experience a change in the availability of fisheries resources (e.g., fish mortality and/or dispersion of stocks) so that resources cannot continue to be used at current levels within the Study Area for more than one fishing season; or unmitigated damage to fishing gear.

Given the extensive nature of the worst-case, unmitigated blowout event, a significant effect is conservatively predicted for commercial fisheries for this scenario. The likelihood of this significant effect occurring is considered low, given the very low potential for a blowout to occur (see Section 7.2.2) and given the response measures that would be in place to mitigate potential effects. Husky will adhere to safety and risk management systems, management of change procedures and global standards. This includes the implementation of spill prevention that will be incorporated into the design and operations for all Project activities as part of contingency planning. Spill response planning is described in detail in Section 7.1.

7.3.3 Marine Mammals and Sea Turtles

7.3.3.1 Project Pathways for Effects

All the accidental events scenarios described above have 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. In the unlikely event of a large oil spill in the Study Area, marine mammals and sea turtles could be adversely affected, particularly by oil fouling and ingestion with water, contaminated food, or absorbed through the respiratory tract. The extent of the potential effects on marine mammals and sea turtles depends on level of exposure to the toxic components of the oil. Potential for accidental vessel strikes is discussed and assessed in Section 6.3.

7.3.3.1.1 Potential Effects on Marine Mammals

Hydrocarbons can be inhaled or ingested, and may cause behavioural changes, inflammation of mucous membranes, pneumonia, and neurological damage; however, many marine mammals seem to show a relatively high tolerance level to oil spills (Geraci and St. Aubin 1990). Whales and seals rely on a layer of blubber for insulation, and so oil has little effect on thermoregulation. In baleen whales, crude oil could coat the baleen and reduce filtration efficiency; but, these effects are considered to be reversible (Geraci 1990). Seals fouled externally with heavy oil may also encounter problems with locomotion, with flippers becoming stuck to their sides (Sergeant 1991). If oil contacted the eyes, effects could include conjunctivitis, corneal abrasion and swollen nictitating membranes, with continued exposure to eyes causing permanent damage (St. Aubin 1990). Damage to the visual system would likely limit foraging abilities, as vision is an important sensory modality used to locate and capture prey.

In addition to effects related to fouling, animals could ingest oil with water, contaminated food, or oil could be absorbed through the respiratory tract; absorbed oil could cause toxic effects (Geraci 1990). 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). Some of the ingested oil is voided in vomit or feces, but some is absorbed and could cause toxic effects (Geraci 1990). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982). Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980, 1982). Only small traces of oil were found in the blubber of a gray whale and liver of a killer whale exposed to *Exxon Valdez* oil (Bence and Burns 1995).

Direct evidence of long-term effects from chronic exposure to hydrocarbons, either through surface contact or ingestion, is lacking for both pinnipeds and cetaceans. However, Spraker et al. (1994) found lesions characteristic of hydrocarbon toxicity in the brains of oiled seals collected several months after the *Exxon Valdez* spill. Killer whales have been shown to be susceptible to accumulating high concentrations of persistent organic pollutants, as they are long lived and are top predators (Ross et al. 2000, 2002).

Inhalation of vapours from volatile fractions of oil from a spill could potentially irritate respiratory membranes and hydrocarbons could be absorbed into the bloodstream (Geraci 1990). Absorbed oil can cause toxic effects such as minor kidney, liver and brain lesions (Geraci and Smith 1976; Spraker et al. 1994); but contaminated animals could depurate this oil when returned to clean water (Engelhardt 1982). Following the Deepwater Horizon 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 2014). 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 six individuals were visibly oiled (NOAA 2010).

There have been several studies on the ability of marine mammals to detect and/or avoid oil-contaminated waters, with varying results (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, 1999). It is possible that cetaceans swim through oil because of an overriding behavioural motivation (for example, feeding). Some evidence exists that indicates dolphins attempt to minimize contact with surface oil by decreasing their respiration rate and increasing dive duration (Smultea and Würsig 1995).

A comparison of sperm whale acoustic activity from pre-spill (2007) and post-spill (2010) conditions, Ackleh et al. (2012) suggested that sperm whales may have relocated farther away from the Deepwater Horizon oil spill site, with a statistically significant reduction in acoustic activity and abundance at a site 40 km (25 miles) compared with 14.5 km (9 miles) from the spill in 2010.

There is conflicting evidence on whether seals detect and avoid spilled oil. Some oiled seals hauled out on land are reluctant to enter the water, even when disturbances from intense cleanup activities occur nearby (St. Aubin 1990; Lowry et al. 1994). In contrast, several thousand grey and harbour seals apparently left Chedabucto Bay, Nova Scotia, after the grounding of the Arrow (Sergeant et al. 1970, in St. Aubin 1990); although this movement may have been caused by the increased human disturbance during cleanup activities rather than by the presence of oil (St. Aubin 1990). Harbour seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994). Other seals have been observed swimming in the midst of oil spills (St. Aubin 1990). Oiling of both mother and pups does not appear to interfere with nursing (Lowry et al. 1994). Following a ruptured storage tank on Cape Tormentine, New Brunswick, releasing 4,000 gal of Bunker C oil into the Gulf of St. Lawrence in an area of sea ice where harp seals were about to pup, 10,000 to 15,000 oil-fouled adults and pups were reported to be heavily contaminated (St. Aubin 1990). Even though the oil-fouled pups migrated as normal towards the Strait of Belle Isle, it was reported that the harp seals were easily taken weeks later by seal hunter as the animals uncharacteristically would not leave the ice floes (Sergeant 1987, in St. Aubin 1990). The young pups were weaned and mature enough to swim; however, they were impeded by the coating of oil that stuck their flippers to their sides (St. Aubin 1990).

A study on the effects of oil coating on harp seals was conducted in 1975 using six experimental seals brushed with oil and three control seals (Geraci and Smith 1977). The six experimental seals showed signs of distress, obviously agitated, and showed sign of eye disturbance (i.e., lacrimation, squinting, conjunctivitis, swollen nictitating membranes). When removed to clean water pens, there was minimal evidence that they had been oiled by third and fourth days as the eye problems disappeared and behaviour became normal (Geraci and Smith 1977). The seals were killed and examined, oil was found in all organs except the lungs, with the highest concentrations found in the urine and bile, suggesting increased gastrointestinal motility (St. Aubin 1990; Geraci and Smith 1977). No relevant lesions were noted (St. Aubin 1990).

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. Following the *Exxon Valdez* oil spill, sea otters (*Enhydra lutris*), harbour seals, Stellar sea lions (*Eumetopias jubatus*), killer whales, and humpback whales were most affected by the spill (Lee et al. 2015). Continued monitoring over 16 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). However, 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.

Several years after the *Exxon Valdez* oil spill in Prince William Sound, there remains uncertainty about effects of the oil spill and recovery of cetaceans. Several dead gray whales were found during the year of the *Exxon Valdez* spill; however, a causal link could not be established (Loughlin 1994; *Exxon Valdez* Oil Spill Trustee Council 2012). 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 Deepwater Horizon oil spill, the low estimated carcass recovery rates of cetaceans (as low as 2%) (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).

7.3.3.1.2 Potential Effects on Sea Turtles

It is unknown whether sea turtles can detect and avoid oil slicks. 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). According to Milton et al. (2003), sea turtles (including SAR and SOCC) appear to be at particular risk to oil spills, because they do not respond with avoidance behaviour, they exhibit indiscriminate feeding in areas and they take large pre-dive inhalations. The ingestion of tar or oil by sea turtles has been documented by numerous studies (e.g., Hall et al. 1983; Balazs 1985; Gramentz 1988; Loehefener et al. 1989; Witherington 1994; Lutz 1989; Bugoni et al. 2001; Torrent et al. 2002).

Sea turtles are often found heavily oiled after a spill. In the US, approximately 1% of sea turtle strandings are associated with oil (Lutcavage et al. 1997, in Milton et al. 2003). NMFS (2011) documented 609 dead sea turtles in 2010 after the Deepwater Horizon spill in the Gulf of Mexico, with at least 18 of the dead turtles visibly oiled. Gross histologic lesions developed in loggerhead sea turtles experimentally exposed to oil, but most effects were apparently reversed by the tenth day after exposure (Bossart et al. 1995). Similarly, Lutcavage et al. (1995) found that juvenile loggerhead turtles exposed to weathered crude oil exhibited gross and histologic changes in the skin and mucosal surfaces, but that the turtles recovered with 21 days. Oil may also reduce lung diffusion capacity, decrease oxygen consumption or digestion efficiency, or damage nasal and eyelid tissue (Lutz et al. 1989); as well, it can have negative effects on the skin, blood, digestive and immune systems and salt glands as well as increased egg mortality and developmental defects (Milton et al. 2003).

7.3.3.2 Mitigation

As per HOIMS, Husky will implement several measures and preventative actions into the daily operation and maintenance of a MODU. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to minimize the likelihood of an accident or malfunction. As noted in Section 7.1, Husky has an established corporate Incident Coordination and Response Management Plan (EC-M-99-X-PR-00003-001) and an Oil Spill Response Procedure - East Coast Oil Spill Response Plan (EC-M-99-X-PR-00125-001). These plans include a number of different options and contingencies to address responding to emergency events, including potential spills and well control events. All relevant plans are submitted to the C-NLOPB prior to the start of any drilling activities in offshore Newfoundland and Labrador. The oil spill response procedure will outline response methods and strategies for addressing different levels of oil spills. Response methods for oil spills that will be considered include but are not limited to: offshore containment and recovery; surveillance and tracking of spills; dispersant application, and wildlife response measures.

In the unlikely event of an accidental event such as a large spill or a blowout, specific monitoring programs (e.g., environmental effects monitoring and follow up) may be required for the Project. In such case, these programs will be developed and implemented in consultation with the appropriate regulatory agencies.

7.3.3.3 Assessment of Residual Environmental Effects on Marine Mammals and Sea Turtles

7.3.3.3.1 Diesel Batch Spill from MODU and OSV

Modelling results indicate that diesel spills from the MODU or OSV are not likely to result in biological effects over a large area. A diesel fuel spill was estimated to have a slick survival time of 48 hours (SL Ross 2012) and would thus have reduced effects on marine mammals and sea turtles (including SAR and SOCC) compared to a crude oil spill. With respect to a change in habitat quality and use for marine mammals and sea turtles, most diesel from a spill from either the MODU or OSV will create a temporary and reversible degradation in habitat quality. These effects would be short-term in duration until the slick disperses and diesel content in the area reaches background levels and is not expected to create permanent or irreversible changes to habitat quality and use. There is no designated critical habitat for marine mammals and sea turtle SAR within the Project or Study Areas.

As described in Section 7.3.3.1, 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 (Geraci and St. Aubin 1990). Except in the case of a vessel spill of diesel during transit to the nearshore, the likelihood of seals encountering 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). It is probable that only a small proportion of a species population would be within the area affected by the spill. Given the foregoing, marine mammals and sea turtles (including SAR and SOCC) are not considered to be at high risk from a diesel spill.

In the unlikely event there is a spill of marine diesel fuel in the nearshore, oil spill response plans will be initiated to contain and clean-up the spill to mitigate potential environmental effects. Residual effects from a nearshore diesel spill from the OSV could include localized mortality and sub-lethal effects to marine mammals and sea turtles. As discussed in Section 7.2.2, a nearshore spill is not predicted to reach the shoreline and will dissipate within 120 hours (during the autumn and winter) and 240 hours (during spring and summer).

7.3.3.3.2 Subsea and Surface Hydrocarbon Blowout

As described in Section 7.3.1.3.2, the oil from a subsea or surface blowout is predicted to be persistent under both summer and winter conditions, natural dispersion would be low, and the oil would remain at the surface for an extended period. A shallow water blowout incident has 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 depends on how the spill trajectory and marine mammals and sea turtles overlap in space and in time.

It is difficult to predict with precision the effects of a change in risk of mortality or physical injury of an accidental event on biota, especially as they relate to the geographic extent of the effects. Numerous parameters (e.g., chemical composition of the hydrocarbon, behaviour of spilled substance at different times of year) influence hydrocarbon spill characteristics and there are many unknowns concerning effects on different marine mammal and sea turtle groups. It may be possible under calm conditions to clean up a large proportion of spilled petroleum hydrocarbons; however, only a small percentage offshore can be retrieved under typical wind and wave conditions, especially in winter. Therefore, there will be an emphasis on accident prevention at all phases of the Project.

Marine mammals and sea turtles (including SAR and SOCC) are not considered to be at high risk from the effects of oil exposure, but some evidence implicates oil spills with seal mortality, particularly young seals. Sea turtle carcasses are also often found after a spill. However, harbour seals are considered rare in the Study Area, and grey seals as well as sea turtles (including the leatherback sea turtle and loggerhead sea turtle) are expected to be uncommon. The harp seal has been recorded in the Study Area and in the Project Area during years with heavy ice pack. As described above (Section 7.3.3.2), seals have the potential to be affected by oiling, causing a change in behaviour and eye problems. Baleen whales appear to be less susceptible to spills than delphinids, as dolphins are often found stranded after an oil spill. Thus, delphinids that occur in the Study Area at the time of the spill are most susceptible to fouling. Although effects of the *Exxon Valdez* oil spill were substantial on killer whales, killer whales are uncommon in the Study Area, and no population-level effects would be expected.

Animals exposed to heavy doses of hydrocarbons for prolonged periods could experience mortality. Chronic exposure to hydrocarbons, either through surface contact or ingestion, may occur in cetaceans, seals, and sea turtles. Hydrocarbon toxicity could result in physiological damage, such as lesions and effects on blood and enzyme chemistry.

There is potential for a change in habitat quality and use as a hydrocarbon spill may indirectly reduce the amount of habitat available to marine mammals or sea turtles by rendering it temporarily unsuitable for foraging and other activities. Since oil is not expected to reach the shore if a spill occurs in the Study Area, hauled out seals are not expected to be affected.

For marine mammals and sea turtles (including SAR and SOCC), it is probable that only small proportions of populations are at risk at any one time in the Study Area. Oil spill prevention measures, along with typical oil spill countermeasures (refer to Section 7.1) will reduce the number of animals exposed to oil. This includes the use of dispersants as a spill countermeasure (Section 7.1.9.3). Marine mammals are susceptible to floating oil due to the fact they need to surface at regular intervals to breathe and therefore chemically dispersed oil may be beneficial for mammals within a spill area to breathe. However, the dispersion of oil as described in Section 7.1.9.3.1, may expose swimming or feeding marine mammals to skin/fur contamination, the consumption of contaminated plankton, and potentially the clogging of baleen (Lee et al. 2015). Hydrocarbons consumed by marine mammals through contaminated diets can be metabolized and excreted, although some will be stored in blubber and other fat deposits which may be released into circulation during periods of physiological stress (low prey availability, migration, lactation). These circulating hydrocarbons may be bioavailable and toxic to fetus or newborns (Lee et al. 2015).

7.3.3.3.3 SBM Spill

The acute toxicity of SBMs is considered relatively low and below environmental guidelines and effects are mostly restricted to physical smothering effects on the sea floor (C-NLOPB 2011). In the event of a SBM spill, effects would be a temporary reduction in habitat quality, and any interaction between SBM and marine mammals and sea turtles would be limited. Any risk of physical injury would be limited to individuals in the immediate vicinity of the spill.

7.3.3.3.4 Summary

Table 7.26 provides a summary of predicted residual environmental effects of accidental events on marine mammals and sea turtles.

Table 7.26 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							
Diesel Batch Spill from OSV and MODU (10 bbl and 100 bbl scenarios)	A	M	SA	ST	S	R	D
Subsea and Surface Hydrocarbon Blowout (blowout rates of 40,476 bopd)	A	H	SA	ST-MT	S	R	D
SBM Spill	A	N-L	PA	MT	S	R	D

KEY:
See Table 6.11 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
SA: Study 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

7.3.3.4 Determination of Significance

In consideration of the present knowledge of Jeanne d'Arc Basin, the modelling exercises, and on past monitoring experience with large spills (e.g., Deepwater Horizon, Exxon Valdez, Arrow and others), the predicted residual environmental effects from any of the accidental event scenarios on marine mammals and sea turtles is not significant (i.e., not predicted to cause a decline in abundance or change in distribution of marine mammal or sea turtle populations within the Study Area, 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). Depending on the time of year, location of animals within the affected area, and type of oil spill, the effects of an offshore oil release on the health of cetaceans is not predicted to cause a decline in abundance or change in distribution of marine mammal or sea turtle populations within the Study

Area; jeopardize the achievement of self-sustaining population objectives for listed SARA species; or result in permanent/irreversible loss of critical habitat. Husky will adhere to safety and risk management systems, management of change procedures and global standards. This includes the implementation of spill prevention that will be incorporated into the design and operations for all Project activities as part of contingency planning. Spill response planning is described in detail in Section 7.1.

7.3.4 Migratory Birds

7.3.4.1 Project Pathways for Effects

All of the identified accidental event scenarios (i.e., diesel batch spill, and blowout incident) can result in a change in risk of mortality or physical injury and change in habitat quality and use for migratory birds. Migratory birds are the most visible and among the first species impacted 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. Reported effects vary with species, type of oil, weather conditions, time of year and duration of the spill (Gorsline et al. 1981).

Diving species such as black guillemot, murres, Atlantic puffin, dovekie, eiders, long-tailed duck, scoters, red-breasted merganser (*Mergus serrator*) and loons 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). Alcids, especially common and thick-billed murres, often have the highest oiling rate of marine birds recovered from beaches along the south and east coasts of the Avalon Peninsula, Newfoundland and Labrador (Wiese and Ryan 2003). Other species such as northern fulmar, shearwaters, storm-petrels, gulls and terns are vulnerable to contact with oil because they feed over wide areas and make frequent contact with the water's surface.

Exposure to oil causes thermal and buoyancy deficiencies that typically lead to the deaths of affected migratory birds. Most mortalities occur during the initial phase of oil spills, when large numbers of birds are exposed to floating oil (Hartung 1995). 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. The external exposure results in matting of the feathers, which effectively destroys the thermal insulation and buoyancy provided by the air trapped by the feathers. Consequently, oiled birds may suffer from hypothermia and/or drown (Clark 1984; Hartung 1995).

Oiled birds that escape death from hypothermia and/or drowning often seek refuge ashore, where they engage in abnormally excessive preening in an attempt to remove the oil (Hunt 1957, in Hartung 1995). The preening leads to the ingestion of substantial quantities of oil that, although apparently only partially absorbed (McEwan and Whitehead 1980) can cause lethal effects. The extent of bioaccumulation of the chemical components of oil in birds is limited because vertebrate species can metabolize them at rates that reduce bioaccumulation (Neff 1985, in

Hartung 1995). Birds generally excrete much of the hydrocarbons within a short time (McEwan and Whitehead 1980).

Another commonly observed effect is adrenal hypertrophy. This condition tends to make birds more vulnerable to adrenocortical exhaustion; this includes mallards (Hartung and Hunt 1966; Holmes et al. 1979), black guillemots (Peakall et al. 1980) and herring gulls (Peakall et al. 1982). The adrenal gland maintains water and electrolyte balance that is essential for the survival of birds living in the marine environment. Hartung and Hunt (1966) found that ingested oils can cause lipid pneumonia, gastrointestinal irritation, and fatty livers in several species of ducks.

Birds exposed to oil are also at risk of starvation (Hartung 1995). For example, oiled common eiders generally deplete all of their fat reserves and much of their muscle protein (Gorman and Milne 1970). Energy demands are higher because the metabolic rate of oiled birds increases to compensate for the heat loss caused by the reduced insulating capacity of their plumage. This can expedite starvation (Hartung 1967; McEwan and Koelink 1973).

Nesting birds that have survived oil contamination generally exhibit decreased reproductive success as they transfer oil from their plumage and feet to their eggs (Albers and Szaro 1978). Very small quantities (1 to 20 µL) of oil on eggs have produced developmental defects and mortality in avian embryos of many species (Albers 1977; Albers and Szaro 1978; Hoffmann 1978, 1979a; Macko and King 1980; Parnell et al. 1984; Harfenist et al. 1990). The resultant hatching and fledging success of young appears to be related to the type of oil (Hoffman 1979b; Albers and Gay 1982; Stubblefield et al. 1995) and the timing of exposure during incubation. Embryos are most sensitive to oil during the first half of incubation (Albers 1978; Leighton et al. 1985). Breeding birds that ingest oil generally exhibit a decrease in fertilization (Holmes et al. 1978), egg laying and hatching (Hartung 1965; Ainley et al. 1981), chick growth (Szaro et al. 1978) and survival (Vangilder and Peterle 1980; Trivelpiece et al. 1984), as well as a reduction in mean eggshell thickness and strength (Stubblefield et al. 1995).

It is difficult to estimate how many migratory birds are oiled during any oil spill, because some birds may not reach shore (dead or alive), and beached carcasses may be scavenged or washed out to sea before being counted (Ford et al. 1987). There is also no clear correlation between the size of an oil spill and numbers of marine birds killed, because the density of birds in a spill area, wind velocity and direction, wave action, and distance to shore can have a greater bearing on mortality than the size of the spill (Burger 1993). Even small spills can cause cumulative mass mortality of marine birds (Joensen 1972; Carter et al. 2003; Hampton et al. 2003). In contrast, relatively low mortalities have been recorded from some large spills. For example, the *Amoco Cadiz* spilled 230,000 tonnes of crude oil along the French coast, causing the recorded deaths of 4,572 birds (Clark 1984).

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). On a broader geographical scale, estimates of the number of birds that die annually from spills range from 21,000 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 sources.

Some studies have suggested that oil pollution is unlikely to have major long-term effects on bird productivity or population dynamics (Clark 1984; 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), while others suggest the opposite (Piatt et al. 1990; Walton et al. 1997; Votier et al. 2005). Natural inter-annual variation in other factors that affect populations (e.g., prey availability and weather) reduces the ability of scientists to assess the full effect of oil spills on bird populations (Eppley 1992; White et al. 1995; Votier et al. 2005).

Studies conducted following the *Exxon Valdez* oil spill in 1989 have tried to ascertain whether marine bird populations have recovered in the Prince William Sound area in Alaska. Esler et al. (2002) noted that as of 1998, the harlequin duck population that winters in Prince William Sound had not yet recovered, based on initial high mortalities, the decrease in population size only in oiled areas during 1995 to 1997, and the finding that fewer female adults survived winters in oiled areas possibly because of continued oil exposure. Based on modelling, Iverson and Esler (2010) suggested a population recovery time of 24 years for harlequin duck after the *Exxon Valdez* spill.

For other populations in Prince William Sound, it is not as clear whether they have or have not yet recovered. However, it was found that different bird populations responded differently to the *Exxon Valdez* oil spill. Some populations showed little signs of being affected, other populations recovered quickly, and some populations took as much as a decade to fully recover (e.g., Pigeon Guillemot; Golet et al. 2002, in Esler et al. 2002). Populations of bird species with little genetic differentiation among breeding colonies are less likely to be affected severely by an oil spill because they have a greater potential for population recovery (Riffaut et al. 2005).

There are possible changes in habitat quality and use of oiled areas by both oiled and un-oiled birds. After a large oil spill off the coast of Washington by the *Nestucca* in December 1988, a study of oiled shorebirds suggested that within 10 days of the oil spill they could be found at beach roosting sites, but that after 10 days they tended to remain in the harbour rather than complete their usual return flight to beach roosting sites at high tide (Larsen and Richardson 1990). In June 1979, an oil blowout occurred from the *Ixtoc I* in the Gulf of Mexico off Mexico, causing shorebirds there to avoid oil-affected foreshores and instead use poorer backshore feeding habitats and freshwater pools (Chapman 1981). Three months after the oil spill, storms cleaned the beaches, but shorebirds failed to return to the foreshore feeding habitats at their pre-spill levels (Chapman 1981).

The greatest decrease in use of contaminated habitats immediately following a spill occurs in species that feed on or close to shore and either breed along the coast or are full-year residents (Wiens et al. 1996). Day et al. (1995) showed that species lacking clear evidence of recovery tended to be intertidal feeders and residents. However, they also found that other ecologically-similar species did not show signs of initial effects or showed rapid recovery.

7.3.4.2 Mitigation

As per HOIMS, Husky will implement several measures and preventative actions into the daily operation and maintenance of a MODU. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to minimize the likelihood of an accident or malfunction. As noted in Section 7.1, Husky has an established corporate Incident Coordination and Response Management Plan (EC-M-99-X-PR-00003-001) and an Oil Spill Response Procedure - East Coast Oil Spill Response Plan (EC-M-99-X-PR-00125-001). These plans include a number of different options and contingencies to address responding to emergency events, including potential spills and well control events. All relevant plans are submitted to the C-NLOPB prior to the start of any drilling activities in offshore Newfoundland and Labrador. The oil spill response procedure will outline response methods and strategies for addressing different levels of oil spills. Response methods for oil spills that will be considered include but are not limited to: offshore containment and recovery; surveillance and tracking of spills; dispersant application, and wildlife response measures.

Routine checks for stranded birds will be conducted on the MODU and OSVs and appropriate procedures for release will be implemented. If stranded birds are found during inspections, they will be handled using the protocol outlined in *Best Practices for Stranded Birds Encountered Offshore Atlantic Canada* (Environment Canada 2015) and *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.

In the unlikely event of an accidental event such as a large spill or a blowout, specific monitoring programs (e.g., environmental effects monitoring and follow up) may be required for the Project. In such case, these programs will be developed and implemented in consultation with the appropriate regulatory agencies.

7.3.4.3 Assessment of Residual Environmental Effects on Migratory Birds

7.3.4.3.1 Diesel Batch Spill from MODU and OSV

Oil spill modelling within the White Rose field indicates that a batch diesel spill was estimated to have a slick survival time of 48 hours (SL Ross 2012) and would thus have reduced effects on migratory birds compared to a large-scale crude oil spill. A batch spill will result in 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; however, effects would be short-term in duration until the slick disperses and the diesel content in the area reaches background levels.

Regarding a change in risk of mortality or physical injury, a diesel batch spill may affect migratory birds (including SAR and SOCC) through direct contact; however, it is predicted that the number of birds affected would be restricted given the short time and small area where the diesel would be on the water's surface. Mortality can also be a result of ingestion during preening and hypothermia due to matted feathers (NOAA 2016). Birds that survive the immediate effects of contact with diesel, may experience long-term physiological changes, lower reproductive rates, or premature death. Oiled migratory birds foraging at sea can bring hydrocarbons back to their nest resulting in contamination of their eggs or nestlings, causing embryo or nestling mortality.

With respect to nearshore environment, the nearest Important Bird Area (IBA) is located outside the Project and Study Areas in St. John's (terminus of the Project Area) (IBA NV022: Quidi Vidi Lake). Seven locations within 3 km of the Project Area support nesting seabirds: Quidi Vidi Lake, Blackhead, Blow Me Down, Deadmans Bay, Freshwater Bay, Logy Bay, and Spriggs Point. Freshwater Bay supports nesting black-legged kittiwakes, herring gulls, and great black-backed gulls; Deadman's Bay and Spriggs Point support colonies of black-legged kittiwakes and herring gulls; colonies of black-legged kittiwakes occur at Blackhead and Blow Me Down; and herring gulls nest at Logy Bay. If marine diesel is released into the nearshore environment (e.g., in the unlikely event of an OSV accident resulting in a nearshore release of fuel oil), coastal habitats that migratory birds depend on, could be affected and result in a decrease in habitat quality. As discussed in Section 7.2.2, a nearshore spill is not predicted to reach the shoreline and will dissipate within 120 hours (during the autumn and winter) and 240 hours (during spring and summer). A batch spill of diesel is not expected to create permanent or irreversible changes to habitat quality and use.

7.3.4.3.2 Subsea and Surface Hydrocarbon Blowout

As described in Section 7.3.1.3.2, the oil from a subsea or surface blowout is predicted to be persistent under both summer and winter conditions, natural dispersion would be low, and the oil would remain at the surface for an extended period.

The presence of hydrocarbons may temporarily affect habitat quality for birds. Prey availability may be reduced and/or migratory birds may react by avoidance of affected habitat. Sublethal effects of hydrocarbons ingested by migratory birds may affect their reproductive rates or survival rates. Sublethal effects may persist for several years, depending upon generation times of affected species and the persistence of any spilled hydrocarbons.

The only migratory bird SAR or SOCC likely to occur in the Study Area are the Ivory Gull (listed as *endangered* under Schedule 1 of SARA, by COSEWIC, and under the NL ESA) and the Red-necked Phalarope (listed as a species of *special concern* by COSEWIC). As discussed in Section 7.3.4.1, exposure to hydrocarbons frequently leads to hypothermia and death of affected migratory birds (including the SAR and SOCC). Although some may survive these immediate effects, long-term physiological changes may eventually result in death. Adult 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. However, in the remote possibility that hydrocarbons released at the MODU reached the exposed coast, a slick would likely be rapidly weathered and dispersed on the high energy, rocky coastline.

As described in Section 7.1.9.3, in the unlikely event of a hydrocarbon blowout, the use of dispersants will be considered as a spill countermeasure. For migratory birds, the use of dispersants has the potential to reduce effects as it can result in less exposure of migratory birds to 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 also less likely to reach coastal areas (Kildrufff and Lopez 2012). However, 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 to reducing effects on seabirds. A review of the effects of oil pollution, chemically treated oil, and cleaning on the thermal balance of birds identified that the effects from oil-dispersant contamination may be similar to 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). 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).

A subsea blowout in July would have the greatest effect on shearwaters, storm-petrels, and murres with up to 49,000 birds affected, representing 0.3%, 0.2%, and 0.04% of the target populations, respectively. Dispersants (either applied to the surface slick or injected subsea) would reduce the number affected to 9,000 birds affected, representing 0.06%, 0.04%, and <0.01% of the target populations, respectively. A subsea blowout in January would have the greatest risks both in terms of numbers and proportion of the population murres (0.3%), dovekies (0.6%), and fulmars (0.8%). A surface application of dispersants would reduce the potential effect to 0.08% (murres) and 0.2% (dovekies and fulmars). While surface dispersant operations may not be 100% effective, subsea injection of dispersants can be expected to be more effective. Even if dispersant operations are only 50% to 70% effective, they will reduce the anticipated large impact on birds by 50% to 70% (SL Ross and LGL Limited 2013 (draft)).

7.3.4.3.3 SBM Spill

SBM whole mud spills, if they accidentally occur, have some potential to form a sheen on the water's surface. However, the most likely scenario would be a release at depths greater than usually used by migratory birds. The muds used are selected for their low toxicity to organisms. The density of SBMs would favour sinking to the sea bottom. The SBM will biodegrade within weeks to months depending upon water temperature and other physical factors.

7.3.4.3.4 Summary

Table 7.27 provides a summary of predicted residual environmental effects of accidental events on migratory birds.

Table 7.27 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							
Diesel Batch Spill from OSV and MODU (10 bbl and 100 bbl scenarios)	A	L	SA	ST	S	R	D
Subsea and Surface Hydrocarbon Blowout (blowout rates of 40,476 bopd)	A	H	SA	ST-MT	S	R	D
SBM Spill	A	N-L	PA	MT	S	R	D

KEY:
See Table 6.18 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
SA: Study 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

7.3.4.4 Determination of Significance

Based on the information above, a precautionary conclusion is drawn that the residual adverse environmental effect of a blowout incident is predicted to be significant for migratory birds, but not likely to occur. Although hydrocarbon spills would likely be significant at the individual level, these environmental effects are predicted to be reversible at the population level. The threshold for significance used in this environmental assessment is: if the consequences are carried over more than one generation; or self-sustaining population objectives or recovery goals for listed species are jeopardized. This is considered possible but 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.

Infrequent batch spills would be not significant. Smaller scale spills in calm conditions may be mitigated via oil spill response measures and marine bird rehabilitation; however, these mitigations are recognized to be limited. Husky will adhere to safety and risk management systems, management of change procedures and global standards. This includes the implementation of spill prevention that will be incorporated into the design and operations for all Project activities as part of contingency planning. Spill response planning is described in detail in Section 7.1.

7.3.5 Special Areas

7.3.5.1 Project Pathways for Effects

As discussed in Section 4.2.9, there is one special area that overlap with the Project Area: the Northeast Shelf and Slope EBSA (EL 1151). The Flemish Pass/Eastern Canyon Closure Zone is managed by NAFO and closed to all bottom fishing activity to preserve the existing benthic environment, mainly due to the presence of deep-sea corals and sponges. The Northeast Shelf and Slope EBSA is recognized for supporting northern wolffish and Greenland halibut populations, as well as providing a feeding area for marine mammals, including cetaceans and pinnipeds.

Outside of the Northeast Shelf and Slope EBSA that overlap with the Project Area, there are 24 other special areas that fall within the Study Area (see Table 6.24), most of which have some potential to be affected by an accidental event occurring in the Study Area.

All the accidental scenarios identified above, including batch spills from the MODU and vessel and a subsea and surface blowout, can interact with special areas, resulting in a change in habitat quality. Potential adverse effects on special areas may degrade the ecological components of the area for which it is valued and thus designated (e.g., protection of commercially important or sensitive species). Therefore, the assessment of special areas is closely linked to the other VCs considered in the EA. In general, potential effects on species from accidental events are addressed in the assessment undertaken for other VCs, including marine fish and fish habitat (Section 7.3.1), migratory birds (Section 7.3.4), and marine mammals and sea turtles (Section 7.3.3). The assessment of effects on special areas focuses on a change in habitat quality.

The WREP EA modelled spill site source was located near the middle of the exploration Project Area, approximately 17 km southwest from the centroid of EL 1152. The centroid for EL 1155 is approximately 48 km northwest and the centroid for EL 1151 is approximately 43 km northeast from the modelled spill source. Moving the spill model origin tens of kilometres would not affect the outcome of the model nor the effects assessment of sensitive areas within EL 1151. A subsurface blow out at these water depths is expected to have little impact on benthic habitat outside the immediate area of the wellsite. The entire plume is expected to reach the surface and not be impeded by hydrate formation. The persistent oil slicks of crude oil generally travel to the east and southeast due to the prevailing winds and surface water currents. The model predicts minimal dispersion of the oil due to water-in-oil emulsification, high oil viscosity, and high oil pour point. Up to 3% of the oil may be lost to evaporation. The oil will be present in small bits or tar balls separated by large expanses of oil-free water after being broken up by waves. The portion of oil that is not dispersed, evaporated, or biodegraded will comprise compounds similar to bitumen or asphalt. These are largely biologically inert and of low toxicity. Some of these compounds may eventually be deposited on the seabed at extremely low concentrations over a large area, posing no risk to marine life (IPIECA-IOGP 2015).

Impacts from a subsea petroleum blowout to benthic communities are expected to be confined to the immediate vicinity of the well. Subsurface blowouts can resuspend sediments, which could be deposited in an area around the well. Given the scale of the area potentially impacted from a blowout scenario, the impacted area of benthic habitat would be relatively small in scale (MMS 2008.)

7.3.5.2 Mitigation

As per HOIMS, Husky will implement several measures and preventative actions into the daily operation and maintenance for a MODU. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to minimize the likelihood of an accident or malfunction. As noted in Section 7.1, Husky has an established corporate Incident Coordination and Response Management Plan (EC-M-99-X-PR-00003-001) and an Oil Spill Response Procedure - East Coast Oil Spill Response Plan (EC-M-99-X-PR-00125-001). These plans include a number of different options and contingencies to address responding to emergency events, including potential spills and well control events. All relevant plans are submitted to the C-NLOPB prior to the start of any drilling activities in offshore Newfoundland and Labrador. The oil spill response procedure will outline response methods and strategies for addressing different levels of oil spills. Response methods for oil spills that will be considered include but are not limited to: offshore containment and recovery; surveillance and tracking of spills; dispersant application, and wildlife response measures.

In the unlikely event of an accidental event such as a large spill or a blowout, specific monitoring programs (e.g., environmental effects monitoring and follow up) may be required for the Project. In such case, these programs will be developed and implemented in consultation with the appropriate regulatory agencies.

7.3.5.3 Assessment of Residual Environmental Effects on Special Areas

7.3.5.3.1 Diesel Batch Spill from OSV and MODU

Due to the limited and temporary nature of any surface oiling because of a batch spill, it is not expected to result in permanent alteration or destruction of habitat quality for special areas within the Study Area. Dissolved hydrocarbons from spilled diesel would be limited to the surface and mixed layer of the water column, therefore the potential for benthic habitat exposure is considered low.

In the unlikely event there is a spill of marine diesel fuel in the nearshore, oil spill response plans will be initiated to contain and clean-up the spill to mitigate potential environmental effects. As discussed in Section 7.2.2, a nearshore spill is not predicted to reach the shoreline and will dissipate within 120 hours (during the autumn and winter) and 240 hours (during spring and summer) and not interact with special areas.

7.3.5.3.2 Subsea and Surface Blowout

As described in Section 7.3.1.3.2, the oil from a subsea or surface blowout is predicted to be persistent under both summer and winter conditions, natural dispersion would be low, and the oil would remain at the surface for an extended period. Natural dispersion will be minimal in all the subsea blowout scenarios either due to emulsion formation or the high oil pour point and cold water. In-water oil concentrations from these spills will remain below 0.001 ppm. The NEBA conducted for the Grand Banks determined that injurious concentrations of oil would occur only in the upper 10 m of the column (SL Ross and LGL Limited 2013). Generally, species and life stages within the upper water column are most vulnerable to an oil spill, even from a subsurface blowout. Subsea discharges of oil released in shallow water (i.e., less than 400 m) will rapidly reach the surface. The portion of oil that is not dispersed evaporated or biodegraded will comprise compounds similar to bitumen or asphalt. These are largely biologically inert and of low toxicity. Some of these compounds may eventually be deposited on the seabed at extremely low concentrations over a large area, posing no risk to marine life (IPIECA-IOGP, 2015). Impacts from a subsea petroleum blowout to benthic communities are expected to be confined to the immediate vicinity of the well. Subsurface blowouts can resuspend sediments, which could be deposited in an area around the well; however, the impacted area should be relatively small in scale (MMS 2008.)

7.3.5.3.2.1 Ecologically and Biologically Significant Areas

The Northeast Shelf and Slope EBSA is located within the Project Area. Habitat in this area supports aggregations of wolffish and Greenland halibut in spring, and aggregations of marine mammals, but the habitat is not considered unique. Effects on these benthic fish species from a blowout would occur primarily if their eggs or larvae were present within the water column at the time of the spill. As described above, the benthic habitat effects are expected to be limited to the immediate area of the blowout. Potential effects on mammals within the area of the spill are described in Section 7.3.3.2.

The Virgin Rocks EBSA is located 41 km to the west of the Project Area. The site is considered geologically unique and provides the only near-surface rocks on the Grand Banks. Groundfish, including Atlantic cod, American plaice, and yellowtail flounder, spawn near this area. Schools of capelin can be found here along with marine birds that feed on them. The Lily Canyon-Carson Canyon EBSA is located approximately 87 km to the south of the Project Area. It is like other canyon habitat on the Grand Banks, but it is recognized as unique because Iceland scallop are abundant, and marine mammals feed and overwinter in the area.

The Southeast Shoal and Tail of the Grand Banks EBSA is located approximately 155 km southwest of the Project Area. If a spill were to occur within the Project Area, hydrocarbons on the surface or in the water column could affect the quality of these area, resulting in an effect on species that use it. Species, such as capelin, Atlantic cod, and yellowtail flounder, spawn in these areas, and Atlantic wolffish, marine birds, and marine mammals (particularly humpback whales and northern bottlenose whales) aggregate there. Marine birds are directly at risk from an oil spill since the survival rate of oiled birds is low. Pelagic eggs and larvae of spawning fish are most vulnerable when exposed to oil. However, the probabilities of exposure are low given the spatial and temporal overlap required for exposure and the minimal risk of a large spill or blowout. Benthic species and life stages are not as vulnerable.

7.3.5.3.2.2 Northwest Atlantic Fisheries Organization Vulnerable Marine Ecosystems

The coral-sponge closure areas identified in the within the Study Area were designated by NAFO because these habitats support diverse marine communities that include fragile, long-lived, deep-water coral and sponges, which increase habitat complexity and structure and support a variety of associated invertebrate and fish communities. As described in Section 7.1.9.4, in the unlikely event of a hydrocarbon blowout, the use of dispersants will be considered as a spill countermeasure, which has potential for implications to corals as the potential for exposure of corals to oil will increase if chemically dispersed. One- to five-day exposures of chemically dispersed oil to embryos and larvae of coral reef species caused greater toxicity than to oil alone with long-term effects including elevated rates of mortality and reduced growth rates that were evident one to two years following a spill (Lee et al. 2015). Although deep-water corals would be less likely to be affected by the dispersed oil, the use of dispersants to manage the discharge of oil from the wellhead during the Deepwater Horizon oil spill demonstrated that benthic organisms in waters 1,300 m in depth are at risk for exposure to chemically-dispersed oil (Lee et al. 2015).

7.3.5.3.3 SBM Spill

In the event of an unintended bulk release of SBM, there would likely be a temporarily and reversible degradation in habitat quality within tens of metres from the spill site. The acute toxicity of SBMs is considered relatively low and below environmental guidelines and therefore will not result in adverse effects from contamination of marine biota or habitats (C-NLOPB 2011). Effects from an SBM spill would likely be reversible and highly localized around the wellsite.

7.3.5.3.4 Summary

Table 7.28 provides a summary of predicted residual environmental effects of accidental events on special areas.

Table 7.28 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							
Diesel Batch Spill from OSV and MODU (10 bbl and 100 bbl scenarios)	A	L	SA	ST	S	R	D
Subsea and Surface Hydrocarbon Blowout (blowout rates of 40,476 bopd)	A	H	SA	ST-MT	S	R	D
SBM Spill	A	L	PA	MT	S	R	D

KEY:
See Table 6.23 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
SA: Study 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

7.3.5.4 Determination of Significance

Spill modelling originating at water depths within the Project Area indicates the majority of the oil will remain within the surface layers of the water column, so benthic habitat and corals within special areas are less prone to effects. Benthic habitat within the immediate area of a blowout would be at risk, but over a relatively small scale. Benthic habitat and organisms in these areas may also be affected by the deposition of weathered oil particles from an oil spill outside the immediate area. Some of these compounds may eventually be deposited on the seabed at extremely low concentrations over a large area, posing no risk to marine life (IPIECA-IOGP 2015). In no case is it predicted that the special areas would be affected on a permanent basis, nor is it predicted that the resident species would be affected in such a way that natural recruitment is unable to return the population or community to its former level within several generations. The residual environmental effect of a change in habitat quality for special areas for a surface or subsea blowout, and batch spill scenarios is therefore predicted to be not significant.

Husky will adhere to safety and risk management systems, management of change procedures and global standards. This includes the implementation of spill prevention that will be incorporated into the design and operations for all Project activities as part of contingency planning. Spill response planning is described in detail in Section 7.1.

7.3.6 Indigenous People and Community Values

7.3.6.1 Project Pathways for Effects

As described in detail in Section 4.3.2, commercial communal fisheries, hunted migratory bird species and seal hunting are the only three traditional resources potentially affected by the proposed Project. In addition to the direct effects from Project activities on Indigenous fishing, indirect effects to socio-economic conditions are also considered in this assessment, including the socio-economic impacts to the Indigenous communities due to effects on commercial communal and FSC fishing.

As with all commercial fishery licence holders, a large-scale spill could have an adverse effect on Indigenous people and community values. An accidental event could affect the fisheries resource (direct or indirect effects on fished species affecting fisheries success), fishing activity (displacement from fishing areas, gear loss or damage), change in risk of mortality or physical injury for migratory birds, and/or change in habitat quality and use for marine mammals resulting in a change in commercial communal fisheries and change in current use of lands and resources for traditional purposes.

In the event of a spill, there could be effects on offshore commercial fishing activities within NAFO Divisions 3KLMNO, and/or on FSC species that could be migrating through the affected area. As discussed in Section 4.3.2, Indigenous communities are known to hunt migratory bird species. Of the migratory bird species hunted by Indigenous communities, the murre is the only species hunted by Indigenous people that is known to occur in the Study Area and potentially affected by an accidental event. 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. Diving species (including murres) are the most susceptible to the immediate effects of surface slicks (Leighton et al. 1985; Chardine 1995; Wiese and Ryan 1999; Irons et al. 2000). Additional detail on the potential effects to migratory birds is discussed above in Section 7.3.4.1.

Indigenous communities are also known to hunt seals; in particular, the harp seal is known to be hunted by indigenous people and occurs within the Study and Project Areas. The Jeanne d'Arc Basin and adjacent areas overlap with regions where harp seals have been observed during January and February (Lacoste and Stenson 2000, in Husky Energy 2012a). During years when pack ice extends to the Northern Grand Banks, harp seals may use the region for spring pupping, mating, and moulting. As described in detail in Section 7.3.3.1, all the accidental events scenarios described above could potentially result in a change in risk of mortality or physical injury and change in habitat quality and use for marine mammals and sea turtles. In the unlikely event of oil spills in the Study Area, marine mammals and sea turtles could be adversely affected. Additional detail on the potential effects to seals are discussed above in Section 7.3.3.1.

A change in commercial communal fisheries and change in current use of lands and resources for traditional purposes could potentially result in changes in socio-economic conditions of affected communities. Revenue generated from commercial communal fishing activity can be a main source of revenue for many Indigenous communities; therefore, indirect socio-economic impacts are also qualitatively considered in this assessment. The assessment also considers the social, spiritual, and cultural value of the FSC fishery to the Indigenous communities; however, it is difficult, if not impossible, to express the importance of this fishery as a monetary value, because it reflects the very nature of Indigenous culture. A qualitative assessment of social and cultural value is provided based on the potential impacts to the current use of lands and resources for traditional purposes.

In addition to the potential effects on a change in commercial communal fisheries and change in current use of lands and resources for traditional purposes described above, Section 7.3.2 describes the potential environmental effects of the various spill scenarios on commercial fisheries, Section 7.3.1 describes potential environmental effects on fish and fish habitat, Section 7.3.3 describes potential environmental effect on marine mammals and sea turtles, and Section 7.3.4 describes potential effects on migratory birds. These sections also help to inform how the accidental release of hydrocarbons to the marine environment may adversely affect Indigenous people and community values.

7.3.6.2 Mitigation

As per HOIMS, Husky will implement several measures and preventative actions into the daily operation and maintenance of a MODU. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to minimize the likelihood of an accident or malfunction. As noted in Section 7.1, Husky has an established corporate Incident Coordination and Response Management Plan (EC-M-99-X-PR-00003-001) and an Oil Spill Response Procedure - East Coast Oil Spill Response Plan (EC-M-99-X-PR-00125-001). These plans include a number of different options and contingencies to address responding to emergency events, including potential spills and well control events. All relevant plans are submitted to the C-NLOPB prior to the start of any drilling activities in offshore Newfoundland and Labrador. The oil spill response procedure will outline response methods and strategies for addressing different levels of oil spills. Response methods for oil spills that will be considered include but are not limited to: offshore containment and recovery; surveillance and tracking of spills; dispersant application, and wildlife response measures.

In the unlikely event of an accidental event such as a large spill or a blowout, specific monitoring programs (e.g., environmental effects monitoring and follow up) may be required for the Project. In such case, these programs will be developed and implemented in consultation with the appropriate regulatory agencies.

Specific mitigation to reduce effects from an accidental spill on fisheries includes compensation for gear loss or damage caused by the spill. Compensation for damage to gear will be in accordance with Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and Canada-Nova Scotia Offshore Petroleum Board 2002). Husky will continue to engage commercial fishers annually to share Project details and facilitate coordination of information sharing.

7.3.6.3 Assessment of Residual Environmental Effects on Indigenous People and Community Values

7.3.6.3.1 Diesel Batch Spill from OSV and MODU

A commercial communal fisheries licence for NAFO division 3L extends to the shoreline of Newfoundland, so in the case of a vessel (OSV) diesel spill, this risk of exposure and subsequent contamination of a commercial fishery is possible. However, in the unlikely event of a diesel spill from an OSV, evaporation rates would be high (see Section 7.2.3), exposure of fisheries resources to the diesel would be short-term, and the resulting risk of contamination of commercial fisheries resources would be low.

As discussed in 7.3.4.3.1, oil spill modelling in the Project Area indicates that a batch spill was estimated to have a slick survival time of 48 hr (SL Ross 2012) and would thus have reduced effects on migratory birds compared to a large-scale crude oil spill. A batch spill will result in a temporary and reversible degradation in habitat quality. The resulting risk to traditionally harvested migratory birds is very low.

As described in 7.3.3.3.1, with respect to a change in habitat quality and use for marine mammals and sea turtles, most diesel from a spill from either the MODU or OSV (including a nearshore spill) will create a temporary and reversible degradation in habitat quality. These effects would be short-term until the slick evaporates and dissipates and is not expected to create permanent or irreversible changes to habitat quality and use. As discussed in Section 7.2.2, a nearshore spill is not predicted to reach the shoreline and will dissipate within 120 hours (during the autumn and winter) and 240 hours (during spring and summer). With respect to change in risk of mortality or physical injury, the accidental release of diesel fuel has potential to adversely affect marine mammals and sea turtles. However, diesel fuel would evaporate and disperse faster than crude oil, limiting the potential for surface exposure, although there would be increased toxicity associated with the risk of inhalation of toxic fumes and ingestion. In terms of traditionally harvested species that may migrate through the area affected by a spill, only a small proportion of the harp seal population would be at risk from a diesel spill.

In general, a diesel batch spill from the MODU or OSV would be short-term and highly localized. If a fisheries closure was implemented due to the spill, this could result in a temporary loss of access to Indigenous fishers for commercial communal or FSC purposes; however, a small spill offshore is unlikely to measurably affect fisheries occurring outside the MODU operational safety zone and therefore social, cultural, and economic impacts are predicted to be low.

7.3.6.3.2 Subsea and Surface Blowout

As described in Section 7.3.1.3.2, the oil from a subsea or surface blowout is predicted to be persistent under both summer and winter conditions, natural dispersion would be low, and the oil would remain at the surface for an extended period. In the case of a subsea or surface blowout, a slick would likely reach an active commercial communal fishing area resulting in the closure of current fisheries in the area. The affected licence holders will be affected by loss of income, fouling of gear within the spill and possibly increased cost associated with having to relocate harvesting effort.

As discussed in Section 7.3.2.3, effects due to market perceptions of poor product quality (e.g., no buyers or reduced prices) are more difficult to predict, since the actual (physical) effects of the spill might have little to do with these perceptions. 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). In the unlikely event of a blowout, a fishery closure may be imposed to prevent gear from being contaminated and to protect or reassure seafood consumers, and remain in place until an area is free of oil/oil sheen on the surface 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). A fishery closure in the event of an oil spill would prevent localized or area-specific harvesting of fish, and potentially alleviate concerns about marketing of tainted product. Testing to confirm the safety of seafood harvested after such a spill would also reduce the potential for long term impacts to fishers and consumers. In the very unlikely event of a very large oil spill (9.5×10^{-5} per exploration well drilled), there is a possibility of salmon being exposed to hydrocarbons if they happen to be migrating through the area of the spill. However, based on the available data on migration routes of salmon within the Study Area, their ability to avoid inhosbitable environments, and the low probability of a large-scale oil spill, the probability that Atlantic salmon would be affected is very low.

Concern was noted regarding potential impacts to the health of communities, should harvested species be consumed that have been exposed to oil contamination. As noted above, should there be an oil spill, a fishery closure would be implemented and testing of species prior to the re-opening of the fishery. In addition, the biomagnification of petroleum hydrocarbons typically does not occur in food webs. Vertebrates, such as fish, birds and mammals, can readily metabolize petroleum hydrocarbons and as a result, biomagnification of these substances is not an issue for these species (Lee et al. 2015). Therefore, in the event that fish are exposed to hydrocarbons via respiration, direct contact, or through diet, these hydrocarbons will be metabolized and generally will not pose a risk through bioaccumulation.

As described in Section 7.3.4.3.2, the presence of hydrocarbons may temporarily affect habitat quality and risk of mortality for migratory birds. Of the migratory bird species hunted by Indigenous communities, the murre is the only species hunted by Indigenous people that is known to occur in the Study Area and potentially affected by an accidental event. 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. Migratory birds are the most visible and among the first species impacted by oil spills, with diving species (such as murres) the most susceptible to the immediate effects of surface slicks (Leighton et al. 1985; Chardine 1995; Wiese and Ryan 1999; Irons et al. 2000). A spill will result in a temporary and reversible degradation in habitat quality and change in risk of mortality or physical injury.

A 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 seals. The extent of the potential effects will depend on the spill trajectory and overlap with individual seal. Seals are not considered to be at high risk from the effects of oil exposure, but harp seal pups may succumb to exposure if oiled during the spring. Adult harp seals are only present during the winter. With a population estimate of 7 to 9 million, there is little chance of a population level effect on harp seals.

Oil spill prevention measures, along with typical oil spill countermeasures (refer to Section 7.1) will serve to reduce the number of traditional use species exposed to oil. Potential effects of the use of dispersants on fish and fish habitat, marine mammals and sea turtles and migratory birds is discussed in Sections 7.3.1, 7.3.3, and 7.3.4, respectively.

In the event of a blowout, there is also a potential for adverse effects on socio-economic conditions. During recent engagement, the importance of the commercial communal fishery was emphasized by the communities as being culturally important, beyond the economics of financially supporting the community. For some Indigenous communities, the fishery is one of its primary contributors to sole source revenue, providing important gap funding for many community programs. It is the perception from the communities, that in the event of a blowout, there would be an adverse effect to the commercial communal fishery with impacts to the quality of life within the communities. The FSC fishery has also been identified as being culturally important and, although traditional food may currently be a small portion of the community's diet, given some community members face food insecurity, it is highly important to their diet (BP 2017). It is the perception from the communities, that in the event of a blowout, there would be an adverse effect to the FSC fishery with effects to the quality of life within Indigenous communities.

7.3.6.3.3 SBM Spill

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). A fisheries closure and fouling of gear would be unlikely given the relatively small spatial and temporal footprint of the spill event. Associated socio-economic effects in the event of an SBM spill are predicted to be limited.

7.3.6.3.4 Summary

Table 7.29 provides a summary of predicted residual environmental effects of accidental events on Indigenous people and community values.

Table 7.29 Summary of Residual Project-Related Environmental Effects on Indigenous People and Community Values – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Commercial Communal Fisheries and Current Indigenous Use of Lands and Resources for Traditional Purposes							
Diesel Batch Spill from OSV and MODU (10 bbl and 100 bbl scenarios)	A	L	SA	MT	S	R	U
Subsea and Surface Hydrocarbon Blowout (blowout rates of 40,476 bopd)	A	H	SA	LT	S	R	U
SBM Spill	A	L	PA	MT	S	R	D

KEY:
See Table 6.28 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
SA: Study 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

7.3.6.4 Determination of Significance

In consideration of the information presented above, the predicted residual environmental effects from a diesel batch spill on Indigenous people and community values is not significant. Local fishers are unlikely to be displaced or unable to use portions of the areas currently commercially fished for all or most of a fishing season; experience a change in the availability of fisheries resources (e.g., fish mortality and/or dispersion of stocks) so that resources cannot continue to be used at current levels within the Study Area for more than one fishing season; or experience unmitigated damage to fishing gear.

Given the extensive nature of the worst-case, unmitigated blowout event, a significant effect is conservatively predicted for Indigenous people and community values for this scenario including potential socio-economic effects. The likelihood of this significant effect occurring is considered low, given the very low potential for a blowout to occur (see Section 7.2.2) and given the response measures that would be in place to mitigate potential effects. Husky will adhere to safety and risk management systems, management of change procedures and global standards. This includes the implementation of spill prevention that will be incorporated into the design and operations for all Project activities as part of contingency planning. Spill response planning is described in detail in Section 7.1.

8.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

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 as required under section 19(1)(h) of CEAA 2012. Potential adverse effects of the environment on a project are typically managed through consideration of anticipated environmental conditions, and project engineering incorporating environmental design criteria, industry standards, and environmental monitoring.

An adverse environmental effect resulting from an effect of the environment on the Project (e.g., a spill resulting from a severe weather event) is addressed in the context of Accidents and Malfunctions in Section 7.3.

8.1 Significance Definition

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 Project infrastructure resulting in harm to Project workers or the public; and
- damage to Project infrastructure such that the well has to be temporarily abandoned in order to conduct repairs and/or damage resulting in repairs that cannot be technically or economically implemented.

8.2 Environmental Considerations

The existing marine physical environment is described in Section 4.1. Elements of the environment that may affect the Project include:

- marine geology (sediment and seafloor stability; landslides);
- atmospheric and physical oceanography environment (extreme weather conditions; visibility; and seismic events and tsunamis); and
- sea ice and icebergs.

8.2.1 Marine Geology - Sediment and Seafloor Instability

Slope instability, seismicity, sediment loading, venting of shallow gas, gas hydrates, seabed instabilities, and ice scour are common offshore geohazards. Factors contributing to sediment failure include gradient, magnitude of seismic acceleration, and sediment strength (Amec 2014). Except in cases of steep slopes, most continental margin sediments are relatively stable and would require seismic accelerations associated with a large earthquake (magnitudes of five or greater) to fail (Nadim et al. 2005). In any given area offshore Eastern Canada, there is a risk of a major landslide every 20,000 years and a minor one every few thousand years. Most of the large failures on the seabed date back more than 10,000 years during periods of glaciations when large amounts of sediment were deposited directly onto the slope of the continental shelf (NRCan 2013, in Amec 2014).

Within the vicinity of the Study Area, slope stability risk is highest on the south side of the Orphan Basin and in the northern Flemish Pass (Amec 2014). In general, there is evidence of slope failures approximately every 10,000 years in this area due to the steep slopes, abundant shallow gas, and possible greater seismicity, which make large landslides more frequent (Cameron et al. 2014, in Amec 2014).

The most recent widespread slope failure in the Orphan Basin occurred approximately 7,000 years ago. Slopes steeper than three degrees in this area are prone to failure except where underlain by glacial till. Failures in the Orphan Basin have resulted from earthquakes with magnitudes ranging from 5.6 to 7.6 (Piper et al., in press, in Amec 2014; Cameron et al. 2014).

Major sediment failures have occurred along the Flemish Pass, approximately 27,000 and 20,500 years ago, and are believed to have been a result of earthquake triggers (Cameron et al. 2014). The pattern of younger debris-flow deposits in the central region of the Flemish Pass suggest that gas hydrates may also act as a trigger for failure in this area (Piper and Campbell 2005, in Amec 2014).

Ormen Lange is a gas field in the Norwegian Sea located approximately 130 km northwest of Molde, Norway in water depth of 850 to 1,100 m. The field is located at the site of a submarine clay landslide, which occurred approximately 8,200 years ago in approximately 300 to 2,500 m of water, moving approximately 800 km out into deep water. The slide area was approximately 90,000 m^2, moving a volume of 3,500 km^3 (Solheim et al. 2005; Statoil 2011). The event generated a 10 to 20 m-high tsunami that impacted the Norwegian Coast (Norsk Oljemuseum 2011), Scotland and the Faeroes (Nadim et al. 2005). Studies have concluded that the submarine landslide was triggered by an extremely strong, low-probability earthquake (Kvalstad et al. 2005) combined with excess pore pressure (due to a high sedimentation rate) (Leynaud et al. 2007).

Slide risk assessment indicated that the prehistoric Storegga slide removed all soft sediments; therefore, only natural causes (i.e., extremely strong earthquake) are a realistic trigger mechanism; there is no project-generated risk. The Ormen Lange field development activities have negligible effects on stability and will not trigger tsunami-generating slides. The annual probability of a slide with a run out of the field development area is almost zero. Shallow slide events and surficial slides could occur, but the risk is acceptable (Scandpower 2004). A case study on Ormen Lange (Norway's first deep-water oil and gas project) of hazards related to subsea processing facilities indicated that landslide risks were negligible (10^{-6}/year) (Nadim et al. 2005; Lloyd's Register Consulting 2013).

A quantitative assessment of continental slope stability in deep-water areas off Uruguay and northern Argentina indicated that stability was governed by lithologies and the sectors assessed were stable under present-day conditions. This suggested that strong muddy deposits on gentle slopes would require a large earthquake to trigger a submarine landslide (Ai et al. 2014).

8.2.1.1 Potential Effects of Sediment and Seafloor Instability on the Project

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. Sediment and seafloor instability could cause damage to, or failure of, essential Project components/infrastructure such as the drill string, wellhead, and/or BOP.

Mitigation to reduce risks associated with sediment and seafloor instability is discussed in Section 8.3.

8.2.2 Atmospheric and Physical Oceanography Environment

8.2.2.1 Extreme Weather Conditions

The Project Area experiences predominately southwest to west winds throughout the year. There is a strong annual cycle in the wind direction. West to northwest winds which are prevalent during the winter months begin to shift counter-clockwise during March and April, resulting in a predominant southwest wind by the summer months. As autumn approaches, the tropical-to-polar temperature gradient strengthens, and the winds shift slightly, becoming predominately westerly again by late fall and into winter. Low pressure systems crossing the area are more intense during the winter months. As a result, mean wind speeds tend to peak during this season (refer to Table 4.1 in Section 4.1.2.1 for mean wind speed statistics).

In addition to mid-latitude low pressure systems crossing the Grand Banks, tropical cyclones often move northward out of the influence of the warm waters of the Gulf Stream, passing near the Island of Newfoundland (see Figure 4-9 in Section 4.1.2.7 for illustration of tropical systems storm tracks). Once the cyclones move over colder waters, they lose their source of latent heat energy and often begin to transform into a fast-moving and rapidly developing extratropical cyclones, producing large waves and sometimes hurricane-force winds. Additional detail on tropical cyclones is provided in Section 4.1.2.7.

Wind speeds are much lower in the summer than in winter (refer to Figures 4-5 to 4-6 in Section 4.1.2.1). As noted in Table 4.1 in Section 4.1.2.1, the wind speeds recorded at MSC50 grid point 12214 and 11422 are consistent for each grid points in each month. The mean monthly wind speed varied by 0.1 to 0.2 m/s between all four sites.

Rapidly deepening storm systems known as weather bombs frequently cross the Grand Banks. These storm systems typically develop in the warm waters of Cape Hatteras and move northeast across the Grand Banks. In one example, on February 11, 2003, a 987 mb low pressure off Cape Hatteras deepened to 949 mb as it moved northeast, crossing eastern Newfoundland (Oceans Ltd. 2016). The low then began to weaken as it moved north of the forecast waters in the evening.

There were no observations from the White Rose field during this event. Wind speeds of 49.4 and 50.9 m/s from the southwest were recorded by the Hibernia and the Henry Goodrich anemometers, respectively, as this system passed (Oceans Ltd. 2016). The anemometers on all platforms on the Grand Banks (i.e., Henry Goodrich, Terra Nova, and Hibernia) registered the maximum speeds the anemometers could record during gusts.

A wind speed of 43.7 m/s was recorded by the *SeaRose FPSO* in the White Rose field on October 15, 2009 (Oceans Ltd. 2016). During this event, the low pressure system deepened from 1,002 mb on October 14, 2009, to 963 mb as the system passed northeast of the Avalon (Oceans Ltd. 2016).

The hurricane season in the North Atlantic basin normally extends from June through November, although tropical storm systems occasionally occur outside this period. While the strongest winds typically occur during the winter months and are associated with mid-latitude low pressure systems, storm-force winds may occur at any time of the year as a result of tropical systems. Once formed, a tropical storm or hurricane will maintain its energy as long as a sufficient supply of warm, moist air is available. Between 1947 and 2015, 30 tropical systems have passed within 278 km of 46.9°N; 47.9°W (approximately the centre of the Project Area).

On average, 46% of tropical cyclones that form in the Atlantic transform into extratropical cyclones. During this transformation, the system loses tropical characteristics and becomes more extratropical in nature. This results in an increase in system size, which produces large waves, gale- to hurricane-force winds, and intense rainfall. The likelihood that a tropical cyclone will undergo transition increases toward the second half of the tropical season, with October having the highest probability of transition. In the Atlantic, extratropical transition occurs at lower latitudes in the early and late hurricane season and at higher latitudes during the peak of the season (Hart and Evans 2001, in Husky Energy 2012a).

The annual 100-year extreme significant wave height ranges from 14.8 to 14.9 m (see Table 4.7 in Section 4.1.3.6). The highest extreme significant wave height occurs during the month of February with an extreme height ranging from 15.0 to 15.1m. The annual 100-year extreme 1-hour wind speed was determined to range 32.1 to 32.2 m/s. The highest extreme winds occur during February with a 100-year extreme wind estimate ranging from 31.6 to 31.7 m/s.

8.2.2.1.1 Potential Effects of Extreme Weather Conditions on the Project

Extreme wind and waves have the potential to increase stress on surfaces, superstructures and vessels and disrupt scheduling of marine operations.

High wind and wave conditions could delay loading and offloading of cargo to the MODU, or the operation of the MODU itself. 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 7.1.

Extreme wind and wave conditions could result in accidental events, 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 substantial 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 (Safety Plan Guidelines (NEB et al. 2011) as per the *Drilling and Production Regulations*).

Mitigation to reduce risks associated with operating in extreme weather is discussed in Section 8.3.

8.2.2.2 Fog and Other Environmental Factors Reducing Visibility

Visibility is defined as the greatest distance at which objects of suitable dimensions can be seen and identified. Horizontal visibility may be reduced by any of the following environmental phenomena, either alone or in combination:

- fog (visibility less than 1 km);
- mist (visibility less than 10 km);
- liquid precipitation (e.g., drizzle);
- freezing precipitation (e.g., freezing rain); and
- frozen precipitation (e.g., snow).

Advection fog forms when warm moist air moves over cooler waters. By April each year, the sea surface temperature south of Newfoundland is cooler than the surrounding air. As warm moist air from the south moves over the colder sea surface, the air cools and its ability to hold moisture decreases. The air continues to cool until it becomes saturated and the moisture condenses to form fog. Fog also occurs as relatively warm rain falls through cooler air beneath a frontal surface. Typically, the base of the cloud layer lowers as the air becomes saturated and condensation occurs. If the cloud base reaches the surface, frontal fog occurs. Most frequently, frontal fog occurs ahead of a warm front associated with a frontal disturbance. As the front moves through, clearing of the fog may occur. However, frontal fog frequently gives way to advection fog in the warm sector of a low pressure system. Typically, fog clears as drier air is adverted into the region from continental source regions to the west.

The presence of advection fog on the Grand Banks increases from April through July. The month of July has the highest percentage of obscuration of visibility (Oceans Ltd. 2016), most of which is in the form of advection fog; although frontal fog can also contribute to the reduction in visibility. In August, the temperature difference between the air and the sea begins to decrease and by September, the air temperature begins to fall below the sea surface temperature. As the air temperature drops, the occurrence of fog decreases. Reduction in visibility during autumn and winter is relatively low and is mainly attributed to the passage of low-pressure systems. Fog is the main cause of reduced visibility in autumn, and snow is the main cause of reduced visibility in the winter. September and October have the lowest occurrence of reduced visibility since the air temperature has, on average, decreased below the sea surface temperature and it is not yet cold enough for snow.

The frequency distribution of visibility from ICOADS, 1986 to 2015, indicates that obstructions to vision can occur in any month. Annually, 47.4% of the observations during that period had reduced visibilities less than 10 km (Oceans Ltd. 2016). Percentages of observations is provided in Figure 4-7 in Section 4.1.2.5.

8.2.2.2.1 Potential Effects of Fog on the Project

Environmental conditions resulting in poor visibility can hinder offshore supply vessel and helicopter transportation, potentially resulting in delay of supply and personnel movement to and from the MODU. Poor visibility can also increase the risk of an accidental event (e.g., a vessel or helicopter collision potentially resulting in a spill).

Mitigation to reduce risks associated with foggy conditions is discussed in Section 8.3.

8.2.2.3 Seismic Events and Tsunamis

The Jeanne d'Arc Basin is a narrow and elongate basin formed by normal movement on the listric Murre fault, which soles out towards the east at approximately 26 km depth (Tankard and Welsink 1987, in Husky Energy 2012a; Hurley et al. 1992, in Husky Energy 2012a). This fault bounds the basin on its west side and separates pre-Mesozoic metamorphosed Precambrian and Paleozoic basement rocks from Mesozoic strata within the basin (Hurley et al. 1992, in Husky Energy 2012a). Northwest-southeast intra-basin trans-basin faulting splits the basin and the Egret fault bounds it to the south (Tankard and Welsink 1987, in Husky Energy 2012a; Magoon et al. 2005, in Husky Energy 2012a). Other major tectonic features of the Jeanne d' Arc Basin include the Bonavista platform to the west, the Avalon uplift to the south and the Central Ridge Complex to the east (Hurley et al. 1992, in Husky Energy 2012a).

The largest seismic event near Newfoundland measured M7.2 in 1929 that ruptured the slope within the Laurentian Channel, causing a 200-km long slump of slope deposits, a turbidity current that destroyed numerous telegraph cables and a tsunami that led to 27 deaths in southern Newfoundland (Basham and Adams 1983). Seismic reflection surveys have located young faulting in the Laurentian Channel, but offsets in the uppermost layers of sediments are not definitive (King 1979).

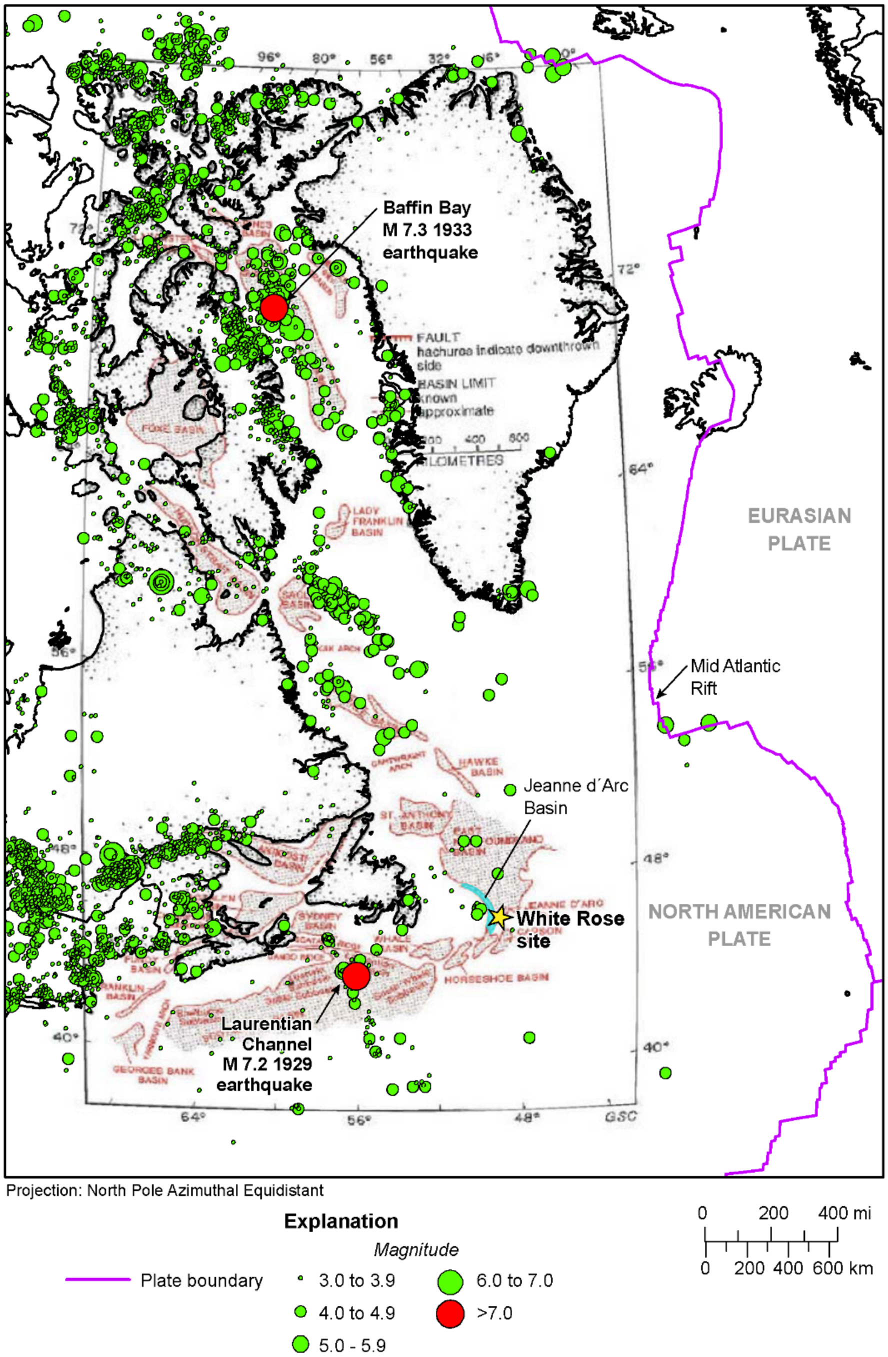
The earthquakes that have occurred within 500 km of White Rose over the last 22 years are shown in Table 8.1. The largest earthquake during this time had a magnitude of 4.2. A 4.2 magnitude earthquake was recorded northwest of the Project Area on September 2, 2018, 293 km northeast of Bonavista, NL; no tsunami was generated from the event (CBC 2018).

Table 8.1 Earthquakes within 500 km of White Rose 1988 to 2010

Date	Time(UT)	Lat	Long	Depth	Mag	Region and Comment
2010/12/01	03:35:32	48.86	-50.55	18.0g (A)	3.3ML (B)	190 km E from Bonavista
2010/01/12	22:47:18	48.01	-50.65	18.0g	2.7MN (B)	164 km E from St. John's
2009/04/29	01:26:03	47.40	-53.50	18.0g	3.3MN	28 km SW from Bay Roberts
2008/12/17	07:20:22	47.93	-52.81	18.0g	3.2MN	37 km NE from Carbonear
2008/11/18	00:15:29	50.23	-49.70	18.0g	4.2ML	Offshore Newfoundland.
2008/10/30	05:34:37	49.97	-50.42	18.0g	2.9ML	245 km NE from Bonavista
2008/06/12	12:34:51	48.10	-50.72	18.0g	3.1MN	162 km E from St. John's
2007/02/06	01:27:51	48.08	-49.25	18.0g	2.9MN	Grand Banks
2005/04/05	15:07:13	49.87	-50.50	18.0g	3.3ML	234 km NE from Bonavista
2003/04/20	10:30:25	50.24	-51.06	18.0g	2.6MN	320 km N from St. John's
2002/03/02	07:37:39	49.13	-51.87	18.0g	3.1MN	185 km N from St. John's
2001/04/06	21:09:48	48.75	-51.69	18.0g	3.1MN	150 km NE from St. John's
1996/03/13	23:55:07	47.75	-53.00	18.0g	2.4MN	Conception Bay
1995/01/22	06:46:20	47.84	-52.52	18.0g	2.4MN	34 km NE from St. John's
1994/12/01	09:32:25	47.31	-51.72	18.0g	2.6MN	Offshore Newfoundland
1994/08/11	18:13:49	47.83	-52.67	0.0g	3.1MN	St. John's Newfoundland
1992/08/10	11:31:52	47.34	-49.11	18.0g	3.4MN	Grand Banks
1992/07/17	04:20:22	46.12	-47.44	18.0g	3.9MN	Eastern Margin of Grand Banks
1992/07/06	16:58:16	47.33	-49.35	18.0g	3.0ML	Grand Banks
1992/01/13	06:07:28	47.24	-49.24	18.0g	4.0MN	Southern Grand Banks
1991/07/23	11:23:01	47.36	-50.17	18.0g	3.2MN	Grand Banks
1989/12/03	05:15:40	46.98	-49.32	18.0g	4.2ML	Offshore Newfoundland
1988/08/09	00:16:45	47.46	-49.29	18.0g	3.1ML	Grand Banks
1988/01/09	07:15:43	49.88	-49.88	18.0g	3.5ML	Offshore Newfoundland

Source: Oceans 2016b
(A) g = Peak ground acceleration
(B) ML refers to `local magnitude` which was originally defined for California by Charles Richter. However, this does not apply to eastern North America, where seismic waves attenuate differently. Otto Nuttli developed a formula for measuring seismicity of eastern Canada, Nuttli Magnitude or MN

The most seismically active portion of the Continental Slope occurs at the mouth of the Laurentian Channel. There is very little seismic activity in the Jeanne d'Arc Basin/White Rose area (Figure 8-1).



Source: Husky Energy 2012a

Figure 8-1 Seismic Activity in Newfoundland and Labrador

Tsunamis are long-period gravity waves generated in a body of water by an impulsive disturbance that vertically displaces the water column. Earthquakes, landslides, volcanic eruptions and even explosions or the impact of cosmic bodies such as meteorites can generate tsunamis. The resulting wave energy spreads outwards across the ocean at high speed. Tsunami occurrences in Canada are rare, with the Pacific Coast at greatest risk due to the high occurrence of earthquake and landslide activity in the Pacific Ocean. Their occurrence can result in major damage and loss of life in affected coastal areas.

8.2.2.3.1 Potential Effects of Seismic Events and Tsunamis on the Project

A seismic event could disrupt Project activities and increase the risk of potential accidental events (e.g., spills). As discussed further in Section 8.2.5, a seismic event could also contribute to sediment and seafloor instability.

The wave height of a passing tsunami offshore would be small, on the order of 1 m or less (Husky Energy 2012a). Therefore, should a tsunami occur, it would not be expected to adversely affect the Project, particularly given the long period of the waves.

There is a low likelihood of seismic events or tsunamis occurring within the Study Area (Husky Energy 2012a). Given the relatively short duration of Project activities, the probability of a major seismic event or tsunami occurring during the life of the Project is considered low.

Mitigation to reduce risks associated with seismic events and tsunamis is discussed in Section 8.3.

8.2.3 Superstructure Icing, Sea Ice and Icebergs

Freezing spray can accumulate on vessels and offshore structures when air temperatures are below the freezing temperature of water and there is potential for spray generation. This is known as superstructure icing. In addition to air temperature, superstructure icing severity depends on water temperature, water salinity, wave conditions, and wind speed, which influence the amount of spray and the cooling rate of droplets.

Potential sea spray icing conditions start during the month of November with a frequency of icing potential of just 0.2%. As temperatures cool throughout the winter, the frequency of icing potential increases to a maximum of 19.5% of the time in February (Oceans Ltd. 2016a). Extreme sea spray icing conditions were calculated to occur 0.7% of the time during February and March. Icing potential decreases rapidly after February in response to warming air and sea surface temperatures, and by May the frequency of icing conditions is only 0.2% (Ocean Ltd. 2016a).

The rate of superstructure ice accumulation 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 2012e). Husky has no record of ice accretion on the *SeaRose FPSO* or from drilling rigs while under contract to Husky (Husky Energy 2013).

In addition to superstructure icing, the Grand Banks are susceptible to seasonal incursions of sea ice and icebergs from the north. The 30-year median concentration of sea ice reaches its maximum over the Project Area the week of March 19 with 64.7% of the region covered in 7/10ths or greater sea ice (Ocean Ltd. 2016a).

Grand Banks icebergs originate primarily from the glaciers of West Greenland. Between 10,000 and 15,000 icebergs are calved each year, primarily from 20 major glaciers between the Jacobshaven and Humboldt glaciers. These glaciers account for 85% of the icebergs that reach the Grand Banks. Of the remaining icebergs, 10% come from the East Greenland glaciers and 5% from the glaciers and ice shelves of Ellesmere Island. Icebergs have been observed within the Project Area each month of the year, but the peak number of sightings is during the months of April and May.

Over the 55 years studied, there have been 18,169 icebergs sightings inside the Project Area. The highest number of icebergs on the field occurred in 1972, with 1,140 iceberg sightings. The second highest was in 1993, when there were 708 icebergs sighted. The mean number of iceberg sightings within the Project Area in one year is 195.

Although icebergs have occurred each month, a monthly analysis shows that icebergs are generally most likely spotted within the region from January to September and they are most prominent during the month of May. The most prominent icebergs are small (5 to 15 m in height, 15 to 60 m in length, and 100,000 t), accounting for 28.0% of observed icebergs within the region. Large icebergs occur 11.3% of the time and very large occur 0.5% of the time.

8.2.3.1 Potential Effects of Superstructure Icing, Sea Ice and Icebergs on the Project

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 2012e). Superstructure icing can cause delays because operations are slowed or suspended to remove or avoid ice accumulations.

Icebergs and sea ice are hazards to navigation that can hinder offshore supply vessel transportation, potentially resulting in delay of supply and personnel movement to and from the MODU. The MODU can also be affected by icebergs. For example, drill rigs have been taken off site to avoid being struck by an iceberg, should alternative ice management strategies fail. Sea ice and icebergs can also increase the risk of an accidental event (e.g., a vessel collision potentially resulting in a spill).

Mitigation to reduce risks associated with superstructure icing, sea ice, and icebergs is discussed in Section 8.3.

8.3 Mitigation

8.3.1 Marine Geology - Sediment and Seafloor Instability

As discussed in Section 2.4.1, well site/geohazard/geotechnical surveys will be conducted in advance of initiating drilling. These surveys will identify potential geohazards (e.g., sediment scour, liquefaction of sediments from seismic events, shallow gas pockets, and slope failure) that could be present in the vicinity of proposed drilling sites and therefore require avoidance and/or special consideration in Project planning.

In addition, as noted in Section 8.3.1, Husky must conduct analyses, model tests and/or simulations to determine the behaviour of the soils that support the installation or anchoring systems, under all foreseeable installation and operating conditions, in order to receive a Certificate of Fitness in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations.*

8.3.2 Atmospheric and Physical Oceanography Environment

8.3.2.1 Extreme Weather Conditions, Fog and Other Environmental Factors Reducing Visibility, and Superstructure Icing

The primary means of mitigating effects of the environment upon normal project operations is through detailed engineering, design and sound planning, including testing (and treatment, if necessary). All engineering design adheres to national/international standards. These standards document the proper engineering design for site-specific normal and extreme physical environmental conditions and provide design criteria that the regulatory agencies consider satisfactory for withstanding the potential physical environmental conditions. These codes consider physical environmental criteria such as temperature, wind, snow, wave and ice loading and drainage. In addition, the design life is taken into consideration so that materials are chosen with sufficient durability and corrosion resistance.

In addition to standard design mitigation, standard operation procedures are implemented as appropriate to assist in OSV and helicopter navigation during times of poor visibility. This includes reducing vessel or helicopter speed, adjusting flight altitude, and using appropriate sound and light signals. Navigational safety equipment will be kept in working condition at all times. Radio communication systems will be in working order for contacting other marine vessels, if necessary, as well as communication between the MODU, OSV and shore.

As part of the C-NLOPB authorizations required to conduct the drilling program, and in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations,* Husky will obtain a Certificate of Fitness from an independent third party Certifying Authority for the MODU prior to commencement of drilling operations. 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 *Newfoundland Offshore Petroleum Installations Regulations*, which stipulate that every installation and every component of an installation shall be designed in accordance with good engineering practice.

Part II of the *Newfoundland 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 provides 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 OSV will also be equipped for safe all-weather operations, including stability in rough sea conditions and inclement weather. Mitigation measures to reduce superstructure icing hazards on the OSV may include:

- 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.

Environment Canada through the MSC, Weatheradio, and regional Storm Prediction Centres, issues hourly marine weather observations, forecast bulletins and warnings for Canadian marine areas. Observations and forecast bulletins are available on MSC's Automated Telephone Answering Device and Weatheradio and continuously broadcasted over VHF or FM radio. The Newfoundland and Labrador Weather Office in Gander provides year-round marine weather and wave height information, consisting of a weather watch, warning, and amendment service, for the waters around Newfoundland and Labrador out to approximately 250 nautical miles (DFO 2015h). The frequency of these marine forecasts is indicated in Table 8.2.

Table 8.2 Marine Forecast Schedule

Forecast Name	Details	Issue Time (NDT/NST)
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.	06:00, 18:00
Marine Weather Statement	Issued when deemed necessary, it provides additional information on potentially high impact marine conditions.	As needed
Source: DFO 2015g		

Through regular monitoring of these forecasts, OSVs, helicopters, and the MODU will be forewarned 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 OSVs or helicopters will be avoided if possible. 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 OSV, helicopter, or MODU operations.

8.3.2.2 Seismic Events and Tsunamis

As noted in Section 8.3.1, in order to receive a Certificate of Fitness in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations,* the MODU must be designed with good engineering practice and taking into account potential environmental loads imposed by earthquakes and other naturally occurring phenomena.

Modern drillships 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, if necessary in the unlikely event of a seismic event or tsunami.

8.3.3 Sea Ice and Icebergs

This section provides an overview of ice management practices used by Husky within the Project Area. These practices are intended to provide a safe environment and reduce operational disruptions caused by ice. The ice management plan is comprised of:

- detection;
- monitoring and assessment; and
- physical management.

Ice management was first conducted by the offshore oil and gas industry in the early 1970s (Bruneau and Dempster 1971, in Husky Energy 2012a) and continued to develop through the following three decades. Initially, ice management was a reactive process, but as offshore oil and gas operations expanded, ice management evolved into a proactive operation. Today, a coordinated approach is taken, and decisions are made with respect to all activities being conducted by the offshore oil and gas industry on the Grand Banks. Physical management is conducted well upstream to move any hazardous ice off the Grand Banks and into areas where faster moving currents will carry the ice safely past the production fields and other offshore oil and gas operations.

8.3.3.1 Detection

Sea ice and iceberg detection (in various forms) has been conducted for most of the twentieth century. These early detection efforts were primarily conducted to provide warnings to mariners about where ice would likely be encountered, and a typical vessel's response was to avoid these areas. Offshore oil and gas exploration is one of the few relatively stationary activities involving complex operations in ice-infested waters.

In the early days of exploration drilling off Canada's East Coast, most ice detection efforts were limited to detecting icebergs that drifted within radar range. With the increased use of moored semi-submersible drilling rigs in the early 1980s, the need to detect and accurately locate ice at greater distances became critical.

Detecting small floating targets in open seas is a well-understood and documented process. Technological advances in the past two decades have improved ice detection capabilities to a point where both sea ice and icebergs can be detected, and their positions determined with great accuracy.

Typically, oil and gas exploration and production operations off Canada's East Coast use a combination of radar technologies and procedures to quantify and monitor ice distribution. Between government (both Canadian and American) and private industry, there are over 5,000 hours of airborne reconnaissance conducted annually over the Grand Banks and areas to the north. In addition to these radar-equipped aircraft, the areas off Canada's East Coast are swept daily by an assortment of satellite-based sensors and long-range, shore-based radars. Data from all these sources are integrated into a daily summary of ice distribution. The sequential ice distribution data are then used to monitor growth and movement. Using these procedures, operators are able to detect and monitor ice conditions 300 km or more upstream of an operations area, allowing for long-term resource and operational ice management planning.

If ice moves south of 48°N, dedicated radar-equipped ice reconnaissance aircraft are used to monitor the advancing ice. These reconnaissance aircraft are capable of detection on even very small ice targets (Rudkin and Ripply 1988, in Husky Energy 2012a). In the unlikely event that any ice evades this detection network, most oil and gas facilities are equipped with ice detection and monitoring radars that have been optimized for detection of small ice masses.

8.3.3.2 Monitoring and Assessment

Once detected, ice must be monitored to establish the speed and direction of its movement (drift) and, when enough information has been obtained, assess its potential threat to a project. Typically, this is accomplished in stages. The initial detection is usually accompanied by a general classification of the type of ice or iceberg. As successive detections are made over an area, a general drift track is established. At this stage, the available data allow only for general assumptions to be made. However, these initial data are used primarily for ice management resource planning. As ice closes on a production area, more detailed information is required. The components of detailed ice assessment data are:

- physical dimensions of sea ice and/or icebergs;
- depth measurements of icebergs (draft); and
- accurate drift (direction and speed).

The standard method for obtaining physical dimensions of icebergs is comprised of a mix of measurement, calculation and, in some cases, estimation, depending on the operational importance of the ice in question. Smaller icebergs and ice floes are usually estimated because their masses are well within the capabilities of ice management vessels. More detail about the overall mass and draft of larger icebergs is required. Methods of measuring the above-water dimensions of icebergs were pioneered approximately 30 years ago and remain little changed today. These methods are described in the Grand Banks operators' ice management plans and have been documented in many reports.

Once the above-water dimensions are known, calculations of overall mass can be made. These calculations are also described in the operators' ice management plans. However, due to the irregular shapes of icebergs, these mass calculations only represent an estimation of true mass and can be in error by ±20% (Comfort and Edwards 1998, in Husky Energy 2012a). Several studies were conducted during the 1980s in an attempt to establish a relationship between above-water size (height and water-line length) and iceberg draft. At best, these attempts provided only a first order approximation. If the above-water-to-draft relationship shows the iceberg may be capable of running aground (scouring), then an operator must acquire more accurate data.

Obtaining accurate iceberg draft information is a long and sometimes complicated process and is accomplished by using underwater sonar deployed near the iceberg by an ice management vessel. This method has remained unchanged for approximately 20 years. Although the sonar units have improved in accuracy and reliability, problems remain with deployment of the instrument and accurately maneuvering the vessel near the iceberg.

Obtaining accurate drift information is a simple process of measuring distance over time. The widespread use of GPS now provides very accurate positions and tracks, even over short distances and time periods.

Once these baseline data have been collected, a reasonable assessment of the risk posed by the ice/iceberg can be made. Typical risk assessment considers the following questions:

- Is the drift of the ice likely to pose a collision risk or disrupt operations?
- Is the draft of the iceberg sufficient to scour or strike components of a project?
- Is the ice in excess of the design criteria for the offshore facility/facilities in question?
- Is the ice/iceberg within manageable parameters?

If the answer to these questions is 'no', then the ice need only be monitored for any drift changes. If the answer is 'yes', then either a physical ice management procedure will have to be attempted or any facilities engaged in offshore oil and gas activities (e.g., the MODU) will have to be secured and prepared for a possible move.

One of the key assessments is establishing collision risk. This is achieved by assessing a combination of:

- the ice;
- local winds;
- local currents; and
- forecasts and predictions of these components.

Several studies show that, when accurate wind and current data are available, observed iceberg trajectories can be predicted with physical-based models of iceberg drift. Results are relatively insensitive to model parameters such as air and water drag coefficients and, to some extent, iceberg dimensions and shape (Murphy and Anderson 1985 and Smith 1993, in Husky Energy 2012a).

8.3.3.3 Physical Management

In general terms, most physical iceberg management consists of towing or deflecting the iceberg off its free-drifting track. The first documented cases of iceberg towing were in 1971 (Bruneau et al. 1977, in Husky Energy 2012a). In simple terms, these first attempts consisted of deploying a long floating rope around the iceberg, then applying force with a towboat in the direction they wished to move the iceberg. These procedures and the equipment used are described in detail in Total Eastcan's iceberg towing manual (Eastcan Exploration Ltd. 1973, in Husky Energy 2012a). In the ensuing years, other methods have been used with varying degrees of success, but this early method has remained the staple of iceberg management, having been used in nearly 500 documented iceberg tows.

The development of an iceberg tow net has proven effective for ice management operation on the Grand Banks. The iceberg tow net was designed to reduce the amount of rope slippage and provide a reduction in iceberg rolling during towing.

Sea ice management procedures have been used much longer than iceberg management procedures and are well documented; breaking up sea ice to assist shipping is a commonplace occurrence in Canadian waters. Because of the loose nature of the pack ice in the vicinity of the Grand Banks, sea ice management primarily consists of using offshore support vessels to break up any large ice floes that meet or exceed the design limits of the offshore facility.

Over the 2008 and 2009 ice seasons, experience was gained using water cannons to open a path in the pack as it advanced towards offshore facilities. The method used a support vessel stationed a few hundred metres ahead of the offshore facility. By sweeping the vessel's water cannon left and right, a path or lead was opened up, keeping the loose pack clear of the offshore facility.

Since 1988, all operators on the Grand Banks adopted a coordinated ice management approach. Under this system, the joint operators share ice information and ice management resources, along with adopting a strategy and procedures for managing icebergs over the whole Jeanne d'Arc Basin.

While the current ice management procedures are generally effective, allowing for safe and, for the most part, efficient operations, there are a few areas where improvements would be beneficial. Both the offshore operators and the authors of a Program of Energy Research and Development (PERD)-sponsored report (King et al. 2009, in Husky Energy 2012a) on ice management have identified problematic areas as:

- detection of small icebergs within pack ice
- iceberg towing operations within pack ice
- obtaining iceberg draft measurements reliably and efficiently
- improved methods of attaching tow lines to icebergs
- cost-effectiveness

A joint industry, academic and private enterprise initiative has been addressing these and other issues related to ice management. In addition, several studies and reports, primarily under the auspices of PERD, have been conducted to address some of those issues, providing, among other things, cross-indexed databases of existing ice and iceberg data (PERD 2004, in Husky Energy 2012a).

8.4 Residual Effects Summary

The key environmental factors that may affect the Project include reduced visibility, high winds and waves, sea ice and icebergs, and sediment and seafloor instability. However, engineering design, operational standards and procedures, geohazard assessments, and other mitigation measures discussed above will reduce the potential adverse effects on, and risks to, the Project. Potential effects from seismic events 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 80 days to drill each individual well to TVD (up to 10 wells) between 2019 and 2027), and the absence of fixed offshore infrastructure for the Project. Fog, 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.

In consideration of the significance criteria defined in Section 8.1; implementation of appropriate engineering, environmental design standards, and operational procedures; and adherence to the Offshore Physical Environment Guidelines (NEB et al. 2008), the adverse residual effects of the physical environment on the Project are predicted to be not significant.

9.0 CUMULATIVE EFFECTS

Section 19(1)(a) of CEAA, 2012 requires that the EIS 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 future (certain or reasonably foreseeable) 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.

9.1 Scope and Methods

The CEA Agency's *Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012* and the 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 WREP (Husky Energy 2012a), which assessed cumulative effects within the Study Area, as well as the SEA undertaken by the C-NLOPB for Eastern Newfoundland (Amec 2014), and other recent CEAs conducted for offshore exploration drilling projects in Atlantic Canadian waters.

9.1.1 Scope

Scoping the assessment of cumulative environmental effects involves: selecting VCs for the CEA; 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 Study Area 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.

9.1.1.1 Valued Components

The CEA for 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 6). These six VCs are:

- Fish and Fish Habitat;
- Commercial Fisheries;
- Marine Mammals and Sea Turtles;
- Migratory Birds;
- Special Areas; and
- Indigenous People and Community Values.

Air quality was not selected as a VC given the Project's distance offshore and the limited atmospheric emissions predicted for the Project, as described in Section 2.6.4.1. The Project Area does not contain any receptors that would be sensitive to atmospheric emission from Project activities and components. Project air emissions are not considered likely to overlap with residual environmental effects of another past, present or future physical activity to create measurable cumulative effects on air quality. Exhaust emissions will comply with the Newfoundland and Labrador *Air Pollution Control Regulations, 2004*, Ambient Air Quality Objectives under the *Canadian Environmental Protection Act*, and any relevant regulations under MARPOL. Potential flaring will occur in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017).

9.1.1.2 Spatial and Temporal Boundaries

The Agency's Technical Guidance document (CEA Agency 201a) requires determination of spatial and temporal boundaries for the CEA and 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 as well as a VC's geographic range and the zone of influence of the project for the VC. Temporal boundaries should consider future physical activities that are certain or reasonably foreseeable, and the degree to which potential environmental effects of these physical activities will overlap those predicted from the designated project.

The spatial boundaries for the assessment of cumulative environmental effects on each VC consists of the Project Area and Study Area as defined in Section 5.2.3.4 and depicted on Figure 2-1. The definition of the Study Area is particularly relevant, as it 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 physical activities. The Study Area is larger than the spatial boundaries for Project-related effects to encompass the other physical activities outside of the Project Area and that have potential to interact cumulatively with the Project (Section 9.1.1.3). It is understood that the migratory range of some species extends beyond the Study Area boundary and therefore potential for individuals of these species to be affected by the combined residual environmental effects of the Project as well as stressors within and beyond the Study Area. However, in many cases, residual effects from other projects and activities (e.g., fishing, shipping, oil and gas activities) identified within the Study Area would resemble residual environmental effects from stressors outside the Study Area and therefore the discussion below is focused on other physical activities within the Study Area.

The temporal boundaries for the Project to be assessed encompass all Project phases, including drilling-associated surveys, well drilling, testing, and abandonment. Up to 10 exploration wells will be drilled over the term of the ELs (i.e., between 2019 and 2027), and each well is anticipated to take up to approximately 80 days to drill to TVD. It is assumed that Project activities could occur year-round. These temporal boundaries are also appropriate for the CEA.

9.1.1.3 Other Physical Activities

In accordance with the OPS (CEA Agency 2016a), the CEA includes consideration of other physical activities that have been, are being, and will be carried out in the Study Area. With respect to future physical activities that will be carried out, the assessment considers (CEA Agency 2016a):

- 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) offshore physical activities within the Study Area that have potential to cause residual environmental effects that overlap spatially and temporally with the residual environmental effects of the Project:

- geophysical survey programs;
- offshore exploration drilling and production projects;
- commercial, Aboriginal, and recreational fisheries; and
- other ocean uses, such as shipping, scientific research, and military activities.

The physical activities listed above are included in the scope of the CEA, 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 9.2.2).

9.1.2 Methods

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. These stages are described in the following subsections.

9.1.2.1 Establishing Context for Cumulative Environmental Effects

Existing environmental conditions for the marine physical environment, marine biological environment, and socio-economic environment have been, and continue to be, shaped by the cumulative environmental effects of historical physical activities previously carried out and ongoing physical activities currently being carried out in the Study Area. Likewise, future physical activities in the Study Area will influence future environmental conditions in the Study Area.

Section 4 describes existing conditions in the Study Area to characterize the setting for the Project, support an understanding of the receiving environment, and provide sufficient context for the CEA.

It is assumed that the existing status or baseline conditions of each VC reflect the influence of other past and present physical activities. Section 9.2.1 provides a brief overview of how the environmental effects of various physical activities in the Study Area 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 also provides context for the CEA.

9.1.2.2 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 above criteria are satisfied.

9.1.2.3 Assessment of Cumulative Environmental Effects

When the two criteria in Section 9.1.2.2 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 Study Area, 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 criteria (i.e., magnitude, geographic extent, duration, frequency, reversibility, and context) defined for each VC in Section 6. 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 6.

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.

9.2 Cumulative Environmental Effects Assessment

9.2.1 Context for Cumulative Environmental Effects in the Study Area

This section provides a brief overview of how the residual environmental effects associated with other past, present, and future physical activities in the Study Area have affected, are affecting, or are anticipated to affect each VC prior to any residual environmental effects that will be contributed by the Project. The effects described in this section represent effects that may have already been realized by past and current activities (which would be reflected in existing conditions for VCs) and those that could occur in the future without the Project.

9.2.1.1 Geophysical Survey Programs

The recent SEA undertaken by the C-NLOPB for Eastern Newfoundland (Amec 2014) describes the geophysical surveys that may be conducted as part of offshore oil and gas exploration activities in and around the Study Area. These descriptions have been adapted for incorporation into Table 9.1.

Table 9.1 Overview of Geophysical Survey Methods

Type of Geophysical Survey	Overview
Gravity Survey	• Measures and records variations in the Earth's gravitational field due to density differences between diverse subsurface rock types. • Detects gravity anomalies, which occur when the density of geological body differs greatly from its surroundings and cause a change in the Earth's gravitational field. • Gravitational anomalies allow the interpreter to gain ideas about the size, depth, and rock type of various features. • Gravity data can be collected from an aircraft or a marine vessel using a gravimeter. • Due to the relative ease of collecting from a ship, gravity data is often recorded in conjunction with a marine seismic acquisition program.
Magnetic Survey	• Investigates subsurface geology by mapping anomalies in the Earth's magnetic field that result from varying magnetic properties in the underlying rocks. • Magnetic data can provide large-scale information about regional geologic structure. • Magnetic surveys can be performed on land, at sea and in the air using a magnetometer and are often completed in conjunction with other surveys.

Type of Geophysical Survey	Overview
Electromagnetic Survey	• Measures the ground's response to propagating electromagnetic fields. • Controlled-source electromagnetics is a marine geophysical technique used to map potential hydrocarbon accumulations below the seafloor. A dipole source that transmits an electromagnetic field is towed by the ship just above the seafloor. The field is altered by the underlying lithology, subsequently detected, and recorded by a receiver array positioned on the seafloor.
Seismic Survey	• Components include a seismic vessel, a sound source, receivers (hydrophones) and associated supporting elements and activities. • An offshore seismic survey vessel is typically approximately 75 to 90 m (250 to 300 ft) in length, depending on local conditions and the characteristics of the survey and associated equipment requirements. • High-energy sound sources (airguns) are towed approximately 100 to 200 m behind a survey vessel while it travels along a track line in a prescribed grid crossing known or suspected hydrocarbon accumulations. • Multiple (often 20 to 30) airgun units are typically used, with individual source unit volumes ranging from about 70 to 250 cubic inches with a combined chamber volume of between 2,000 and 5,000 cubic inches and operating at about 2,000 pounds per square inch (psi). Based on these specifications, the total pressure per source for those array source volumes would be between 137 to 172 Bar-meters, and the peak-to-peak pressure output will be between approximately 240 and 260 dB re 1 µPa @ 1 m. • Each of these receiver arrays are typically between 5 and 10 km long and several hundred meters wide and are towed approximately 5-15 m below the water surface. • The sound source is fired at regular intervals (typically every 25 m) and directs high energy (low frequency) sound bursts toward the seafloor which can penetrate below the surface. • The reflected sound energy is recorded by sensitive hydrophones (streamers, up to several kilometres in length) which are towed behind the vessel. • Seismic surveys may be classified as 2-, 3- or 4-dimensional (2D, 3D, or 4D) surveys based on the density of measurements made over a given area and/or over a period of time.
Source: Amec 2014	

Table 9.2 lists the geophysical survey programs for which EAs are ongoing or have been completed, and that have potential to contribute to cumulative environmental effects in the Study Area. These ongoing and future physical activities have potential to cause a change in risk of mortality or physical injury as well as a change in habitat quality and use affecting fish and fish habitat, marine mammals and sea turtles, and migratory birds; a change in availability of fisheries resources affecting commercial fisheries; and a change in habitat quality affecting special areas (Table 9.3).

Table 9.2 Ongoing and Proposed Geophysical Survey Programs in the Study Area

Proponent	Project Name	Temporal Boundaries
Statoil Canada Limited	Jeanne d'Arc and North Ridge/ Flemish Pass Basin Geophysical Program	2011 to 2019
Husky Energy	Jeanne d'Arc Basin/Flemish Pass Regional Seismic Program	2012 to 2020
Hibernia Management and Development Company Ltd.	2D/3D/4D Seismic Projects for the Hibernia Oil and Gas Production Field	2013 to remaining life of field
Electromagnetic Geoservices Canada, Inc.	East Canada Controlled Source Electromagnetic Survey	2014 to 2018
GX Technology Canada Ltd.	GrandSPAN Marine 2D Seismic, Gravity and Magnetic Survey	2014 to 2018
Multi Klient Invest AS	Southern Grand Banks Seismic Program	2014 to 2018
Suncor Energy	Eastern Newfoundland Offshore Area 2D/3D/4D Seismic Program	2014 to 2024
MG3	Geochemical Data Acquisition and Seabed Sampling for Basin Modelling in Labrador Offshore	2015 to 2024
Bridgeporth Holdings Ltd. and JEBCO Seismic Company	North Flemish Pass Gravity Survey	2015 to 2019
ExxonMobil Canada Ltd.	Eastern Newfoundland Offshore Geophysical, Geochemical, Environmental and Geotechnical Program	2015 to 2024
WesternGeco Canada	Eastern Newfoundland Offshore Seismic Program	2015 to 2024
WesternGeco Canada	Southeastern Newfoundland Offshore Seismic Program	2015 to 2024
Polarcus UK Ltd.	Eastern Newfoundland Offshore 2D, 3D and 4D Seismic Program	2016 to 2022
CGG Services (Canada) Inc.	Newfoundland Offshore 2D, 3D and 4D Seismic Program	2016 to 2025
Seitel Canada Ltd.	East Coast Offshore Seismic Program	2016 to 2025
Multi Klient Invest AS	Newfoundland and Labrador Offshore Seismic Program	2017 to 2026
Fugro Geosurvey	Offshore Seafloor and Seep Sampling Program	2017 to 2027
Nexxen Energy ULC	Newfoundland and Labrador Offshore Seismic Program	2018 to 2027
Statoil Canada Limited	Flemish Pass Exploration Drilling Project	2018 to 2028
ExxonMobil Canada Ltd.	Eastern Newfoundland Offshore Exploration Drilling Program	2018 to 2013
Chevron Canada Limited (Chevron)	Capelin 3D Seismic Survey of EL 1138 Offshore Newfoundland and Labrador	2018 to 2021
Source: C-NLOPB 2017b, as of June 2018		

Table 9.3 Potential Residual Effects Associated with Geophysical Survey Programs in the Study Area

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
Fish and Fish Habitat	Change in Risk of Mortality, Physical Injury, or Health Change in Habitat Quality and Use	• Discharges from survey and support vessels will be made in accordance with MARPOL and are therefore unlikely to cause a change in risk of mortality or physical injury for fish. Discharges may temporarily degrade water quality within a localized area around survey and support vessels, thereby potentially causing temporary behavioural effects (e.g., avoidance/displacement or attraction) for fish within the immediate area. • Vessel-related emissions of artificial light and underwater sound will affect habitat quality in such a way that has potential to disturb fish and cause temporary behavioural effects (e.g., localized avoidance/displacement or attraction) (Amec 2014). • The gravity and magnetic surveys in the Study Area are being carried out using passive measurement technologies. Potential residual environmental effects on fish and fish habitat will therefore be limited to those associated with discharges from survey and support vessels as well as vessel-related emissions of artificial light and underwater sound. • Airgun operations during seismic surveys will affect the quality of the underwater acoustic environment in such a way that has potential to disturb fish and cause temporary behavioural effects (e.g., localized avoidance/displacement and alteration of migration/spawning activities) and/or physiological effects (e.g., damage to hearing structures). Fish eggs and larvae near the airgun array are particularly susceptible to potential injury or mortality from seismic sound (Amec 2014). • Survey activities involving the emission of electromagnetic fields (EMF) have potential to affect electrosensitive species (i.e., species that rely on electrical fields for life functions such as the detection of prey, predators, or conspecifics to assist with feeding, predator avoidance, and social or reproductive behaviours) and magnetosensitive species (i.e., species that rely on magnetic fields for life functions such as orientation, homing, and navigation to assist with long or short-range migrations or movements). Electrosensitive species groups (Normandeau et al. 2011) that may occur in the Study Area include cods, eels, lampreys, rays, sharks, and skates. Magnetosensitive species groups (Normandeau et al. 2011) that may occur in the Study Area include eels, mackerels, rays, salmonids, sea urchin, sharks, and skates. Based on the information available with respect to EMF emissions from subsea power cables, the environmental effects of EMF emissions are generally expected to be limited to localized attraction or repulsion of electrosensitive and magnetosensitive marine species (Collins 2012).

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
Commercial Fisheries	Change in Availability of Fisheries Resources	• It may become necessary for commercial fishers to exert a higher level of effort to achieve the same catch during seismic operations, either due to the temporary displacement of target fish species because of underwater sound from the airgun array, or due to the temporary displacement of fishing vessels to accommodate seismic vessels and streamers, either of which could affect catch rates or otherwise cause a change in availability of fisheries resources for commercial fisheries. • There is potential for fishing gear damage/entanglement because of interaction with seismic streamers.
Marine Mammals and Sea Turtles	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Discharges from survey and support vessels will be made in accordance with MARPOL and are therefore unlikely to cause a change in risk of mortality or physical injury for marine mammals and sea turtles. Discharges may temporarily degrade water quality within a localized area around survey and support vessels, thereby potentially causing temporary behavioural effects (e.g., avoidance/ displacement or attraction) for marine mammals and sea turtles within the immediate area. • Vessel-related sound will affect the quality of the underwater acoustic environment with potential to disturb marine mammals and sea turtles and cause temporary behavioural effects (e.g., localized avoidance/displacement or attraction; and interference with vocal communications and/or masking of other biologically important sounds) (Amec 2014). • The transit of survey and support vessels has potential to cause injury or mortality of marine mammals and sea turtles because of vessel strikes. • The use of aircraft during aerial gravity and magnetic surveys has potential to elicit diving behaviour in marine mammals in response to physical presence or sound, although these behaviours will be temporary. Survey-related aircraft operations may therefore result in a temporary change in habitat quality and use for marine mammals. The gravity and magnetic surveys in the Study Area are being carried out using passive measurement technologies. Other potential residual environmental effects on marine mammals and sea turtles will therefore be limited to those associated with the transit of survey and support vessels, vessel discharges, and vessel-related emissions of underwater sound. • Airgun operations during seismic surveys will affect the quality of the underwater acoustic environment in such a way that has potential to disturb marine mammals and sea turtles and cause temporary behavioural effects (e.g., localized avoidance/displacement, attraction, or other changes in distribution or activities; and changes in vocalizations, respiration, swim speed, diving, and foraging behaviour) and/or physiological effects (e.g., stress immune depression, hearing deterioration [i.e., TTS or PTS], and injury or mortality from strandings) (Amec 2014).

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
		• Survey activities involving the emission of EMF have the potential to affect magnetosensitive species that rely on magnetic fields for life functions such as orientation, homing, and navigation to assist with long or short-range migrations or movements. Magnetosensitive species groups (Normandeau et al. 2011) that may occur in the Study Area include baleen and toothed whales and sea turtles. Based on the information available with respect to EMF emissions from subsea power cables, the environmental effects of EMF emissions are generally expected to be limited to localized attraction or repulsion of electrosensitive and magnetosensitive marine species (Collins 2012).
Migratory Birds	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Discharges from survey and support vessels will be made in accordance with MARPOL and are therefore unlikely to cause a change in risk of mortality or physical injury for migratory birds. Discharges may temporarily degrade water quality within a localized area around survey and support vessels, thereby potentially causing temporary behavioural effects (e.g., avoidance/displacement or attraction) for migratory birds within the immediate area. • The use of aircraft during aerial gravity and magnetic surveys may cause a change in habitat quality and use for migratory birds in proximity to the aircraft (due to atmospheric sound emissions and light), as well as a localized change in risk of mortality or physical injury for migratory birds (due to attraction of birds and/or potential bird strikes). The gravity and magnetic surveys in the Study Area are being carried out using passive measurement technologies. Other potential residual environmental effects on migratory birds will therefore be limited to those associated with the transit of survey and support vessels, vessel discharges, attraction to the lights, and vessel-related emissions of underwater sound. • Although relatively little is known about the potential effects of seismic sound on migratory birds, and the limited information that is available has not provided strong evidence of adverse effects (Amec 2014), it is assumed for the purposes of the CEA that seismic sound from airguns will affect the quality of the underwater acoustic environment in such a way that has potential to disturb migratory birds and cause temporary behavioural and/or physiological effects to individuals diving in proximity to the sound source (Amec 2014).
Special Areas	Change in Habitat Quality	• All the geophysical survey programs identified in Table 9.1 overlap spatially with one or more special areas in the Study Area. Discharges and underwater sound resulting from these programs therefore have potential to affect habitat quality in these special areas. • The use of aircraft during aerial gravity and magnetic surveys has potential to affect habitat quality in special areas where marine mammals and/or migratory birds are likely to occur. The following special areas within the Study Area are known to support aggregations of migratory birds and/or marine mammals: Lily Canyon-Carson Canyon EBSA, Northeast Shelf and Slope EBSA, Southeast Shoal and Tail of the Banks EBSA, Southwest Shelf Edge and Slope EBSA, and Virgin Rocks EBSA.

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
Indigenous People and Community Values	Change in Traditional Use	• It may become necessary for commercial communal fishers to exert a higher level of effort to achieve the same catch during seismic operations, either due to the temporary displacement of target fish species because of underwater sound from the airgun array, or due to the temporary displacement of fishing vessels to accommodate seismic vessels and streamers, either of which could affect catch rates or otherwise cause a change in availability of fisheries resources for commercial fisheries. • Although relatively little is known about the potential effects of seismic sound on migratory birds, and the limited information that is available has not provided strong evidence of adverse effects (Amec 2014), it is assumed for the purposes of the CEA that seismic sound from airguns will affect the quality of the underwater acoustic environment in such a way that has potential to disturb migratory birds and cause temporary behavioural and/or physiological effects to individuals diving in proximity to the sound source (Amec 2014). • Airgun operations during seismic surveys will affect the quality of the underwater acoustic environment in such a way that has potential to disturb seals and cause temporary behavioural effects and/or physiological effects (Amec 2014). • There is potential for fishing gear damage/entanglement because of interaction with seismic streamers. • Discharges from survey and support vessels will be made in accordance with MARPOL and are therefore unlikely to cause a change in risk of mortality or physical injury for migratory birds or seals that maybe traditionally harvested and migrating through the area. Discharges may temporarily degrade water quality within a localized area around survey and support vessels, thereby potentially causing temporary behavioural effects (e.g., avoidance/displacement or attraction) for migratory birds within the immediate area. • The use of aircraft during aerial gravity and magnetic surveys may cause a change in habitat quality and use for migratory birds in proximity to the aircraft (due to atmospheric sound emissions and light), as well as a localized change in risk of mortality or physical injury for migratory birds (due to attraction of birds and/or potential bird strikes). The gravity and magnetic surveys in the Study Area are being carried out using passive measurement technologies. Other potential residual environmental effects on migratory birds will therefore be limited to those associated with the transit of survey and support vessels, vessel discharges, attraction to the lights, and vessel-related emissions of underwater sound.

9.2.1.2 Offshore Exploration Drilling and Production Projects

Offshore oil and gas activities have occurred in the Study Area, including offshore exploration since the late 1950s (C-NLOPB n.d.), and oil production since 1997 (C-NLOPB 2016c).

In addition to Husky's exploration drilling Project, the following offshore exploration drilling projects are proposed in the Study Area:

- Statoil Canada Ltd. (Statoil) and its partners are planning to undertake an exploration drilling program in the Flemish Pass during the period from 2018 to 2028. The area within which Statoil may conduct exploration drilling encompasses ELs 1125, 1139, 1140, 1141, and 1142.
- ExxonMobil Canada Ltd. (ExxonMobil) and its co-venturers are planning to undertake an exploration drilling program in the Flemish Pass and Jeanne d'Arc Basin during the period from 2018 to 2030. The area within which ExxonMobil may conduct exploration drilling encompasses ELs 1135 and 1137.
- Nexen Energy ULC (Nexen) is planning to undertake an exploration project in the Flemish Pass from 2018 to 2028. The area within which Nexen may conduct exploration drilling encompasses ELs 1144 and 1150 (Nexen 2017).
- BP is planning to undertake an exploration project in the Orphan Basin from 2019 to 2026. The area within which BP may conduct exploration drilling encompasses ELs 1145, 1146, 1148, and 1149 (BP 2018).
- Chevron is planning to undertake an exploration project in the Orphan Basin/Flemish Pass area during a 10-year period beginning in 2021. The area within which Chevron may conduct exploration drilling encompasses EL 1138.

All exploration drilling programs propose to use one (or more) MODU to conduct exploration drilling within their ELs, as well as possible delineation drilling in the case of a hydrocarbon discovery. Associated activities include wellsite seabed surveys, VSP, well testing, eventual abandonment, and logistical and supply and service activities.

The following offshore oil production projects are currently operating in the Study Area:

- The Hibernia project is operated by the Hibernia Management and Development Company Ltd. (HMDC), a partnership between ExxonMobil, Chevron Canada Resources (Chevron), Suncor Energy Inc. (Suncor), Canada Hibernia Holding Corp. (Hibernia), Murphy Atlantic Offshore Oil (Murphy Oil), and Statoil. The project employs a gravity-based structure (GBS) and topside facilities to produce oil from the Hibernia field, which consists of two principal reservoirs (i.e., the Hibernia and Ben Nevis-Avalon reservoirs). Production from the Hibernia project began in 1997 and is expected to continue until 2040. The Hibernia Southern Extension, which consists of additional production wells tied back to the Hibernia GBS, began production in 2011.

- The Terra Nova project is operated by Suncor and its co-venturers ExxonMobil, Statoil, Husky Energy, Murphy Oil, Mosbacher Operating, and Chevron. The project employs a FPSO to produce oil from the Graben, East Flank and Far East blocks of the Terra Nova field, which consists of one reservoir (i.e., the Jeanne d'Arc reservoir). Production from the Terra Nova project began in 2002, and the life of the project is estimated to be 25 years from first oil.
- The White Rose project is operated by Husky Energy. The project employs a FPSO to produce oil from the White Rose field and its satellite extensions (i.e., North Amethyst, West White Rose, and South White Rose). Production from the White Rose project began in 2005. The West White Rose pool is being considered for development with a concrete wellhead platform that will tie back to the FPSO. Production from this extension (i.e., WREP) will extend the life of the White Rose field to 2030 or later.
- The Hebron project employs a stand-alone concrete GBS to produce oil from the Hebron oil field; first oil was achieved in December 2017. The expected lifespan of the project is at least 30 years (ExxonMobil 2011).

Equinor Canada Ltd. (Equinor, formerly Statoil Canada Ltd) and its partner Husky recently initiated an EA for development of the Bay du Nord field. The Bay du Nord Development includes offshore construction, installation, hook-up and commissioning, drilling, production operations, maintenance and decommissioning activities, as well as supporting surveys, field work, supply and servicing activities, and may also include potential future development activities (Equinor 2018).

These offshore exploration drilling and production projects have potential to cause a change in risk of mortality or physical injury as well as a change in habitat quality and use affecting fish and fish habitat, marine mammals and sea turtles, and migratory birds; a change in availability of fisheries resources affecting commercial fisheries; and a change in habitat quality affecting special areas, and Indigenous people and community values (Table 9.4). These residual environmental effects are generally predicted to be localized, although the duration and reversibility of effects depend on decommissioning plans for these projects.

Table 9.4 Potential Residual Effects Associated with Offshore Exploration Drilling and Production Projects in the Study Area

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
Fish and Fish Habitat	Change in Risk of Mortality, Physical Injury, or Health Change in Habitat Quality and Use	• Artificial lighting, underwater drilling sound, and other facility-related activities and disturbances will affect habitat quality in such a way that has potential to disturb fish and cause temporary behavioural effects (e.g., localized avoidance/displacement or attraction and alteration of migration/spawning activities) (Amec 2014). • The presence of offshore production facilities has potential to cause a reef and refuge effect due to the attraction of some fish and invertebrate species to subsea infrastructure in areas where fishing is excluded through the establishment of safety zones. The presence of exploration facilities is more transient and less likely to cause potential reef effects (Amec 2014). • Discharges from offshore exploration drilling and production projects are regulated 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. However, discharges may temporarily affect water quality within a localized area around offshore exploration and production facilities and OSVs. • Underwater sound associated with drilling has potential to cause a localized change in risk of injury or mortality for fish near the sound source. However, given that most 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. • Fish that are attracted to artificial night lighting on exploration and production facilities may be at increased risk of predation. • Seismic sound from VSP and other wellsite surveys will affect the quality of the underwater acoustic environment in such a way that has potential to disturb fish and cause temporary behavioural effects (e.g., localized avoidance/displacement and alteration of migration/spawning activities) and/or physiological effects (e.g., damage to hearing structures). Fish eggs and larvae near the airgun array are particularly susceptible to potential injury or mortality from seismic sound (Amec 2014). • OSV-related emissions of artificial light and underwater sound will affect habitat quality in such a way that has potential to disturb fish and cause temporary behavioural effects (e.g., localized avoidance/displacement or attraction) (Amec 2014). • The discharge of drill muds and cuttings is expected to affect water and sediment quality and cause a change in risk of mortality or physical injury for fish due to the potential smothering of benthic organisms.

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
		• SBM from offshore drilling activities can affect benthic habitat more than 6 km from the drill site (Breuer et al. 2008, in Amec 2014), whereas biological effects of WBM are typically restricted to within approximately 250-500 m from a drilling platform (Hurley and Ellis 2004; Schaaning et al. 2008, Jorissena et al. 2009 and Santosa et al. 2009, in Amec 2014). EEM data from offshore oil developments in the NL Offshore Area have indicated that the actual area of effects from drill cuttings discharge have generally been much smaller than predicted (LGL Limited 2005, in Amec 2014). According to the 2014 EEM results for the White Rose field (Husky Energy 2017), the estimated spatial extent of contamination resulting from drill cuttings was less than that predicted from drill cuttings dispersion modelling. Despite seasonal variability of currents, wind and waves (see Section 4.1.3), the deposition of drilling waste from each well is similar in that a well-defined cuttings patch covering an area approximately 0.03 to 0.06 km^2 is located up to 300 m of the well. Each patch is of thicknesses in the range of approximately 1 to 10 mm with portions that are as thick as 25 to 50 mm. • 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 year (Husky Oil Operations Limited 2000; Netto et al. 2009; Manoukain et al. 2010, in Amec 2014); however, recovery rate depends on site-specific environmental characteristics and processes (Neff et al. 2000, in Amec 2014). • During well abandonment if the wellhead is mechanically separated from the seabed, it is expected that fish would avoid the immediate area where well abandonment activities are taking place. If blasting is required, the resultant shock wave has potential to cause injury or mortality to fish, as well as to cause alteration, disruption or destruction of fish habitat (Amec 2014). • Effects of future decommissioning of existing oil production drilling projects will be like those generated by current operational activities, including lighting effects, ongoing vessel and helicopter traffic, underwater sound, and marine discharges. There may be additional benthic disturbance, depending on the nature of decommissioning activities and extent of removal of infrastructure on the seafloor. Effects are predicted to be localized, although the duration and reversibility of effects will depend on specific decommissioning plans for these projects.

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
Commercial Fisheries	Change in Availability of Fisheries Resources	• The effects of offshore exploration and production facilities on fish and fish habitat (described above) 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. • Offshore oil and gas exploration drilling and production projects have localized effects on access to fisheries resources for commercial fishers due to the establishment of a safety zones around field assets. Commercial fishing activity has been, and will continue to be, excluded within existing safety zones for the duration of oil production from the Hibernia, Terra Nova, and White Rose fields. Commercial fishing will also be excluded within the future safety zones that will be established in association with oil production from the Hebron field and exploration activities proposed by Statoil and ExxonMobil. • It may become necessary for commercial fishers to exert a higher level of effort to achieve the same catch during VSP or wellsite surveys, either due to the temporary displacement of target fish species as a result of underwater sound from the airgun array, or due to the temporary displacement of fishing vessels to accommodate wellsite surveys, either of which could affect catch rates or otherwise cause a change in availability of fisheries resources for commercial fisheries.
Marine Mammals and Sea Turtles	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Artificial lighting, underwater drilling sound, and other facility-related activities and disturbances will affect habitat quality in such a way that has potential to disturb marine mammals and sea turtles and cause temporary behavioural effects (e.g., localized avoidance/displacement or attraction), interfere with vocal communications and/or mask other biologically important sounds (Amec 2014). • 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. • Facility-related underwater sound emissions may result in a change in risk of mortality or physical injury to marine mammals and sea turtles near the sound source. However, given that marine mammals and sea turtles 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. • Seismic sound from VSP and other wellsite surveys will affect the quality of the underwater acoustic environment with potential to disturb marine mammals and sea turtles and cause temporary behavioural effects (e.g., localized avoidance/displacement, attraction, or other changes in distribution or activities; and changes in vocalizations, respiration, swim speed, diving, and foraging behaviour) and/or physiological effects (e.g., stress immune depression, hearing deterioration [i.e., TTS or PTS], and injury or mortality from strandings) (Amec 2014). • The transit of OSVs has potential to cause injury or mortality of marine mammals and sea turtles because of vessel strikes. OSV-related sound will affect the quality of the underwater acoustic environment with potential to disturb marine mammals and sea turtles and cause temporary behavioural effects (e.g., localized avoidance/displacement or attraction; and interference with vocal communications and/or masking of other biologically important sounds) (Amec 2014).

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
		• The discharge of mud and cuttings will be in accordance with the OWTG and MARPOL. However, discharges of mud and cuttings will result in localized increases in TSS in the water column, temporarily affecting water quality and potentially resulting in species avoidance. • 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 offshore exploration drilling and production projects may therefore result in a temporary change in habitat quality and use for marine mammals. • During well abandonment activities, if the wellhead is mechanically separated from the seabed, it is expected that marine mammals and sea turtles would avoid the immediate area where well abandonment activities are taking place. If blasting is required, the resultant shock wave has potential to cause mortality of marine mammals, and may cause auditory damage, as well as cause changes in behaviour (Amec 2014). • Effects of future decommissioning of existing oil production drilling projects will be like those generated by current operational activities, including lighting effects, ongoing vessel and helicopter traffic, and underwater sound.
Migratory Birds	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Facility-related underwater and atmospheric sound emissions 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). Some species may be attracted to artificial night lighting and flares on the MODU, while others may be deterred (e.g., ducks and other birds that prefer to sleep at night in the dark). • Migratory birds that are attracted to offshore exploration and production facilities are at an increased risk of potential injury or mortality from direct collision with infrastructure, disorientation and stranding, exhaustion, starvation, incineration, and exposure. • Although relatively little is known about the potential effects of seismic sound on migratory birds, and the limited information that is available has not provided strong evidence of adverse effects (Amec 2014), it is assumed for the purposes of this assessment that seismic sound from VSP and wellsite surveys will affect the quality of the underwater acoustic environment with potential to disturb migratory birds in such a way that causes temporary behavioural effects and/or physiological effects to individuals diving in proximity to the sound source (Amec 2014). • OSV-related emissions of artificial light and atmospheric sound will affect habitat quality with potential to disturb migratory birds and cause temporary behavioural effects (e.g., localized avoidance/ displacement or attraction) (Amec 2014). Artificial lighting from OSVs has potential to disorient migratory birds and could result in injury or mortality (e.g., due to possible exhaustion, stranding and/or exposure to other vessel-based threats) (Amec 2014).

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
		• Helicopter traffic may cause a change in habitat quality and use for migratory birds in proximity to the helicopter (due to atmospheric sound emissions), as well as a localized change in risk of mortality or physical injury for migratory birds (due to potential bird strikes). • As a result of well depths and the nature of well abandonment activities, underwater well abandonment activities are not expected to result in a measurable change in risk of mortality or physical injury for migratory birds. Residual effects of above-surface well abandonment activities within the Project Area are expected to be similar to those described above with respect to OSVs. Underwater activities during well abandonment may result in sensory disturbance to migratory birds, leading to behavioural responses such as temporary habitat avoidance. • Effects of future decommissioning of existing oil production drilling projects will be similar to those generated by current operational activities, including lighting effects, ongoing vessel and helicopter traffic, and underwater sound.
Special Areas	Change in Habitat Quality	• The only offshore production drilling facility within 70 km of any of the special areas in the Study Area is the White Rose platform, which is located approximately 28 km south of the Northeast Shelf and Slope EBSA. All the other existing and proposed production platforms are located at least 72 km and up to 412 km from any special areas. Given these distances, offshore production facilities are not expected to be visible or audible from any of the special areas in the Study Area and are therefore not expected to cause a change in habitat quality for special areas. • Several of the ELs in which proposed offshore exploration drilling activities may be carried out by Statoil, ExxonMobil, and/or BP overlap spatially with special areas in the Study Area. ELs 1125, 1141 and 1142 overlap with the Flemish Pass/Eastern Canyon NAFO sponge/coral closure, and EL 1135 overlaps with the Northeast Shelf and Slope EBSA. The potential presence and operation of one or more MODUs associated with the Statoil and/or ExxonMobil offshore exploration drilling projects could therefore affect habitat quality within one or both these special areas through sensory disturbance. • All of the other ELs associated with the Statoil and ExxonMobil offshore exploration drilling projects are located at least 27 km and up to 744 km from any special areas. Given these distances, MODU(s) or drill ship(s) operating within these ELs are not expected to be visible or audible from any of the special areas in the Study Area and are therefore not expected to cause a change in habitat quality for special areas. • It is conservatively assumed that underwater sound emissions from VSP operations and wellsite surveys could potentially result in a change in habitat quality for marine species in special areas within several kilometers of the sound source. The only offshore production drilling facility within 30 km of any of the special areas in the Study Area is the White Rose platform, which is located approximately 28 km south of the Northeast Shelf and Slope EBSA. Underwater sound emissions from VSP and wellsite surveys carried out in association with the White Rose offshore production drilling project therefore have potential to cause a change in habitat quality for marine species in the Northeast Shelf and Slope EBSA.

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
		• Operational discharges from OSVs transiting in, or immediately adjacent to, a special area have potential to cause localized water quality effects and a resultant change in habitat quality for marine species within the affected special area. • Helicopter traffic has potential to affect habitat quality in special areas where marine mammals and/or migratory birds are likely to occur. The following special areas within the Study Area are known to support aggregations of migratory birds and/or marine mammals: Lily Canyon-Carson Canyon EBSA, Northeast Shelf and Slope EBSA, Southeast Shoal and Tail of the Banks EBSA, Southwest Shelf Edge and Slope EBSA, and Virgin Rocks EBSA. • If well abandonment occurs via mechanical separation, it will have little potential interaction with these special areas outside the immediate vicinity of the wellhead. If blasting is required, the resultant shock wave has potential to alter, disrupt, or destroy benthic habitat within a localized area surrounding the wellhead. • Effects of future decommissioning of existing oil production drilling projects will be like those generated by current operational activities, including lighting effects, ongoing vessel and helicopter traffic, and underwater sound. There may be additional benthic disturbance, depending on the nature of decommissioning activities and extent of removal of infrastructure on the seafloor.
Indigenous People and Community Values	Change in Commercial Communal Fisheries Change in Current Indigenous Use of Lands and Resources for Traditional Purposes	• The effects of offshore exploration and production facilities on fish and fish habitat (described above) 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. • Offshore oil and gas exploration drilling and production projects have localized effects on access to fisheries resources for commercial fishers due to the establishment of a safety zones around field assets. Commercial fishing activity has been, and will continue to be, excluded within existing safety zones for the duration of oil production from the Hibernia, Terra Nova, and White Rose fields. Commercial fishing will also be excluded within the future safety zones that will be established in association with oil production from the Hebron field and exploration activities proposed by Statoil and ExxonMobil. • It may become necessary for commercial fishers to exert a higher level of effort to achieve the same catch during VSP or wellsite surveys, either due to the temporary displacement of target fish species because of underwater sound, or due to the temporary displacement of fishing vessels to accommodate wellsite surveys, either of which could affect catch rates or otherwise cause a change in availability of fisheries resources for commercial fisheries. • See above for potential residual effects associated with offshore exploration drilling and production projects in the Study Area on migratory birds.

9.2.1.3 Commercial Fisheries

Fishing offshore Newfoundland and Labrador has been an important socio-economic activity for hundreds of years. Historically, the commercial fishing effort offshore was primarily concentrated on the use of large stern otter trawlers by local and international fishing fleets to harvest Atlantic cod and other groundfish, until several of the stocks collapsed and the Canadian government imposed a moratorium on the Northern cod fishery in 1992. In addition to cod, several other species of groundfish in NAFO Area 2+3KL are currently under moratorium, including haddock, redfish, American plaice, witch flounder and grenadier. Considerable effort is placed on avoiding these bycatch species (DFO 2014f).

The Project Area is within NAFO Area 3L, while the Study Area overlaps portions of NAFO Areas 3KLMNO. As summarized in Sections 4.3.1 and 6.2.8, within the boundaries of the Study Area, northern shrimp and snow crab have collectively made up approximately 93% of all landings by weight and 96% by value between 2011 and 2015 (Table 4.36). The remaining fisheries are primarily groundfish, consisting of flounder and turbot (Greenland halibut), along with smaller quantities of large pelagic species (e.g., swordfish, tunas). There is also some fishing activity for deep-sea clams and bivalves. Surf clam were commercially harvested outside the Project Area in the Lily Canyon area in 2013. Commercial fishing gear used in the Study Area includes crab pots, clam and scallop dredges/draggers, otter trawls, gillnets, longlines, and seines (purse or tuck). The peak harvesting months in the offshore area are April to September. The shrimp fishery within the Project Area has been closed since 2015 and the crab fishery total allowable catch within the Project Area has declined.

For the purposes of the cumulative effects assessment, past and present commercial fishing activities in the Study Area 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 availability of fisheries resources affecting other commercial fishers; and a change in habitat quality affecting special areas. Table 9.5 presents the details of these potential effects on each VC.

Table 9.5 Potential Residual Effects Associated with Commercial Fisheries in the Study Area

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
Fish and Fish Habitat	Change in Risk of Mortality, Physical Injury, or Health Change in Habitat Quality and Use	• Use of mobile bottom-contact fishing gear can adversely affect fish and fish habitat through physical disturbance, degradation of habitat, removal of biomass (both target and non-target species) and by noise avoidance. • Marine fish can experience a change in risk of mortality or physical injury as they are targeted for fisheries or caught as bycatch. • Discharges from fishing vessels will be discharged in accordance with MARPOL and are therefore unlikely to cause a change in risk of mortality or physical injury for fish. • Discharges may cause a change in habitat quality and use for fish within a localized area around fishing vessels.
Commercial Fisheries	Change in Availability of Fisheries Resources	• Under a relevant licence, commercial fisheries can be carried out in any NAFO Division and Unit Area in the Study Area and thus have potential to cause a change in availability of fisheries resources for competing commercial fisheries in the Study Area (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 Study Area could cause a change in availability of fisheries resources for future commercial fishers due to decreased catch rates 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 rates or otherwise cause a change in availability of fisheries resources for commercial fisheries.
Marine Mammals and Sea Turtles	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• 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 2014a, 2015), resulting in a change in risk of mortality or physical injury. • Fishing vessels may cause a localized change in habitat quality and use for marine mammals, and sea turtles or their prey, 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 marine mammals at close ranges (see Table 9.6 for Other Ocean Users). • 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. • Discharges from fishing vessels will be discharged in accordance with MARPOL and are therefore unlikely to cause a change in risk of mortality or physical injury for marine mammals and sea turtles.

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
		• Discharges may cause a change in habitat quality and use for marine mammals and sea turtles within a localized area around fishing vessels.
Migratory Birds	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• 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. • 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. • Discharges from fishing vessels will be discharged in accordance with MARPOL and are therefore unlikely to cause a change in risk of mortality or physical injury for migratory birds. • Discharges may cause a change in habitat quality and use for migratory birds within a localized area around fishing vessels.
Special Areas	Change in Habitat Quality	• The following special areas in the Study Area are subject to fishing closures or gear restrictions: the NAFO sponge/coral and seamount protection zones are all either closed to all bottom-contact fishing gear or have restrictions in place for bottom-contact fishing gear (refer to Table 4.34), and commercial fishing (excluding snow crab trapping) is prohibited in the Bonavista Cod Box. • None of the other special areas in the Study Area are currently subject to any fishing closures or gear restrictions. The use of mobile bottom-contact fishing gear therefore has potential to cause a change in habitat quality in the remaining special areas in the Study Area. • Fishing vessels may be present in other special areas, thereby potentially causing a localized change in habitat quality through the generation of underwater sound from engines and propellers during transiting, as well as from other physical activities that may be carried out by fishing vessels (e.g., bottom trawling, depth sounding, bottom profiling, and side-scan sonar)
Indigenous People and Community Values	Change in Commercial Communal Fisheries a Change in Current Indigenous Use of Lands and Resources for Indigenous Purposes	• Under a relevant licence, commercial communal fisheries can be carried out in any NAFO Division and Unit Area in the Study Area and thus have potential to cause a change in availability of fisheries resources for competing commercial communal fisheries in the Study Area (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 Study Area could cause a change in availability of fisheries resources for future commercial fishers due to decreased catch rates 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 rates or otherwise cause a change in availability of fisheries resources for commercial fisheries.

9.2.1.4 Other Ocean Users

As summarized in Section 4.3, various other ocean users continue to be active throughout the Study Area, including shipping, scientific research and military activities. The activities of these other offshore users generate varying levels and frequencies of underwater sound emissions (Table 9.6).

Table 9.6 Sound Levels and Frequencies Associated with Natural Sources and Various Marine Related Activities

Source	Source Level (dB re 1µ Pa @ 1m)	Dominant Frequency (Hz)
Sea State* 0	60	100
Sea State 3	97	100
Sea State 5	102	100
Surf Noise	N/A	100–700
650cc Jet Ski	75–125	800–50,000
7 m vessel with outboard engine	152	630
Fishing Boat	151	250–1,000
Fishing Trawler	158	100
Tug	170	1,000
Tanker	180	60
Container Ship	181	8
Freighter	172	41
Airgun Array	255	10–100
Naval Sonar	225	2,000–8,000
Depth Sounder	200	3,000
Bottom Profiler	215	1,000–10,000
Side Scan	225	60,000–300,000
Acoustic Deterrent Devices	205	1,000–25,000
Dredging	131	Broadband
Impact Pile Driving	190	10–120
Drilling (including DP system noise)	130–190	10–10,000
TNT (1–100 lbs)	272–287	2–1,000

Source: JWEL 2002b; OSPAR 2009; Walmsley and Theriault 2011
*Sea State 0 = glassy, wind < 1.8 km/hour; Sea State 3 = small white caps, wind 20.4–29.7 km/hour; Sea State 5 = moderate waves, some spray, wind 40.8–60.0 km/h

The past and present activities of other ocean users in the Study Area 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 availability of fisheries resources affecting commercial fishers; a change in habitat quality affecting special areas; and Indigenous people and community values (Table 9.7).

Table 9.7 Potential Residual Effects Associated with Other Ocean Users in the Study Area

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
Fish and Fish Habitat	Change in Risk of Mortality, Physical Injury, or Health Change in Habitat Quality and Use	• Other ocean users in the Study Area can cause a change in risk of mortality or physical injury and a change in habitat quality and use for fish 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. • 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 around the vessels of other ocean users.
Commercial Fisheries	Change in Availability of Fisheries Resources	• Other ocean users can occur in any NAFO Division in the Study Area and have potential to cause a change in availability of fisheries resources for commercial fisheries through temporary displacement of commercial 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 rates or otherwise cause a change in availability of fisheries resources for commercial fisheries.
Marine Mammals and Sea Turtles	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Other ocean users in the Study Area can cause a change in risk of mortality or physical injury and a change in habitat quality and use for 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. • 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. • There is potential for helicopter traffic to/from production platforms 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.

VC	Residual Environmental Effect(s)	Explanation of Residual Environmental Effect(s)
		• 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 and sea turtles within a localized area around the vessels of other ocean users.
Migratory Birds	Change in Risk of Mortality or Physical Injury Change in Habitat Quality and Use	• Atmospheric and/or underwater noise 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. • Helicopter traffic may cause a change in habitat quality and use for migratory birds in proximity to the helicopter (due to atmospheric sound emissions), as well as a localized change in risk of mortality or physical injury for migratory birds (due to potential bird strikes). • 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 migratory birds within a localized area around the vessels of other ocean users.
Special Areas	Change in Habitat Quality	• The vessels of other ocean users can cause a change in habitat quality in special areas due to the generation of underwater sound emissions and discharge of emissions. • Helicopter traffic has potential to affect habitat quality in special areas where marine mammals and/or migratory birds are likely to occur. The following special areas within the Study Area are known to support aggregations of migratory birds and/or marine mammals: the Lily Canyon-Carson Canyon EBSA, Northeast Shelf and Slope EBSA, Southeast Shoal and Tail of the Banks EBSA, Southwest Shelf Edge and Slope EBSA, and Virgin Rocks EBSA.
Indigenous People and Community Values	Change in Commercial Communal Fisheries Change in Current Indigenous Use of Lands and Resources for Traditional Purposes	• Other ocean users can occur in any NAFO Division in the Study Area and have potential to cause a change in availability of fisheries resources for commercial communal fisheries through temporary displacement of commercial communal 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 rates or otherwise cause a change in availability of fisheries resources for commercial communal fisheries.

9.2.2 Potential Cumulative Interactions between the Project and Other Physical Activities

As summarized in Table 9.8, the residual environmental effects of the Project on each VC (i.e., fish and fish habitat, commercial fisheries, marine mammals and sea turtles, migratory birds, special areas, and Indigenous people and community values) could overlap spatially and temporally with the residual environmental effects of each of the past, present, and future physical activities identified in Section 9.1.1.3.

Table 9.8 Potential Spatial and Temporal Overlap of Residual Environmental Effects of the Project and Other Physical Activities

Other Physical Activities	Spatial Overlap	Temporal Overlap
Geophysical Survey Programs	Based on review of the Project and Study Area boundaries proposed in the respective EAs for each of the geophysical survey programs identified in Table 9.2, the residual environmental effects of underwater noise (disturbance of marine species) from Project activities (within several kilometres of a geophysical program) of these programs could overlap spatially with the residual effects of the Project on each VC.	All the geophysical survey programs identified in Table 9.2 are proposed to be carried out at least partially during the period from 2019 to 2027. Residual environmental effects from these programs are expected to overlap temporally with the residual environmental effects of the Project on each VC.
Offshore Exploration Drilling and Production Projects	None of the ELs where Statoil is currently proposing to drill exploration wells are in close proximity to the Project Area. The distance between the Project Area and the nearest EL associated with the Statoil project (EL 1125) is approximately 45 km. Potential cumulative interactions between the Statoil exploration drilling project and the Project are therefore generally expected to be limited to any Statoil-related OSV and helicopter transportation that may occur within the Project Area. Even where there is little spatial overlap between the residual environmental effects of the Project and the residual environmental effects of the Statoil offshore exploration drilling project, certain VCs may nonetheless be affected by sequential exposure to the residual environmental effects of the Project and offshore exploration drilling and production projects in the Study Area. The life cycles of several species of fish, marine mammals, sea turtles, and migratory birds include long-distance movement within the Study Area, and there is potential for individuals of these species to be affected by the combined residual	The Statoil and ExxonMobil offshore exploration drilling projects are proposed to be carried out during the periods from 2018 to 2028 and 2018 to 2030, respectively. Residual environmental effects from these proposed offshore exploration drilling projects are expected to overlap temporally with the residual environmental effects of the Project on each VC. Production operations are currently ongoing on the existing Hibernia, Terra Nova, and White Rose platforms, and are anticipated to continue until 2020 or later (White Rose; note, if the WREP is sanctioned, the life of the field will be extended by up to 25 years), 2027 (Terra Nova) and 2040 (Hibernia). Production from the Hebron platform is anticipated to begin in 2017 and continue until at least 2047. Residual environmental effects from these existing and future offshore production drilling projects are expected to

Other Physical Activities	Spatial Overlap	Temporal Overlap
	environmental effects of the Project and other offshore exploration drilling and production 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 Study Area). Given that ExxonMobil's EL 1135 is located partially within the Project Area, the residual environmental effects of the proposed ExxonMobil offshore exploration drilling project may overlap spatially (if drilling activities occur simultaneously) with the residual effects of the Project on each VC. (No other ELs associated with the ExxonMobil exploration drilling project overlap with the Project Area.) The existing Hibernia, Terra Nova, and White Rose production platforms are all located within the Project Area. The Hebron platform is also being developed within the Project Area. Residual environmental effects from these offshore production drilling projects are expected to overlap spatially with the residual environmental effects of the Project on each VC.	overlap temporally with the residual environmental effects of the Project on each VC.
Commercial Fisheries	The use of bottom-contact fishing gear is prohibited within the portion of the Project Area that overlaps with the Flemish Pass/Eastern Canyon NAFO sponge/coral closure. Commercial fishing activity is also excluded within the safety zones surrounding offshore exploration drilling and production projects within the Project Area. Except where noted above, commercial fishing activity has potential to occur anywhere else in the Project Area. In addition, residual environmental effects related to underwater sound, emissions of artificial night lighting, and operational discharges originating from commercial fishing vessels within or near the Project Area have potential to interact cumulatively with the residual environmental effects of the Project on marine species. Residual environmental effects from commercial fisheries are therefore expected to overlap spatially with the residual environmental effects of the Project on each VC. Because the customary fishing grounds of any given commercial fisher may encompass a broad area or include multiple areas, there is	There is a long history of commercial fishing in the Project Area. Commercial fishing activities are currently ongoing and will continue for the foreseeable future. Residual environmental effects from commercial fisheries are expected to overlap temporally with the residual environmental effects of the Project on each VC.

Other Physical Activities	Spatial Overlap	Temporal Overlap
	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 Study Area).	
Other Ocean Users	Other ocean users are excluded from each of the safety zones surrounding offshore exploration drilling and production projects within the Project Area. Activities associated with other ocean users have potential to occur anywhere else in the Project Area. In addition, residual environmental effects related to underwater sound, emissions of artificial night lighting, and operational discharges originating from the vessels of other ocean users within or near the Project Area have potential to interact cumulatively with the residual environmental effects of the Project on marine species. Residual environmental effects from other ocean users are therefore expected to overlap spatially with the residual environmental effects of the Project on each VC.	There is a long history of activities being carried out by other ocean users in the Project area. These activities are currently ongoing and will continue for the foreseeable future. Residual environmental effects from other ocean users are expected to overlap temporally with the residual environmental effects of the Project on each VC.

Table 9.9 applies the criteria from Section 9.1.2.2 to determine whether further assessment of cumulative environmental effects is warranted for each VC, and indicates where the residual effects of routine Project activities and components may overlap and interact cumulatively with the environmental effects of other physical activities in the Study Area. The potential cumulative environmental effects identified in Table 9.9 are assessed in Sections 9.2.3 to 9.2.8. An assessment of cumulative interactions from accidental events is presented in Section 9.2.8.

Table 9.9 Potential Residual Effects Associated with Other Physical Activities in the Study Area

Environmental Effect	Potential Cumulative Environmental Effects*			
	Geophysical Survey Programs	Offshore Exploration and Drilling Production Projects	Fisheries	Other Ocean Users
Fish and Fish Habitat				
Change in Risk of Mortality, Physical Injury, or Health	✓	✓	✓	✓
Change in Habitat Quality and Use	✓	✓	✓	✓
Commercial Fisheries				
Change in Availability of Fisheries Resources	✓	✓	✓	✓
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	✓	✓	✓	✓
Indigenous People and Community Values				
Change in Commercial Communal Fisheries	✓	✓	✓	✓
Change in Current Indigenous use of Lands and Resources for Traditional Purposes	--	--	--	--

Note:

*The "✓" indicates that both 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).

9.2.3 Assessment of Cumulative Environmental Effects on Fish and Fish Habitat (including SAR and SOCC)

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 Study Area.

Underwater sound emissions from the Project can contribute to a cumulative change in risk of mortality or physical injury. Some of the underwater sound emissions generated by geophysical survey programs, offshore exploration drilling and production projects, commercial 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 9.6). SPLs generated by wellsite and VSP surveys for the offshore exploration drilling and production projects as well as this Project, will generate sound levels that may result in physical damage to fish very close to the sound source. Given the nature of fish migrations, the possibility of cumulative interaction is uncertain, though unlikely, given the infrequent nature and short duration (e.g., VSP less than one day per well; and wellsite survey of 5-7 days per well) of drilling –associatedsurveys. Furthermore, drilling-associated surveys may not be completed for each well of the Project or for each well of the other offshore exploration drilling and production projects in the Study Area.

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 close to those sound sources. 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 drilling-associated source array in accordance with the SOCP will mitigate potential underwater sound effects on fish, marine mammals, sea turtles, and diving birds close to Project and non-Project seismic sources.

The SPLs produced by Project and non-Project drilling-associated surveys may be 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 an effect of this magnitude would be in the range of the natural variability of mortality (not affecting population recruitment). Fish eggs/larvae are passive drifters and are therefore more susceptible to harm very close to these sound sources than other life stages of fish. However, the sound sources between projects are far enough apart that, even if there was some temporal overlap of activities, it is expected that there would be no spatial overlap of residual environmental effects on fish eggs/larvae. The safety zone around the MODU within which non-Project activities are excluded, will further reduce potential cumulative interactions between underwater sound emissions from Project-related surveys and from other third-party physical activities generating high SPLs in the Study Area.

Various activities in the Study Area contribute underwater sound at levels that are not expected to cause a change in risk of mortality or physical injury for fish but may still affect fish and fish habitat. For example, routine activities associated with marine transportation generate underwater sound that has potential to cause a change in habitat quality and use for fish. However, the contribution of a small number of vessels in association with the Project is not expected to considerably increase the amount of ambient sound in the Study Area. OSV activities in support of the Project (i.e., one OSV trip per week) are a minimal increase to ongoing shipping activity in the region, as the offshore operators currently employ numerous OSVs that conduct more than 1,000 trips to the Project Area per year (SMS 2012).

The presence of Project and non-Project vessels in any area is generally anticipated to be medium-term and transient in nature, thus limiting potential effects (and associated cumulative changes in habitat quality and use) at any given location, including areas of importance for reproduction, feeding, and migration of fish.

Underwater sound emissions produced during operation of the Project MODU, other offshore exploration drilling and production facilities will be longer lasting and generated from a stationary source. These sound emission levels may cause behavioural responses such as temporary habitat avoidance or changes in activity state, at each site during the duration of each well.

Underwater noise and EMF emissions from geophysical surveys in the Study Area also have potential to cause temporary behavioural effects on fish, including localized avoidance/ displacement or attraction. The localized areas potentially affected by underwater sound from the Project in combination with underwater sound and EMF emissions from other physical activities represent a relatively small proportion of the total amount of habitat available within the Study Area and are not expected to overlap in such a way that causes any substantial cumulative change in habitat quality and use for fish.

Routine discharges from the Project and from other third-party physical activities will comply 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 habitat. 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, 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.

Nonetheless, there is a potential cumulative environmental effect from discharges of drill muds and cuttings when considered together with other drilling projects. While it is acknowledged that each production or exploration well is contributing to a localized effect on marine fish habitat, each of these the environmental effects are reversible, once drilling ceases.

The deposition of Project-related drill muds and cuttings may smother marine benthos within a localized area around the wellhead. Although drill waste dispersion modelling results (Section 2.6.1.1) indicate that dispersed sediment from Project-related discharge of drill muds and cuttings may extend up to a maximum distance of 12 km from the release site (at a deposition thickness of 0.1 mm), cuttings thicknesses are expected to remain below 1 mm at distances beyond approximately 200 to 250 m from the Project drill centres. This sediment thickness is well below the 9.6 mm threshold (Neff et al. 2004) for average burial depth at which there will likely be no net adverse effects to benthic organisms attributable to sedimentation. Similar radii for benthic smothering are expected around each well. These affected areas from different drilling projects will not likely overlap spatially but could result in additive effects for benthic fish species in the

Project Area, thereby potentially contributing to a cumulative change in risk of mortality or physical injury.

The predicted 200 to 250 m radius in which sediment thicknesses of ≥ 1 mm may occur is within the safety zone around the MODU. Other third-party physical activities are excluded within this safety zone, thereby limiting potential cumulative interactions between Project-related drill muds and cuttings. Project-related discharges of drill muds and cuttings will be at such low water column concentrations outside of the safety zone that any potential cumulative change in habitat quality and use caused by interaction with the discharges of other physical activities would be negligible. 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 suspended during commercial fishing activity outside of the safety zone would be negligible based on the localized nature and duration of the activity.

Species whose ranges cover a large extent of the Study Area may be exposed to various sources of underwater sound and discharges throughout their life cycle. The Project will introduce an additional source of underwater sound and discharges that these individuals have potential to encounter. Fish (and other marine wildlife) may temporarily avoid localized areas subject to underwater sound and/or degraded water quality. 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 Study Area (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 for fish if the availability of important habitat areas is affected.

The change in risk of mortality or physical injury predicted for the Project could also combine with the harmful effects that commercial fisheries (i.e., groundfishing) can have on benthic organisms, resulting in adverse cumulative effects. However, the current level of commercial exploitation within the Project Area is very limited, and DFO manages commercial fisheries to keep populations at sustainable levels. Potential cumulative environmental interactions between the Project and commercial fisheries will be further limited by the presence of the safety 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 zone are unlikely to contribute to the residual effects of groundfishing outside of the safety zone.

In summary, the residual cumulative environmental effects on fish and fish habitat (i.e., change in risk of mortality or physical injury and change in habitat quality and use) are generally predicted to be low to moderate in magnitude, limited in extent to the Project Area (for change in risk of mortality or physical injury) or Study Area (for change in habitat quality and use), short- to medium-term in duration, reversible, sporadic to regular in frequency, and to occur in a context of moderate disturbance. A cumulative change in risk of mortality or physical injury associated with underwater sound is also considered unlikely to occur from the varying spatial and temporal scale of drilling associated surveys. 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 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.

In consideration of the various physical activities that have been, are being, and will be carried out in the Study Area, the Project is expected to result in a relatively small, incremental increase in cumulative residual environmental effects on fish and fish habitat in comparison with the future scenario without the Project. 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. 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 Study Area, as well as the effectiveness of standard mitigation measures. No additional mitigation measures are proposed to mitigate potential cumulative environmental effects on fish and fish habitat. Given the high level of confidence, the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing EEM and existing literature, no additional monitoring and follow-up requirements are proposed for fish and fish habitat.

9.2.4 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 Study Area.

A safety zone will be established around the MODU, within which fisheries activities will be excluded while the MODU is in operation. The overall geographic extent of the area lost to fishing activity due to the safety zone will be determined once the preferred MODU type has been determined identified for each well for up to 80 days for each well. For example, a MODU requiring anchors will require a safety zone of 50 m around each anchor, which will extend up to 1,500 m from the MODU, depending on water depth, while a non-anchored MODU, such as a drill ship or jack-up rig will require only a 500 m safety zone. There is a possibility of more than one concurrent well. The safety zones associated with offshore exploration drilling and production projects will increase the cumulative area that will be temporarily unavailable to fishers at any given time during Project activities. No substantial change in availability of fisheries resources for fishers is anticipated to result from the cumulative interaction of the various safety zones associated with the Project, Hibernia, Terra Nova, White Rose, Hebron, and the proposed Statoil and ExxonMobil exploration drilling projects. Alternative fishing locations are anticipated to be available nearby as these safety zones are relatively small and occupy a negligible amount of the total harvestable grounds in the Study Area.

In addition to the safety zones associated with offshore exploration drilling and production projects, the presence of OSVs, seismic vessels and streamers, competing fishing vessels, and the marine traffic associated with other ocean users are other sources of potential conflict with fishing vessels within the Study Area that could cause a change in availability of fisheries resources for fishers. Project OSVs are not expected to contribute to space-use conflicts with fishing vessels, as Project OSVs will use existing shipping routes when travelling between the MODU and the supply base, and Project-related OSV traffic will represent a minor component of total marine traffic in the Study Area, occupy a negligible proportion of the total available fishing area in the Study Area, and be short-term and transient in nature.

During consultations completed in support of the WREP EA (Husky Energy 2012a), fish harvesters indicated concerns about the offshore hydrocarbon developments related to the combined effects with other petroleum industry activities in the Jeanne d'Arc Basin oil field area. They cited concerns about reduced fishing opportunity resulting from general activities, such as extensive vessel hailing zones around each installation, ice deflection activities and surveys. Fishers reported that the current situation is forcing fishing vessels to steam farther to get around activities and installations to reach grounds, costing fishing time and increasing expenses, and that additional activity will exacerbate conditions. Fishers cited growing levels of frustration, misunderstanding and miscommunication between fishing industry and petroleum industry operations. Husky is committed to work with the One Ocean petroleum industry liaison organization, relevant offshore fishers, FFAW representatives, and other agencies to promote good relations, cooperation and partnering between all offshore marine user groups to address any other potential effects.

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 because of the Project in combination with other physical activities in the Study Area 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 Study Area, thereby causing a cumulative change in availability of fisheries resources.

The Project Area does not include any unique fishing grounds or concentrated fishing effort that occurs exclusively within the Project Area, 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 because 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 Study Area.

All the physical activities within the Study Area 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 Study Area 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 2017).

Standard practices for at-sea 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.

In summary, the residual cumulative change in availability of fisheries resources for commercial fisheries is predicted to be negligible in magnitude, limited in extent to the Project Area, medium-term in duration, reversible, continuous in frequency, and will occur in a context of moderate interference.

In consideration of the various physical activities that have been, are being, and will be carried out in the Study Area, the Project is expected to result in a relatively small, incremental increase in cumulative residual environmental effects on commercial fisheries in comparison with the future scenario without the Project. With the application of proposed mitigation and environmental protection measures, residual cumulative environmental effects on commercial fisheries are 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 Study Area, as well as the effectiveness of standard mitigation measures. No additional mitigation measures are proposed to mitigate potential cumulative environmental effects on commercial fisheries. Given the high level of confidence, the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing EEM and existing literature, no additional monitoring and follow-up requirements are proposed for commercial fisheries.

9.2.5 Assessment of Cumulative Environmental Effects on Marine Mammals and Sea Turtles (including SAR and SOCC)

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 Study Area.

Underwater sound emissions from Project-related drilling-associated surveys will contribute to the underwater sound emissions of other third-party physical activities generating high SPLs in the Study Area to potentially result in a cumulative change in risk of mortality or physical injury. Other Project activities will also contribute to the underwater sound produced by the various physical activities in the Study Area. 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 helicopters and other aircraft has potential to elicit temporary diving responses in marine mammals. Project-related helicopter traffic could potentially trigger additional diving responses in individual marine mammals already exposed to the presence and sound of helicopter/aircraft traffic from geophysical survey programs, offshore exploration drilling and production projects, and other ocean users (where applicable). However, the residual environmental effects of helicopter traffic from the Project will generally be so spatially and temporally limited that potential cumulative interactions with the residual environmental effects of other helicopter/aircraft traffic in the Study Area will be minimal and are not anticipated to result in a substantial cumulative change in habitat quality and use for marine mammals.

Similar to the cumulative interactions discussed in Section 9.2.3 for fish and fish habitat, underwater sound and water quality effects from the Project and other third-party physical activities may temporarily reduce habitat availability within the Study Area (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 localized nature of potential residual Project effects. 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 9.2.3 is also generally applicable for marine mammals and sea turtles.

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 Study Area (including Project activities). Marine mammals and sea turtles are also at risk of mortality due to entanglement in seismic and fishing gear. Project activities, geophysical survey programs, offshore exploration drilling and production projects, and the activities of commercial fisheries and other ocean users all have potential to occur in different parts of the Study Area at the same time, thereby cumulatively increasing the risk of mortality or physical injury for marine mammals and sea turtles.

The operation of the Project MODU and OSVs will represent only a small, incremental increase over existing levels of marine traffic in the Study Area 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. OSV activities in support of the Project (i.e., one OSV trip per week) are expected to be minimal compared to ongoing shipping activity in the region, as the offshore operators currently employ numerous OSVs that conduct more than 1,000 trips to the Project Area per year (SMS 2012). 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.

In summary, the residual cumulative effects on marine mammals and sea turtles (i.e., change in risk of mortality or physical injury and change in habitat quality and use) are predicted to be low to moderate in magnitude, limited in extent to the Project Area, short- to medium-term in duration, reversible, sporadic to regular in frequency, and will occur in a context of moderate disturbance.

In consideration of the various physical activities that have been, are being, and will be carried out in the Study Area, the Project is expected to result in a relatively small, incremental increase in cumulative residual environmental effects on marine mammals and sea turtles in comparison with the future scenario without the Project. With the application of proposed Project-related mitigation and environmental protection measures, residual cumulative environmental effects on marine mammals and sea turtles are 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 drilling-associated surveys on marine mammals and the effectiveness of mitigation measures. No additional mitigation measures are proposed to mitigate potential cumulative environmental effects on marine mammals and sea turtles. Given the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing literature, no additional monitoring and follow-up requirements are proposed for marine mammals and sea turtles.

9.2.6 Assessment of Cumulative Environmental Effects on Migratory Birds (including SAR and SOCC)

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 Study Area.

As discussed in Sections 9.2.3 and 9.2.4, underwater sound emissions from Project-drilling associated surveys will contribute to the underwater sound emissions of other third-party physical activities generating high SPLs in the Study Area to potentially result in a cumulative change in risk of mortality or physical injury. The analysis provided in Section 9.2.3 regarding underwater sound emissions from Project-related sources in combination with the underwater sound emissions of other physical activities generating high SPLs in the Study Area could be relevant for diving migratory birds. However, based on current scientific knowledge regarding the effects of underwater sound on birds (refer to Section 6.5), diving migratory 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.

Atmospheric 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 marine bird habitat available within the Study Area (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. However, such a potential cumulative effect is considered unlikely given the lack of special areas of importance for reproduction, foraging and feeding, and/or migration of birds within the Project Area. 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 vessel-related atmospheric sound effects at any given location.

Atmospheric sound emissions produced during operation of the Project MODU and the facilities for offshore exploration drilling and production projects will be generated from a stationary source for the duration of Project exploration drilling activities at each well and production activities at the Hibernia, Terra Nova, White Rose, and Hebron platforms. 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 Study Area and are not known to contain any uniquely important habitat for migratory birds.

For migratory birds whose ranges cover a large extent of the Study Area, individuals may be exposed to atmospheric sound emissions and liquid discharges from various sources (i.e., geophysical survey programs, offshore exploration drilling and production projects, commercial 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.

The discussion in Section 9.2.3 regarding the potential for marine discharges to cause a cumulative change in habitat quality and use for fish is also generally applicable for the migratory birds, as the discharge of cuttings has potential to affect water quality within a localized area as the discharges migrate through the water column, resulting in the formation of small sheens under certain conditions (i.e., calm winds and small waves), which could affect migratory birds. In addition, migratory birds are particularly vulnerable to potential injury or mortality when exposed to hydrocarbon contamination. Marine traffic contributes chronic oil pollution and Wiese and Ryan (2003) report that, due to the density of traffic off Newfoundland (i.e., between Europe and North America), the amount of persistent oil in the marine environment is very high along Newfoundland coastlines. Non-routine discharges from the Project and various other physical activities in the Study Area could contribute to a cumulative change in risk of mortality or physical injury for migratory birds (refer to Section 9.2.9). 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 migratory birds) and are therefore unlikely to cause a measurable cumulative change in risk of mortality or physical injury to migratory birds.

Although rare, it is possible for helicopter traffic from the Project and other helicopter/aircraft traffic from geophysical survey programs, offshore exploration drilling and production 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 presence and sound of helicopter/aircraft traffic may also cause a change in habitat quality and use for migratory birds. Cougar Helicopters logs 4,000 to 5,000 flying hours annually providing helicopter services to all offshore installations in the Jeanne d'Arc Basin and conducted 1,012 flights in and around the Project Area in 2008 alone, reported a total of five bird strikes during the period from 2005 to 2011 (SMS 2012). 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/aircraft traffic in the Study Area will be minimal and are not expected to result in a substantial change in risk of mortality or physical injury or change in habitat quality and use for migratory birds. Helicopter activities in support of the Project (i.e., five helicopter trips per week) will only account for a small, incremental increase in overall helicopter/aircraft traffic within the Study Area.

Artificial night lighting associated with the Project will contribute to the total amount of night lighting from various sources in the Study Area, including lighting on survey and support vessels, OSVs and facilities for offshore exploration drilling and production projects, 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., well 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 flaring from other offshore exploration drilling and production projects.

Routine checks for stranded birds on the MODU and OSVs and appropriate procedures for release (i.e., the protocol outlined in *Best Practices for Stranded Birds Encountered Offshore Atlantic Canada* (Environment Canada 2015) and *The Leach's Storm Petrel: General Information and Handling Instruction*s (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 is used as required to comply with regulations and to ensure 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 C-NLOPB Drilling and Production Guidelines. Project lighting and flaring (conducted for approximately two wells within the Project Area taking between 1.5 and 2 days) will represent only a small increase over existing levels of lighting and flaring in the Study Area, will be temporary and localized, and will occur by licence areas from other light sources. Residual lighting and flaring effects of the Project are therefore not anticipated to contribute to those of other third-party physical activities within the Study Area in such a way that causes a substantive cumulative increase in mortality or injury affecting migratory birds.

In summary, the residual cumulative environmental effects on migratory birds (i.e., change in risk of mortality or physical injury and change in habitat quality and use) are predicted to be low to moderate in magnitude, limited in extent to the Project Area, short- to medium-term in duration, reversible, sporadic (VSP operations) to continuous (artificial night lighting) in frequency, and will occur in a context of moderate disturbance.

In consideration of the various physical activities that have been, are being, and will be carried out in the Study Area, the Project is expected to result in a relatively small, incremental increase in cumulative residual environmental effects on migratory birds in comparison with the future scenario without the Project. With the application of proposed Project-related mitigation and environmental protection measures, residual cumulative environmental effects on migratory birds are 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 Study Area, as well as the effectiveness of standard mitigation measures. No additional mitigation measures are proposed to mitigate potential cumulative environmental effects on migratory birds. Given the high level of confidence, the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing literature, no additional monitoring and follow-up requirements are proposed for migratory birds.

9.2.7 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 Study Area.

The only special area located within the Project Area is portions of the Northeast Shelf and Slope EBSA. Given the distance of the Project Area from other Special Areas (Table 6.24), potential cumulative interactions associated with the Project will be limited, for the most part, to these special areas and the adjacent NAFO sponge/coral closures. Cumulative environmental effects from Project activities will be localized and not extend to distances that may interact with other special 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 Study Area. 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 within the Northeast Shelf and Slope EBSA, the Flemish Pass/Eastern Canyon NAFO sponge/coral closure, Northwest Flemish Cap NAFO sponge/coral closure, and the Beothuk Knoll VME, all of which are within or near the Project Area (i.e., where the Project will have a residual effect on water quality).

- The dispersion of Project-related discharges of drill muds and cuttings up to 12 km (0.1 mm thickness of benthic deposition) from each wellsite could contribute to the residual environmental effects of fishing activity, 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 12 km radius. This cumulative environmental effect has potential to occur within the Northeast Shelf and Slope EBSA.
- Underwater sound generated by various Project activities and components will contribute to the underwater sound produced by other physical activities in the Study Area. Fish, marine mammals, and sea turtles may temporarily avoid localized areas subject to underwater sound. This cumulative change in habitat quality 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. For the purposes of the CEA, it is conservatively assumed that underwater sound emissions from VSP operations and wellsite surveys could potentially result in a change in habitat quality for marine species in special areas within several kilometers of the sound source. This cumulative environmental effect therefore has potential to occur in the Northeast Shelf and Slope EBSA (which supports spotted wolffish and Greenland halibut populations, contains two important coral areas at Tobin's Point and Funk Island Spur, and is a known feeding area for marine mammals, particularly harp seals, hooded seals, and pilot whales [CPAWS 2009]); the Flemish Pass/Eastern Canyon, Northwest Flemish Cap and Beothuk Knoll NAFO sponge/coral closures (which support cold-water corals and sponges can be important habitats for protection from currents and predators, nurseries for young fish, and feeding, breeding, and spawning areas for numerous species); and Beothuk Knoll VME (which supports cold-water corals and aggregations of deep-sea fishes such as redfish); all of which are located within 30 km of the Project Area. It is noted that some of the resources responsible for the designation of these special areas may be less susceptible to noise effects (e.g., corals) and more susceptible to more localized forms of direct disturbance; therefore, a 30 km potential zone of influence may not apply.
- 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 and/or other aircraft traffic from geophysical survey programs, offshore exploration drilling and production projects, and other ocean users (where applicable). This cumulative environmental effect has potential to occur in the Northeast Shelf and Slope EBSA, which is the only special area within the Project Area known to support aggregations of marine mammals.
- Atmospheric sound generated by various Project activities and components will contribute to the atmospheric sound produced by other third party physical activities in the Study Area. The sound emissions from these activities may physically displace migratory birds for short durations. However, none of the special areas within the Project Area are known to provide unique or important habitat for migratory birds.

Given the importance of the Northeast Shelf and Slope EBSA, NAFO sponge/coral closures and Beothuk Knoll VME for fish and fish habitat, as well as the importance of the Northeast Shelf and

Slope EBSA for marine mammals, much of the analysis of cumulative environmental effects provided for fish and marine mammals, in Sections 9.2.3 and 9.2.5, is also applicable for special areas.

Although OSVs, geophysical survey and support vessels, 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.

In summary, the residual cumulative change in habitat quality of special areas is generally predicted to be low to moderate in magnitude, primarily limited in extent to the Project Area, short- to medium-term in duration, reversible, sporadic to regular in frequency, and predicted to occur in a context of moderate disturbance. 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 and to be long-term in duration.

In consideration of the various physical activities that have been, are being, and will be carried out in the Study Area, the Project is expected to result in a relatively small, incremental increase in cumulative residual environmental effects on special areas in comparison with the future scenario without the Project. With the application of proposed Project-related mitigation and environmental protection measures, residual cumulative environmental effects on special areas are 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 Study Area, as well as the effectiveness of standard mitigation measures. No additional mitigation measures are proposed to mitigate potential cumulative environmental effects on special areas. Given the high level of confidence, the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing literature, no additional monitoring and follow-up requirements are proposed for special areas.

9.2.8 Assessment of Cumulative Effects on Indigenous People and Community Values

This section assesses the potential cumulative change in traditional use with respect to the Indigenous people and community values 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 Study Area. Similar to the cumulative effects assessed for commercial fisheries (Section 9.2.4), the following cumulative environmental effect mechanisms are also applicable with respect to the Indigenous people and community values, specifically commercial communal fisheries:

- temporary displacement from fishing grounds due to establishment of safety (exclusion) zones around the Project MODU, and Hibernia, Terra Nova, White Rose, Hebron, and the proposed Statoil and ExxonMobil exploration drilling projects;

- space-use conflicts between 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 Study Area.

The analysis of cumulative environmental effects provided in Sections 9.2.4 relating to commercial fisheries is also directly applicable for Indigenous fishers. That section should be referred to for the assessment of potential cumulative effects related to a change in traditional use.

Routine Project activities may also interact with migratory bird and seal species traditionally and currently hunted by Indigenous communities because of potential attraction to the lights and flares associated with the presence and operation of the MODU and underwater sound emissions from drilling-associated VSP surveys. The analysis of cumulative environmental effects provided in Sections 9.2.6 relating to migratory birds and marine mammals is also directly applicable for Indigenous hunters. That section should be referred to for the assessment of potential cumulative effects related to a change in traditional use.

In summary, the residual cumulative change in traditional use for Indigenous people and community values is predicted to be negligible in magnitude, limited in extent to the Project Area, medium-term in duration, reversible, continuous in frequency, and will occur in a context of moderate interference.

In consideration of the various physical activities that have been, are being, and will be carried out in the Study Area, the Project is expected to result in a relatively small, incremental increase in cumulative residual environmental effects on traditional use in comparison with the future scenario without the Project. With the application of proposed mitigation and environmental protection measures, residual cumulative environmental effects on traditional use are 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 Study Area, as well as the effectiveness of standard mitigation measures. No additional mitigation measures are proposed to mitigate potential cumulative environmental effects on Indigenous people and community values. Given the high level of confidence, the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing literature, no additional monitoring and follow-up requirements are proposed for Indigenous people and community values.

9.2.9 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 physical activities that have been or will be carried out" (CEA Agency 2016a).

The potential environmental effects of various Project-related malfunction and accidental event scenarios are assessed in Section 7. These scenarios are considered very unlikely to occur. Of the identified scenarios, the most likely accidental events which could occur are small operational spills from the MODU (i.e., spills less than 10 bbls). Based on the Newfoundland and Labrador spill frequency and volume annual summary (C-NLOPB 2017c), approximately 35 bbl (5,580 L) of hydrocarbons has been spilled during exploration drilling between 1997 and 2016, with less than 1 bbl total spilled per year in all but three years. Spill prevention and response procedures will be in place for the Project to reduce the risk of all spills, including small spills, and associated environmental effects (refer to Section 7 for additional information), and other operators will also implement spill prevention and response measures. Given the low likelihood of a spill event occurring during one physical activity in the Study Area, 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 remote.

Although a hydrocarbon spill could cause residual adverse environmental effects to various VCs (refer to Section 7.3), it would be unlikely to interact with the residual environmental effects of discharges from geophysical survey programs, offshore exploration drilling and production projects, commercial fisheries, or other ocean users in such a way that causes a cumulative environmental effect. 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, Husky'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 potential spills and the discharges of other third party physical activities. The potential contribution of the residual environmental effects of an accidental spill to the residual environmental effects of another physical activity in the Study Area is not considered a likely scenario and is therefore not assessed further.

9.2.10 Follow-up and Monitoring

Given the high level of confidence, the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing EEM and existing literature, no additional monitoring and follow-up requirements are proposed with respect to cumulative effects. As described in Section 9.2.1, there are other operators in the Study Area who are/will undertake various monitoring programs in support of other third-party physical activities that are regulated by C-NLOPB. Monitoring programs 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.

Husky will communicate with Indigenous groups, fishers and other ocean users before, during, and after drilling programs, and details of safety zones will be published in Notices to Shipping and/or Notices to Mariners, as appropriate. This will allow Indigenous groups, fishers and other ocean users to plan accordingly and mitigate potential space-use conflicts or environmental effects.

10.0 SUMMARY OF ENVIRONMENTAL EFFECTS

The purpose of this section is to summarize the changes and effects that may occur because of the Project based on those components listed in section 5 of CEAA, 2012. Analysis in Sections 6 through 8 of this EIS are summarized into the following categories:

- changes to components of the environment within federal jurisdiction (Section 10.1);
- changes to the environment that would occur on federal or transboundary lands (i.e., inside and outside the 200 nm Exclusive Economic Zone) (Section 10.2);
- changes to the environment occurring in Canada on Indigenous people (Section 10.3); and
- changes to the environment and effects to the environment that are directly linked or necessarily incidental to federal decisions (Section 10.4).

Table 10.1 summarizes the potential changes to the environment.

Table 10.1 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, Physical Injury, or Health • Change in Habitat Quality
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	
Fish and Fish Habitat	• Change in Risk of Mortality, Physical Injury, or Health • Change in Habitat Quality
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
Commercial Fisheries	• Change in Availability of Fisheries Resources
Indigenous People and Community Values	• Change in Commercial Communal Fisheries • Change in Current Indigenous use of Lands and Resources for Traditional Purposes
Changes to the Environment Occurring in Canada on Indigenous people	
Indigenous People and Community Values	• Change in Traditional Use

Topic	Changes
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 *Newfoundland 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 all 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 in the event of an accidental event)	• 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.

10.1 Changes to Components of the Environment within Federal Jurisdiction (CEAA, 2012 section 5(1)(a))

As required under section 5(1)(a) of CEAA, 2012, the following environmental components that are within federal jurisdiction (i.e., within the legislative authority of Parliament) are considered in this assessment:

- fish and fish habitat, as defined in section 2(1) of the *Fisheries Act*;
- aquatic species, as defined in section 2(1) of SARA;
- migratory birds, as defined in section 2(1) of the MBCA; and
- species at risk, as listed on Schedule 1 of SARA or assessed by COSEWIC.

The following subsections summarize the changes affecting fish and fish habitat, marine mammals and sea turtles, and migratory birds. Additional detail on these components is provided in Section 6.1 (Fish and Fish Habitat), Section 6.3 (Marine Mammals and Sea Turtles), and Section 6.4 (Migratory Birds).

10.1.1 Fish and Fish Habitat

Marine benthic, demersal, and pelagic fish species, including SOCC, and habitat are present in the Project Area and Study Area. In consideration of the potential interaction, primarily due to underwater noise emissions and from approved operational discharges (see Section 6.1.9), and the policies put in place to protect fish and their habitat outlined in the *Fisheries Act* and SARA, 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, physical injury, or health; and
- change in habitat quality.

A change in risk of mortality, physical injury, or health to fish may result from operational discharges, particularly smothering of sessile invertebrates near the well site. Mortality of early life stage fish (eggs and larvae) may also result from close proximity to the underwater sound associated with the presence and operation of the MODU (DP thrusters) and drilling associated surveys. Likewise, during abandonment, if shaped charges must be used in wellhead severance, mortality may result nearby from acute changes in pressure. A change in habitat quality for marine fish may occur because of Project activities affecting the marine environment, including the presence of the structure (MODU), noise from drilling, WBM and SMB cuttings, lighting, operation of seawater systems, waste water generation (domestic waste, sanitary waste), operation of helicopters and vessels, cementing and completing wells, surveys (geotechnical, geophysical, and environmental), oily water treatment, and presence of no-fishing safety zone. As discussed in Section 6.1.10, with the implementation of proposed mitigation and environmental protection measures (see Section 6.1.10.2), the residual environmental effects of a change in risk of mortality, physical injury, or health and change in habitat quality on fish and fish habitat from Project activities and components are predicted to be not significant.

All accidental event scenarios described in Section 7.2 could potentially interact with fish and fish habitat. Potential effects include a decrease in habitat quality or potential mortality through reduction of water and/or sediment quality, reduced primary productivity due to the 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. In consideration of the characterization of residual effects (see Section 7.3.1.3), as well as implementation of spill response and emergency response (see Section 7.1), the predicted residual environmental effects from any of the accidental event scenarios on fish and fish habitat are not significant.

10.1.2 Marine Mammals and Sea Turtles

Several species of baleen whales (mysticetes), toothed whales (odontocetes), seals (phocids), and sea turtles, including species at risk and SOCC, are present in and around the Project Area and Study Area. In consideration of the potential interactions, primarily from underwater sound emissions produced by operation of the MODU, OSV and helicopter transport, and geophysical surveys (see Section 6.3.9), the assessment of Project-related environmental effects on marine mammals and sea turtles is focused on the following potential environmental effects:

- change in habitat quality and use; and
- change in mortality risk or physical injury.

Potential effects to habitat quality and use may occur from changes in the chemical composition of water from the discharge of drill muds and cuttings and other discharges and emissions. Underwater noise will result from activities such as helicopter overflights, operation of vessels, drilling, and VSP and wellsite surveys. These activities could also affect habitat quality and use by marine mammals and sea turtles. Underwater sound levels may also result in a change in risk of mortality or physical injury of marine mammals and sea turtles in close proximity during VSP and wellsite surveys, or for individuals that remained in close proximity to the MODU (i.e., during the use of DP thrusters during station keeping and drilling) and OSV. 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 OSV operations. As discussed in Section 6.3.10, with the implementation of proposed mitigation and environmental protection measures (see Section 6.3.10.2), 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 are predicted to be not significant.

In the unlikely event of an oil spill in the Study Area (see Section 7.2 for spill scenarios), marine mammals and sea turtles could be adversely affected. There are several physical and physiological functions that may be adversely affected through direct contact, ingestion, or respiratory inhalation by marine mammals and sea turtles. In consideration of the present knowledge of the Jeanne d'Arc Basin and Flemish Pass, the modelling exercises, and on past monitoring experience with large spills (e.g., *Exxon Valdez*, Arrow, and others), as well as implementation of spill response and emergency response (see Section 7.1), the residual environmental effects (see Section 7.3.3.3) from any of the accidental event scenarios on marine mammals and sea turtles are predicted to be not significant.

10.1.3 Migratory Birds

In consideration of the potential interactions with the Project (see Section 6.4.9), the assessment of the 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 presence and operation of the MODU and OSVs has the greatest potential of any Project activities to result in changes to risk of mortality or physical injury for migratory birds. Migratory birds are known to aggregate around offshore structures because of night lighting, food, and other visual cues. The Project has potential to result in a change in risk of mortality or physical injury to migratory birds from exposure to underwater sound caused by VSP and wellsite surveys, exposure to hydrocarbons sheens associated with drilling waste discharge, and disturbance from and collisions with transiting helicopters during supply and servicing activities within the Project Area. A change in habitat quality and use for migratory birds could also potentially occur due to Project activities. Migratory bird habitat may be particularly influenced by Project activities during operations, including: sound, lights, and flaring from the MODU and OSVs; the presence of hydrocarbons and suspended solids within the water column from the discharge of drill muds and cuttings; the release of emissions and other discharges (including cooling water, ballast water, bilge and deck water, grey/black water); the exposure of migratory birds to underwater sound during drilling and associate surveys; and disturbance from helicopter transportation. As discussed in Section 6.4.10, with the implementation of proposed mitigation and environmental protection measures (see Section 6.4.10.2), the residual environmental effects of the Project on migratory birds (i.e., a change in risk of mortality or physical injury and a change in habitat quality and use) are predicted to be not significant.

All the identified accidental event scenarios (diesel batch spill from the MODU and OSV and/or subsea and surface blowout) 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. Migratory birds are the most visible and among the first species impacted by oil spills. Based on the information presented in Section 7.3.4.3, a precautionary conclusion is drawn that the residual adverse environmental effect of a blowout incident, or a large batch spill from the MODU or vessel spill, is predicted to be significant for migratory birds, but not likely to occur. Infrequent, small diesel spills would be not significant.

10.1.4 Species at Risk (SAR)/Species of Conservation Concern (SOCC)

As per the EIS Guidelines (CEA Agency 2018), Species at Risk (SAR) include potential or known federally listed at-risk species (Schedule 1 of SARA) and Species of Conservation Concern (SOCC) include federal species designated by COSEWIC for listing on Schedule 1 of SARA. In addition, SAR listed under the Newfoundland and Labrador Endangered Species Act are included where relevant. No International Union for Conservation of Nature red list species are identified; neither the EIS Guidelines nor CEAA 2012 prescribe their inclusion. To reduce redundancy and improve efficiency of the EIS, SAR and SOCC were not presented as a stand-alone VC but instead were assessed under their respective biological VCs (Fish and Fish Habitat VC (Section 6.1), Marine Mammals and Sea Turtles VC (Section 6.3), and the Migratory Birds VC (Section 4.4)).

The SAR/SOCC with potential to occur in the Study Area are identified in Table 10.2 and whether a recovery strategy/action plan/management plan has been developed. No critical habitat has been defined within the Study Area for any species.

Potential interactions on SAR/SOCC species are primarily underwater noise emissions produced by operation of the MODU, OSVs, helicopters and geophysical surveys; approved operational discharges; the presence and operation of the MODU and OSVs; the assessment of Project-related environmental effects on SAR and SOCC habitat is focused on the following potential environmental effects:

- change in risk of mortality, physical injury, or health; and
- change in habitat quality.

A summary of predicted effects, and proposed mitigation and monitoring for SAR and SOCC is presented below. For more information and context, please refer to the respective VCs in the EIS (as referenced above).

Table 10.2 Species at Risk and/or Species of Conservation Concern Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
Marine Fish							
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	No	High	Year-round	Species has long life span with slow growth and therefore considered to have low resilience to adverse effects. Potential for long-term adverse effects with accidental events
American eel	*Anguilla rostrata*	Not Listed	Threatened	No	Moderate	March to July - glass eels on the Grand Banks	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
American plaice (Newfoundland and Labrador population)	*Hippoglossus platessoides*	Not Listed	Threatened	No	High	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered	No	Moderate	June to October	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Atlantic cod (Newfoundland and Labrador population)	*Gadus morhua*	Not Listed	Endangered	No	Moderate	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Atlantic salmon (South Newfoundland population)	*Salmo salar*	Not Listed	Threatened	No	Moderate	June to August	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Atlantic wolffish	*Anarhichas lupus*	Special Concern (Schedule 1)	Special Concern	Manageme nt Plan	High	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern	No	Low	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Blue shark (Atlantic population)	*Prionace glauca*	Not Listed	Special Concern	No	Moderate	June to October	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
Cusk	*Brosme brosme*	Not Listed	Endangered	No	Low	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, high abundance areas outside the Project Area, no critical habitat)
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened	No	High	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Northern wolffish	*Anarhichas denticulatus*	Threatened (Schedule 1)	Threatened	Yes[3]	High	Year-round	Limited potential for interaction (mobile species, Project mitigation measures) Proposed critical habitats has been identified within the Study Area, although not anticipated to be affected by routine Project activities
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered	No	Moderate	Year-round	Limited potential for interaction (mobile species, project mitigation measures)
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern	No	High	Year-round	Limited potential for interaction (mobile species, no critical habitat, Project mitigation measures)
Roundnose grenadier	*Coryphaenoid es rupestris*	Not Listed	Endangered	No	High	Year-round	Limited potential for interaction (mobile species, no critical habitat, Project mitigation measures)
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened	No	Low	July to October	Limited potential for interaction (mobile species, project mitigation measures)
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern	No	Moderate	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Smooth skate (Funk Island Deep population)	*Malacoraja senta*	Not Listed	Endangered	No	Moderate	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern	No	Low	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat, main population outside of project area, seasonal presence)
Spotted wolffish	*Anarhichas minor*	Threatened (Schedule 1)	Threatened	Yes[3]	High	Year-round	Limited potential for interaction (mobile species, Project mitigation measures) Proposed critical habitathas been identified within the Project Area, although not anticipated to be affected by routine Project activities
Thorny skate	*Amblyraja radiata*	Not Listed	Special Concern	No	High	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
White shark	*Carcharodon Carcharias*	Endangered (Schedule 1)	Endangered	No[4]	Low	July to October	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
White hake	*Urophycis tenuis*	Not Listed	Threatened	No	Moderate	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Winter skate (Eastern Scotian Shelf-Newfoundland Population	*Leucoraja ocellata*	Not Listed	Endangered	No	Low	November to March	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
***Mysticetes* (Toothless or Baleen Whales)**							
Blue whale (Atlantic population)	*Balaenoptera musculus*	Endangered	Endangered	Yes[3]	Low	Year- round (highest concentrations from June to September)	Uses sounds to investigate their environment, therefore, increasing anthropogenic sound levels from activities such as seismic surveys, shipping traffic, and industrial activities, may affect their hearing range and may affect certain behaviours (however Project mitigation measures will be implemented and there is no critical habitat)
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Special Concern	Yes[5]	High	Year- round (highest concentrations from June to October)	Uses sounds to investigate their environment, therefore, increasing anthropogenic sound levels from activities such as seismic surveys, shipping traffic, and industrial activities, may affect their hearing range and may affect certain behaviours (however Project mitigation measures will be implemented and there is no critical habitat)
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered	Yes[3]	Low	May to September	Uses sounds to investigate their environment, therefore, increasing anthropogenic sound levels from activities such as seismic surveys, shipping traffic, and industrial activities, may affect their hearing range and may affect certain behaviours (however Project mitigation measures will be implemented and there is no critical habitat)

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
***Odontocetes* (Toothed Whales)**							
Harbour porpoise (Northwest Atlantic subspecies)	*Phocoena phocoena*	Not Listed	Special Concern	No	Low	Year- round (highest concentration from May to October)	Harbour porpoises have been shown to exhibit behavioural responses to operating seismic air source arrays (however Project mitigation measures will be implemented and there is no critical habitat)
Killer whale (Northwest Atlantic/Eastern Arctic population)	*Orcinus orca*	Not Listed	Special Concern	No	Low	Year- round (highest concentration from June to October)	Uses sounds to investigate their environment, therefore, increasing anthropogenic sound levels from activities such as seismic surveys, shipping traffic, and industrial activities, may affect their hearing range and may affect certain behaviours (however Project mitigation measures will be implemented and there is no critical habitat)
Northern bottlenose whale (1: Scotian Shelf population/ 2: Davis Strait-Baffin Bay-Labrador Sea population)	*Hyperoodon ampullatus*	1: Endangered 2: Not Listed	1: Endangered 2: Special Concern	Yes[5]	High	Year-round	Uses sounds to investigate their environment, therefore, increasing anthropogenic sound levels from activities such as seismic surveys, shipping traffic, and industrial activities, may affect their hearing range and may affect certain behaviours (however Project mitigation measures will be implemented and there is no critical habitat)
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Special Concern	Yes[3]	Low	Year-round	Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat, t is likely that beaked whales would show avoidance to seismic vessels and activity)

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
Sea Turtles							
Leatherback sea turtle[2]	*Dermochelys coriacea*	Endangered (Schedule 1)	Endangered	Yes[3]	Moderate	June to November	Potential for behavioural effects and communication masking (however Project mitigation measures will be implemented and there is no critical habitat)
Loggerhead sea turtle	*Caretta caretta*	Endangered (Schedule 1)	Endangered	No	Low	June to October	Potential for behavioural effects and communication masking (however Project mitigation measures will be implemented and there is no critical habitat)
Birds							
Ivory Gull	*Pagophila eburnea*	Endangered	Endangered	Yes	Likely	April	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, Project mitigation measures will be implemented and there is no critical habitat
Harlequin Duck	*Histrionicus histrionicus*	Special Concern	Special Concern	No	Unlikely	Unlikely	Limited interaction (unlikely to be present in the Study Area, Project mitigation measures, no critical habitat
Barrows Goldeneye	*Bucephala islandica*	Special Concern	Special Concern	No	Unlikely	Unlikely	Limited interaction (unlikely to be present in the Study Area, Project mitigation measures, no critical habitat
Piping Plover (melodus subspecies)	*Charadrius melodus melodus*	Endangered	Endangered	No	Unlikely	Unlikely	Limited interaction (unlikely to be present in the Study Area, Project mitigation measures, no critical habitat

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
Red Knot rufa ssp	*Calidris canutus rufa*	Endangered	Endangered	No	Unlikely	Unlikely	Limited interaction (unlikely to be present in the Study Area, Project mitigation measures, no critical habitat
Buff-breasted Sandpiper	*Tryngites subruficollis*	Not Listed	Special Concern	No	Unlikely	Unlikely	Limited interaction (unlikely to be present in the Study Area, Project mitigation measures, no critical habitat
Red-necked Phalarope	*Phalaropus lobatus*	Not Listed	Special Concern	No	Likely	Fall	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, Project mitigation measures will be implemented and there is no critical habitat
Short-eared Owl	*Asio flammeus*	Special Concern	Special Concern	No	Potential during nocturnal migration	Any time of year	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, Project mitigation measures will be implemented and there is no critical habitat
Peregrine Falcon	*Falco perigrinus anatum/tundrius*	Special Concern	Special Concern	No	Potential during nocturnal migration	Any time of year	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, Project mitigation measures will be implemented and there is no critical habitat

Common Name	Scientific Name	SARA Status[1]	COSEWIC Designation[1]	Recovery Strategy or Action Plan	Potential for Occurrence in the Study Area[2]	Timing of Presence	Potential for Project-related Effects
Bank Swallow	*Riparia riparia*	Not Listed	Threatened	No	Potential during nocturnal migration	Any time of year	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, Project mitigation measures will be implemented and there is no critical habitat
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Threatened	No	Potential during nocturnal migration	Any time of year	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, Project mitigation measures will be implemented and there is no critical habitat
Bobolink	*Dolichonyx oryzivorus*	Not Listed	Threatened	No	Potential during nocturnal migration	Any time of year	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, Project mitigation measures will be implemented and there is no critical habitat

Sources: Modified from Husky Energy 2012a and BP 2016

Notes:

1. The *Species at Risk Act* establishes Schedule 1 as the official list of wildlife species at risk. However, note that while Schedule 1 lists species that are extirpated, endangered, and threatened, the prohibitions do not apply to SOCC or those on Schedule 2 or 3 regardless of status.
2. This qualitative characterization is based on expert opinion, and an analysis of understood habitat preferences across life-history stages, available distribution mapping, and sightings data for each species within the Study Area.
3. Action Plan anticipated in 2017.
4. Recovery Strategy anticipated in 2017.
5. Management Plan anticipated in 2017.

Mortality of early life stage fish SAR/SOCC (eggs and larvae) may result from close proximity to the underwater sound associated with the presence and operation of the MODU (DP) and drilling associated surveys. Underwater sound levels may also result in a change in risk of mortality or physical injury of marine bird SAR/SOCC and marine mammal and sea turtle SAR/SOCC (i.e., increased risk of exposure to underwater sound at levels capable of causing auditory injury) in close proximity during VSP and wellsite surveys, or for individuals that remained in close proximity to the MODU and OSV. Exposure to underwater sound of sufficient intensity from the MODU or OSV may result in temporary or permanent hearing loss to marine mammal and sea turtle SAR/SOC. Mortality or physical injury of marine mammal and sea turtle SAR/SOCC could also occur from the potential for vessel collisions with marine mammals and sea turtles during OSV operations. Mortality or physical injury to marine bird SAR/SOCC could also occur from exposure to hydrocarbons sheens (occasionally associated with drilling waste discharge), attraction to the MODU or OSV lighting, and disturbance from and collisions with transiting helicopters during supply and servicing activities within the Project Area. Mortality or physical injury of marine fish SAR/SOCC could occur during abandonment, if shaped charges must be used in wellhead severance, due to acute changes in pressure.

A change in habitat quality and use for fish, bird, mammal and turtle SAR/SOCC may occur because of Project activities affecting the marine environment, including the presence of the structure (MODU), including lighting, changes in the chemical composition of water from the discharge of WBM and SMB cuttings and other operational discharges such as waste water (domestic waste, sanitary waste), and oily water treatment, operation of helicopters and vessels, cementing and completing wells, surveys (geotechnical, geophysical, and environmental), and presence of no-fishing safety zone.

There are 10 SAR identified in Table 10.2 that have management plans or recovery strategies; including Atlantic wolffish, northern wolffish, spotted wolffish, blue whale, fin whale, North Atlantic right whale, Northern bottlenose whale, Sowerby's beaked whale, leatherback sea turtle and ivory gull. A recovery strategy is used to identify what needs to be done to stop or reverse the decline of the species listed as endangered, threatened, or extirpated under SARA. Within these management plans or recovery strategies, there is the common objective that anthropogenic threats in Canadian waters do not contribute to the decline in the population of the SAR or a reduction in the currently observed Canadian range. Human-induced mortality needs to be reduced to levels that allow for potential population growth. Mitigation measures described in Sections 6.1.10.2 (Fish and Fish Habitat), 6.3.10.2 (Marine Mammals and Sea Turtles), and 6.4.10.2 (Migratory Birds) are also applicable to SAR to help reduce anthropogenic effects. This includes compliance with OWTG and OCSG as described in the Sowerby' Beaked Whale Management Plan (DFO 2016b). Anthropogenic noise was identified as a threat for marine mammal SAR. As described in Section 6.3.10.2, mitigation measures for geophysical surveys will be consistent with the SOCP (DFO 2007b). No new mitigative measures or follow-up monitoring is proposed for SAR beyond that already described in the VC sections.

As discussed in Sections 6.1.10, 6.3.10, and 6.4.10, with the implementation of proposed mitigation and environmental protection measures (see Sections 6.1.10.2, 6.3.10.2, and 6.4.10.2), the residual environmental effects of a change in risk of mortality, physical injury, or health and change in habitat quality on fish and fish habitat from Project activities and components are predicted to be not significant. Changes to the list of SAR and SOCC would be monitored through the annual EA updates with a review of mitigation effectiveness.

All accidental event scenarios described in Section 7.2 could potentially interact with SAR and SOCC. In the unlikely event of an oil spill in the Study Area, Potential effects include a decrease in habitat quality or potential mortality through reduction of water and/or sediment quality, lethal and sub-lethal effects from acute or chronic exposure to water-soluble fractions of hydrocarbons, physical and physiological functions that may be adversely affected through direct contact, ingestion, or respiratory inhalation, and risk of mortality or physical injury to marine bird SAR and SOCC through oiling of feathers.

In consideration of the present knowledge of the Jeanne d'Arc Basin, the modelling exercises, and on past monitoring experience with large spills (e.g., *Exxon Valdez*, Arrow, and others), as well as implementation of spill response and emergency response (see Section 7.1), the residual environmental effects from any of the accidental event scenarios on marine fish and marine mammal and sea turtle SAR and SOCC are predicted to be not significant. A precautionary conclusion is drawn that the residual adverse environmental effect of a blowout incident, or a large batch spill from the MODU or vessel spill, is predicted to be significant for migratory bird SAR and SOCC, but not likely to occur. Infrequent, small diesel spills would be not significant.

10.2 Changes to the Environment that Would Occur on Federal or Transboundary Lands (CEAA, 2012 section 5(1)(b))

The consideration of changes that may be caused to the environment that would occur on federal lands, in another province, or outside of Canada is required under section 5(1)(b) of CEAA, 2012. The Project and Study Areas are partly located within Canada's EEZ on the Grand Banks and the Flemish Pass portion of Canada's continental shelf. The helicopter route occurs in the airspace above these areas. These areas constitute federal lands as defined under section 2(1) of CEAA, 2012. Given the scope of the Project does not include 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*.

In the event of an accidental spill, either a large batch spill or blowout, transboundary effects outside of Newfoundland and Labrador or Canadian offshore areas are likely. A spill may enter international waters, which fall outside the Canadian EEZ. Spill-related effects in international waters could include adverse effects to fish and fish habitat, marine mammals and sea turtles, migratory birds, special areas, and commercial and commercial communal fisheries. There are several special areas within the Study Area that are located partially or wholly within international waters (outside the Canadian EEZ), including: Orphan Knoll, Northeast Shelf and Slope, Beothuk

Knoll, Lilly Canyon-Carson Canyon, Southeast Shoal, the Southeast Shoal and Tail of the Banks, newfoundland Seamounts, the Southwest Shelf Edge and Slope, as well as several canyon VMEs.

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; however, these components have been addressed above in Section 10.1. This section therefore focuses on commercial fisheries, special areas and Indigenous people and community values, with greater detail provided in Section 6.2 (Commercial Fisheries), Section 6.5 (Special Areas), and Section 6.6 (Indigenous People and Community Values).

10.2.1 Commercial Fisheries

Routine Project activities have the potential to interact with commercial fisheries resources either directly or indirectly via effects on the species fished and/or fishing activity itself (e.g., through displacement from fishing areas, gear loss or damage). In consideration of the potential interactions, the assessment of Project-related environmental effects on commercial fisheries is focused on the following potential environmental effect:

- change in availability of fisheries resources.

A change in availability of fisheries resources for commercial fisheries may occur as a result of: fisheries exclusions; underwater sound effects on commercially fished species around the MODU; a reduction of water and sediment quality on fisheries species from discharge of drill muds and cuttings; underwater sound from drilling-associated surveys, and supply and servicing operations; and well abandonment (the potential use of shaped charges and their effects on commercial fish health and behaviour). As discussed in Section 6.2.10, with the implementation of proposed mitigation and environmental protection measures (see Section 6.2.10.2), 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.

Section 7.3.1 concludes that biophysical effects on fish from a batch spill or blowout will be not significant. However, in the event of an accidental spill, local fishers may be displaced or unable to use portions of the areas currently fished, experience a change in availability of fisheries resources so that resources cannot continue at current levels within the Study Area, or sustain damage to fishing gear. Given the extensive nature of a worst-case, unmitigated blowout event, a significant effect is conservatively predicted for commercial fisheries for this scenario. The likelihood of this significant effect occurring is considered low, given the unlikely potential for a blowout to occur and the response measures that would be in place to mitigate potential effects (see Section 7.3.1 for additional information).

10.2.2 Special Areas

Project-related environmental effects from routine activities could affect the ability of a special area to maintain important biological and ecological functions. In consideration of the potential interactions, the assessment of Project-related environmental effects on special areas is focused on the following potential environmental effect:

- change in habitat quality.

There are 27 special areas located within or near the Study Area; these are described in Section 4.2.9 and shown in Figure 4-33. Special areas include EBSAs, VMEs, and NAFO closure areas; there are no designated Marine Protected Areas within the Study Area. A change in habitat quality for special areas could potentially occur because of Project activities affecting the marine environment. The primary pathway for Project-related activities to affect the physical quality of special areas is the presence and operation of the MODU (sound emissions, presence of anchors or legs on the seabed), the discharge of drill muds and cuttings (effect on water and sediment quality), and other emissions and discharges (effects on water quality), drilling associated surveys (sound emissions), support vessel activities (sound emissions), and well abandonment (shock pulse and energy from the use of shape charges, if required). As discussed in Section 6.5.10, with the implementation of mitigation and environmental protection measures (see Section 6.5.10.2), residual environmental effects on the special areas are predicted to be not significant.

All the accidental scenarios identified in Section 7.2, including batch spills from the MODU and vessel and a subsea or surface blowout, have potential to interact with special areas, resulting in a change in habitat quality. Potential adverse effects on special areas may degrade the ecological function for which the special area was designated (i.e., designated for the protection of commercially important or sensitive species). The residual environmental effect of a change in habitat quality for special areas because of a subsea or surface blowout, or batch spill scenario is predicted to be not significant. In the highly unlikely event of a spill offshore, spill modelling predicts that the dispersed oil will have a low to moderate chance of interacting with special areas in the Study Area. But in no case is it predicted that the special areas, and ecological functions for which they are designated, would be affected on a permanent basis, nor is it predicted that the resident species would be affected in such a way that natural recruitment is unable to return the population or community to its former level (within several generations).

10.2.3 Indigenous People and Community Values

Routine Project activities can interact with commercial communal fisheries resources either directly or indirectly through effects on the species fished and/or fishing activity itself (e.g., through displacement from fishing areas, gear loss or damage). Routine Project activities may also interact with migratory fish and bird species traditionally and currently hunted by Indigenous communities because of presence and operation of the MODU and underwater sound emissions from drilling-associated VSP surveys. Seals traditionally hunted (i.e., harp seal) are not anticipated to be affected by routine Project activities. In consideration of the potential interactions, the assessment of Project-related environmental effects on Indigenous people and community values is focused on the following potential environmental effect:

- change in commercial communal fisheries; and
- change in current use of lands and resources for traditional purposes.

This section summarizes the potential effects of the routine Project activities on Indigenous communities and their activities as prescribed in the EIS Guidelines and in section 5(1) of CEAA 2012, including:

(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.

Given that routine Project-related activities will occur in the offshore marine environment, it is unlikely that effects will directly interact with the physical or social health and well-being of Indigenous persons or communities. Activities will occur in a localized area, over a short period of time, and the accepted mitigation practices will be implemented to reduce adverse effects. The Project is also unlikely to affect receptors that would be sensitive to atmospheric air or sound emissions from routine Project activities due to its distance offshore. Routine Project activities are predicted to result in no significant adverse environmental effects on marine fish, marine mammals and sea turtles, or migratory birds (see Section 6.1, 6.3, and 6.4). Routine Project activities are therefore not anticipated to result in changes to the environment that would influence human health and well-being of Indigenous peoples.

Given the offshore location of Project activities, routine activities are not predicted to interact with on-land or near-shore Indigenous activities that contribute to the socio-economic conditions, including with services and infrastructure within or used by Indigenous people and their communities. Residual effects on fish and fish habitat, including species harvested for commercial communal and FSC purposes, are determined to be temporary and of low magnitude. Associated potential effects to socio-economic conditions such as employment and business activity and income, community revenue, and availability of culturally important species in the Indigenous communities are anticipated to be low due to the low likelihood of residual effects (discussed in Section 6.6) on Indigenous fisheries from routine activities.

As described in the *Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site or Thing that is of Historical, Archeological, Paleontological or Architectural Significance under CEAA, 2012*, heritage is associated with important aspects of human history and culture and can encompass social, economic, political, environmental, scientific, natural, and cultural dimensions. Cultural landscape also often describes a geographical area that has been modified, influenced, or given special cultural meaning by people (CEA Agency 2015c).

There are no known heritage sites in the Project Area. Routine Project activities are also not anticipated to result in changes to the environment that would influence physical and cultural heritage due to the Project's offshore location.

As described in the *Technical Guidance for Assessing the Current Use of Lands and Resources for Traditional Purposes under CEAA, 2012*, current use of lands and resources for traditional purposes, and the exercise of Treaty rights, is associated with an Indigenous group's practices, traditions, or customs, which are part of an Indigenous group's distinctive culture and fundamental to their social organization and the sustainment of present and future generations (CEA Agency 2015d). "Current use" is defined as the use (i.e., activities involving the harvest of resources and travelling to engage in these or other kinds of activities) of lands and resources throughout the proposed project's lifecycle and includes uses by Indigenous peoples that are actively being carried out or are likely to be carried in a reasonably foreseeable future (CEA Agency 2015d). A detailed discussion of the potential effects from routine Project activities and current use of lands and resources for traditional purposes is provided in Section 6.6. Current use of lands and resources related to traditional fisheries, also known as FSC fisheries, includes harvesting activities to collect resources that provide nourishment, or for use in traditional ceremonies and social events. A change in current use of lands and resources for traditional purposes could occur from routine Project activities affecting the marine environment; however, with the implementation of mitigation, effects were predicted to be low in magnitude, localized, short-term in duration, and reversible. Routine Project activities, therefore, are not predicted to interact with current use of lands and resources for traditional purposes by an Indigenous community.

Indigenous groups in the Maritime provinces, and the Gaspe region of Quebec, have a right to fish for a moderate livelihood, based on the Peace and Friendship Treaties, and the 1999 Marshall decision. The Nunatsiavut Government land claims agreement also establishes conditions for commercial fishing. All Indigenous groups have a constitutionally-protected Aboriginal right to harvest for FSC purposes. Based on the CEA Agency's review of potential impacts on claimed or established Aboriginal and/or Treaty rights, the Agency determined that there is a low likelihood of interaction between the Project under normal operations, and the claimed or established Aboriginal and/or Treaty rights of Indigenous groups.

Any structure, site, or thing of historical, archaeological, paleontological, or architectural significance includes something that may be movable (e.g., tools) or immovable (e.g., cultural landscape), above (e.g., historic building) or below ground (e.g., burial site), and on land or in water, and is distinguished from other lands and resources by the value placed on it (CEA Agency 2015a). There are no known physical and cultural sites, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance in the Project Area. Routine Project activities are unlikely to adversely affect any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance because of the offshore location of the Project and the localized extent of Project interactions.

As discussed in Section 6.6.10, with the implementation of mitigation and environmental protection measures (see Section 6.6.10.2), residual environmental effects on Indigenous people and community values because of routine operations are predicted to be not significant.

All accidental scenarios considered in this assessment could have an adverse environmental effect on Indigenous people and community values. An accidental event could affect the fisheries resource (direct or indirect effects on fished species affecting fisheries success), fishing activity (displacement from fishing areas, gear loss or damage), change in risk of mortality or physical injury for migratory birds, and/or change in habitat quality and use for marine mammals resulting in a change in traditional use. In the event of a batch spill, adverse environmental effects are predicted to be not significant for Indigenous people and community values. A significant adverse environmental effect is predicted to occur in the event of a worst-case, unmitigated blowout event. The likelihood of this significant environmental effect occurring is considered low, given the unlikely potential for a blowout incident to occur and the response measures that would be in place to mitigate potential effects (see Section 7.3.1 for additional information).

10.3 Effects of Changes to the Environment on Indigenous People (CEAA, 2012 section 5(1)(c))

In accordance with section 5(1)(c) of CEAA, 2012, this section of the EIS summarizes the effects of changes to the environment on Indigenous people caused by the Project. Effects of changes to the environment on Indigenous People as outlined in the EIS Guidelines are presented in Section 6.6 (Indigenous People and Community Values). Changes to the following environmental components are summarized below:

- health and socio-economic conditions
- physical and cultural heritage and any structure, site or thing that is of historical, archaeological, paleontological or architectural significance
- the current use of lands and resources for traditional purposes

As discussed above and in Section 6.6, effects on socio-economic conditions may occur from the following potential changes to the environment:

- change in availability of fisheries resources (for commercial and commercial communal fisheries)
- change in traditional use for Indigenous fisheries

Given that the potential changes to the environment caused by the Project are temporary and localized around the MODU and OSVs, and that other suitable fish habitat and fishing areas are readily available throughout the Study Area, these potential changes to the environment are not anticipated to measurably affect socio-economic conditions for commercial or Indigenous fishers (refer to Sections 6.2 and 6.6)

Given its distance offshore, the Project is unlikely to affect any receptors that would be sensitive to atmospheric air or noise emissions from Project activities and components or accidental events. As discussed in Section 2.6.4.1, Project-related emissions will comply with the Newfoundland and Labrador *Air Pollution Control Regulations, 2004*, Ambient Air Quality Objectives under *the Canadian Environmental Protection Act*, and any relevant regulations under MARPOL. Wastes will be discharged in accordance with the Husky's Environmental Protection and Compliance Monitoring Plan (EPCMP), which is based on the OWTG, Transport Canada's *Ballast Water Control and Management Regulations* and/or MARPOL, as applicable, and will be protective of the marine environment. Any substances, wastes, residues, or discharges not identified in the EPCMP are not permitted for discharge. Emissions and discharges from routine drilling operations will not result in contamination of marine fish tissues such that consumption of traditionally harvested marine fish species would result in adverse health effects. The Project is therefore not expected to result in significant residual adverse environmental effects on the health of Indigenous or non-Indigenous people.

Although unlikely to occur, accidental events, such as spills, could result in contamination of fish species commonly harvested for human consumption through commercial communal. However, fisheries closures would be imposed in the event of such an incident, thus preventing human exposure to contaminated food sources. The implementation of an exclusion zone around the affected area(s) would prevent human contact with spilled oil.

As discussed in Section 4.3.1.8, the Miawpukek First Nation, Qalipu Mi'kmaq First Nation Band, Nunatukavut Community Council, Innu Nation, and the Nunatsiavut Government hold commercial communal fishing licences within the Study Area, including within NAFO Area 3L (D. Ball, pers. comm.). Although the licences are issued, the Indigenous groups may not execute all fisheries. For example, groundfish is still under moratoria (3L cod, haddock, redfish, American plaice, witch founder, grenadier) and Shrimp Fishing in Area 7, while other licences in 3L may be traded for licences off Labrador. In addition to species commercially fished by the Newfoundland and Labrador Indigenous groups, Indigenous groups within the Maritime provinces hold commercial communal licences which are located within the Study Area. This includes commercial communal licences for swordfish and tuna. There are no identified FSC fisheries within the Study Area; however, species harvested for FSC purposes have the potential to migrate through the area.

As detailed in Section 6.6, the Project may interact with Indigenous commercial communal and traditional hunting, potentially resulting in a change in traditional use. Potential environmental effect pathways for Indigenous people and community values are similar to those considered with respect to a change in availability of fishery resources for commercial fisheries (Section 6.2) and change in habitat or risk of mortality for migratory birds (Section 6.4). In consideration of the extent of the interactions and the planned implementation of known and proven mitigation (refer to Section 6.6), Project activities are not predicted to result in: a loss of access to lands and resources for traditional purposes (beyond the safety zone established temporarily around the MODU); a change in availability of fisheries resources; serious harm to fish that are part of or support a CRA fishery; or traditionally hunted migratory bird species. Residual environmental effects on Indigenous people and community values are therefore predicted to be not significant.

All accidental scenarios considered in this assessment could have an adverse environmental effect on Indigenous people and community values. As discussed in Section 7.3.6, in the event of a batch spill, adverse environmental effects are predicted to be not significant for Indigenous people and community values. A significant adverse environmental effect is predicted to occur in the event of well blowout scenario. The likelihood of this significant effect occurring is considered low, given the unlikely potential for a blowout incident to occur and given the response measures that would be in place to mitigate potential effects.

10.4 Exercise of Power or Performance of Duty or Function by Federal Authority (CEAA, 2012 section 5(2))

10.4.1 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 key regulatory approvals required for 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. Potential changes to fish and fish habitat is discussed above in Section 10.1.1 and in more detail in Section 6.1.

Environmental components referred to under sections 5(1)(a) and (b) of CEAA 2012 are considered in Sections 10.1 or 10.2 of this assessment and therefore this section focusses on potential changes to the atmospheric environment.

The primary source of atmospheric emissions for the Project are exhaust emissions from the combustion of fuel during the operation of the MODU, OSVs, and helicopters. Well testing could also result in atmospheric emissions through the potential [limited] flaring of produced gas. Flaring activities will be kept to a minimum, reflecting only those tests necessary to determine reservoir parameters (including produced gas and fluids). Emissions released from these activities include GHGs, CO, SO_2, NO_X, PM, and VOCs. An estimate of emissions of GHGs (CO_{2eq}) from the operation of the MODU, OSVs, and helicopters and flaring during the multi-well exploration drilling could be 74,164 tonnes CO_{2eq}/yr (see Table 2.8). These emissions represent 0.70% of the total reported NL provincial GHG emissions (10,600,000 tonnes CO_{2eq}) for 2014 and 0.01% of the national emissions (732,000,000 tonnes CO_{2eq}) (Environment and Climate Change Canada 2016).

These emissions will comply with the Newfoundland and Labrador *Air Pollution Control Regulations, 2004*, the National Ambient Air Quality Objectives under *the Canadian Environmental Protection Act*, the Canada Wide Standard for fine particulate matter ($PM_{2.5}$), and any relevant regulations/limits under MARPOL. Potential flaring will occur in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017).

Atmospheric and underwater noise is generated from various activities associated with exploration drilling, including the operation of helicopters, OSVs, and the MODU. Given its distance offshore, the Project is 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. Atmospheric noise is assessed as a component of the migratory birds VC and residual environmental effects are predicted to be not significant (refer to Section 6.4). Underwater noise is assessed as a component of fish and fish habitat (refer to Section 6.1), marine mammals and sea turtles (refer to Section 6.3) and migratory birds (refer to Section 6.4) and residual environmental effects for all VCs are predicted to be not significant.

10.4.2 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 10.3 summarizes the changes to the environment that are linked to federal decisions on the Project that are required under the Accord Acts and the *Fisheries Act*.

Oil and gas exploration and development activities in the Newfoundland and Labrador offshore area are regulated by the Accord Acts. The C-NLOPB, established by the joint operation of the Accord Acts, is a prescribed federal authority to which CEAA, 2012 applies. In accordance with CEAA, 2012, the C-NLOPB and other federal authorities are required to conduct an environmental assessment of proposed oil and gas projects before they may issue authorizations, licenses and permits to enable such projects to be developed. The environmental assessment process requires projects be considered in a careful and precautionary manner before federal authorities take action to determine that such projects do not cause significant adverse environmental effects.

Table 10.3 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 *Newfoundland Offshore Petroleum Drilling and Production Regulations*)	Change in Risk of Mortality, Physical Injury, or Health	• Fish and Fish Habitat
	Change in Risk of Mortality or Physical Injury	• Marine Mammals and Sea Turtles • Migratory Birds
	Change in Habitat Quality and Use	• Marine Mammals and Sea Turtles • Migratory Birds
	Change in Habitat Quality	• Fish and Fish Habitat • Special Areas
	Change in Availability of Fisheries Resources	• Commercial Fisheries
	Change in Traditional Use	• Indigenous People and Community Values
Fisheries Act Authorization (Authorization for Serious Harm to Fish under section 35(2)(b) of the *Fisheries Act*) (if applicable in the event of an accidental spill)	Change in Risk of Mortality or Physical Injury	• Fish and Fish Habitat
	Change in Habitat Quality	• Fish and Fish Habitat

For the same reasons as explained above with respect to the effects of changes to the environment on Indigenous people (Section 10.3), Project activities are not expected to result in changes to the environment that would affect: health conditions; physical and cultural heritage; or any structure, site or thing that is of historical, archaeological, paleontological or architectural significance for Indigenous or non-Indigenous people. However, effects on socio-economic conditions may occur from the following potential changes to the environment:

- change in availability of fisheries resources (for commercial and commercial communal fisheries); and
- change in traditional use for Indigenous fisheries.

Given that these potential changes to the environment are temporary and localized around the MODU and OSVs, and that other suitable fish habitat and fishing areas are readily available throughout the Study Area, these potential changes to the environment are not anticipated to measurably affect socio-economic conditions for commercial or Indigenous fishers (refer to Sections 6.2 and 6.6).

As described in Sections 6.1, 6.2, and 6.6, in consideration of the extent of the interactions and the planned implementation of known and proven mitigation, residual environmental effects from routine Project activities on socio-economic conditions pertaining to commercial fisheries and Indigenous people and community values are predicted to be not significant.

Given the extensive nature of the worst-case, unmitigated blowout event, a significant effect is conservatively predicted for commercial fisheries and Indigenous people and community values for this scenario. The likelihood of this significant environmental effect occurring is considered low, given the very low potential for a blowout to occur (see Section 7.2.2) and the response measures that would be in place to mitigate potential effects.

11.0 SUMMARY AND CONCLUSIONS

Husky is proposing to conduct exploration drilling activities within the area of its offshore ELs on the Grand Banks in EL 1151, EL 1152, and EL 1155. This document is an EIS submitted to the CEA Agency to fulfil the requirements of the Guidelines issued March 27, 2017, under CEAA 2012 and amended May 31, 2018.

11.1 Summary of Potential Effects

The Project under assessment is an offshore exploration drilling program comprising the drilling, testing and abandonment of up to ten exploration wells within a Project Area encompassing Husky's offshore licences on the Grand Banks.

The EA method is focused on the identification and assessment of potential adverse environmental effects of the Project on VCs. VCs are environmental or socio-economic attributes associated with the Project that are of particular value or interest because they have been identified to be of concern to Indigenous peoples, regulatory agencies, Husky, resource managers, scientists, key stakeholders, and/or the general public. The VCs selected for this assessment include:

- fish and fish habitat
- commercial fisheries
- marine mammals and sea turtles
- migratory birds
- special areas
- Indigenous people and community values

Specific candidate VCs identified in the Final EIS Guidelines that were not selected as VCs in this EIS include marine plants, federal species at risk, air quality and greenhouse gas emissions, and the human environment. Marine plants are addressed, as relevant, in the fish and fish habitat. To eliminate repetition throughout the EIS, SAR and SOCC are considered as part of the fish and fish habitat, the marine mammals and sea turtles, and the migratory birds VC assessments, where applicable, rather than as a stand-alone VC. A summary of potential effects on SAR and SOCC is provided in Section 10.1.4. Air quality and greenhouse gas emissions are addressed in Section 2.6.3.1 of this EIS. Human environment aspects are discussed in Section 4.3. Given the lack of predicted interactions with most aspects of the human environment (as demonstrated in Table 5.1), it was not selected as a stand-alone VC.

The potential environmental effects of Project activities and components are assessed in Section 6 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).

Routine operations represent physical activities that would occur throughout the life of the Project and include:

- presence and operation of MODU (presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; water management, well testing; cementing and completing wells)
- drilling-associated surveys (VSP and wellsite surveys; geotechnical / geophysical / environmental surveys; diving surveys; ROV surveys)
- waste management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)
- supply and servicing (operation of helicopters and supply / support / standby / tow vessels within the Project Area)
- well abandonment (plugging, suspending, and abandoning of wells)

Environmental effects associated with potential accidental events are assessed in Section 7. 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.

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 11.1.

Table 11.1 Potential Project-VC Interactions and Effects

Project Activities and Components	Fish and Fish Habitat		Commercial Fisheries	Marine Mammals and Sea Turtles		Migratory Birds		Special Areas	Indigenous People and Community Values	
	Change in Risk of Mortality, Physical Injury, or Health	Change in Habitat Quality and Use	Change in Availability of Fisheries Resources	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 Commercial Communal Fisheries	Change in Current Use of Lands and Resources for Traditional Purposes
Routine Activities										
Presence and Operation of MODU (Presence of structure; safety zone; lighting; drilling; air emissions; noise emissions; chemical use and management; operation of seawater systems; well testing; cementing and completing wells)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Drilling-associated Surveys (VSP and wellsite surveys; geotechnical / geophysical / environmental surveys; diving surveys; ROV surveys)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Project Activities and Components	Fish and Fish Habitat		Commercial Fisheries	Marine Mammals and Sea Turtles		Migratory Birds		Special Areas	Indigenous People and Community Values	
	Change in Risk of Mortality, Physical Injury, or Health	Change in Habitat Quality and Use	Change in Availability of Fisheries Resources	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 Commercial Communal Fisheries	Change in Current Use of Lands and Resources for Traditional Purposes
Waste Management (WBM and SBM cuttings discharge; domestic waste; sanitary waste; oily water treatment; cooling water; deck drainage; bilge water; BOP fluid; cement; vent and flare system)	✓	✓	✓	-	-	✓	✓	✓	✓	✓
Supply and Servicing (operation of helicopters and supply / support / standby/ tow vessels within the Project Area)	–	✓	✓	✓	✓	✓	✓	✓	✓	✓
Well Abandonment (plugging and abandoning of wells)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Accidental Events										
Diesel Batch Spill from OSV and MODU (10 bbl and 100 bbl scenarios)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Subsea and Surface Hydrocarbon Blowout (blowout rates of 40,476 bopd)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

11.2 Summary of Mitigation 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 11.2.

Table 11.2 Summary of Commitments

No.	Proponent Commitments	EIS Section Reference
General		
1	Husky will continue to engage Indigenous and commercial fishers on an ongoing basis to share Project details as applicable and facilitate coordination of information sharing.	6.2.10.2 6.6.10.2
2	Any Project-related damage to fishing gear will be compensated in accordance with the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and Canada-Nova Scotia Offshore Petroleum Board 2002). Husky has a gear/vessel damage compensation program, to promptly settle claims for loss and/or damage that may be caused by Project-related activities such as drilling-associated surveys or OSV operations. The scope of the compensation program includes replacement costs for lost or damaged gear and any additional financial loss that is demonstrated to be associated with the incident. Procedures are in place so that any incidents of contact with fishing gear are clearly detected and documented (e.g., time, location of contact, loss of contact, and description of any identifying markings observed on affected gear).	6.2.10.2 6.6.10.2
3	The primary means of mitigating effects of the environment on the Project is through detailed engineering design and sound planning, including testing (and treatment, if necessary). All engineering design will adhere to national/ international standards.	8.3.1
4	As part of the C-NLOPB authorizations required to conduct the drilling program, and in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations,* Husky will obtain a Certificate of Fitness from an independent third party Certifying Authority for the MODU prior to commencement of drilling operations.	8.3.1
5	Husky will conduct analyses, model tests and/or simulations to determine the behaviour of the soils that support the installation or anchoring systems, under all foreseeable installation and operating conditions, in order to receive a Certificate of Fitness in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations* should a jack-up or anchored MODU be selected.	8.3.1 8.3.2
6	Follow ice management plan as outlined in Section 8.3.3, including, detection, monitoring and assessment, and physical management.	8.3.3

No.	Proponent Commitments	EIS Section Reference
Presence and Operation of the MODU		
7	A safety zone will be extended 500 m from the furthest extent of the MODU (typically either anchors or rig legs).	2.5.2
8	Lighting on the MODU is designed to comply with requirements stipulated in the *Petroleum Occupational Safety and Health Regulations* to provide safe operations. There is no extraneous lighting. All lighting except navigational lighting is pointed downward.	6.1.10.2 6.4.10.2
9	Once the type of MODU is selected, Husky 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. The operator will publish a Canadian Coast Guard "Notice to Mariners" and a "Notice to Fishers" via the CBC (Canadian Broadcasting Corporation) Radio Program Fisheries Broadcast.	6.2.10.2 6.6.10.2
10	The frequency and duration of flaring events will continue to be restricted to the amount necessary to characterize the well potential (drill stem test (DST)) and as required to maintain safe operations. Flaring will occur in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017), which requires a DST not begin at night. A high pressure spray of seawater between the MODU and the flare is routinely used as a heat dissipating curtain, which will also act as a deterrent to seabirds in the area.	6.4.10.2
11	Routine checks for stranded birds will continue to be conducted on the MODU and OSVs and appropriate procedures for release will be implemented. If stranded birds are found during inspections, they will be handled using the protocol outlined in Best Practices for Stranded Birds Encountered Offshore Atlantic Canada (Environment Canada 2015) and 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.	6.4.10.2
Drilling-associated Surveys		
12	VSP activity will be conducted in consideration of the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (SOCP) (DFO 2007), according to Husky Procedure EC-M-99-X-PR-00121-001 Vertical Seismic Profiles and Well Site Surveys - Environmental Requirements.	2.5.3
13	The requirement for a Fisheries Liaison Officer (FLO) during certain offshore Project activities, such as wellsite surveys, will be determined in accordance with the Risk Management Matrix Guidelines developed by One Ocean. The Risk Management Matrix Guidelines provides guidance on the requirements for FLOs and/or Fisheries Guide Vessels based on the level of fishing activity in an area and the activity being undertaken by the oil and gas operator.	6.2.10.2 6.6.10.2

No.	Proponent Commitments	EIS Section Reference
14	As required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017a), mitigation measures for geophysical surveys will be consistent with the SOCP. • 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. • 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 near the source at the onset of the activity. It assumes 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 500 m of the wellsite. • Shutdown of the air gun array when a member of the eastern Newfoundland (Sackville Spur) population of northern bottlenose whale is sighted within the safety zone. • Delay of ramp-up if any marine mammal or sea turtle is sighted within the safety zone.	6.1.10.2 6.3.10.2 6.5.10.2
Waste Management		
15	All chemicals used will be screened as per the OCSG (NEB et al. 2009) and Husky's chemical management system and chemical screening program.	2.6 6.1.10.2 6.3.10.2 6.4.10.2 6.5.10.2
16	Any substances, wastes, residues or discharges not identified in the EPCMP are not permitted for discharge.	2.6
17	Exhaust emissions will comply with the Newfoundland and Labrador *Air Pollution Control Regulations, 2004*, Ambient Air Quality Objectives under the *Canadian Environmental Protection Act,* and any relevant regulations under MARPOL. Potential flaring will occur in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017).	2.6.4.1
18	All routine discharge limits (i.e., deck drainage, bilge water, cooling water) will be in accordance with the OWTG (NEB et al. 2010), *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals* under the *Canada Shipping Act*, 2001 and the International Conventions for the Prevention of Pollution from Ships (MARPOL).	6.1.10.2 6.3.10.2 6.4.10.2 6.5.10.2
19	Sewage will be macerated to a particle size of <6 mm and discharged as per the OWTG.	6.1.10.2 6.3.10.2 6.4.10.2 6.5.10.2

No.	Proponent Commitments	EIS Section Reference
20	Waste discharges not meeting Husky's EPCMP requirements and domestic garbage will be transported to shore for disposal or recycled. Garbage is segregated as required and hazardous waste is disposed of separately and in compliance with waste disposal requirement and Husky's Waste Management Plan.	6.1.10.2 6.3.10.2 6.4.10.2 6.5.10.2
21	Concentration of SBM on cuttings will be monitored on the MODU for compliance with the Husky EPCMP.	6.1.10.2 6.3.10.2 6.4.10.2 6.5.10.2
22	All foreign vessels operating in Canadian jurisdiction must comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act, 2001* during ballasting and de-ballasting activities	6.1.10.2 6.3.10.2 6.4.10.2 6.5.10.2
Supply and Servicing		
23	Adhere to *Canada Shipping Act* and industry best practices and follow marine traffic rules and regulations.	2.4.3.2 6.1.10.2
24	Husky will implement its Vessel Traffic Management Standard (AR-M-99-R-PR-00003-001), which includes procedures for management and communication relevant to the movement of OSVs, survey vessels, and MODU during Project related activities. All communications between Husky, operators, and fishers will adhere to this standard.	6.2.10.2 6.3.10.2 6.6.10.2
25	OSVs travelling between the Project Area and supply base will follow established shipping routes from St. John's.	6.2.10.2 6.3.10.2 6.6.10.2
26	Project-related vessel traffic will avoid concentrations of marine mammals and sea turtles whenever possible. Vessels will maintain a steady course and safe vessel speed whenever possible, as sudden changes in these factors are known to increase behavioural effects in marine mammals. Helicopters will typically only reduce altitude on approach for landing.	6.3.10.2
27	If a vessel strikes a marine mammal or sea turtle, the following notifications will occur: • The master of the vessel will contact the CCG through the nearest Marine Communications and Traffic Services. The CCG will communicate this information to the appropriate regulatory departments. • The applicable Operator will also inform DFO within 24 hours, As outlined on the DFO website (DFO 2018d), to report a marine mammal or sea turtle emergency there is a 24-hour number to contact – Whale Release and Strandings Newfoundland and Labrador at 1-888-895-3003.	6.3.10.2

No.	Proponent Commitments	EIS Section Reference
28	In addition to standard design mitigation, standard operation procedures are implemented as appropriate to assist in OSV and helicopter navigation during times of poor visibility. This includes reducing vessel or helicopter speed, adjusting flight altitude, and using appropriate sound and light signals. Navigational safety equipment will be kept in working condition at all times. Radio communication systems will be in working order for contacting other marine vessels, if necessary, as well as communication between the MODU, OSV and shore.	8.3.1
29	Mitigation measures to reduce superstructure icing hazards on the OSV may include: • 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.	8.3.1
30	Extreme weather conditions that are outside the operating limits of OSVs or helicopters will be avoided if possible. 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 OSV, helicopter, or MODU operations.	8.3.1
Well Abandonment		
31	Well abandonment will follow industry standard abandonment procedures and practices in accordance with C-NLOPB regulations.	2.5.5
32	Proper notification via Notice to Shipping and Notice to Mariners will be made to identify the subsea obstruction until it is removed.	2.5.5
33	Mechanical means of wellhead severance will be preferential; should blasting be required to sever the wellhead, shape charges will be set below the sediment surface, reducing the amount of explosive used. In the unlikely event that shape charges are required to remove the wellhead during well abandonment, a MMO will visually monitor marine mammals and sea turtles in the area of the wellhead and detonation will be delayed until there are no sighting for at least 45 minutes.	6.1.10.2 6.3.10.2
Accidental Events		
34	As per HOIMS, Husky will implement several measures and preventative actions into the design and daily operation and maintenance of a MODU. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to minimize the likelihood of an accident or malfunction. Details on spill prevention and response to spills of all types are provided in Section 7.	7.3.1.2 7.3.2.2 7.3.3.2 7.3.4.2 7.3.5.2 7.3.6.2
35	In the unlikely event of an accidental event such as a large spill or a blowout, specific monitoring programs (e.g., EEM and follow up) may be required for the Project. In such case, these programs will be developed and implemented in consultation with the appropriate regulatory agencies.	7.3.1.2 7.3.2.2 7.3.3.2 7.3.4.2 7.3.5.2 7.3.6.2

Husky's EPCMP commits to an active environmental compliance monitoring program to meet and where possible exceed compliance with all relevant regulatory and corporate requirements.

Management of compliance focuses on the effluent streams that are regulated under the Canada Oil and Gas Drilling and Production Regulations and the Newfoundland Offshore Petroleum Drilling and Production Regulations (the Drilling and Production Regulations) and any other applicable provincial or federal legislation. The requirements for the Drilling and Production Regulations are further defined in the OWTG, which are used to develop facility-specific environmental protection and compliance monitoring plans.

All monitoring results are reviewed, and data trending of the respective effluent streams is completed, to ensure that compliance limits are met and environmental exceedances are avoided or reported.

11.3 Residual Environmental Effects

Section 6 of this EIS presents the residual environmental effects for routine operations for each VC. Table 11.3 summarizes the residual environmental effect findings for routine activities for each VC and indicates the significance of these effects. Section 7 of this EIS presents the residual environmental effects for accidental events for each VC. Table 11.4 summarizes the residual environmental effect findings for accidental events for each VC and indicates the significance of these effects. Where an effect is predicted to be significant (refer to Section 6 for significance criteria for each VC), the likelihood of that effect occurring is also presented.

Table 11.3 Summary of Residual Effects for Routine Operations

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation References (refer to Table 11.2)	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, Physical Injury and Health	Presence and Operation of MODU	See Section 6.1.10.2 and Table 11.2	L	PA	MT	IR	R	D	N	N/A
			Drilling Associated Surveys		L	PA	ST	IR	R	D	N	N/A
			Waste Management		L	PA	LT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of MODU		L	PA	MT	IR	R	D	N	N/A
			Drilling Associated Surveys		L	SA	ST	IR	R	D	N	N/A
			Waste Management		L	PA	LT	IR	R	D	N	N/A
			Supply and Servicing		L	PA	MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
Commercial Fisheries	s. 5(2)(b)(i)	Change in Availability of Fisheries Resources	Presence and Operation of MODU	See Section 6.2.10.2 and Table 11.2	L	PA	MT	IR	R	D	N	N/A
			Waste Management		L	PA	MT	IR	R	D	N	N/A
			Drilling Associated Surveys		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing		L	SA	MT	IR	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 Habitat Quality and Use	Presence and Operation of MODU	See Section 6.3.10.2 and Table 11.2	M	PA	MT	IR	R	D	N	N/A
			Drilling Associated Surveys		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing		L	PA	MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
		Change in Risk or Mortality or Physical Injury	Presence and Operation of MODU		L	PA	MT	IR	R	D	N	N/A
			Drilling-Associated Surveys		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing		L	PA	MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
Migratory Birds	s. 5(1)(a)(iii)	Change in Risk of Mortality or Physical Injury	Presence and Operation of MODU	See Section 6.4.10.2 and Table 11.2	L-M	PA	MT	IR	R	D	N	N/A
			Drilling-associated Surveys		N	PA	ST	IR	R	D	N	N/A
			Waste Management		N	PA	MT	IR	R	D	N	N/A
			Supply and Servicing		L	PA	MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of MODU		L	PA	MT	IR	R	D	N	N/A
			Drilling-associated Surveys		L	PA	ST	IR	R	D	N	N/A
			Waste Management		N	PA	MT	IR	R	D	N	N/A
			Supply and Servicing		L	PA	MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation References (refer to Table 11.2)	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			
Special Areas	s. 5(1)(b)(i)	Change in Habitat Quality	Presence and Operation of MODU	See Section 6.5.10.2 and Table 11.2	L-M	PA	MT	IR	R	D	N	N/A
			Drilling-associated Surveys		L	PA	ST	IR	R	D	N	N/A
			Waste Management		L-M	PA	MT-LT	IR	R	D	N	N/A
			Supply and Servicing		L	PA	MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
Indigenous People and Community Values	s.5(1)(c)(i) s.5(1)(c)(iii)	Change in Commercial Communal Fisheries / Change in Current Use of Lands and Resources for Traditional Purposes	Presence and Operation of MODU	See Section 6.6.10.2 and Table 11.2	L	PA	MT	IR	R	D	N	N/A
			Drilling-associated Surveys		L	PA	ST	IR	R	D	N	N/A
			Waste Management		L	PA	MT	IR	R	D	N	N/A
			Supply and Servicing		L	SA	MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A

Magnitude: N: Negligible; L: Low; M: Moderate; H: High
Geographic Extent: PA: Project Area; SA: Study 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

Key/Note:
VC specific definitions included for each VC in Section 6.
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:

- fish as defined in section 2 of the *Fisheries Act* and fish habitat as defined in subsection 34(1) of that Act,
- aquatic species as defined in subsection 2(1) of SARA,
- migratory birds as defined in subsection 2(1) of the *Migratory Birds Convention Act*, 1994, and
- 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

- on federal lands,
- 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
- 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

- health and socio-economic conditions,
- physical and cultural heritage,
- the current use of lands and resources for traditional purposes, or
- any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

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

- health and socio-economic conditions,
- physical and cultural heritage, or
- any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Table 11.4 Summary of Residual Effects for Accidental Events

Valued Component	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Accidental Event Scenario	Mitigation References (refer to Table 11.2)	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, Physical Injury and Health / Change in Habitat Quality and Use	Diesel Batch Spill from OSV and MODU	See Section 7.3.1.2 and Table 11.2	M	SA	ST	S	R	D	N	N/A
			Subsea and Surface Hydrocarbon Blowout		M	SA	ST-MT	S	R	D	N	N/A
			SBM Spill		L	PA	MT	S	R	D	N	N/A
Commercial Fisheries	s. 5(2)(b)(i)	Change in Availability of Fisheries Resources	Diesel Batch Spill from OSV and MODU	See Section 7.3.2.2 and Table 11.2	M	SA	ST	S	R	D	N	N/A
			Subsea and Surface Hydrocarbon Blowout		H	SA	ST-MT	S	R	D	S	U
			SBM Spill		L	PA	MT	S	R	D	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	Diesel Batch Spill from OSV and MODU	See Section 7.3.3.2 and Table 11.2	M	SA	ST	S	R	D	N	N/A
			Subsea and Surface Hydrocarbon Blowout		H	SA	ST-MT	S	R	D	N	N/A
			SBM Spill		N-L	PA	ST	S	R	D	N	N/A
Migratory Birds	s. 5(1)(a)(iii)	Change in Risk of Mortality or Physical Injury / Change in Habitat Quality and Use	Diesel Batch Spill from OSV and MODU	See Section 7.3.4.2 and Table 11.2	L	SA	ST	S	R	D	S	U
			Subsea and Surface Hydrocarbon Blowout		H	SA	ST-MT	S	R	D	S	U
			SBM Spill		N-L	PA	MT	S	R	D	N	N/A
Special Areas	s. 5(1)(b)(i)	Change in Habitat Quality	Diesel Batch Spill from OSV and MODU	See Section 7.3.5.2 and Table 11.2	L	SA	ST	S	R	D	N	N/A
			Subsea and Surface Hydrocarbon Blowout		H	SA	ST-MT	S	R	D	N	N/A
			SBM Spill		L	PA	MT	S	R	D	N	N/A
Indigenous People and Community Values	s.5(1)(c)(i) s.5(1)(c)(iii)	Change in Commercial Communal Fisheries / Change in Current Use of Lands and Resources for Traditional Purposes	Diesel Batch Spill from OSV and MODU	See Section 7.3.6.2 and Table 11.2	M	SA	MT	S	R	D	N	N/A
			Subsea and Surface Hydrocarbon Blowout		H	SA	LT	S	R	D	S	N/A
			SBM Spill		L	PA	MT	S	R	D	N	N/A

Note:
See Table 11.3 for key

11.4 Monitoring and Follow-up

Follow-up and monitoring programs are used to verify the accuracy of the environmental assessment of the Project and determine the effectiveness of any measures taken to mitigate the adverse environmental effects of the Project, where uncertainty around these aspects may exist in the EIS. Given the nature of the Project (i.e., exploration drilling) and the existing knowledge of potential environmental effects related to this type of activity gained through existing EEM and existing literature, monitoring and follow-up requirements for the proposed Project, including cumulative effects, is limited. As detailed in Section 2.7.5, Husky has conducted seven EEM programs since 2004 (2004, 2005, 2006, 2008, 2010, 2012, and 2014), with results compared to baseline data collected in 2000 and 2001. The EEM programs examine potential project effects on sediment chemistry, sediment toxicity and benthic community structure. As discussed in Section 6.1.10.3, results from the ongoing White Rose EEM program have confirmed original assessment predictions (Husky Oil Operations Limited 2000; LGL 2007a) of no significant environmental effect on benthic fauna or commercial fish species due to operational discharges.

Monitoring programs for various VCs recommended during certain activities associated with the Project are discussed in the relevant VC sections (see Section 6). In summary, these include the following:

- MMOs will be employed to monitor and report on sightings of marine mammals and sea turtles as required in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017a) (see Section 6.3.10.2).
- Routine checks for stranded birds on the MODU and OSVs (with handling as per the Environment Canada (2015) and 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.

Husky will communicate with Indigenous groups, 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.

11.5 Conclusions

A summary of the significance of residual environmental effects identified in Tables 11.3 and 11.4 for each VC for routine operations, cumulative effects and accidental events, and, where applicable, the likelihood of significant residual adverse environmental effects is provided in Table 11.5. The residual adverse environmental effects from planned routine activities associated with the Project are predicted to be not significant. Most environmental effects are predicted to be reversible, of limited duration, magnitude, and geographic extent. The only potential for significant residual adverse environmental effects as a result of the Project is associated with an accidental event. Should an accidental event occur, significant adverse environmental effects have been predicted for commercial fisheries, migratory birds and Indigenous people and community values; however, the likelihood of an accidental event occurring is considered low. Husky will design the Project and conduct all activities with a focus on safety and pollution prevention.

Table 11.5 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
Commercial Fisheries	N	S	L	N
Marine Mammals and Sea Turtles	N	N	N/A	N
Migratory Birds	N	S	L	N
Special Areas	N	N	N/A	N
Indigenous People and Community Values	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 11.2). Mitigation measures have been proposed to address potential Project and cumulative environmental 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.

Husky has and will continue to follow a performance-based assessment and continuous improvement approach with respect to environmental management of the Project using the HOIMS, which covers all of Husky's businesses, with particular emphasis on projects and operations, and manages operational integrity through the life-cycle of the assets.

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