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8.0 AIR QUALITY AND GREENHOUSE GASES

To support the regulatory review of the Project, Stantec conducted an air emissions and dispersion modelling study to estimate the Project-related quantities of air contaminants and greenhouse gases (GHGs) released to the atmosphere and to predict associated ground-level concentrations of air contaminants in the vicinity of the Project.

A summary of the findings from this study is presented in this section. Further details pertaining to the development of the air emissions inventory for criteria air contaminants (CACs) and greenhouse gases (GHGs) and dispersion modelling can be found in the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K.

8.1 Overview of Project Emissions

The sources of air contaminants and GHGs during the life of the Project include the following:

- Power and heat production on the floating production, storage and offloading (FPSO)
- Non-routine, unplanned, flaring from the FPSO (i.e. during depressurization of process systems and emergency shut-downs)
- Power production on the drilling installation
- Vessel (support, supply and shuttle tankers) traffic
- Helicopter traffic

The phases of the Project for which air emissions and GHGs were estimated include:

- Construction and installation, and hook-up and commissioning (HUC)
- Concurrent drilling and production
- Normal production operations

These phases were chosen as they represent the timeframe during the Project when air emissions are likely to be greatest, and therefore represents worst-case scenarios for predicting air emissions.

The Core Bay du Nord (BdN) Development Area (refer to Figure 8-1) encompasses the immediate area in which Project activities and components may occur includes the area within which direct physical disturbance to the marine environment may occur. It occupies an offshore area of approximately 470 km², encompassing the planned and potential location of the FPSO and supporting infrastructure and activities, including associated anti-collision zones for the FPSO and/or drilling installation(s). The actual footprint of Project facilities within the Core BdN Development Area is approximately 7 km². The Project Area (refer to Figure 8-1) includes the Core BdN Development Area and is where Potential Future Development (as described in Section 2.6.7) activities may occur and has an area of approximately 4,900 km².

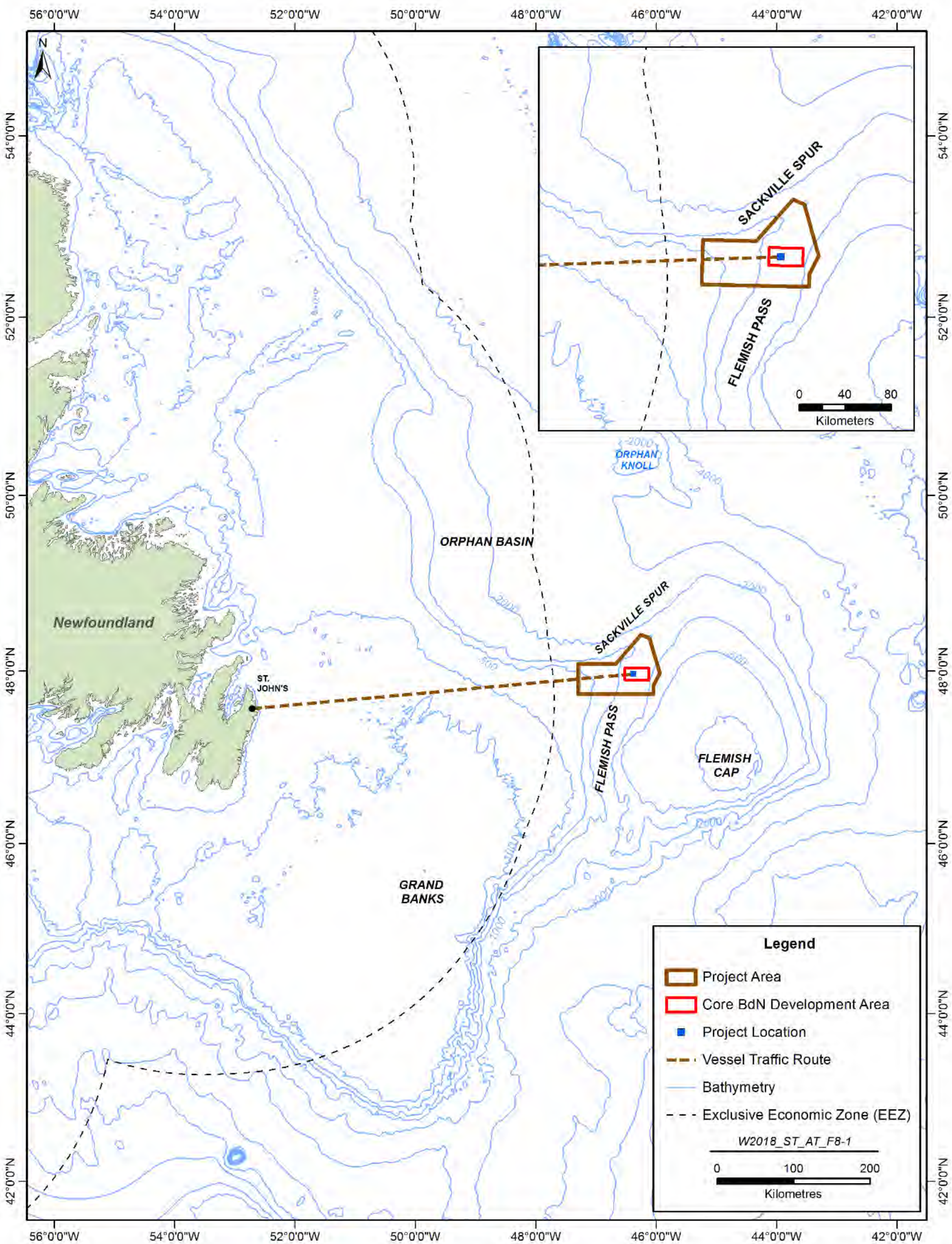

Figure 8-1 Core BdN Development Area

In addition to the above Project phases, air emissions estimates are also provided for specific accidental event scenarios. An overview of potential cumulative interactions of the Project's air emissions in combination with other ongoing or planned activities is also provided.

The following is a description of the assumptions used to estimate overall air emissions.

Hook-up and Commissioning (HUC): The construction and installation, and HUC phase of the Project will occur over approximately five years (2020 to 2025). The HUC portion is expected to release the highest rates (per time unit) of construction related emissions and is anticipated to occur in the latter part of the phase (i.e., 2025) and anticipated to have a duration of approximately four-months. The major sources of air emissions during HUC include power generation at the FPSO, the concurrent operation of the drilling installation, vessel and helicopter traffic, as well as other marine vessels that are used to support the installation (i.e., marine construction). During HUC it is anticipated that the FPSO will be powered by four reciprocating engines (eight engines in total at the FPSO, with four of these on standby), and both the drilling installation and FPSO will be fueled by diesel. During this phase of the Project there will be two support vessels maneuvering within the Core BdN Development Area and one supply vessel making two trips per week between the Core BdN Development Area and eastern Newfoundland and Labrador (NL). Helicopter operation during this phase includes transit, landing and take-off (LTO), approach, and ground idling for up to five trips per week.

Concurrent Drilling and Production, Power Option 1: During the first two to three years of production and maintenance operations, the drilling installation will still be operational within the Core BdN Development Area. The major sources of air emissions during this phase of the Project (2025 to 2027) include the FPSO (both combustion and fugitive emission sources), the drilling installation and vessel and helicopter traffic. For this phase, it is assumed that FPSO will be powered by seven reciprocating engines fueled by produced gas (eight engines in total at the FPSO, with one engine on standby). The drilling installation will be fueled by diesel. Both the FPSO and the drilling are expected to operate year-round. There will be two support vessels maneuvering within the Core BdN Development Area year-round, and supply vessel operation including transit, maneuvering, and offloading for up to two trips per week. The shuttle tanker operation includes transit, maneuvering and loading for 78 trips per year. Helicopter operation during this phase includes LTO, approach, and ground idling for up to 15 trips per week.

Concurrent Drilling and Production, Power Option 2: This phase of the Project would be the same as described above under "Concurrent Drilling and Production, Power Option 1"; however, it involves a second power option for the FPSO which is being considered by the Project. Power Option 2 consists of one gas turbine. All other activities and sources of emissions would be the same as presented above.

Normal Production Operations: The normal operation phase of the Project is expected to occur from 2028 to the end of the life of the Project in 2054. This phase of the Project considers all of the major sources of Project emissions except for the operation of the drilling installation. The FPSO will be fueled by produced gas powered by eight reciprocating engines (seven running, one on standby). There will be one support vessel maneuvering within the Core BdN Development Area and one supply vessel operating (including transit, maneuvering, and offloading) for up to two trips per week.

The shuttle tanker operation includes transit, maneuvering and loading for 78 trips per year and helicopter operation includes LTO, approach, and ground idling for up to five trips per week. Flaring would occur as needed for safety reasons and includes a pilot flare.

Accidental Event 1: One accidental event considered for this Project is the release of air contaminants and GHGs during an emergency non-routine, unplanned, flaring event. For emissions inventory purposes, it is assumed that in one year, up to three full system depressurizations may occur. As this event is non-routine and unplanned, this assumption is likely an overestimate and represents a credible worst-case scenario.

Accidental Event 2: Throughout the production and maintenance phase of the Project there is the potential that produced gas would not be available at the right specification to power the reciprocating engines, and therefore the engines would have to operate on diesel for up to seven days, until the issue is resolved. The scenario assumes continuous operation of 4 power generating engines during this event. All other sources of emissions considered under this operational scenario are the same as those considered under operational Scenario 2, Concurrent Drilling and Production, Power Option 1.

Cumulative Operations: The Project-related releases of air contaminants and GHGs to the atmosphere have the potential to interact and accumulate with the emissions from other sources in the Project Area and beyond.

8.2 Air Emissions Substances of Interest

The air contaminants that are relevant for the Project activities are:

- Nitrogen dioxide (NO_2)
- Sulphur dioxide (SO_2)
- Carbon monoxide (CO)
- Total particulate matter (TPM)
- Particulate matter < 10 microns (PM_{10})
- Particulate matter < 2.5 microns ($PM_{2.5}$)
- Non-methane volatile organic compounds (nmVOC)

The GHGs relevant to the Project are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

These air contaminants and GHGs were selected for this assessment as these are expected to be released from activities during the different phases of the Project. Although the quantities of non-methane VOCs released to the atmosphere from the Project are expected to be small, estimates of non-methane VOC emissions have been provided due to their potential contribution in the formation of ozone. It is important to note, that ozone will not be emitted from the offshore construction or operation of the Project, but its formation in the atmosphere is dependent on the availability of NO_2, VOCs, and sunlight.

8.3 Regulatory Criteria and GHG Emission Reduction Targets

8.3.1 Regulatory Criteria

Since the Project is located offshore, there are no air quality regulations that directly apply to the Project. NL is the nearest jurisdiction to the Project. Therefore, the provincial and the federal air quality regulations are applicable to the following overview of air quality.

Ambient air quality in NL is regulated by the *Air Pollution Control Regulations, 2004* (the Regulations) administered under the *Environmental Protection Act* (O.C. 2004-232). The NL Ambient Air Quality Standards (NLAAQS) for several air contaminants are prescribed in Schedule A of the Regulations.

The Canadian Ambient Air Quality Standards (CAAQS) are being developed to reduce emissions and ground-level concentrations of various air contaminants nationally. The CAAQS have been endorsed by the Canadian Council of Ministers of the Environment (CCME) for sulphur dioxide, fine particulate matter ($PM_{2.5}$) and ozone. More recently CAAQS for NO_2 have been endorsed by the CCME. These CAAQS are adopted for the 2020 to 2025 period and are lowered beyond 2025. Predicted Project-related concentrations are compared with the CAAQS adopted for the 2020 to 2025 period.

The CCME has yet to publish a guidance document on the procedures and methodologies that one should follow to determine if measured concentrations of SO_2 or NO_2 exceed the CAAQS. However, it is understood from federal guidance that model predictions (i.e. predicted Project-related concentrations) should not be directly compared to the CAAQS, because these are intended to be compared with measured ambient air quality data and are not considered directly applicable to industrial fence-line concentrations. As such, although the predicted ground-level concentrations of CACs are compared to both the CAAQS and the NLAAQS in Section 8.5, only the NLAAQS would be applicable to the Project.

The provincial and federal ambient air quality standards are presented in Tables 8.1 and 8.2 for the NL *Air Pollution Control Regulations* and the Canadian Ambient Air Quality Standards, respectively.

Table 8.1 Newfoundland and Labrador Ambient Air Quality Standards

Air Contaminant	Time Averaging Period	Ambient Air Quality Standard (μg/m³)
NO_2	1-Hour	400
	24-Hour	200
	Annual	100
SO_2	1-Hour	900
	3-Hour	600
	24-Hour	300
	Annual	60
CO	1-Hour	35,000
	8-Hour	15,000

Table 8.1 Newfoundland and Labrador Ambient Air Quality Standards

Air Contaminant	Time Averaging Period	Ambient Air Quality Standard (µg/m³)
TPM	24-Hour	120
	Annual	60[1]
PM_{10}	24-Hour	50
$PM_{2.5}$	24-Hour	25
	Annual	8.8[2]

[1] Geometric Mean
[2] The 3-year average of the annual average concentration
Source: Office of the Legislative Counsel NL (2004)

Table 8.2 Canadian Ambient Air Quality Standards

Air Contaminant	Time Averaging Period	Ambient Air Quality Standard (µg/m³)	
$PM_{2.5}$	24-Hour	27[1] (2020)	
	Annual	8.8[2] (2020)	
NO_2	1-Hour	113[3] (2020)	79[3] (2025)
	Annual	32[4] (2020)	23[4] (2025)
SO_2	1-Hour	183[5] (2020)	170[5] (2025)
	Annual	13[6] (2020)	10[6] (2025)

[1] The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations
[2] The 3-year average of the annual average concentrations.
[3] The 3-year average of the annual 98th percentile of the NO_2 daily-maximum 1-hour average concentrations
[4] The average over a single calendar year of all the 1-hour average NO_2 concentrations
[5] The 3-year average of the annual 99th percentile of the SO_2 daily-maximum 1-hour average concentrations
[6] The average over a single calendar year of all the 1-hour average SO_2 concentrations
Source: CCME (2014a), CCME (2014b), CCME (2014c)

Typically, the results of a Project-related air dispersion modelling study would be added to the existing ambient air quality within the Project Area prior to comparison with ambient air quality standards. However, given the offshore location of the Project where there are no other substantive emission sources nearby, it is likely that background air contaminant concentrations would be very low. Therefore, the background concentrations are assumed to be nominal (zero) for the purposes of this study.

8.3.2 GHG Emission Reduction Targets

Based on information contained in the latest National Inventory Report, produced by Environment and Climate Change Canada (ECCC) (2018) for the 2016 calendar year, the emissions of GHGs from NL are 10,800,000 tonnes carbon dioxide equivalent (CO_2e) and the Canadian GHG emissions for the 2016 calendar year are 704,000,000 tonnes CO_2e.

Beginning on January 1, 2019, the federal government will implement an output-based pricing system (OBPS) for industrial facilities across Canada (Government of Canada 2018) for the provinces of New Brunswick, Ontario, Manitoba, Saskatchewan, Yukon, Nunavut, and Prince Edward Island (Bennett Jones LLP 2018). Other provinces, including NL, have their own systems that have been accepted by ECCC. The NL *Management of Greenhouse Gas Reporting Regulations*, made under the *Management of Greenhouse Gas Act* (Office of the Legislative Counsel 2017), specifies the industrial sectors to which the Regulations apply. In addition to the Regulations, the Government of NL has a proposed carbon pricing plan that would set performance standards (i.e., GHG targets) for large industrial facilities (Government of NL 2018). Currently, offshore oil and gas activities are not subject to the Regulations or the *Management of Greenhouse Gas Act*; however, the proposed carbon pricing plan indicates that amendments are proposed to the Regulations to include offshore oil and gas activities.

In addition to GHG targets for large industrial facilities, the province of NL will also implement a carbon tax on fossil fuels. The carbon tax will start at $20 per tonne of CO_2e and will be adjusted periodically depending on the rates applied to other Atlantic provinces, which, other than Nova Scotia, are subject to the federal carbon tax rate.

On a federal level, GHG emission reduction targets have been set as follows (ECCC 2018):

- A 17 percent reduction below the 2005 emission levels by 2020 (under the 2009 Copenhagen Accord)
- A 30 percent reduction below the 2005 emission levels by 2030 (2015 submission to the United Nations Framework Convention on Climate Change)

8.4 Summary of Mitigation Measures

Mitigation measures that will be implemented to help avoid or reduce the Project-related quantities of air contaminants and GHGs released to the atmosphere include:

- Flaring on the FPSO will not occur during routine operations and excess gas will be reinjected into the reservoir
- Low-pressure (LP) flare gas will be recovered
- High efficiency burners (flare tip) will be used when flaring is required
- Use of variable speed drive equipment with high power consumption (e.g., gas compressors, water injection pumps) to optimize energy efficiency
- Use of waste heat recovery units (WHRUs) for energy optimization, capturing energy from engines / turbine exhaust stack to provide heat for systems on board the FPSO
- Use of high efficiency equipment for power generation
- Air emission sources associated with vessels will adhere to applicable limits set out in Canada's *Vessel Pollution and Dangerous Chemicals Regulations* under the *Canada Shipping Act, 2001*

- Sulphur content in diesel fuel used for the Project will meet the *Sulphur in Diesel Fuel Regulations* and will comply with the sulphur limits in fuels for large marine diesel engines, per the *Vessel Pollution and Dangerous Chemicals Regulations*
- The Project will operate in accordance with the *Canadian Environmental Protection Act*, through the National Ambient Air Quality Objectives for specified CACs, the Ambient Air Quality Standard for fine particulate ($PM_{2.5}$), and International Maritime Organization (IMO) relevant regulations and emission limits under MARPOL

8.5 Project Emissions

As the magnitude and duration of emissions from each of the sources described in Section 8.1 will vary by Project phase, the emissions inventory for CACs and GHGs and the air dispersion modelling for CACs focused on five different operational scenarios. As there is potential for non-routine, unplanned events to occur throughout the life of the Project, two of the operational scenarios included accidental events. Emissions related to cumulative operation with other projects or activities unrelated to the Project are also considered below, qualitatively.

Where applicable, emission factors from the Norwegian Oil and Gas Association (2018) reference are used, as identified in subsequent sections. The Norwegian emission factors were developed specific to the oil and gas industries and use sources that are relatively more recent (ranging from 1993-2017) compared to other emission factors.

8.5.1 Hook-up and Commissioning

8.5.1.1 Air Quality

For the HUC phase, CAC emissions were estimated for a four-month period and include the operation of the drilling installation, the FPSO, support and supply vessels, helicopters and marine construction. The emissions were estimated using anticipated fuel consumption volumes and fuel-based emission factors (Norwegian Oil and Gas Association 2018) provided by Equinor Canada, which is based on global experience, for the FPSO, drilling installation, support vessels and marine construction, with the exception of particulate matter. The emission factor for total suspended particles (TSP) was acquired from the United States Environmental Protection Agency's (US EPA) AP-42: "Compilation of Air Emission Factors, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines*"* (US EPA 1996).

As a conservative assumption, it was assumed that the emissions of PM_{10} and $PM_{2.5}$ were equal to that of TSP.

Emissions from the operation of the helicopters were estimated by Stantec using guidance and emission factors published by the Swiss Confederation in the "Guidance on the Determination of Helicopter Emissions" document (Rindlisbacher and Chabbey 2015). The SO_2 emissions from helicopter LTO were estimated using the estimated fuel used per LTO and the assumed sulphur content of jet fuel (4,000 ppm by mass).

Emissions of nmVOCs from fuel combustion and from fugitive emission sources were estimated by Equinor.

The emission factors used in the estimates are shown in Table 8.3.

Table 8.3 Emission Factors

Source and Fuel	Emission Factor				
	NO_x	CO	SO_2	$PM_{2.5}$	nmVOC
FPSO (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Drilling Installation (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Offshore Support and Supply Vessels (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Marine Construction (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Helicopter (LTO) (jet fuel)	1,066 g/LTO	525 g/LTO	NA	29 g/LTO	-
Note: t/t - tonne of air contaminant per tonne of fuel consumed Source: US EPA (1996), Norwegian Oil and Gas Association (2018), Rindlisbacher and Chabbey (2015)					

The estimated emissions during this phase of the Project (which occurs over a period of 4 months) are presented in Table 8.4.

Table 8.4 Air Contaminant Emissions from Hook-up and Commissioning

Source	Air Contaminant Emission Estimates (tonnes/phase)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
FPSO	297	4.24	29.7	8.14	8.14	8.14	64
Drilling Installation	373	5.34	37.3	10.2	10.2	10.2	27
Offshore Support and Supply Vessels	46.8	0.67	4.68	1.28	1.28	1.28	4
Marine Construction	147	2.10	14.7	4.04	4.04	4.04	10
Helicopter	3.69	2.08	0.45	0.09	0.09	0.09	-
Total	**868**	**14.4**	**86.9**	**23.8**	**23.8**	**23.8**	**105**

Dispersion modelling of air contaminant releases from Project activities, including HUC, was also conducted using the most recent version of the CALPUFF modelling system. As there are no regulatory criteria for total nmVOCs, and as the emissions of nmVOCs were estimated to be small, they were not modelled. For more details pertaining to the dispersion modelling approach and methodology, refer to the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K.

The predicted ground-level concentrations for CO, NO_2, SO_2, TPM, PM_{10}, and $PM_{2.5}$ during HUC are provided in Table 8.5.

Table 8.5 Predicted Ground-level Concentrations – Hook-up and Commissioning

Substance	Average Period	Maximum Predicted Ground-level Concentrations (µg/m³)	NL Ambient Air Quality Standards (µg/m³)	Canadian Ambient Air Quality Standards (2020) (µg/m³)
CO	1-hour (9th highest)	123	35,000	-
	8-hour (3rd highest)	71.0	15,000	-
NO_2 (OLM)	1-hour (9th highest)	188	400	-
	24-hour (2nd highest)	124	200	-
NO_2 (OLM) (effective January 1, 2020)	Daily max 1-hour (98th percentile) [1]	172	-	113
SO_2	1-hour (9th highest)	18.0	900	183
	3-hour (6th highest)	13.3	600	-
	24-hour (2nd highest)	6.99	300	-
$PM_{2.5}$	24-hour (2nd highest) [2]	15.5	25	27
PM_{10}	24-hour (2nd highest) [2]	15.5	50	-
TSP	24-hour (2nd highest) [2]	15.5	120	-

Notes:
Predicted 1-hour, 3-hour and 8-hour average concentrations are based on hourly emission rates
Predicted 24-hour average concentrations are based on daily emission rates
Predicted annual average concentrations are based on annual emission rates
[1] Concentration represents the 3-year average of the annual 98th percentile (8th highest) of the daily maximum 1-hour average concentrations
[2] Includes secondary formation of particulate matter
OLM – Ozone Limiting Method

Based on the modelling results, the predicted ground-level concentrations for HUC are below the respective NLAAQS. The predicted SO_2, $PM_{2.5}$ and annual NO_2 ground-level concentrations are below the CAAQS. However, the hourly predicted NO_2 concentrations are above the CAAQS that are to be implemented in 2020.

Although the predicted concentrations are above the hourly NO_2 CAAQS for HUC, the Project site is in a remote location approximately 500 km off the coast of NL with no sensitive receptors nearby. The maximum predicted concentration (above the CAAQS) generally occur approximately 500 m to 1,700 m from the FPSO and/or drilling installation. Further, the CAAQS are not directly comparable with the model predictions, as the CAAQS are intended to be compared with measured ambient air quality data and not directly applicable to industrial fence-line concentrations

8.5.1.2 GHGs

The CO_2 emissions released during HUC are provided by Equinor Canada and are based on the company's global operations. Produced gas fuel information is based on supplier specification and is used to estimate CH_4 and N_2O emissions from power generation during this phase. N_2O emissions from the offshore support, supply vessels, and helicopters were calculated by Equinor.

The emission factors used in the GHG emissions calculations for HUC are listed in Table 8.6.

Table 8.6 Emission Factors

Source and Fuel	Emission Factor (tonne/tonne)		
	CO_2	CH_4	N_2O
FPSO (diesel)	3.17	NA	0.0002
Drilling Installation (diesel)	3.17	NA	0.0002
Offshore Support and Supply Vessels (diesel)	3.17	NA	0.0002
Marine Construction (diesel)	3.17	NA	0.0002
Source: Norwegian Oil and Gas Association (2018)			

A summary of the estimated GHG emissions during the four-month HUC phase are provided in Table 8.7, and the total GHG emissions are estimated to be 67,819 t CO_2e.

Table 8.7 GHG Emissions from Hook-up and Commissioning

Source	Greenhouse Gas Emissions (t CO_2e/phase)			
	CO_2	CH_4	N_2O	Total
FPSO	40,322	NA	758	41,081
Drilling Installation	16,913	NA	318	17,231
Offshore Support and Supply Vessels / Helicopter	2,667	NA	50	2,717
Marine Construction	6,667	NA	125	6,792
Total	**66,569**	**-**	**1,251**	**67,819**
Note: NA – not applicable				

8.5.2 Concurrent Drilling and Production

8.5.2.1 Air Quality

Three operational scenarios were assessed during the production and maintenance operations phase of the Project including:

- Concurrent Drilling and Production, Power Option 1
- Concurrent Drilling and Production, Power Option 2
- Normal Production Operations

For each of the operational scenarios described above emissions were estimated for a one-year period (i.e., the year with the most equipment in operation at the one time) using anticipated fuel consumption volumes and fuel-based emission factors (Norwegian Oil and Gas Association 2018) provided by Equinor Canada for the drilling installation, flare, shuttle tanker and support vessels, with the exception of particulate matter. The emission factor for TSP was acquired from the US EPA AP-42: "Compilation of Air Emission Factors, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines" (US EPA 1996). As a conservative assumption, it was assumed that the emissions of PM_{10} and $PM_{2.5}$ were equal to that of TSP. Emissions of the operations of the FPSO were estimated using anticipated fuel consumption volumes and fuel-based emission factors provided by the potential suppliers for each Power Option – the engine supplier Wartsila for Power Option 1, and the turbine supplier General Electric for Power Option 2. Emissions from the operation of the helicopters were calculated by Stantec using guidance and emission factors published by the Swiss Confederation in the "Guidance on the Determination of Helicopter Emissions" document (Rindlisbacher and Chabbey 2015). The SO_2 emissions from helicopter LTO were estimated using the estimated fuel used per LTO and the assumed sulphur content of jet fuel (4,000 ppm by mass).

Emissions of nmVOCs from fuel combustion were estimated by Equinor using emission factors from the Norwegian Oil and Gas Association (2018). Emissions of nmVOCs from fugitive releases were estimated by Equinor based on the BdN FPSO Concept Study (2017).

Tables 8.8 to 8.10 outline the emission factors used in the estimates for each production and maintenance operations scenario.

Table 8.8 Emission Factors for Concurrent Drilling and Production, Power Option 1

Source and Fuel	Emission Factor				
	NO_x	CO	SO_2	PM	nmVOC
FPSO (gas)	10 g/Sm^3	9.3 g/Sm^3	0.0675 g/Sm^3	0.856 g/Sm^3	0.00024 t/kSm^3
Drilling Installation (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Offshore Support and Supply Vessels (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Shuttle Tanker (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Helicopter (jet fuel)	1,066 g/LTO	525 g/LTO	NA	29 g/LTO	-
Flaring (gas)	1.4 g/Sm^3	1.5 g/Sm^3	0.0675 g/Sm^3	0.856 g/Sm^3	0.00006 t/kSm^3

NA – not available. SO_2 emissions were estimated using a mass balance.
Note: t/t - tonne of air contaminant per tonne of fuel consumed
Source: Norwegian Oil and Gas Association (2018), US EPA (1996), Rindlisbacher and Chabbey (2015), Wartsila 14V31DF Specifications.

Table 8.9 Emission Factors for Concurrent Drilling and Production, Power Option 2

Source and Fuel	Emission Factor				
	NO_x	CO	SO_2	PM	nmVOC
FPSO (gas)	1.8 g/Sm^3	1.7g/Sm^3	0.0675 g/Sm^3	0.856 g/Sm^3	0.00024 t/kSm^3
Drilling Installation (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Offshore Support and Supply Vessels (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Shuttle Tanker (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Helicopter (jet fuel)	1,066 g/LTO	525 g/LTO	NA	29 g/LTO	-
Flaring (gas)	1.4 g/Sm^3	1.5 g/Sm^3	0.0675 g/Sm^3	0.856 g/Sm^3	0.00006 t/kSm^3

NA – not available. SO_2 emissions were estimated using a mass balance.
Note: t/t - tonne of air contaminant per tonne of fuel consumed
Source: Norwegian Oil and Gas Association (2018), US EPA (1996), Rindlisbacher and Chabbey (2015), General Electric GE LM6000 Specifications.

Table 8.10 Emission Factors for Normal Production Operations

Source and Fuel	Emission Factor				
	NO_2	CO	SO_2	PM	nmVOC
FPSO (gas)	10 g/Sm^3	9.3 g/Sm^3	0.0675 g/Sm^3	0.856 g/Sm^3	0.00024 t/kSm^3
Offshore Support and Supply Vessels (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Marine Construction (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Shuttle Tanker (diesel)	0.07 t/t	0.007 t/t	0.001 t/t	0.04 g/MJ	0.005 t/t
Helicopter (jet fuel)	1,066 g/LTO	525 g/LTO	NA	29 g/LTO	-
Flaring (gas)	1.4 g/m^3	1.5 g/m^3	0.0675 g/m^3	0.856 g/m^3	0.00006 t/kSm^3

NA – not applicable. SO_2 emissions were estimated using a mass balance.
Note: t/t - tonne of air contaminant per tonne of fuel consumed
Source: Norwegian Oil and Gas Association (2018), US EPA (1996), Rindlisbacher and Chabbey (2015), Wartsila 14V31DF Specifications.

The estimated emissions from the three scenarios are presented below in Tables 8.11, 8.12, and 8.13, respectively. The emissions presented for concurrent drilling and production are based on data for the years 2025 to 2027 (data varies by source; maximum annual emissions from 2025 to 2027 were carried forward into the inventory) and for normal production the year 2055.

Table 8.11 Air Contaminant Emissions from Concurrent Drilling and Production – Power Option 1

Source	Air Contaminant Emissions (t/yr)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
FPSO (combustion)	643	4.34	598	55.0	55.0	55.0	15
FPSO (fugitive)	NA	NA	NA	NA	NA	NA	15
Drilling Installation	1,120	16.0	112	30.7	30.7	30.7	80
Support and Supply Vessels	140	2.01	14.0	3.85	3.85	3.85	13
Shuttle Tanker	110	1.58	11.0	3.03	3.03	3.03	8
Helicopter	33.2	18.7	4.09	0.85	0.85	0.85	NA
Flaring	6.36	0.31	6.81	3.89	3.89	3.89	0.1
Total	**2,053**	**42.9**	**746**	**97.4**	**97.4**	**97.4**	**130**

Table 8.12 Air Contaminant Emissions from Concurrent Drilling and Production – Power Option 2

Source	Air Contaminant Emission Estimates (t/yr)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
FPSO (combustion)	150	5.64	142	71.5	71.5	71.5	19
FPSO (fugitive)	NA	NA	NA	NA	NA	NA	15
Drilling Installation	1,120	16.0	112	30.7	30.7	30.7	80
Support and Supply Vessels	140	2.01	14.0	3.85	3.85	3.85	13
Shuttle Tanker	110	1.58	11.0	3.03	3.03	3.03	8
Helicopter	33.2	18.7	4.09	0.85	0.85	0.85	NA
Flaring	6.36	0.31	6.81	3.89	3.89	3.89	0.1
Total	**1,561**	**44.3**	**290**	**114**	**114**	**114**	**135**

Table 8.13 Air Contaminant Emissions from Normal Production Operations

Source	Air Contaminant Emissions (t/yr)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
FPSO (combustion)	664	4.48	618	56.9	56.9	56.9	16
FPSO (fugitive)	NA	NA	NA	NA	NA	NA	15
Support and Supply Vessels	140	2.01	14.0	3.85	3.85	3.85	13
Shuttle Tanker	105	1.50	10.5	2.88	2.88	2.88	8
Helicopter	11.1	6.24	1.36	0.28	0.28	0.28	NA
Flaring	2.79	0.13	2.99	1.71	1.71	1.71	0.2
Total	**923**	**14.4**	**647**	**65.6**	**65.6**	**65.6**	**52**

Dispersion modelling of air contaminant releases from Project production and maintenance operations was also conducted using the most recent version of the CALPUFF air dispersion modelling system. Similar to Hook-up and Commissioning, as there are no regulatory criteria for total nmVOCs, and as the emissions of nmVOCs were estimated to be small, they were not modelled. For more information refer to the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K.

The predicted ground-level (i.e. sea-level) concentrations for each operational scenario modelled have been compared to the NLAAQS and CAAQS and the results are presented in Tables 8.14 through 8.16.

Table 8.14 Predicted Ground-level Concentrations – Concurrent Drilling and Production, Power Option 1

Substance	Average Period	Maximum Predicted Ground-level Concentrations (µg/m³)	NL Ambient Air Quality Standards (µg/m³)	Canadian Ambient Air Quality Standards (2020) (µg/m³)
CO	1-hour (9th highest)	250	35,000	-
	8-hour (3rd highest)	136	15,000	-
NO_2 (OLM)	1-hour (9th highest)	143	400	-
	24-hour (2nd highest)	105	200	-
	Annual (1st highest)	9.8	100	-
NO_2 (OLM) (effective January 1, 2020)	Daily max 1-hour (98th percentile) [1]	134	-	113
	Annual (1st highest)	9.8	-	32
SO_2	1-hour (9th highest)	11.6	900	183
	3-hour (6th highest)	8.99	600	-
	24-hour (2nd highest)	3.95	300	-
	Annual (1st highest)	0.21	60	13
$PM_{2.5}$	24-hour (2nd highest) [2]	14.5	25	27
	Annual (3-year average) [2, 3]	0.70	8.8	8.8
PM_{10}	24-hour (2nd highest) [2]	14.5	50	-
TSP	24-hour (2nd highest) [2]	14.5	120	-
	Annual (1st highest) [2, 4]	0.92	60	-

Notes:
Predicted 1-hour, 3-hour and 8-hour average concentrations are based on hourly emission rates
Predicted 24-hour average concentrations are based on daily emission rates
Predicted annual average concentrations are based on annual emission rates
[1] Concentration represents the 3-year average of the annual 98th percentile (8th highest) of the daily maximum 1-hour average concentrations
[2] Includes secondary formation of particulate matter
[3] Concentration represents the 3-year average of the annual average concentrations
[4] Concentration represents the geometric mean annual concentration
OLM – Ozone Limiting Method

Table 8.15 Predicted Ground-level Concentrations – Concurrent Drilling and Production, Power Option 2

Substance	Average Period	Maximum Predicted Ground-level Concentrations (µg/m^3)	NL Ambient Air Quality Standards (µg/m^3)	Canadian Ambient Air Quality Standards (2020) (µg/m^3)
CO	1-hour (9th highest)	60.6	35,000	-
	8-hour (3rd highest)	42.2	15,000	-
NO_2 (OLM)	1-hour (9th highest)	130	400	-
	24-hour (2nd highest)	96.9	200	-
	Annual (1st highest)	9.19	100	-
NO_2 (OLM) (effective January 1, 2020)	Daily max 1-hour (98th percentile) [1]	125	-	113
	Annual (1st highest)	9.19	-	32
SO_2	1-hour (9th highest)	10.6	900	183
	3-hour (6th highest)	8.45	600	-
	24-hour (2nd highest)	3.91	300	-
	Annual (1st highest)	0.21	60	13
$PM_{2.5}$	24-hour (2nd highest) [2]	10.8	25	27
	Annual (3-year average) [2,3]	0.52	8.8	8.8
PM_{10}	24-hour (2nd highest) [2]	10.8	50	-
TSP	24-hour (2nd highest) [2]	10.8	120	-
	Annual (1st highest) [2,4]	0.88	60	-

Notes:
Predicted 1-hour, 3-hour and 8-hour average concentrations are based on hourly emission rates
Predicted 24-hour average concentrations are based on daily emission rates
Predicted annual average concentrations are based on annual emission rates
[1] Concentration represents the 3-year average of the annual 98th percentile (8th highest) of the daily maximum 1-hour average concentrations
[2] Includes secondary formation of particulate matter
[3] Concentration represents the 3-year average of the annual average concentrations
[4] Concentration represents the geometric mean annual concentration
OLM – Ozone Limiting Method

Table 8.16 Predicted Ground-level Concentrations – Normal Production Operations

Substance	Average Period	Maximum Predicted Ground-level Concentrations (µg/m^3)	NL Ambient Air Quality Standards (µg/m^3)	Canadian Ambient Air Quality Standards (2020) (µg/m^3)
CO	1-hour (9th highest)	259	35,000	-
	8-hour (3rd highest)	141	15,000	-
NO_2 (OLM)	1-hour (9th highest)	126	400	-
	24-hour (2nd highest)	85.9	200	-
	Annual (1st highest)	6.01	100	-
NO_2 (OLM) (effective January 1, 2020)	Daily max 1-hour (98th percentile) [1]	119	-	113
	Annual (1st highest)	6.01	-	32
SO_2	1-hour (9th highest)	8.78	900	183
	3-hour (6th highest)	6.38	600	-
	24-hour (2nd highest)	2.47	300	-
	Annual (1st highest)	0.06	60	13
$PM_{2.5}$	24-hour (2nd highest) [2]	13.5	25	27
	Annual (3-year average) [2,3]	0.6	8.8	8.8
PM_{10}	24-hour (2nd highest) [2]	13.5	50	-
TSP	24-hour (2nd highest) [2]	13.5	120	-
	Annual (1st highest) [2,4]	0.87	60	-

Notes:
Predicted 1-hour, 3-hour and 8-hour average concentrations are based on hourly emission rates
Predicted 24-hour average concentrations are based on daily emission rates
Predicted annual average concentrations are based on annual emission rates
[1] Concentration represents the 3-year average of the annual 98th percentile (8th highest) of the daily maximum 1-hour average concentrations
[2] Includes secondary formation of particulate matter
[3] Concentration represents the 3-year average of the annual average concentrations
[4] Concentration represents the geometric mean annual concentration
OLM – Ozone Limiting Method

Based on the modelling results, the predicted ground-level concentrations for the three production and maintenance operations scenarios are below the respective NLAAQS. The predicted SO_2, $PM_{2.5}$ and annual NO_2 ground-level concentrations are also below the CAAQS. The hourly predicted NO_2 concentrations, however, are above the CAAQS to be implemented in 2020 for the Concurrent Drilling and Production scenarios as well as the Normal Production Operations scenario.

Although the predicted concentrations are above the hourly NO_2 CAAQS for each operational modelling scenario assessed, the Project is in a remote location well offshore (>500 km off the coast of Newfoundland) with no sensitive receptors nearby. The maximum predicted concentration (above the CAAQS) generally occur approximately 500 m to 1,700 m from the FPSO and/or drilling installation. Further, the CAAQS are not directly comparable with the model predictions, as the CAAQS are intended to be compared with measured ambient air quality data and not directly applicable to industrial fence-line concentrations.

The modelling results are provided in more detail in the Technical Data Report for Air Quality and Greenhouse Gases provided in Appendix K.

8.5.2.2 GHGs

Emissions of GHGs during the production and maintenance operations phase of the Project were estimated for the three operational scenarios, as with air quality.

Emissions information for CO_2 for Concurrent Drilling and Production (Power Options 1 and 2) as well as Normal Production Operations were estimated by Equinor Canada based on global operations. Produced gas fuel information is based on supplier specification and is used to estimate CH_4 and N_2O emissions from power generation during this phase. CH_4 and N_2O emissions from flaring and N_2O emissions from the offshore support and supply vessels were estimated by Equinor. Emissions of CH_4 from fugitive releases were estimated by Equinor based on the BdN FPSO Concept Study (2017).

The emission factors used in in the GHG emissions calculations for the three operations scenarios were obtained from the Norwegian Oil and Gas Association (2018) and are listed in Table 8.17.

Table 8.17 Emission Factors for Concurrent Drilling and Production – Power Option 1, Power Option 2, and Normal Production Operations

Source and fuel	Emission Factor		
	CO_2	CH_4	N_2O
FPSO (gas), t/kSm^3	2.34	0.00091	0.000019
Drilling Installation (diesel), t/t	3.17	N/A	0.0002
Offshore Support and Supply Vessels (diesel), t/t	3.17	N/A	0.0002
Note: The drilling installation is not included in the Normal Production Operations phase Source: Norwegian Oil and Gas Association (2018)			

A summary of the estimated annual GHGs for Power Option 1, Power Option 2 and Normal Production Operations are provided in Tables 8.18, 8.19, and 8.20. The emissions presented for concurrent drilling and production are based on data for the years 2025 to 2027 (data varies by source; maximum annual emissions from 2025 to 2027 were carried forward into the inventory) and for normal production the year 2055.

Table 8.18 Annual GHG Emissions from Concurrent Drilling and Production, Power Option 1

Source	Greenhouse Gas Emissions (t CO_2e/yr)			
	Combustion			Total CO_2e/yr
	CO_2	CH_4	N_2O	
FPSO (combustion)	142,562	1,386	345	144,293
FPSO (fugitive)	NA	900	NA	900
Drilling Installation	50,738	NA	954	51,692
Offshore Support and Supply Vessels/Helicopter	8,000	NA	150	8,150
Shuttle Tanker	5,000	NA	94	5,094
Flaring	4,277	11	11	4,299
Total	**210,577**	**2,297**	**1,554**	**214,428**

The total annual GHG emissions are estimated to be approximately 214,428 t CO_2e for Concurrent Drilling and Production, Power Option 1. The predicted annual CO_2e emissions for this operational scenario therefore represent approximately 2 percent of NL's average annual emissions, and 0.03 percent of the national average annual emissions.

Table 8.19 Annual GHG Emissions from Concurrent Drilling and Production, Power Option 2

Source	Greenhouse Gas Emissions (t CO_2e/yr)			
	Combustion			Total CO_2e/yr
	CO_2	CH_4	N_2O	
FPSO (combustion)	185,330	1,802	448	187,581
FPSO (fugitive)	NA	900	NA	900
Drilling Installation	50,738	NA	954	51,692
Offshore Support and Supply Vessels/Helicopter	8,000	NA	150	8,150
Shuttle Tanker	5,000	NA	94	5,094
Flaring	4,277	11	11	4,299
Total	**253,345**	**2,713**	**1,657**	**257,715**

The total annual GHG emissions are estimated to be approximately 257,715 t CO_2e for Concurrent Drilling and Production, Power Option 2. The predicted annual CO_2e emissions for this operational scenario therefore represent approximately 2.4 percent of NL's average annual emissions and 0.04 percent of the national average annual emissions.

Table 8.20 Annual GHG Emissions from Normal Production Operations

Source	Greenhouse Gas Emissions (t CO_2e/yr)			
	Combustion			Total CO_2e/yr Option 1 / Option 2
	CO_2 Option 1 / Option 2	CH_4 Option 1 / Option 2	N_2O Option 1 / Option 2	
FPSO (combustion)	157,031 / 199,096	1,527 / 1,936	380 / 482	158,938 / 201,513
FPSO (fugitive)	NA	900	NA	900
Offshore Support and Supply Vessels/Helicopter	8,000	NA	150	8,150
Shuttle Tanker	5,000	NA	94	5,094
Flaring	4,664	12	12	4,688
Total	**174,695 / 216,760**	**2,439 / 2,848**	**636 / 738**	**177,770 / 220,345**

The total annual GHG emissions are estimated to be approximately 177,770 t CO_2e (Option 1) and 220,345 t CO_2e (Option 2) for Normal Production Operations. The predicted annual CO_2e emissions for this operational scenario therefore represent approximately 1.6 percent of NL's average annual emissions and 0.02 percent of the national average annual emissions.

In summary, the total annual GHG emissions from production and maintenance operations phase of the Project are estimated to range from 177, 770 t CO_2e/year to 257,715 t CO_2e/year, depending on the power option chosen for the Project and whether drilling activities overlap with normal production activities.

The EIS Guidelines require that the estimated GHG emissions for the Project be compared to other similar projects. Stantec retrieved reported GHG emissions from three operating offshore production platforms from the federal GHG Reporting Program for the 2016 reporting year (ECCC 2017). The Project normal production emissions and concurrent drilling and production (Option 2) were compared to those from the three offshore production platforms. The Hebron Platform commenced operations in late 2017 and therefore there is no reporting data for 2016, the latest year that data is available. The comparison is shown in Table 8.21.

Table 8.21 Comparison of Estimated Project GHG Emissions to Operating Production Platforms Offshore NL

Scenario	t CO_2e/year
Terra Nova	560,600
Hibernia	562,463
White Rose	445,861
BdN Project - Predicted Normal Operations (Option 1 / Option2)	177,770 / 220,345
BdN Project – Concurrent Drilling & Production, Power Option 2	257,715

8.5.3 Accidental Events

8.5.3.1 Air Quality

There is potential for the release of air contaminants to the atmosphere from an accidental event during production and maintenance operations. A full system depressurization and the FPSO running on diesel (in substitute of produced gas) could result in the release of contaminants to the atmosphere.

Therefore, two accidental event scenarios were considered:

- Accidental Event 1 – Full system depressurization over a period of three hours
- Accidental Event 2 – FPSO on diesel for seven days

Air contaminants released from each accidental event were estimated for the event itself and over a one-year period taking into consideration the assumptions regarding credible number of events per year. The emissions were calculated using anticipated fuel consumption volumes and fuel-based emission factors (Norwegian Oil and Gas Association 2018) provided by Equinor Canada for the drilling installation, flare, shuttle tanker and support vessels, with the exception of particulate matter. The emission factor for TSP was acquired from US EPA AP-42: “Compilation of Air Emission Factors, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines” (US EPA 1996).

As a conservative assumption, it was assumed that the emissions of PM_{10} and $PM_{2.5}$ were equal to that of TSP. Emissions of the operations of the FPSO were estimated using anticipated fuel consumption volumes and fuel-based emission factors provided by the engine supplier, Wartsila.

Emissions from the operation of the helicopters were calculated by Stantec using guidance and emission factors published by the Swiss Confederation in the “Guidance on the Determination of Helicopter Emissions” document (Rindlisbacher and Chabbey 2015). SO_2 emissions were from helicopter LTO were estimated using the estimated fuel used per LTO and the assumed sulphur content of jet fuel (4,000 ppm by mass).

Emissions of nmVOCs from fuel combustion were estimated by Equinor using emission factors from the Norwegian Oil and Gas Association (2018).

The estimated emissions during each accidental event scenario considered are presented in Tables 8.22 and 8.23, respectively. The emissions shown in these tables reflect only the source affected by the event.

Table 8.22 Air Contaminant Emissions from Accidental Event 1 (Per Event)

Source	Air Contaminant Emission Estimates (t/event)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
Flaring	0.40	0.02	0.43	0.25	0.25	0.25	0.05

Table 8.23 Air Contaminant Emissions from Accidental Event 2 (Per Event)

Source	Air Contaminant Emission Estimates (t/event)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
FPSO (combustion)	51.9	0.74	5.19	1.42	1.42	1.42	3.8

Annual emissions during a one-year period assuming that up to three accidental events could occur with respect to Accidental Event 1 and two for Accidental Event 2 are shown in Tables 8.24 and 8.25.

Table 8.24 Air Contaminant Emissions from Accidental Event 1 (Annual)

Source	Air Contaminant Emission Estimates (t/yr)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
FPSO (combustion)	643	5.00	591	54.2	54.2	54.2	15
FPSO (fugitive)	NA	NA	NA	NA	NA	NA	15
Drilling Installation	1,120	16.0	112	30.7	30.7	30.7	80
Offshore Supply and Support Vessels	140	2.01	14.0	3.85	3.85	3.85	13
Shuttle Tanker	110	1.58	11.0	3.03	3.03	3.03	8
Helicopter	33.2	18.7	4.08	0.85	0.85	0.85	NA
Flaring	7.57	0.36	8.11	4.63	4.63	4.63	0.2
Total	**2,054**	**43.0**	**747**	**98.1**	**98.1**	**98.1**	**131**

Table 8.25 Air Contaminant Emissions from Accidental Event 2 (Annual)

Source	Air Contaminant Emission Estimates (t/yr)						
	NO_2	SO_2	CO	TPM	PM_{10}	$PM_{2.5}$	nmVOC
FPSO (combustion)	722	5.65	585	55.7	55.7	55.7	14
FPSO (fugitive)	NA	NA	NA	NA	NA	NA	15
Drilling Installation	1,120	16.0	112	30.7	30.7	30.7	80
Offshore Supply and Support Vessels	140	2.01	14.0	3.85	3.85	3.85	13
Shuttle Tanker	110	1.58	11.0	3.03	3.03	3.03	8
Helicopter	33.2	18.7	4.08	0.85	0.85	0.85	NA
Flaring	6.36	0.31	6.81	3.89	3.89	3.89	0.1
Total	**2,132**	**44.3**	**733**	**98.1**	**98.1**	**98.1**	**130**

Dispersion modelling of air contaminant releases from accidental event activities were conducted using the most recent version of the CALPUFF modelling system. As with the construction and operation of the Project, emissions of nmVOCs released from potential accidental events were not modelled. For more details pertaining to the dispersion modelling approach and methodology refer to the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K.

The predicted ground-level concentrations of CO, NO_2, SO_2, during both accidental events are presented in Tables 8.26 and 8.27. Note that TPM, PM_{10} and $PM_{2.5}$ results are not presented for Accidental Event 1 as only those contaminants with averaging periods of less than 24 hours were considered.

Table 8.26 Predicted Ground-level Concentrations – Accidental Event 1 - Flaring

Substance	Average Period	Maximum Predicted Ground-level Concentrations (µg/m³)	NL Ambient Air Quality Standards (µg/m³)	Canadian Ambient Air Quality Standards (2020) (µg/m³)
CO	1-hour (9th highest)	250	35,000	-
NO_2 (OLM)	1-hour (9th highest)	136	400	-
NO_2 (OLM) (effective January 1, 2020)	Daily max 1-hour (98th percentile) [1]	143	-	113
SO_2	1-hour (9th highest)	11.6	900	183
	3-hour (6th highest)	8.99	600	-

Notes:
Predicted 1-hour, 3-hour and 8-hour average concentrations are based on hourly emission rates
Predicted 24-hour average concentrations are based on daily emission rates
Predicted annual average concentrations are based on annual emission rates
[1] Concentration represents the 3-year average of the annual 98th percentile (8th highest) of the daily maximum 1-hour average concentrations
OLM – Ozone Limiting Method

Table 8.27 Predicted Ground-level Concentrations – Accidental Event 2 – FPSO on Diesel Seven Days

Substance	Average Period	Maximum Predicted Ground-level Concentrations (µg/m³)	NL Ambient Air Quality Standards (µg/m³)	Canadian Ambient Air Quality Standards (2020) (µg/m³)
CO	1-hour (9th highest)	126	35,000	-
	8-hour (3rd highest)	73.2	15,000	-
NO_2 (OLM)	1-hour (9th highest)	187	400	-
	24-hour (2nd highest)	115	200	-
NO_2 (OLM) (effective January 1, 2020)	Daily max 1-hour (98th percentile) [1]	172	-	113

Table 8.27 Predicted Ground-level Concentrations – Accidental Event 2 – FPSO on Diesel Seven Days

Substance	Average Period	Maximum Predicted Ground-level Concentrations (μg/m^3)	NL Ambient Air Quality Standards (μg/m^3)	Canadian Ambient Air Quality Standards (2020) (μg/m^3)
SO_2	1-hour (9th highest)	20.4	900	183
	3-hour (6th highest)	15.8	600	-
	24-hour (2nd highest)	6.12	300	-
$PM_{2.5}$	24-hour (2nd highest) [2]	13.4	25	27
PM_{10}	24-hour (2nd highest) [2]	13.4	50	-

Notes:
Predicted 1-hour, 3-hour and 8-hour average concentrations are based on hourly emission rates
Predicted 24-hour average concentrations are based on daily emission rates
Predicted annual average concentrations are based on annual emission rates
[1] Concentration represents the 3-year average of the annual 98th percentile (8th highest) of the daily maximum 1-hour average concentrations
[2] Includes secondary formation of particulate matter
OLM – Ozone Limiting Method

Based on the modelling results, the predicted ground-level concentrations for the two accidental event scenarios are below the respective NLAAQS. The hourly predicted NO_2 concentrations are above the CAAQS that are to be implemented in 2020. The maximum predicted concentrations (above the CAAQS) generally occur within a small distance (approximately 500 m to 1,700 m) from the anti-collision zone associated with the drilling installation and FPSO installation.

Although the predicted concentrations are above the hourly NO_2 CAAQS, the Project is in a remote location more than 500 km from coastal Newfoundland with no sensitive receptors nearby. The maximum predicted concentration (above the CAAQS) generally occur approximately 500 m to 1,700 m from the FPSO and/or drilling installation. Further, the CAAQS are not directly comparable with the model predictions, as the CAAQS are intended to be compared with measured ambient air quality data and not directly applicable to industrial fence-line concentrations.

The modelling results are provided in more detail in the Technical Data Report for Air Quality and Greenhouse Gases provided in Appendix K.

8.5.3.2 GHGs

Emissions of GHGs during the during the two accidental events were estimated for each event, and annually, as with air quality.

Stantec calculated the CO_2 emissions from the flaring resulting from a depressurization event using flowrate and composition information from Equinor Canada.

The GHG emissions associated with the combustion of diesel for power generation during a seven-day period when produced gas is not available were also calculated by Stantec. Stantec used the estimated produced gas required for operation as provided by Equinor Canada to determine the equivalent diesel volume required, after taking into account the differing heating values of the two fuels.

Emissions of CH_4 from fugitive releases were estimated by Equinor based on the BdN FPSO Concept Study (2017).

A summary of the estimated GHGs released from Accidental Event 1 and Accidental Event 2 are provided in Tables 8.28 and 8.29, respectively.

Table 8.28 Estimated Greenhouse Gas Emissions for Accidental Event 1 (Per Event)

Source	t CO_2e/event			
	CO_2	CH_4	N_2O	Total
Flaring	2,027	5	5	2,037

Table 8.29 Estimated Greenhouse Gas Emissions for Accidental Event 2 (Per Event)

Source	t CO_2e/event			
	CO_2	CH_4	N_2O	Total
PSO - Power Option 1 on diesel fuel	2,352	NA	44	2,396

A summary of the estimated annual GHGs from Project sources during a year with Accidental Event 1 and Accidental Event 2 are provided in Tables 8.30 and 8.31.

Table 8.30 Estimated Greenhouse Gas Emissions for Accidental Event 1 (Annual)

Source	Greenhouse Gas Emissions (t CO_2e/yr)			
	Combustion			Total CO_2e/yr
	CO_2	CH_4	N_2O	
FPSO (combustion)	142,562	1,386	345	144,293
FPSO (fugitive)	NA	900	NA	900
Drilling Installation	50,738	NA	954	51,692
Offshore Support and Supply Vessels/Helicopter	8,000	NA	150	8,150
Shuttle Tanker	5,000	NA	94	5,094
Flaring	10,358	27	26	10,411
Total	**216,658**	**2,313**	**1,569**	**220,539**

Table 8.31 Estimated Greenhouse Gas Emissions for Accidental Event 2 (Annual)

Source	Greenhouse Gas Emissions (t CO_2e/yr)			
	Combustion			Total CO_2e/yr
	CO_2	CH_4	N_2O	
FPSO (combustion)	141,798	1,333	332	143,463
FPSO (fugitive)	NA	900	NA	900
Drilling Installation	50,738	NA	954	51,692
Offshore Support and Supply Vessels/Helicopter	8,000	NA	150	8,150
Shuttle Tanker	5,000	NA	94	5,094
Flaring	4,277	11	11	4,299
Total	**209,813**	**2,244**	**1,541**	**213,597**

The total GHG emissions for one year during which Accidental Event 1 occurs three times are estimated to be approximately 220,539 t CO_2e. Based on information contained in the National Inventory Report, produced by ECCC (2018) for the 2016 calendar year the emissions of GHGs from NL are 10,800,000 tonnes CO_2e and the Canadian GHG emissions for the 2016 calendar year are 704,000,000 tonnes CO_2e. Therefore, the predicted GHG emissions for Accidental Event 1 represent approximately 2 percent of NL's average annual GHG emissions and 0.03 percent of the national average annual GHG emissions.

The total GHG emissions for one year during which Accidental Event 2 occurs twice are estimated to be approximately 213,597 t CO_2e. The predicted annual CO_2e emissions for Accidental Event 2 therefore represent approximately 2 percent of NL's average annual emissions, and 0.03 percent of the national average annual emissions.

Further details pertaining to the development of the GHG emissions inventory can be found in the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K.

8.5.4 Project Contribution to Cumulative Air Emissions

Generally, concentrations of air contaminants in the Project Area without the Project would be low and at background levels. Project-related releases of air contaminants and GHGs to the atmosphere, as described above, have the potential to interact and accumulate with emissions from other sources in the Project Area and beyond. Air quality would be occasionally influenced by transient sources as they pass the Project Area during transit. These transient sources include other marine vessel traffic (including fishing vessels) in the area and other exploration activities (e.g., seismic, drilling, and others). In terms of fishing, and other marine vessel traffic, the short-term and transient nature of these activities and thus their releases of CACs and GHGs to the atmosphere limits the potential for direct interaction with air quality and GHGs from this Project. There is also potential for the emissions from the operation of existing offshore production platforms to interact and accumulate with the Project emissions (see Section 5.7.1 for an overview of concentrations of CACs and GHG emissions from these facilities and their effects on ambient air quality in the region). The Project is located over

180 km from the nearest production platform (White Rose); therefore, the locations of these sources with respect to the Project makes interactions unlikely. This conclusion is supported by air dispersion modelling results for the Project:

- Air quality dispersion modelling conducted for this Project, which concluded that the maximum predicted concentration (above the CAAQS) generally occur approximately 500 m to 1,700 m from the FPSO and/or drilling installation.
- Based on the predictive modelling completed for the Project and modelling previously completed for offshore Newfoundland and Labrador to support an Environmental Studies Research Fund (ESRF) project (Stantec 2013), predicted concentrations from offshore production activities approach background levels within 25 -30 km's from the Project/Facility. At these distances, a cumulative overlap of concentrations from the other existing platforms with the Project is not expected.
- The ESRF project (Stantec 2013) also concluded that air contaminant concentrations (in the case of NOX) from the operation of the existing facilities (SeaRose FPSO and the Terra Nova FPSO (the Hibernia platform was not included in the study) and future facilities (the Hebron Platform) generally meet onshore ambient air quality regulations at 3 km or less from the emitting structure. Therefore, there will be no spatial overlap in air contaminant emissions from the Project with existing offshore producing operations. GHG emissions calculated for the three Project phases each represent a small fraction to both provincial (1.6 percent to 2.4 percent) and national (0.02 percent to 0.04 percent) totals.

8.6 Summary

8.6.1 Air Quality

The quantities of criteria air contaminants released to the atmosphere from Project activities were estimated for both construction and operation. The emission inventories were then used to conduct air dispersion modelling to predict the downwind concentrations of air contaminants at ground level (NO_x, SO_2, CO, TSP, PM_{10}, and $PM_{2.5}$).

Emissions of nmVOCs were estimated, and found to be very small, and were therefore not modelled. For example, the estimated nmVOC emissions (combustion and fugitive sources) from the Project ranged from 52 tonnes/year to 132 tonnes/year, with 52 tonnes/year representative of normal operations. The estimated VOC emissions from Newfoundland and Labrador in 2017 were 6,519 tonnes/year (ECCC 2018b). The Project nmVOC emissions from normal operation are therefore a small fraction (0.80 %) of the Newfoundland and Labrador VOC emissions. Based on the low ambient concentrations of NO_2 and VOCs in the Project Area, the relatively low emission rates from the Project, and combined with the infrequent events where there is sufficient warmth from the sun to support the conversion of nmVOCs to ozone, the potential for the generation of ground level ozone is quite small.

The predicted ground level concentrations of the air contaminants of interest to this Project were compared to both the NLAAQS and CAAQS. The predicted ground-level concentrations are below the NLAAQS for each modelled emissions scenario. The predicted SO_2, $PM_{2.5}$ and annual NO_2 ground-level concentrations are below the CAAQS for each modelled scenario. However, the predicted hourly NO_2 concentrations are above the CAAQS to be implemented in 2020 for the six modelled scenarios (HUC, the three production and maintenance operations scenarios, and the two accidental event scenarios). Although predicted concentrations are above the hourly NO_2 CAAQS, the Project is in a remote location approximately 500 km off the coast of Newfoundland. There are no known sensitive receptors nearby. The maximum predicted concentration (above the CAAQS) generally occur at locations approximately 500 m to 1,700 m from the FPSO and/or drilling installation and decrease rapidly with distance for the source. Further, as explained by ECCC, the CAAQS are intended to be used as targets to manage the air quality of the airshed and not to be directly applicable to industrial fence-line concentrations.

8.6.2 GHGs

Annual GHG emissions from the Project were estimated to range from 176,183 t CO_2e/year to 257,715 t CO_2e/year depending on the Project phase. Based on these emissions, the magnitude of the Project's contributions to greenhouse gases would be considered medium. These emissions represent 2.4 percent or less of NL's emissions and 0.04 percent or less (i.e., a small fraction) of the national GHG emissions reported by ECCC for the year 2016.

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9.0 MARINE FISH AND FISH HABITAT: ENVIRONMENTAL EFFECTS ASSESSMENT

Marine fish and their habitats are important considerations in the environmental assessment (EA) of activities that occur within, and that may affect, the marine environment. The Project Area and surrounding marine environments are known to be used by a diversity of marine biota. The presence, abundance and distribution of marine fish species and associated habitat characteristics (both abiotic and biotic) vary considerably across this rather large and diverse marine environment, which transitions from relatively shallow shelf zones, through the continental slope to deep areas. These areas are used by fish and invertebrate species of commercial, cultural, and/or ecological importance and support regionally important areas of biodiversity and marine productivity.

Marine Fish and Fish Habitat, and the potential effects of the Project on this valued component (VC), are subject to the relevant provisions of the federal *Fisheries Act* and its associated Regulations, which provides protection to commercial, recreational, and Indigenous fisheries by protecting the fish resources and habitats that support these activities. Under the *Fisheries Act*, “fish” include all parts and life stages of fish, shellfish, crustaceans, and marine animals. Fish habitats include areas that fish directly or indirectly use to live, including nursery, rearing, spawning, migration and foraging areas. Certain fish species and their habitats may also be provided with legislative protection within Canadian (*Species at Risk Act* (SARA)) and/or provincial (*Endangered Species Act* (ESA)) jurisdictions.

For the purpose of this Environmental Impact Statement (EIS), this VC includes consideration of relevant fish species (both secure and at risk), as well as plankton, algae, marine plants, benthos, and relevant components of their habitats (such as water and sediment), given the clear interrelationships between these environmental components. The consideration of these components within a single VC is in keeping with current and standard EA practice, and provides for a more comprehensive, holistic approach, while at the same time reducing unnecessary repetition. Although identified fish species at risk (SAR) are considered integrally within the environmental effects assessment for this VC, these species are given special attention and emphasis in the identification, analysis and evaluation of potential environmental effects and required mitigation measures herein.

9.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

The following sections define the spatial and temporal context within which potential environmental effects on the Marine Fish and Fish Habitat are assessed. These have been established to direct and focus the environmental effects assessment for the VC.

9.1.1 Spatial Boundaries

Four spatial assessment boundaries have been defined for the environmental effects assessment of this VC. They reflect the Core Bay du Nord (BdN) Development, the Project Area Tiebacks, and the varying ways in which the Project and VC may interact. The boundaries are informed by the nature, scale, timing, and other characteristics of the Project and the existing environmental setting, and potential environmental interactions. These Study Areas are defined as follows and are illustrated in Figure 9-1.

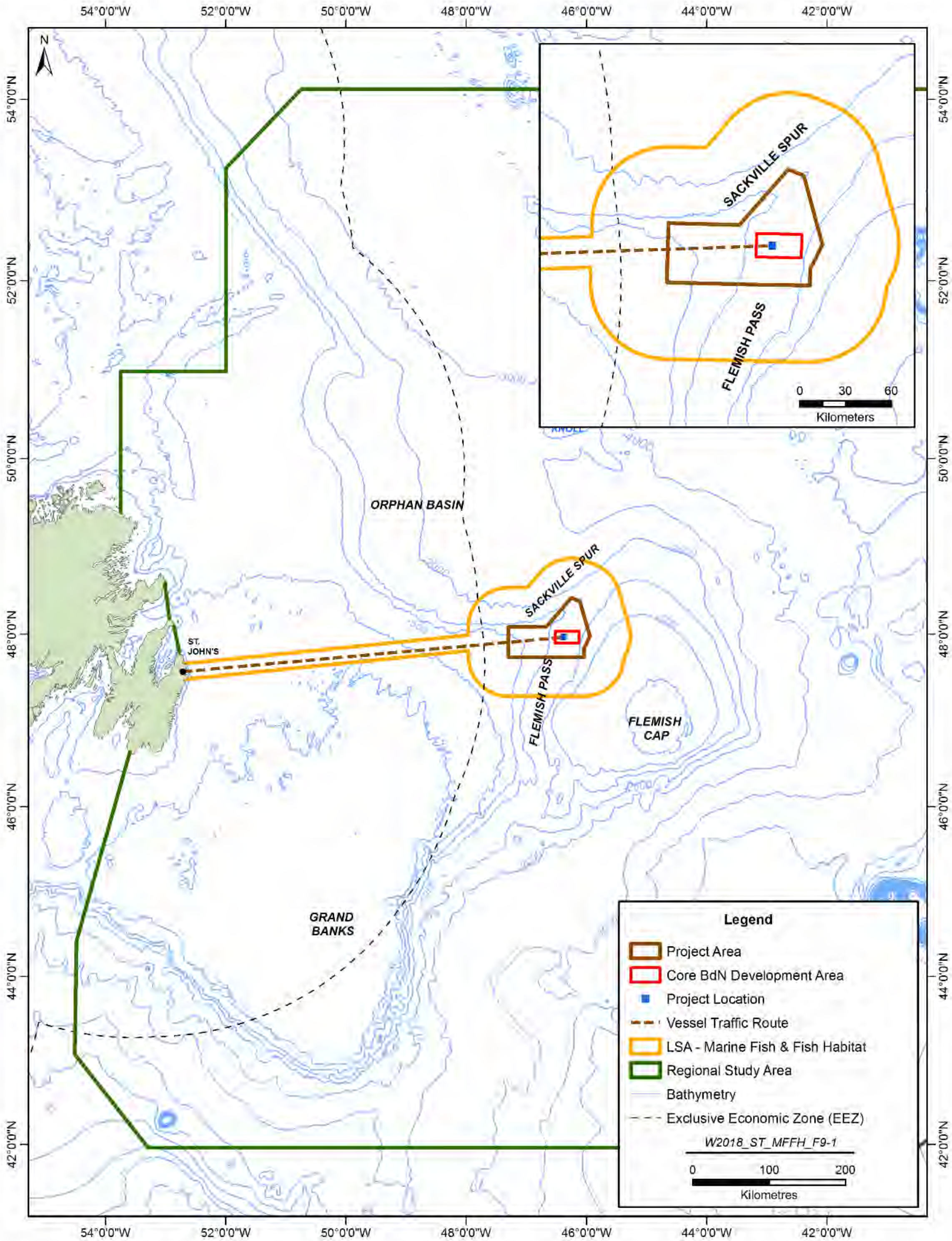

Figure 9-1 Environmental Assessment Study Areas: Marine Fish and Fish Habitat

Core BdN Development Area: The Core BdN Development Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbance to the marine environment may occur. It occupies an offshore area of approximately 470 km², encompassing the proposed location of the floating production, storage offloading (FPSO) and supporting subsea infrastructure and activities. The actual seabed footprint of subsea infrastructure within the Core BdN Development Area is approximately 7 km², representing approximately 1.5 percent of the entire Core BdN Development Area.

Project Area: The broader Project Area is where Project Area Tiebacks (as described in Section 2.6.6) may occur. While the Project Area is defined as an overall area that encompasses such activities for the duration of the Project, different components and activities may occupy smaller areas within this overall area, as described in Chapter 2. The Core BdN Development Area is located entirely within the Project Area. The Project Area is approximately 4,900 km². The footprint of the Core BdN Development subsea infrastructure is approximately 0.1 percent of the Project Area. If Project Area Tiebacks were to be undertaken, using the illustration presented in Figure 9-2, the footprint of the subsea infrastructure for potential new tiebacks, including Core BdN Development, is estimated to be approximately 15 km², which represents less than 0.5 percent of the Project Area.

Local Study Area (LSA): The LSA encompasses the overall geographic area over which all routine Project-related environmental interactions may occur. It represents the predicted environmental zone of influence of the Project's planned components and activities, within which Project-related environmental changes to Marine Fish and Fish Habitat may occur and can be assessed and evaluated. The LSA is therefore (conservatively) defined as a 50 km area around the offshore Project Area, as well as a 10 km area around and the associated vessel and aircraft traffic routes between the Project Area and St. John's, Newfoundland and Labrador (NL).

Regional Study Area (RSA): The environmental effects assessment recognizes and considers the characteristics, distributions, and movements associated with the individual VCs under consideration from an ecological and socioeconomic perspective. The RSA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). The RSA is defined based on the predicted zone of influence of a potential oil spill event, as summarized in Section 16.4, specifically, the area of maximum cumulative surface oil thickness for the 95th percentile surface oil exposure case at the ecological threshold of 10 g/m² (0.01 mm). The RSA captures the marine waters offshore eastern NL including all or part of NAFO Divisions 2J, 3K, 3L, 3M, 3N and 3O.

9.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the frequency and duration of routine Project-related activities as well as the likely timing of resulting environmental effects. The overall schedule for the Project is provided in Section 2.1.1, and the temporal boundaries of each Project phase are provided in Table 9.1

Table 9.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Core BdN Development Phases	
Offshore Construction and Installation, and Hook-up, and Commissioning (HUC)	• Site surveys commencing as early as 2021 • Offshore construction as early as 2023, but may occur later • Approximately 5 years; seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of year
Production and Maintenance Operations	• Commencement as early as 2026 • 12 to 20 years; year-round
Drilling Activities	• Commencement as early as 2024 • On average, drilling time is approximately 45-85 days per well (may be shorter for pilot wells and/or tiebacks) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2021 • Ongoing throughout life of Project; year-round
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed. • Approximately 2 to 4 years; seasonal or year-round
Project Area Tiebacks	*Extension of Project life to a maximum of 30 years*
Offshore Construction and Installation, and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to five tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but activities could occur year-round • May occur at any time over life of Project
Production and Maintenance Operations	• Continuation of activities from existing FPSO out to end of Project life • Year-round
Drilling Activities	• Total timeframe for drilling depends on number of wells required; • On average, drilling time is approximately 45-85 days per well • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Drilling will be carried out year-round when it occurs

Table 9.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Supply and Servicing	• Continuation of ongoing activities to end of Project life • Year-round
Supporting Surveys	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

9.1.3 Approach and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on the EA methodology detailed in Chapter 4 of this EIS and include the nature, scale and timing of the Project's planned components and activities (see Chapter 2), and the existing environment for this VC (see Section 6.1). This analysis has focused on identifying key potential Project-VC interactions and anticipated changes to the existing biophysical environment resulting from planned Project activities that may, through one or more associated pathways, lead either directly or indirectly to overall effects on the presence, abundance, diversity, health or other aspects of Marine Fish and Fish Habitat at the individual and/or population levels.

The assessment VC considers what is known and can reasonably be deduced about the presence, abundance and distribution of fish species and habitats within the LSA and RSA, with a focus on important or sensitive species and components, and those with the potential to be affected by the Project. The assessment and description of environmental effects and the identification of mitigation has been informed by a review of the existing and available literature, including scientific studies and monitoring initiatives that have investigated and documented the actual effects of such activities on marine fish and their habitats.

Modelling was undertaken to provide additional Project-specific information and analysis of specific discharges (drill cuttings [Appendix I] and produced water [Appendix J]), air emissions (Appendix K) and sound emissions (Appendix D) to evaluate the potential dispersion and predicted "footprint" of these discharges the possible ecological implications of these interactions. The following sections provide an overview of the results of modelling.

Drill Cuttings Dispersion Modelling

Drill cuttings dispersion modelling was conducted to help assess the potential effects of discharged cuttings dispersion and deposition on Marine Fish and Fish Habitat. Modelling was carried out at a representative site within the Core BdN Development Area to evaluate the potential dispersion and predicted seabed "footprint" of these cuttings in seasonal scenarios (Wood 2018 in Appendix I). The modelling site is in the eastern Core BdN Development Area, at an approximate water depth of 1,170 m, and is located within a NAFO fisheries closure area (FCA) (i.e., Northwest Flemish Cap (10) (see Figure 9-2).

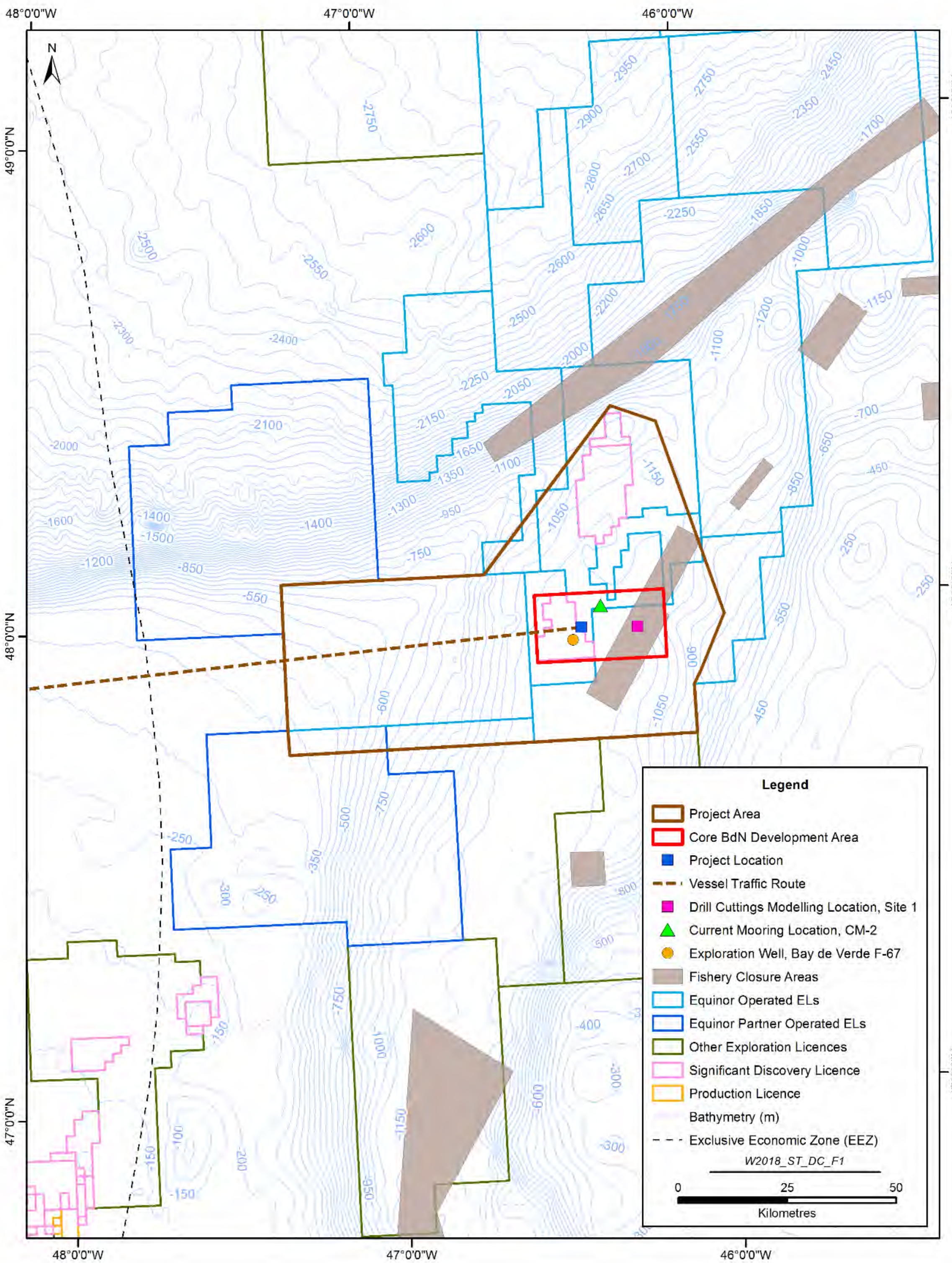

Figure 9-2 Modelling Location – Drill Cuttings Dispersion Modelling

A numerical model developed by Wood PLC (Wood) employs a transport computation to simulate the advection of dispersed drill cuttings materials in three dimensions through the water column, following release into the sea, until the particles come to rest on the sea bottom. As the behaviour of discharged cuttings is largely dependent on particle size distribution (PSD), a primary estimate of cuttings PSD for the Core BdN Development Area was based on laser diffraction data from the nearby Bay de Verde F-67 well in 2014 (Figure 9-2). There is a tendency for smaller particles to clump and form aggregate particles called flocs or aggregates. An increase in the flocculation process can result from the presence of drilling fluid chemicals which cause particles to become sticky and result in larger-sized particles with increased settling velocities. In the absence of an in-field ocean monitoring program or laboratory studies of cuttings samples in seawater to measure settling velocities, two settling velocity characterizations are assumed for the base case cuttings PSD to bracket the potential dispersion of the small silt- and clay-sized particles: one with flocculation assumed and one with no flocculation. One-well scenarios were assessed for five PSD input scenarios with the remaining cases based on literature values from other drill cuttings programs in the North Sea:

- Base case, estimated for the BdN field, with assumed flocculation of cuttings particles
- Base case, estimated for the BdN field, with no flocculation assumed: the smaller cuttings are assumed to stay disaggregated as separate particles and not flocculate to form larger particles with faster settling
- Troll A platform (from a Norwegian Continental Shelf (NCS) well), average PSD (Frost et al. 2014)
- Troll A platform maximum PSD (Frost et al. 2014)
- Nedwed (Nedwed 2004)

Further model exploration runs were based on worst case scenarios using an eight-well case and the base case (flocculation) that would likely promote aggregation of drill cuttings. Drill cuttings modelling using the “Troll A platform” case was also conducted for comparison and was based on representative wells drilled on the NCS as reported in Frost et al. (2014).

Water-based mud (WBM) cuttings from conductor and surface sections are released estimated at 0.2 m above the seabed. Synthetic-based mud (SBM) (Paradril-IA LV) cuttings from intermediate and reservoir sections are released from the drilling installation at an estimated 14 m below the sea surface. For the purposes of determining potential effects on Marine Fish and Fish Habitat, total drill cuttings (SBM and WBM cuttings) were assessed. Model simulations assumed a single discharge point for the eight wells, which results in higher potential thicknesses. During drilling activities, cuttings discharges will likely be redirected to reduced accumulations, therefore the modelling approach is deemed very conservative to support the effects assessment. A detailed discussion of the drill cuttings model and results is provided in Appendix I (Wood 2018). Drill cuttings dispersion modelling results that are relevant to Marine Fish and Fish Habitat are presented and discussed in Section 9.2.3.

Previous studies indicate that sedimentation and burial effects from drill muds and cuttings on benthic invertebrates have mainly been localized to the vicinity of a drill cuttings pile area (Neff et al. 2000; Holdway 2002; Schaanning et al. 2008; Smit et al. 2008; Trannum et al. 2010; Gates and Jones 2012; Larsson et al. 2013; Cordes et al. 2016; Tait et al. 2016). An average burial depth threshold of 6.3 mm is considered to be the predicted no-effect threshold (PNET) for non-toxic sedimentation based on benthic invertebrate species tolerances to burial, oxygen depletion and change in sediment grain size (Smit et al. 2008). This PNET (6.3 mm) was updated based on the work performed by Kjeilen-Eilertsen et al. (2004) and Smit et al. (2006), that derived a PNET of 6.5 mm. However, as some species may be more susceptible to shallower burial depths, an average PNET burial depth of 1.5 mm is suggested to be a more conservative approach to assess drilling discharges (Kjeilen-Eilertsen et al. 2004). Burial effects on invertebrates are also predicted to occur between depositions at 1.5 mm to 6.5 mm sediment thickness, as evidenced by damage to *Lophelia pertusa* coral observed with deposited drill cuttings of 6.5 mm (Larsson and Purser 2011) and reduced sediment reworking by invertebrates occurring with deposition of WBM drill cuttings of 2.5 mm (Trannum 2017). Given that species may be susceptible to different thresholds, both the 1.5 mm and 6.5 mm thresholds are considered in this assessment.

Produced Water Plume Modelling

To provide additional Project-specific information and analysis related to the nature and extent of the produced water plume resulting from the Project, detailed produced water plume modelling using DREAM was carried out. This included modelling the potential plume extent in June, considered the most sensitive month for when biological resources are most vulnerable (DeBlois 2019 in Appendix J). The thermal plume was not assessed as part of the produced water discharge modelling as the discharge temperature and rates were much lower compared to other studies where modelled effects were estimated to be negligible (SINTEF 2014). Produced water plume modelling results that are relevant to Marine Fish and Fish Habitat are presented and discussed in Section 9.3.2.

Six scenarios for produced water release were simulated:

Scenarios simulated with a produced water release rate of 30,000 m^3/day:

- **Case 1**: 15 ppm OIW concentration, no mixing with cooling water
- **Case 2**: 30 ppm OIW concentration, no mixing with cooling water
- **Case 3**: 15 ppm OIW concentration, mixing with cooling water
- **Case 4**: 30 ppm OIW concentration, mixing with cooling water

Scenarios simulated with a produced water release rate of 50,000 m^3/day:

- **Case 5**: 30 ppm OIW concentration, no mixing with cooling water
- **Case 6**: 30 ppm OIW concentration, mixing with cooling water

Chemical profiles for the naturally occurring constituents in produced water represented at dispersed oil concentrations of 15 ppm and 30 ppm are provided in Table 9.2 as are predicted no-effect concentrations (PNEC) values (after OSPAR 2012). Information on produced water for the Project will not be available until produced water is generated, therefore the chemical profiles are standard average profiles used by Equinor for new developments based on values observed at their existing developments. Constituents examined in modelling exercise for the Project are those identified as relevant in OSPAR (2012). Special attention was given to dispersed oil, but results are also presented for other constituents. In all cases, constituent concentrations in the water column were compared to PNEC values as provided in OSPAR (2012) to provide a spatial and temporal estimate of concentrations that exceed no-effects concentrations (i.e., concentrations that might lead to an effect) (Table 9.2). OSPAR (2012) PNEC are based on laboratory studies toxicity tests, usually at three trophic levels (algae, zooplankton and fish). As such, they are general and can be used as a gauge of potential effects (Table 9.2).

Table 9.2 OSPAR (2012) Predicted No-Effects Concentrations for Produced Water for Simulations

Group	Variable	PNEC values (µg/L)
Dispersed oil	Dispersed oil	70.5
BTEX	Benzene (and xylene)	8
	Toluene	7.4
	Ethylbenzene	10
Naphthalene	Naphthalene (and alkyl homologues)	2
2-3 ring PAH	Acenaphthylene	0.13
	Acenaphthene	0.38
	Fluorene	0.25
	Phenanthrene (and alkyl homologues)	1.3
	Anthracene (+dibenzothiophene and alkyl homologues)	0.1
4 ring PAH	Fluoranthene	0.0063
	Pyrene	0.023
	Chrysene	0.007
	Benz(a)anthracene	0.0012
5-6 ring PAH	Benzo[b]fluoranthene	0.00017
	Benzo[k]fluoranthene	
	Benzo(a)pyrene	
	Indeno[1,2,3-cd]pyrene	
	Benzo(g,h,i)perylene	
	Dibenzo(a,h)anthracene	0.00014
Alkylphenol C0-C3	Phenol (and C1-C3 alkyl phenols)	7.7
Alkylphenols C4	Butylphenol (and other C4 alkyl phenols)	0.64
Alkylphenols C5	Penthylphenol (and other C5 alkyl phenols)	0.2
Alkylphenols C6-C8	Octylphenol (and C6-C8 alkyl phenols)	0.01
Alkylphenols C9	Nonylphenol (and other C9 alkyl phenols)	0.3

Table 9.2 OSPAR (2012) Predicted No-Effects Concentrations for Produced Water for Simulations

Group	Variable	PNEC values (µg/L)
Metals	Cadmium (Cd)	0.21
	Zinc (Zn)	3.4
	Copper (Cu)	2.6
	Lead (Pb)	1.3
	Nickel (Ni)	8.6
	Mercury (Hg)	0.048
	Arsenic (As)	0.6
	Chromium (Cr)	0.6

Notes: PNEC values are from OSPAR (2012); BTEX = Benzene, toluene, ethylbenzene and xylene
PAH = Polycyclic aromatic hydrocarbons;

Sound Propagation Modelling

Sound propagation modelling was conducted to help assess the potential effects of exposure to Project-related underwater sound on fishes and invertebrates. The sound sources used in the modelling included a 5,058 in^3 seismic airgun array, two geohazard survey sources, specifically a multibeam echosounder (MBES) and a subbottom profiler (SBP), and three marine vessel scenarios, specifically a drillship, an FPSO and a drillship/FPSO combined. Impulsive sound is emitted by the airgun array, the MBES and the SBP, while continuous sound is emitted by the vessels. The modelling report is provided in Appendix D.

With respect to the seismic airgun array, this exercise provided predicted maximum received levels of pressure and energy at numerous locations along various azimuth transects associated with two source locations, S1 within the Core BdN Development Area, and S2 located within the Project Area approximately 50 km west of S1 and in shallower water depths. The modelling was conducted for the representative months February and August. The frequency range 10 Hz to 25,000 Hz was used in this modelling. Pressure and energy levels were provided for the depth at which the maximum received levels are predicted and at the seabed for each location along the azimuth transects (Zykov 2018 in Appendix D). The sound level metrics provided for the seismic airgun array modelling included the zero-to-peak pressure level ($SPL_{0\text{-}p}$), the root-mean-square (rms) pressure level (SPL_{rms}), and the sound exposure level (SEL). The seismic sound source array sound modelling also produced a series of plots (see Zykov 2018 - Figure 15 and Figure 16 in Appendix D) showing the predicted SPL_{rms} and SEL levels throughout the water column out to a 20 km horizontal distance from the source locations for both February and August.

Sound modelling using the MBES and SBP sources was conducted at Site S1 within the Core Development Area. The Simrad EM2000 was selected as a proxy source to represent the MBES for the Project. This echosounder produces a narrow band signal at 200 kHz. The EdgeTech 3300 was selected as a proxy source to represent the SBP for the Project. This SBP produces a signal within the 2 kHz to 16 kHz range. The sound level metrics relevant to Marine Fish and Fish Habitat provided for the geohazard survey source modelling included $SPL_{0\text{-}p}$ and SPL_{rms}. The resultant maximum-over-depth SPL fields were presented as two distances to certain sound levels: (1) R_{max}, the maximum range at which the given sound level would be received, and (2) $R_{95\%}$, the maximum range at which the given sound level would be received after exclusion of 5 percent of the farthest such points. Modelling for the geohazard sound sources was completed for February as it had environmental conditions for the furthest sound extent.

Sound modelling for the vessel scenarios was conducted at Site S1 using both August and February propagation conditions. Source levels represented operation of the vessels with 50 percent power output of the dynamic positioning (DP) thrusters. Modelling was conducted for the frequency range 10 Hz to 25,000 Hz along 72 transects up to 50 km from the sound source. The sound level metric relevant to Marine Fish and Fish Habitat provided for the vessel source modelling was SPL_{rms}. The resultant maximum-over-depth SPL fields were presented as two distances (R_{max} and $R_{95\%}$), as was done for the geohazard sound source modelling.

Sound modelling results that are relevant to Marine Fish and Fish Habitat are presented and discussed in Sections 9.3.1.3, 9.3.2.3, 9.3.3.3, and 9.3.4.1 and 9.3.5.3 and 9.3.5.5

Popper et al. (2014) suggest guideline levels of $SPL_{0\text{-}p}$ and SEL_{cum} representing the received sound levels that could produce a specified effect (i.e., mortality and potential mortal injury, recoverable injury, and temporary threshold shift) in fishes and eggs and larvae. Three classes of fish are included: (1) those without a swim bladder; (2) those with a swim bladder that is not involved in hearing; and (3) those with a swim bladder that is involved in hearing. The suggested guideline levels related to seismic air sources (Table 9.3) and shipping and other continuous sounds (Table 9.4) are the most relevant to invertebrates and fishes in this EIS. It is important to note that the guidelines related to sound from seismic air sources are derived from data generated from studies on the effects of pile-driving sound, another impulsive sound type. SEL_{cum} is difficult to determine in relation to seismic air source sound since both the sound source and the receiving fish are likely moving. The $SPL_{0\text{-}p}$ levels apply to seismic somewhat; however, the characteristics of pile-driving sound and seismic air source sound differ enough (e.g., lesser rise time for pile-driving) that extrapolation from the pile-driving guidelines is tenuous at best. Guidelines provided for continuous sounds (Table 9.4) are primarily qualitative and of limited use.

Table 9.3 Sound Exposure Guidelines for Seismic Airguns (Popper et al. 2014)

Type of Animal	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable injury	Temporary Threshold Shift	Masking	
Fish: no swim bladder (particle motion detection)	>219 db SEL_{cum} or >213 db peak	>216 db SEL_{cum} or >213 db peak	>>186 db SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	210 db SEL_{cum} or >207 db peak	203 db SEL_{cum} or >213 db peak	>>186 db SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low

Table 9.3 Sound Exposure Guidelines for Seismic Airguns (Popper et al. 2014)

Type of Animal	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable injury	Temporary Threshold Shift	Masking	
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 db SEL_{cum} or >207 db peak	203 db SEL_{cum} or >213 db peak	>>186 db SEL_{cum}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Eggs and larvae	>210 db SEL_{cum} or >207 db peak	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes:

Peak and rms sound pressure levels dB re 1 μPa; SEL dB re 1 μPa²·s. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F) as detailed in Popper et al. 2014.

Data on mortality and recoverable injury from Halvorsen et al. (2011, 2012a, 2012b) based on 960 sound events at 1.2 s intervals. TTS based on Popper et al. (2005).

Note that the same peak levels are used both for mortality and recoverable injury since the same SEL_{ss} was used throughout the pile driving studies. Thus, the same peak level was derived (Halvorsen et al. 2011).

Table 9.4 Sound Exposure Guidelines for Shipping and Other Continuous Sounds (Popper et al. 2014)

Type of Animal	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable injury	Temporary Threshold Shift	Masking	
Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 db rms for 48 hr	158 db rms for 12 hr	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Table 9.4 Sound Exposure Guidelines for Shipping and Other Continuous Sounds (Popper et al. 2014)

Type of Animal	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable injury	Temporary Threshold Shift	Masking	

Notes:

Peak and rms sound pressure levels dB re 1 μPa; SEL dB re 1 $\mu Pa^2 \cdot s$. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F) as detailed in Popper et al. 2014.

For the most part, data in this table are based on knowing that fish will respond to sounds and their hearing sensitivity, but, as discussed in the Popper et al. (2014), there are no data on exposure or received levels that enable guideline numbers to be provided.

Using the modelling results in combination with results of the most rigorous scientific studies and the guidelines provided in Popper et al. (2014), the potential effects of exposure to underwater sound on Marine Fish and Fish Habitat is assessed.

As described in Section 2.7 of this EIS, given the current stage of planning and design for the various aspects of the Project, the EIS assesses the various alternatives still under consideration in planning and design. It also considers potential variation in the possibility, nature and degree of environmental interactions and resulting effects between species and species groups and/or in different parts of the LSA or at different times of the year, as applicable. Fish SAR are considered integrally within the environmental effects assessment for this VC, although these species are given attention and emphasis in the identification, analysis and evaluation of potential environmental effects and required mitigation measures herein.

9.1.4 Environmental Effect Significance Definitions

The definitions used to characterize environmental effects are provided in Chapter 4 (Table 4.5) and are provided in Table 9.5 specific to Marine Fish and Fish Habitat. These characterizations will be used throughout this VC assessment in describing residual environmental effects on Marine Fish and Fish Habitat from routine Project Activities.

Table 9.5 Characterization of Residual Effects on Marine and Migratory Birds

Characterization	Description	Definition of Categories
Nature / Direction of effect	The long-term trend of the residual environmental effect relative to baseline conditions	• **Positive** – a residual environmental effect on habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health that is considered beneficial to Marine Fish and Fish Habitat relative to baseline conditions • **Adverse** - a residual environmental effect on habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health that is considered harmful to Marine Fish and Fish Habitat relative to baseline conditions • **Neutral** – no change in habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health of Marine Fish and Fish Habitat relative to baseline conditions
Magnitude of effect	The degree of change in habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health relative to baseline conditions	• **Negligible** although there is a potential for a Project-VC interaction, there would be no change in habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health relative to baseline conditions • **Low** – a change in habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health relative to baseline conditions, that is considered within the range of natural variability, but with no associated adverse effect on the viability of the affected population • **Medium** - a change in habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health relative to baseline conditions that is considered beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population • **High** - a change in habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health relative to baseline conditions that is considered beyond the range of natural variability, but with an adverse effect on the viability of the affected population
Geographic Extent of effect	The spatial area within which the residual environmental effect will likely occur	• Less 1 km^2 • Less than 10 km^2 • Less than 100 km^2 • Less than 1,000 km^2 • Less than 10,000 km^2 • Greater than 10,000 km^2

Table 9.5 Characterization of Residual Effects on Marine and Migratory Birds

Characterization	Description	Definition of Categories
Duration of effect	The period of time required until the habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health of fish and fish habitat returns to its baseline condition, or the residual effect can no longer be measured or otherwise perceived	• Short Term - less than 12 months (1 year) • Medium Term - 1 to 5 years • Long Term - more than 5 years • Permanent - recovery to baseline conditions unlikely
Frequency of effect	Identifies how often a residual effect will likely occur	• Not likely to occur • Occurs once – effect occurs one time • Occurs sporadically – effect occurs episodically, a no set schedule • Occurs regularly – effect occurs at regular intervals • Occurs continuously – effect occurs continuously
Reversibility of effect	Pertains to whether habitat quality / availability, food quality / availability, behaviour, mortality, injury and/or health of fish and fish habitat can return to baseline conditions after the Project / activity stops	• Reversible: Will eventually recover to baseline conditions • Irreversible: Permanent
Confidence	Level of confidence or certainty in the predictions of significance.	Generally speaking, there is high confidence in significance predictions associated with a robust level of knowledge in the existing conditions, modelling and/or effectiveness of mitigation. Assigning a medium or lower level of confidence indicates a lesser level of knowledge, predictive tools and/or confidence in mitigation measures. The level of confidence in the effects prediction: *L:* Low level of confidence *M:* Moderate level of confidence *H:* High level of confidence

Significant residual environmental effects are considered to be those that could cause a change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. In consideration of the descriptors listed in Table 9.5, as well as a consideration of regulatory requirements, SARA recovery plans, a significant residual adverse environmental effect on Marine Fish and Fish Habitat resulting from the Project is defined as one that would cause one or more of the following:

- A detectable decline in overall fish abundance or change in the spatial and temporal distributions of fish populations within the overall RSA over multiple generations

- Effects to fish habitat such that it results in harmful alteration or disruption or destruction of fish habitat that cannot be adequately compensated by offsetting
- Effects on a designated (protected) SAR or its critical habitat such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected

Summary effects assessment statements are provided for each phase / she activity (e.g., Offshore Construction and Installation and HUC; Production and Maintenance, etc.).

The potential environmental effects of accidental events on Marine Fish and Fish Habitat are evaluated and assessed in Chapter 16 (Accidental Events).

9.1.5 Potential Environmental Changes, Effects, and Mitigation Measures

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine Fish and Fish Habitat. Mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable.

9.1.5.1 Potential Project-related Environmental Changes and Effects

Potential environmental interactions between proposed Project activities and Marine Fish and Fish Habitat have been identified through review of the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014), the Flemish Pass Exploration Drilling EIS (herein referred to as the Drilling EIS) (Statoil 2017) and the information required by the Canadian Environmental Assessment Agency (the CEA Agency) arising from its technical review of the Drilling EIS (the “IRs”). In addition, the EIS Guidelines issued by the CEA Agency in September 2018 identify and specify a number of issues and potential effects on this VC that are also considered in the EIS (refer to Section 7.1.3 in Appendix A). Based on review of these resources, it has been determined that direct and indirect adverse effects on Marine Fish and Fish Habitat, including population level effects that could be caused by Project activities, include:

- Change in habitat availability and/or quality
- Change in food availability and/or quality
- Change in fish and/or invertebrate mortality, injury, and/or health
- Change in fish and invertebrate presence and/or abundance (behavioural effects)

Equinor Canada completed an environmental assessment process per the *Canadian Environmental Assessment Act*, 2012 (CEAA 2012) process for its Drilling EIS. Marine Fish and Fish Habitat associated comments from the Drilling EIS EA process, as well as those received during ongoing engagement with Indigenous groups and stakeholders in regard to the BdN Development (as identified in Sections 3.3.1.2 and 3.4 of this EIS) are as follows and are addressed, as applicable to the scope of the assessment, herein.

Government Departments and Agencies

- Potential effects to Atlantic salmon
- Potential effects of drilling wastes on key fish species and sensitive benthic habitat (e.g., corals and sponges)
- Survey methodology for coral and sponge surveys and the drill cuttings model used
- Potential interactions with SAR

Indigenous Groups

- Potential effects to key fish species that are harvested for commercial and/or traditional use purposes (e.g., American eel, Atlantic bluefin tuna, Atlantic salmon, Swordfish)
- Potential effects of sound, pollution, seismic surveys and light on Marine Fish and Fish Habitat
- Potential effects on population distribution and food sources
- Research regarding salmon migration through the Project Area
- Potential effects of discharges (e.g., drill cuttings and produced water) and emissions on fish (including pelagic species) and benthic species (e.g., corals, sponges)
- Potential effects on crab, sea cucumber, shrimp and migratory fish stocks

Stakeholder Organizations

- Potential effects of discharges (e.g., drill cuttings) on benthic species (e.g., corals, sponges)
- Marine refuges and protected areas

The environmental effects assessment for this VC considers and focuses on the issues and questions identified through these issues scoping exercises, and as identified in Section 7.3.1 of the EIS Guidelines (Appendix A), including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from them. These are summarized in Table 9.6.

Table 9.6 Potential Project-Related Environmental Changes and Potential Effects: Marine Fish and Fish Habitat

Potential Environmental Effect	Potential Environmental Change
Change in Habitat Availability and/or Quality	• Installation and removal of subsea infrastructure may result in the harmful alteration, disruption or destruction (HADD) of fish habitat as determined by DFO and may require a Section 35(2) *Fisheries Act* Authorization • Project-related discharges and emissions (e.g., produced water, cooling water, other liquid discharges, drill cuttings) may change the physical and/or chemical characteristics of habitats used by marine fishes (including invertebrates) • Project-related disturbances to the marine environment from underwater light and sounds that may change the physical characteristics of habitats used by marine fishes (including invertebrates)

Table 9.6 Potential Project-Related Environmental Changes and Potential Effects: Marine Fish and Fish Habitat

Potential Environmental Effect	Potential Environmental Change
	• Resulting environmental change in the availability, extent and quality of habitats have the potential to affect the presence, abundance and health of marine fishes and invertebrates that use the affected areas
Change in Food Availability and/or Quality	• Project-related discharges (e.g., organic wastes) that may increase organic matter in the water column. • Project-related disturbances to the marine environment from underwater light and sounds that may result in behavioural effects (e.g., avoidance, attraction) on marine fishes and invertebrates. • Resulting changes to presence of fish and invertebrates and levels of organic waste can potentially affect the presence, abundance of marine fishes and invertebrates.
Change in Fish and Invertebrate Mortality, Injury, and/or Health	• Direct environmental changes from the Project (e.g., discharge of produced water and drill cuttings, sedimentation). Smothering and burial and increased suspended sediment from discharge of drill cuttings may result in injury and mortality of marine fish and invertebrates. • Direct injury and mortality of marine fish and invertebrates from placement of infrastructure. Installation and removal of subsea infrastructure may result HADD of fish habitat as determined by DFO and may require a Section 35(2) *Fisheries Act* Authorization • Indirect effects on fish health from environmental changes to food sources or fish habitat. • Injury or mortality to marine fishes and invertebrates as a result of exposure to underwater sound during 2D/3D/4D seismic surveys, wellsite surveys or vertical seismic profiling (VSP) survey activity
Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	• Project-related disturbances to the marine environment from underwater light and sounds that may result in behavioural effects (e.g., avoidance, attraction) of marine fishes and invertebrates.

An overview of the potential for interactions between each of the Project's planned components and activities and Marine Fish and Fish Habitat, and specifically, the potential for these to result in environmental changes to the various aspects of this VC, is presented in Table 9.7. In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of project activities is based on those discharges/activities "with the greatest potential to have environmental effects." This is based on scientific literature, research studies, Indigenous knowledge, input from Indigenous groups and stakeholders, and professional experience of the EIS team. Most Project activities have the potential to interact with Marine Fish and Fish Habitat. Planned mitigations as identified in Section 9.1.5.2 are linked to each Project component and/or activities

Sound and light emissions from vessels are the primary pathways of effects on Fish and Fish Habitat influencing fish behaviour and prey availability and unlikely to have injury and mortality effects on fish. The presence of structures is focused the FPSO as an interaction with fish and fish habitat due to its longer-term presence. The presence of structures is not considered an interaction with fish and fish habitat during construction and installation and HUC, and drilling activities, due to the temporary and short-term nature of these activities. Drill cuttings and produced water discharges are considered the primary discharges to interact with marine fish and fish habitat. Other marine discharges from vessels and installations, such as bilge and ballast water are treated in accordance with regulatory requirements, and as such are considered not to have an effect on fish and fish habitat. Routine flaring will not occur during the Project. Flaring will only occur during non-routine flaring events, including safety flaring and flaring during turn-around/maintenance activities. As thermal, atmospheric, and lighting emissions from flaring will be sporadic and occur above the water and is therefore predicted to not interact with nor have effects on marine fish and fish habitat.

Marine discharges include, but are not limited to, bilge and/or ballast water, hydraulic fluid, deck drainage, and BOP fluids. Bilge water is water that accumulates in the bottom of any vessel hull over time from a number of small sources (e.g., steaming, washing, rain or seawater spray entering the vessel). Deck drainage water occurs on the surface decks resulting from precipitation and sea spray, as well as operational activities such as wash-down, fire control testing or equipment testing. Bilge and deck drainage water often can come in contact with equipment and machinery and may be contaminated with oil. Bilge and deck drainage water will be managed in accordance with the OWTG (NEB et al. 2010). Hydraulic fluids may be discharged in association with operation of valves of subsea wellheads and manifolds. Blowout preventer (BOP) fluids, which typically consist of a mixture of water and glycol (90/10) will be discharged; function testing of the BOP is a regulatory requirement and assists in safe well operations. While discharge of fluids may have potential effects on Marine Fish and Fish Habitat (Cordes et al. 2016), overall discharges would be of low quantity or sporadically discharged, adhere to OCSG (NEB et al. 2009), and discharged in consideration with the OWTG (NEB et al. 2010). BOP fluids are low in volume and are screened in accordance with CNLOPB requirements. Sewage discharge into offshore environments will disperse quickly and be degraded by bacteria (EMCP 2011). In estimates of the effects of discharges from large cruise ships in Alaskan waters, the effects of sewage release on enhancing nitrogen concentrations for plankton growth was considered negligible (Mearns et al. 2003; Loehr et al. 2006). Given the initial rapid dilution and subsequent dilution in marine waters, cruise ship discharges were considered to have little effect on natural marine nutrient cycles (Loehr et al. 2006). Sewage and food waste will be treated accordance with Canadian and international regulatory requirements prior to discharge and will not significantly increase organic matter into the development area and therefore are not considered an interaction with fish and fish habitat. All wastewater discharges would be low in volume and highly dispersed in the deep-water environment resulting in overall low potential for interactions or effects. It is therefore, not predicted to result in significant changes to water quality and fish habitat and is not considered an interaction with the greatest potential to have environmental effects.

For Project Area Tiebacks, interactions and effects that are the same for Core BdN Development activities and Project Area Tieback activities are not identified in Table 9.7. For instance, as discussed in Section 9.4.2, there is no change in Production and Maintenance Operations from Core BdN Development associated with Project Area Tiebacks. The FPSO remains on its location in the Core BdN Development and the effects assessment presented in 9.3.2 would be the same should Project Area Tiebacks be undertaken. The only interaction that would be new would be the presence of subsea infrastructure in the Project Area, which is noted in Table 9.7 and assessed in Section

9.4.2.1. Similarly Supply and Servicing activities would not change and the interaction and effects on Marine Fish and Fish Habitat would be the same as assessed in Section 9.3.4.

Air emissions associated with Production and Maintenance and Drilling Activities, and presence and sound related to helicopter use during Supply and Servicing were determined to have no discernible effects and are therefore not identified as interactions. Environmental surveys are not predicted to have discernible environmental effects with marine fish and fish habitat due to the short term and transient nature of these surveys. The spatial footprint for potential seabed sampling would also be very limited. Decommissioning activities are not likely to have effects on injury and mortality of fish. However, if subsea infrastructure is removed it will result in the injury and mortality of colonizing organisms.

Table 9.7 Potential Project VC Interactions and Associated Effects: Marine Fish and Fish Habitat

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 9.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Fish and Invertebrate Mortality, Injury, and/or Health	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	
CORE BdN DEVELOPMENT					
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING (HUC)					
Marine Vessels					
• Presence of Vessels	No Interaction				
• Light Emissions		•		•	
• Underwater Sound Emissions		•		•	
• Marine Discharges	No Interaction				D, G, H, I
• Installation of Subsea Infrastructure	•	•	•	•	A, C
Hook-up and Commissioning					
• HUC Discharges			•		E, F
PRODUCTION AND MAINTENANCE OPERATIONS					
FPSO and Subsea Infrastructure					
• Presence	•	•			C, D, J
• Light Emissions		•		•	L, M
• Underwater Sound Emissions		•	•	•	

Table 9.7 Potential Project VC Interactions and Associated Effects: Marine Fish and Fish Habitat

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 9.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Fish and Invertebrate Mortality, Injury, and/or Health	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	
Waste Discharges from FPSO					
• Produced Water	•	•	•		E, F
• Marine Discharges	No Interaction				D, E, F, G, H, I
• Non-routine Flaring	No Interaction				
DRILLING ACTIVITIES					
Drilling Installation					
• Presence	No Interaction				
• Light Emissions		•		•	
• Underwater Sound Emissions		•	•	•	
Waste Discharges from Drilling Installation					
• Drill Cuttings	•	•	•		B, E, F
• Marine Discharges	No Interaction				D, E, F, G, H, I
• Flaring during formation flow testing	No Interaction				
SUPPLY AND SERVICING					
Marine Vessels					
• Presence	No Interaction				
• Light Emissions		•		•	
• Underwater Sound Emissions		•		•	
• Marine Discharges	No Interaction				D, G, H, I
Aircraft (helicopters)					
• Presence	No Interaction				
• Sound	No Interaction				

Table 9.7 Potential Project VC Interactions and Associated Effects: Marine Fish and Fish Habitat

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 9.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Fish and Invertebrate Mortality, Injury, and/or Health	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	
SUPPORTING SURVEYS					
• Presence of Vessels and Towed Equipment	No Interaction				
• Light Emissions from Vessels		•		•	
• Underwater Sound Emissions from Vessels		•		•	
• Marine Discharges	No Interaction				D, G, H, I
• Underwater Sound Emissions from Geophysical Survey Equipment		•	•	•	K
DECOMMISSIONING					
• Decommissioning of FPSO	No Interaction				N
• Decommissioning of Subsea infrastructure	•	•	•	•	N
• Well Decommissioning	•				N, O, P
PROJECT AREA TIEBACKS					
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HUC					
Marine Vessels					
• Light Emissions		•		•	
• Underwater Sound Emissions		•		•	
• Installation of Subsea Infrastructure	•	•	•	•	A, C
Hook-up and Commissioning					
• HUC Discharges			•		E, F

Table 9.7 Potential Project VC Interactions and Associated Effects: Marine Fish and Fish Habitat

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 9.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Fish and Invertebrate Mortality, Injury, and/or Health	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	
PRODUCTION AND MAINTENANCE OPERATIONS					
Presence of FPSO – No Change from Core BdN Development					
• Light Emissions		•		•	L, M
• Underwater Sound Emissions		•	•	•	
Presence of Subsea Infrastructure					
• Presence of Subsea Infrastructure	•	•			C, D, J
Waste Discharges from FPSO – No Change from Core BdN Development					
• Produced Water	•	•	•		E, F
DRILLING ACTIVITIES					
Drilling Installation					
• Light Emissions		•		•	
• Underwater Sound Emissions		•	•	•	
Waste Discharges from Drilling Installation					
• Drill Cuttings	•	•	•		B, E, F
SUPPLY AND SERVICING – No Change from Core BdN Development					
Marine Vessels					
• Light emissions		•		•	
• Underwater Sound Emissions		•		•	
SUPPORTING SURVEYS					
• Light Emissions from Vessels		•		•	
• Underwater Sound Emissions from Vessels		•		•	

Table 9.7 Potential Project VC Interactions and Associated Effects: Marine Fish and Fish Habitat

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 9.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Fish and Invertebrate Mortality, Injury, and/or Health	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	
• Underwater Sound Emissions - Geophysical Survey Equipment		●	●	●	K
DECOMMISSIONING – No Change from Core BdN Development					
• Decommissioning of Subsea infrastructure	●	●	●	●	N
• Well Decommissioning	●				N, O, P

9.1.5.2 Summary of Mitigation Measures

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine Fish and Fish Habitat. Mitigation measures to prevent or reduce adverse effects upon this VC, as listed below, are identified and considered in an integrated manner within and throughout the environmental effects analysis that follows, as applicable. Mitigations for the associated interactions are identified in Table 9.7. The environmental effects assessment for accidental events for VCs is presented separately in Chapter 16.

A. With regards to subsea layout, well templates will not be placed over *Lophelia pertusa* corals
B. Discharge locations for water-based cuttings, when cuttings transport system is used, will be determined based on the C-NLOPB requirements to avoid *Lophelia pertusa* complexes and/or assemblages of 5 or more corals in 100 m² with heights greater than 30 cm within 100 m of the discharge location.
C. Where Project activities may affect fish habitat, and it is determined through DFO's "Request for Review" process pursuant to the *Fisheries Act* that a *Fisheries Act* Authorization is required, a habitat offsetting program will be developed in conjunction with DFO and in consultation with Indigenous Groups and stakeholders as a mitigation measure for the net loss of fish habitat resulting from the Project (See Appendix O).
D. Ballast water and hull fouling will be managed in consideration of applicable Canadian and international requirements to reduce the potential spread of invasive species.

E. In consideration of the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010) and regulatory discharge limits, for discharges associated with the Project, the use of best treatment practices that are commercially available and economically feasible will be implemented.
F. The selection and screening of chemicals to be discharged, will be undertaken in consideration of the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG) (NEB et al. 2009) and Equinor Canada's chemical selection and screening processes.
G. Marine discharges (e.g., bilge water) will be treated in accordance with MARPOL and Canadian requirements prior to discharge.
H. Sewage and food waste will be treated in consideration of the OWTG and in accordance with Canadian and international regulatory requirements (e.g., IMO).
I. Appropriate procedures will be implemented for the handling, storage, transportation, and onshore disposal of solid and hazardous waste.
J. Use of anti-fouling paint on hull of FPSO
K. In consideration of the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2018), mitigation measures applied during the Project's geophysical surveys where air source arrays are used will be consistent with those outlined in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) (DFO 2007).
L. Lighting on the FPSO will be reduced to the extent that worker safety and safe operations, per regulatory requirements, are not compromised. Lighting reduction options will be evaluated during detail design, and economically and technically feasible options which do not compromise worker safety and safe operations will be implemented. This may include, but not limited to shading, avoiding use of unnecessary lighting, and directional lighting (i.e., towards the deck and not out to sea). Equinor Canada will engage with ECCC on the results of the lighting engineering study(s) undertaken in the front-end engineering and design phase before proceeding to detailed design. The selection of technical and economic feasible lighting options will be undertaken at detail design, in which Equinor Canada will again engage with ECCC on the selection of lighting options.
M. Low pressure flare gas (e.g., produced water degassing, cargo tank blanket gas) will be recovered, therefore no continuous flaring, which reduces air emissions and light emissions.
N. A decommissioning plan will be submitted to the C-NLOPB for review and acceptance. The plan will be developed in consideration of regulatory requirements in place at the time of decommissioning, engagement with Indigenous groups, commercial fisheries and other stakeholders and likely effects on the environment.
O. Use of explosives will not be employed for removal of wellheads.
P. At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements
Q. At the time of decommissioning, all surface facilities (e.g., FPSO, turret, anchor lines) will be removed.

While not a mitigation, upon completion of final subsea layout design, the area occupied by the final layout design will be compared against the layout used in the 2018 survey. Based on the final design, if there are areas where subsea infrastructure will be installed on the seafloor that were not captured by the 2018 survey, these areas will be surveyed to collect coral, sponge and/or sea pens data. The survey methodology and plan will be provided to DFO in advance of survey commencement date for review and acceptance. Equinor Canada will commence the process for a “Request for Review Application” pursuant to the provisions of the *Fisheries Act* prior to the commencement of offshore construction and installation phase of the Project. IF DFO determines a *Fisheries Act Authorization* is required regarding the harmful alteration, disruption or destruction (HADD) of fish habitat resulting from Project activities, additional fish habitat data may be required in support of the authorization.

9.2 Overview of Marine Fish and Fish Habitat in the Project Area

The existing biological environment for Marine Fish and Fish Habitat is described in Section 6.1 and key components and associated linkages are summarized below as context for the overall effects assessment. Table 9.8 and Table 9.9 provide a summary listing of this information. Information on marine fish and fish habitat within the Project Area was based on regional government datasets, Equinor underwater visual surveys, Indigenous knowledge, and scientific literature. The life history characteristics, details on movements and feeding are not completely understood for various deepsea fish and invertebrates within the Project Area. However, scientific literature from other regions or similar species have been used to provide additional information where data is limited. Overall, the information available on the existing environment is sufficient appropriate for assessing the effects of the Project.

The Project Area (Core BdN and Project Tieback Areas) includes areas of the Flemish Pass and slopes of the Grand Bank and Flemish Cap in water depths range from 340 m to 1,200 m. The Core BdN Development Area lies directly in the northern part of the Flemish Pass. Fish habitat is characterized by a generally low complexity environment with survey areas dominated by fine substrates with intermittent occurrences of hard substrates. A variety of corals and sponges occur in the Project Area and may provide biogenic habitat to fishes and invertebrates. Based on the depths of area, seagrasses and macroalgae are not likely to occur in the Project Area.

Plankton, including phytoplankton and zooplankton occurs in the water column with seasonal increases in the spring and fall. The spring and fall blooms would be considered a sensitive time for various species as reproduction and presence of sensitive early life history stages coincide with these events. Calanus copepods are an important zooplankton prey species in the region with abundance dependent on their dynamics. Effects on early life history stages can have implications for connectivity between areas and recruitment to populations. Plankton also form the base of the food web and this productivity is transferred to deep waters through sinking biomass and waste. Pelagic macroinvertebrates in the area are derived from surveys on the Flemish Cap and include squid, shrimp, mysid shrimp, and jellyfish. These species are also prey species meso and epipelagic fish that occur in the area. Benthic invertebrates are characterized by echinoderms, crustaceans, and bivalves in the shelf areas, transitioning to sponges and corals on the middle to deep slopes (including the Core BdN Development Area). Benthic surveys in the Core BdN Development Area indicated occurrences of corals, sponges, echinoderms, and jellyfish/anemones with lesser occurrences of shrimp, bivalves, whelk, and squid. In the Equinor 2018 seabed surveys, sea pens and soft corals were the main functional groups observed and geodid sponges were the main sponge morphological groups observed. Feeding strategies for benthic invertebrates range from predators of other invertebrates to scavengers and suspension feeders (detritus, particulate organic matter).

A variety of fish species occur within the Project Area. Key species were identified based, conservation status (SARA schedule 1), and Indigenous social, cultural, commercial, and traditional importance, occurrence in Equinor seabed surveys and regional trawl data in the area. This included Atlantic cod, American plaice, blue hake, capelin, Greenland halibut, grenadiers (common, roughhead, roundnose), lanternfish, longnose eel, redfish (Acadian, deepwater, golden), swordfish, and wolffish (Atlantic, northern, spotted). Grenadiers and longnose eel were species commonly observed in the Equinor seabed surveys in the Core BdN Development Area. These species occupy various parts of the water column and may undergo seasonal migrations associated with foraging or reproduction (e.g., Atlantic cod, capelin, swordfish). Species may also undergo diel vertical migrations such as lanternfish and redfish, linking deep areas to upper areas of the water columns. These fish use various feeding strategies from consuming plankton, fish, benthic organisms, or a combination of these groups, linking these species to other organisms in the Project Area. Fish and invertebrates in the Project Area may also be preyed upon by marine mammals, sea turtles, and marine birds.

Table 9.8 Summary of Key Fish Species in the Project Area

Depth Zone	Movements	Species	Feeding Group	Prey Species	Predators	References
Benthic		American plaice	Benthivore	invertebrates and fish	Larger piscivores such as cods and sharks	Scott and Scott 1988
Benthic	Seasonal migrations	Atlantic cod	Piscivore	sand lance, redfish, squid, crab, shrimp, whelks, and polychaetes		COSEWIC 2010a
Benthic		Blue hake	Benthivore	euphausiids, chaetognaths, polychaetes, copepods, and amphipods	Limited information	Houston and Haedrich 1986, Nielsen et al. 2015, Parzanini et al. 2017
Benthic		Common grenadier	Benthivore	euphausiids, amphipods, and polychaetes		

Table 9.8 Summary of Key Fish Species in the Project Area

Depth Zone	Movements	Species	Feeding Group	Prey Species	Predators	References
Benthic		Longnose eel	Benthivore	euphausiids, amphipods, fish, cephalopods, mysid shrimp and molluscs	Roundnose grenadiers	Houston and Haedrich 1986, Jamieson et al. 2011, Parzanini et al. 2017, DuBuit 1978
Benthic		Roughhead grenadier	Benthivore	echinoderms, crustaceans and bivalves, shrimp, small fish including myctophids, and squid	Larger piscivores such as cods	COSEWIC 2007, Parzanini et al. 2017
Benthic	Seasonal migrations	Roundnose grenadier	Benthivore	planktonic crustaceans and chaetognaths, shrimp, lanternfish, longnose eel, and squid		COSEWIC 2008, Parzanini et al. 2017, DuBuit 1978
Benthic		Spotted wolffish	Benthivore	Primarily invertebrates (echinoderms, crustaceans, and bivalves) and some fish.		COSEWIC 2012a,
Epipelagic	Diel vertical migration	Acadian redfish	Plank-piscivore	copepods, euphausiids and fish	Seals, and piscivorous fish (Greenland halibut, thorny skate, Atlantic cod, black dogfish, wolffish	COSEWIC 2010b
Epipelagic	Seasonal migrations, Diel vertical migration	Capelin	Planktivore	Plankton (e.g., copepods, amphipods, euphausiids))	Piscivorous fish, marine mammals, seabirds	Scott and Scott 1988, Trenkel et al. 2014, Maxner et al. 2016

Table 9.8 Summary of Key Fish Species in the Project Area

Depth Zone	Movements	Species	Feeding Group	Prey Species	Predators	References
Epipelagic	Seasonal migrations, Diel vertical migration	Swordfish	Piscivore	squid, Atlantic mackerel, Atlantic herring, and other fishes		Scott and Tibbo 1968, Stillwell and Kohler 1985, Lerner et al. 2013
Mesopelagic	Diel vertical migration	Deepwater redfish	Plank-piscivore	copepods, euphausiids and fish		COSEWIC 2010b
Mesopelagic	Diel vertical migration	Golden redfish	Plank-piscivore	copepods, euphausiids and fish		
Mesopelagic	Seasonal migrations	Greenland halibut	Piscivore	Pelagic fish and invertebrates including Atlantic cod, capelin, redfish, shrimp and squid		Morgan et al. 2013
Mesopelagic	Diel vertical migration	Lanternfish	Planktivore	amphipods, ostracods, hyperiids and fish eggs	Cod, hake, tunas, salmon, marine mammals	Kawaguchi and Mauchline 1982, Halliday et al. 2015, Scott and Scott 1988
Mesopelagic		Northern wolffish	Piscivore	pelagic fish and invertebrates including jellyfish and gelatinous zooplankton		COSEWIC 2012b

Table 9.9 Summary of Key Invertebrate Species in the Project Area

Depth Zone	Movements	Species Groups	Prey	Predators	References
Pelagic (epi, meso, bathy)	Diel vertical migrations	Squid	Small invertebrates, pelagic fish and invertebrates	Fish, seals, dolphins, toothed whales	Pauly and Trites 1998, Joyce et al. 2002
Pelagic (epi, meso, bathy)	Diel vertical migrations	Shrimp	Plankton	Planktivorous fish, baleen whales	Vázquez et al. 2013, Parsons et al. 1998

Table 9.9 Summary of Key Invertebrate Species in the Project Area

Depth Zone	Movements	Species Groups	Prey	Predators	References
Pelagic (epi, meso, bathy)		Jellyfish, pelagic tunicates,	Plankton, POM, detritus	Planktivorous fish such as tuna and ocean sunfish, and sea turtles	Fromentin and Powers 2005, Dodge et al. 2011, Potter and Howell 2011
Pelagic (epi, meso, bathy)	Diel vertical migrations	Amphipods, Copepods	Plankton	Planktivorous fish, baleen whales	Bowman et al. 2000, Coyle et al. 2007, Bergstad et al. 2003, Fiksen and Carlotti 1997
Benthic (epifauna)	Low mobility	Brittlestars, sea cucumbers	Detritus, copepods	Benthivorous fish and invertebrates	Pearson and Gage 1984, Templeman 1985, Hamel and Mercier 1998, Howell et al. 2003
Benthic (epifauna)	Low mobility	Sea urchin, sea star	Detritus, copepods	Benthivorous fish and invertebrates	Campos-Creasey 1995, Gale et al. 2013, Howell et al. 2003
Benthic (epifauna)	Seasonal migrations	Crab	Polychaetes, crustaceans, clams, small fish	Planktivorous fish (juveniles), benthivorous fish (small adults), other snow crab	Squires and Dawe 2003, Lovrich and Sainte-Marie 1997
Benthic (epifauna)	Sessile	Corals, Sponges, Sea anemones	POM, detritus	Limited information, evidence of predation by sea stars	Murillo et al. 2016a, Beazley and Kenchington 2015, Gale et al. 2013, Knudby et al. 2013
Benthic (infauna)	Low mobility	Polychaetes, bivalves, sand dollars	POM, detritus	Benthivorous fish and invertebrates	Bergstad et al. 2003, Ellers and Telford 1984

9.3 Core BdN Development Area

The Core BdN Development Area includes six broad phases / categories of activities as described in Chapter 2:

- Offshore construction and installation, and HUC
- Production and maintenance operations
- Drilling activities
- Supply and servicing

- Supporting surveys
- Decommissioning

The assessment in the following sections is based on these activities and associated potential interactions as identified in Section 9.1.5.1.

Some or all of these activities may also be part of Project Area Tiebacks which may occur in the larger Project Area; the interactions and potential environmental effects associated with Project Area Tiebacks are discussed in Section 9.4. Behavioural responses by fish and invertebrates to a Project activity cannot be isolated to a single interaction, rather behavioural responses are due to the collective factors influencing it. For many studies, it is not possible to isolate reactions to any single factor (i.e., fish behavioural response to only vessel lighting, sound, or discharges) due to the difficulties of separating factors for laboratory and field studies. While there is sufficient scientific literature to make assessments of general behaviour in responses to Project activity or component, reactions may deviate depending on species sensitivities, schooling or non-schooling behaviour, inter- and intraspecies reactions and mindset (e.g., predator avoidance, foraging, reproduction). Information on species and species groups are highlighted in the assessment below where possible.

9.3.1 Offshore Construction and Installation, Hook-up and Commissioning

Activities associated with offshore construction and installation and HUC, as described in Section 2.6.1, are those activities that are undertaken before and during the arrival of the FPSO at the Core BdN Development Area.

Offshore construction and installation activities include site preparation for, and the installation of subsea infrastructure (i.e., well templates, flowlines, risers, riser base, umbilicals, fibre optic cable). As noted in Section 2.6.1.2, options for installation of flowlines, umbilicals, and/or cables include placement on seafloor, or laid via trenching. In certain cases, there may be a requirement for protection of the flowlines/cables/umbilicals. Options for protection include rock placement, concrete mattresses or trenching. These protection measures would be undertaken during the offshore construction and installation phase.

Construction and installation activities will likely be carried seasonally, when offshore weather conditions are favourable, and could extend seasonally over a five-year period. For the purpose of this EA, seasonal offshore activities are generally assumed to occur between the spring and fall months when weather conditions are more favorable for offshore marine activity. Specialized vessels, as listed in Section 2.6.4.2, will be engaged as required to carry out these activities; the number of vessels offshore at any one time will depend on the activities ongoing at that time. Vessels would be engaged in activities at set locations within the footprint of the subsurface installations. For instance, for well template installations, it is likely that a single vessel would be engaged for installation, therefore the zone of influence during well template installation would be limited to a specific well template location and when installation is complete at one location, the vessel would move to the next well template location. Similarly, for flowline installation, the vessel engaged would be situated at one location only. While two different activities may occur at the same time (i.e., well template installation and flowline installation by two different vessels), it is not anticipated that there would be more than one vessel engaged in the same activity, simultaneously. The approximate sequence of SURF installation would be to install well templates and related components, install the FPSO mooring system, install the flowlines, risers and umbilicals, install the turret buoy, pull-in the risers, hook up the FPSO, and install infrastructure protection, as needed.

HUC activities may occur at any time of the year and are estimated to last approximately four months, depending on operational and/or technical issues. Vessels on site during HUC activities, in addition to the FPSO, may include, but not limited to, vessels engaged to attach flowlines, moorings, risers, etc., to the FPSO. Activities also include the flushing and leak testing of production lines on the FPSO and flowlines on the seafloor.

As indicated in Section 9.1.5.1, the effects assessment for offshore construction and installation and HUC is focused on those interactions and activities "with the greatest potential to have environmental effects" (Part 2, Section 3.2 of the EIS Guidelines) and therefore includes: light and sound emissions from vessels, and marine discharges (e.g., HUC, organic waste from vessels), and the installation of subsea infrastructure (including potential protection measures).

9.3.1.1 Light Emissions from Vessels

The primary effects on Marine Fish and Fish Habitat associated with light emissions from vessels during offshore construction and installation are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with the temporary attraction or avoidance of fish and invertebrates in the water column from vessels lighting during construction, installation, and HUC activities. Vessels are on-site for four to six months in the Core BdN Development Area, an area which is typically occupied by transient ocean-going vessels. Vessels would likely occupy a single location at any one time, as described in Section 9.3.1.

Lighting from vessels may result in the attraction or avoidance by fish and invertebrate species, such as plankton, krill, and lanternfish in the Core BdN Development Area, as described above. Light sensitive fish such as lanternfish that depend on dark areas for predator avoidance would likely react to a light field with avoidance horizontally or vertically depending on other environmental effects and presence of prey species (e.g., plankton). Krill, capelin, and cod may avoid vessel lighting based on measurements of acoustic backscatter in the Barents Sea (Berge et al. 2020).

The changes in behaviour associated with light emissions from vessels would be adverse, as described above, but short-term during the construction season. The geographic extent of the change in behaviour would be less than 1 km² of the location of the vessel within the Core BdN Development Area. The change in fish behaviour would occur regularly at night, and reversible once the vessel(s) leaves the area. As the change in behaviour is localized to the vessel, which occupies a very small footprint in the 470 km² of the Core BdN Development Area (including if more than one vessel were onsite at the same time), and does not affect fish behaviour in the larger Core BdN Development Area, there is no change in fish behaviour relative to baseline conditions and is therefore negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with light emissions from vessels engaged in Offshore Construction and Installation and HUC activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with light emissions from vessels during Construction and Installation and HUC activities. Vessels would likely occupy a single location at any one time, as described in Section 9.3.1. Vessels are on-site for four to six months in the Core BdN Development Area, an area which is typically occupied by transient ocean-going vessels and has only natural lighting sources (sunlight, moonlight).

Lighting from vessels may result in the attraction or avoidance of fish and invertebrate species that occur in epipelagic areas or undergo diel vertical migrations. Therefore, the displacement of fish may shift the spatial distribution of prey species and effect food availability. Migrating individuals, phototaxic plankton, and pelagic species may be attracted to the lighting effect on the surface water caused by lights reflecting off water surface. The presence of the vessel and artificial light emissions from the operating decks and navigation may create a “reef effect” in which fish may aggregate underneath in response to increased foraging and shelter opportunities (Picken and McIntyre 1989; Røstad et al. 2006; Slabbekoorn et al. 2010; Reynolds et al. 2018), even in areas of elevated underwater sound. Lighting around the vessel may attract phototaxic plankton and may provide increased opportunities for prey capture by fish and other species (Keenan et al. 2007; Cordes et al. 2016). Lanternfish are important mesopelagic prey species in the Core BdN Development Area that use photophores to imitate ambient light and reduce visibility to predators (Peña 2019). Peña (2019) assessed the reactions of mesopelagic fishes to vessel DP in the Canary Islands where the most abundant mesopelagic fishes were lanternfish species. When the vessel with continuous lighting turned on and the vessel in DP mode, adding underwater sound, mesopelagic fishes reacted with migrations to deeper in the water column (Peña 2019). The combination of DP mode in vessels and lighting from ambient night levels resulted in both migrations to deeper in the water column (from 20 to 70 m) and scattering of fishes (Peña 2019). The reaction of lanternfish to the sudden change in light intensity was likely due to becoming visible in downwelling light and therefore migrated to deeper waters where their visibility to predators remained reduced (Peña 2019). Light sensitive fish such as lanternfish that depend on dark areas for predator avoidance would likely react to a light field with avoidance horizontally or vertically depending on other environmental effects and presence of prey species (e.g., plankton). Turning on the vessel lights during Arctic polar night in the Barents Sea, resulted in reduced acoustic backscatter in an area dominated by krill, capelin, Atlantic cod, and polar cod indicating potential avoidance by these species (Berge et al. 2020). Within the Core BdN Development Area, lighting from vessels may generally result in some degree of attraction by phototaxic plankton and avoidance by krill and lanternfish. Individual behavioural responses may vary depending upon the species, and reproductive and foraging states involved. However, the effects to fish availability would be limited from Project-related vessel activity due to its transitory nature and thus its short-term presence at any one location.

The Change in Food Availability and/or Quality due to the light emissions from vessels would be adverse, as described above, but short-term during the construction season. The geographic extent of the change in food availability would be less than 1 km² of the location of the vessel within the Core BdN Development Area. The change in food availability would occur regularly at night while vessels were on-site, and reversible once the vessel(s) leaves the area. While light emissions may change food availability within a localized area of the vessel, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with light emissions from vessels during Offshore Construction and Installation, and HUC activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with light emissions from vessels engaged in Offshore Construction, Installation and HUC activities are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with light emissions from of vessels engaged in Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions.

9.3.1.2 Underwater Sound Emissions from Vessels

The primary effects on Marine Fish and Fish Habitat associated with underwater sound emissions from vessels during offshore construction and installation and HUC activities are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

The discussion of effects of underwater sound in this Section are in relation to vessels. Refer to Section 9.3.5.4 for a full discussion on effects of underwater sound emissions on fish and invertebrates. Given the transient nature of fish and the demonstrated avoidance behaviours of fish in response to underwater sound (see Section 9.2.5.2) it is unlikely that fish would remain in the immediate area long enough (i.e., 12-hour and 48-hour periods indicated by Popper et al. (2014)) for potential injury effects of exposure to continuous sound. Therefore, there would not be a Change in Injury, Mortality and/or Health associated with underwater sound emissions from vessels.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with underwater sound emissions from vessels engaged in construction and installation activities and HUC activities. Vessels would likely occupy a single location at any one time, as described in Section 9.3.1. Vessels are on-site for four to six months in the Core BdN Development Area, an area which is typically occupied by transient ocean-going vessels.

A variety of behavioural responses by marine fishes and invertebrates to anthropogenic underwater sound emissions has been observed in studies as described in Section 9.3.5.2 and 9.3.5.4. These responses vary by, for example, species, life stage, received sound level, frequency of sound, type of sound (i.e., impulsive vs. continuous), and rise time. These behavioral effects include both temporary responses (e.g., startle/avoidance responses) and longer-term responses (e.g., larger-scale redistribution).

Underwater sound generated by vessel traffic and use can be transmitted through water and may cause avoidance or attraction by some species (Røstad et al. 2006; De Robertis and Handegard 2013), (e.g., such as redfish, which is in the Core BdN Development Area). Norwegian experiments involving fish behaviour and vessel sound have suggested some degree of attraction of fishes to vessels with DP (Røstad et al. 2006). Acoustic tracking of fishes indicated attraction of non-schooling (e.g., whiting) and schooling fishes (e.g., herring, sprat) to a vessel with limited lighting and continuous operation of DP (Røstad et al. 2006). Similar effects could be likely in the Core BdN Development Area with the presence of redfish. Fish scattering and avoidance of the vessel was attributed to its shifting of position rather than to the continuous sound from the thrusters (Røstad et al. 2006). As noted above, lanternfish are an important mesopelagic prey species in the Project Area. Lanternfish species in the Canary Islands have been observed to avoid vessel DP sound (Peña 2019). When the vessel with continuous lighting turned on DP, mesopelagic fishes reacted with migrations from <60 m to 60-200 m (Peña 2019). The combination of turning on vessel DP and lighting from ambient night levels resulted in both vertical migrations (from 20 to 70 m) and scattering of fishes (Peña 2019). Avoidance behaviour may be linked with the abruptness of turning on vessel DP relative to attraction of schooling fish to vessels with continuous DP (Røstad et al. 2006, Peña 2019). Given the transient nature of fish and the demonstrated avoidance behaviours of fish in response to sound (see Section 9.3.5.2) it is unlikely that fish would remain in the immediate area long enough (i.e., 12-hour and 48-hour periods indicated by Popper et al. (2014)) for potential effects of exposure to continuous sound. If there is displacement from underwater sound, pelagic fishes in the Core BdN Development Area (e.g., lanternfish) are typically highly mobile and would likely return after cessation of the activity or removal of the sound source.

The change in behaviour associated with underwater sound emissions from vessels would be adverse, as described above, but short-term during the construction season. The geographic extent of the change in behaviour would be less than 1 km² of the location of the vessel within the Core BdN Development Area. The change in behaviour would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. While underwater sound emissions may affect the presence and/or abundance of fish within the localized (less than 1 km²) area of the vessel for a short duration, their abundance and or presence is not affected within the entire Core BdN Development Area. There is no change in abundance and/or presence relative to baseline condition and is therefore the magnitude of effect is considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat availability and/or quality are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with underwater sound emissions from vessels during Construction and Installation and HUC activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with underwater sound emissions from vessels engaged in Construction and Installation Activities and HUC activities. Vessels would likely occupy a single location at any one time, as described in Section 9.3.1. Vessels are on-site for four to six months in the Core BdN Development Area, an area which is typically occupied by transient ocean-going vessels.

Fish may respond with avoidance or attraction responses to vessel sounds as described above. Therefore, the displacement of fish may shift the spatial distribution of prey species and have effects on food availability. Changes to the spatial distribution of fish from underwater sound would likely be temporary as the fishes in the water column (e.g., lanternfish) are typically highly mobile and would likely return after cessation of the activity or removal of the sound source.

The change in food availability and/or quality associated with underwater sound emissions from vessels are predicted to be adverse, as described above, but short-term during the construction season. The geographic extent of the change in food availability would be less than 1 km² of the location of the vessel within the Core BdN Development Area. The change in food availability would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. While underwater sound emissions may reduce food availability within a localized area of the vessel, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and quality are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound emissions from vessels during Construction and Installation and HUC Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities are not proposed

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions.

9.3.1.3 Installation of Subsea Infrastructure (including Potential Protection)

As described in Section 2.5.3.2, subsea infrastructure includes well templates and riser bases, moorings, flowlines, umbilicals and cables. Moorings will be permanently positioned on the seafloor likely via suction pile driving (see Section 2.6.1.2). Flowlines, umbilicals, and cables will likely be laid directly on seafloor or laid via trenching. Should protection measures be required, installation of subsea infrastructure protection may include activities such as rock placement, trenching and/or installation of concrete mattresses. Depending on installation methods chosen, and if protection measures were required, activities that may interact with the seabed during the installation of subsea infrastructure include site clearing, excavating, dredging, rock dumping, trenching, suction-pile moorings, or disposal of sediments.

The primary effects on Marine Fish and Fish Habitat, due to the installation of subsea infrastructure during offshore construction and installation are:

- Change in Habitat Availability and/or Quality
- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury, and/or Health
- Change in Food Availability and/or Quality

Change in Habitat Availability and/or Quality is a potential effect associated with the installation of subsea infrastructure.

Site preparation and installation of subsea infrastructure may include the disturbance and direct physical interaction with the seabed and may result in change in seabed characteristics and water quality through introduction of suspended particles in the water column (Watling and Norse 1998; Thrush and Dayton 2002; Roberts 2012; Clark et al. 2016; Cordes et al. 2016). Coral and sponge biogenic habitats, where habitat is created by an organism itself, are of concern due to their fragile nature and slow recovery (Henry and Hart 2005; Cordes et al. 2016; NAFO 2016). In fine mud substrate habitat, common in the Flemish Pass (Murillo et al. 2016b), including the Core BdN Development Area, installation of subsea infrastructure, including dredging, suction pile driving, trenching, and placement of rock protection or concrete mattresses may resuspend sediments within tens of meters where work is occurring. Increased suspended particles may clog feeding structures of filter feeding organisms (Bell et al. 2015; Liefmann et al. 2018; Vad et al. 2018), such as sea anemones, soft corals, sea pens, and sponges found in the Core BdN Development Area, and reduce visibility for benthic fish (e.g., grenadiers, longnose eel, wolffish) through increased turbidity (De Robertis et al. 2003; Higham et al. 2015). Suspended particles may also promote temporary avoidance by mobile fish and invertebrates. Excavation of sediments may also introduce sediment particles of different shapes and sizes relative to surficial sediments not normally encountered in the area, thereby potentially resulting in changes in habitat quality which may affect feeding behaviour and organism injury (Liefmann et al. 2018) and may result in a local change in benthic community composition. Offshore construction and installation activities, as noted above, will likely be seasonal, thereby reducing overall duration and allowing for recovery between activity years.

Should protection measures be required, installation of subsea infrastructure protection may include activities such as rock placement, trenching and/or installation of concrete mattresses. These activities would have similar environmental interactions as site preparation and installation of subsea infrastructure as described above. The potential adverse effects may be offset as the rock protection, subsea infrastructure itself, may have localized positive effects with the addition of hard substrate and habitat complexity creating additional habitat. These potential positive long-term effects due to the presence of subsea infrastructure as habitat are addressed in Section 9.3.2.1.

The Change in Habitat Availability and/or Quality due to the subsea infrastructure installation would be adverse, as described above, but short-term during the construction season. The geographic extent of the change in habitat would be within tens of meters of the location of the subsea infrastructure within the Core BdN Development Area. Overall, the subsea infrastructure covers approximately 7 km² of the seabed within the 470 km² Core BdN Development Area. The change in habitat would range from sporadic for turbidity effects to regular for changes to seabed effects during installation and reversible once construction activities cease. As the change in habitat represents approximately 1.5 percent of total habitat available within the Core BdN Development Area, the change in habitat is considered to be within the range of natural variability, therefore the magnitude of change in habitat would be low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

Mitigations to reduce the change in habitat availability and/or quality include no placement of well templates over *Lophelia pertusa* corals. If the installation of subsea infrastructure is determined by DFO to require a *Fisheries Act* Authorization, a habitat offsetting program will be developed in conjunction with DFO as a mitigation measure for the net loss of fish habitat resulting from the Project. Equinor Canada will commence the process for a "Request for Review" pursuant to the provisions of the *Fisheries Act* prior to the commencement of the Offshore Construction and Installation phase of the Project.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with the installation of subsea infrastructure during Construction and Installation are predicted to be adverse, low in magnitude, with a geographic extent less than 10 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with the installation of subsea infrastructure.

As described above, increased suspended particles in the water column could increase turbidity and may result in avoidance by fish including grenadiers and longnose eels. However, these effects would only be temporary during the initial excavation or placement of infrastructure for turbidity effects or for the duration of construction with sound effects. The change in fish and invertebrate behaviour due to the subsea infrastructure installation would be adverse, as described above, but short-term during the construction season. Overall, the subsea infrastructure covers approximately 7 km² of the seabed; however, installation and associated disturbance effects would not be occurring simultaneously along the entire footprint. Therefore, the overall geographic extent would be less than 1 km² (i.e., the geographic extent of the behavioural disturbance would be localized to the location of the subsea infrastructure within the Core BdN Development Area). While installation of subsea infrastructure may affect the presence and/or abundance of fish within the localized (less than 1 km²) area, their abundance and or presence is not affected within the entire Core BdN Development Area. There is no change in abundance and/or presence relative to baseline conditions, and the change in behaviour therefore is considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in fish and invertebrate behaviour are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with the installation of subsea infrastructure during Construction and Installation are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Fish and Invertebrate Mortality, Injury and/or Health is a potential effect associated with the installation of subsea infrastructure.

As described above, site preparation and installation of subsea infrastructure may include the disturbance and direct physical interaction with the seabed, and may result in exposure, injury, and/or mortality of benthic organisms, through burial and introduction of suspended particles in the water (Watling and Norse 1998; Thrush and Dayton 2002; Roberts 2012; Clark et al. 2016; Cordes et al. 2016). Sessile or low mobility benthic organisms, such as sea anemones, echinoderms (brittle stars, sea stars, sea urchins), and bivalves in the Core BdN Development Area, are vulnerable to physical disturbance due to their low avoidance capabilities (Clark et al. 2016; Cordes et al. 2016). The placement of suction anchors or other subsea infrastructure can disturb bottom habitats and cause injury or mortality to benthic invertebrates, (Davis et al. 1982; Cordes et al. 2016; Ragnarsson et al. 2017), including soft corals, sea pens, and solid/massive sponges observed at well template locations (Equinor 2020) in the Core BdN Development Area. As noted above, in fine mud substrate habitat installation of subsea infrastructure may resuspend sediments. Increased suspended particles may clog feeding structures of filter feeding organisms (Bell et al. 2015; Liefmann et al. 2018; Vad et al. 2018). Excavation of sediments may also introduce sediment particles of different shapes and sizes that are different from surficial substrate and not normally encountered in the area thereby potentially resulting in changes in feeding behaviour and organism injury (Liefmann et al. 2018) and may result in a local change in benthic community composition (Heery et al. 2017). As described above, the eventual recolonization of fish and invertebrates to the subsea structures may counterbalance initial losses.

Coral and sponge biogenic habitats, where habitat is created by an organism itself, are of concern due to their fragile nature and slow recovery (Henry and Hart 2005; Cordes et al. 2016; NAFO 2016). Coral densities have been shown to decrease in areas of disturbance (i.e., trawling), however, some sea pen species have been able to re-anchor themselves into sediment after dislodgement (Malecha and Stone 2009; NAFO 2011). The soft coral *Gersemia rubiformis* has also been shown to be resistant to mechanical disturbance such as crushing, with only temporary impairments to colony retraction and expansion (Henry et al. 2003). Other Nephtheidae soft corals in the Project Area may have similar resistance to mechanical disturbance. During the 2018 Equinor Seabed Survey, anthropogenic objects (e.g., fishing nets) in the Project Area were observed to be colonized by local sponges, anemones, and soft corals (see Figure 9-3) (Equinor 2020). While it is not possible to identify timescales for colonization, it indicates that structures may be colonized by hard substrate limited species, such as soft corals, sponges, and sea anemones in the Core BdN Development Area (Equinor 2020). In a study of disposal of dredged material, which was native material moved during the excavation of drill centers (T. Edgell, pers. comm. 2020) on the Grand Banks (in about 100 m water depth) effects on sediments and benthic and demersal species were observed initially after ocean disposal of the native dredged material (Edgell et al. 2019). However, conditions were similar to reference stations after three years, at the end of the study (Edgell et al. 2019). This study indicates recovery and recolonization of disturbed seabed areas in the shallower waters of Northwest Atlantic region. However, recolonization timescales would likely be longer in the deeper waters of the Core BdN Development Area.

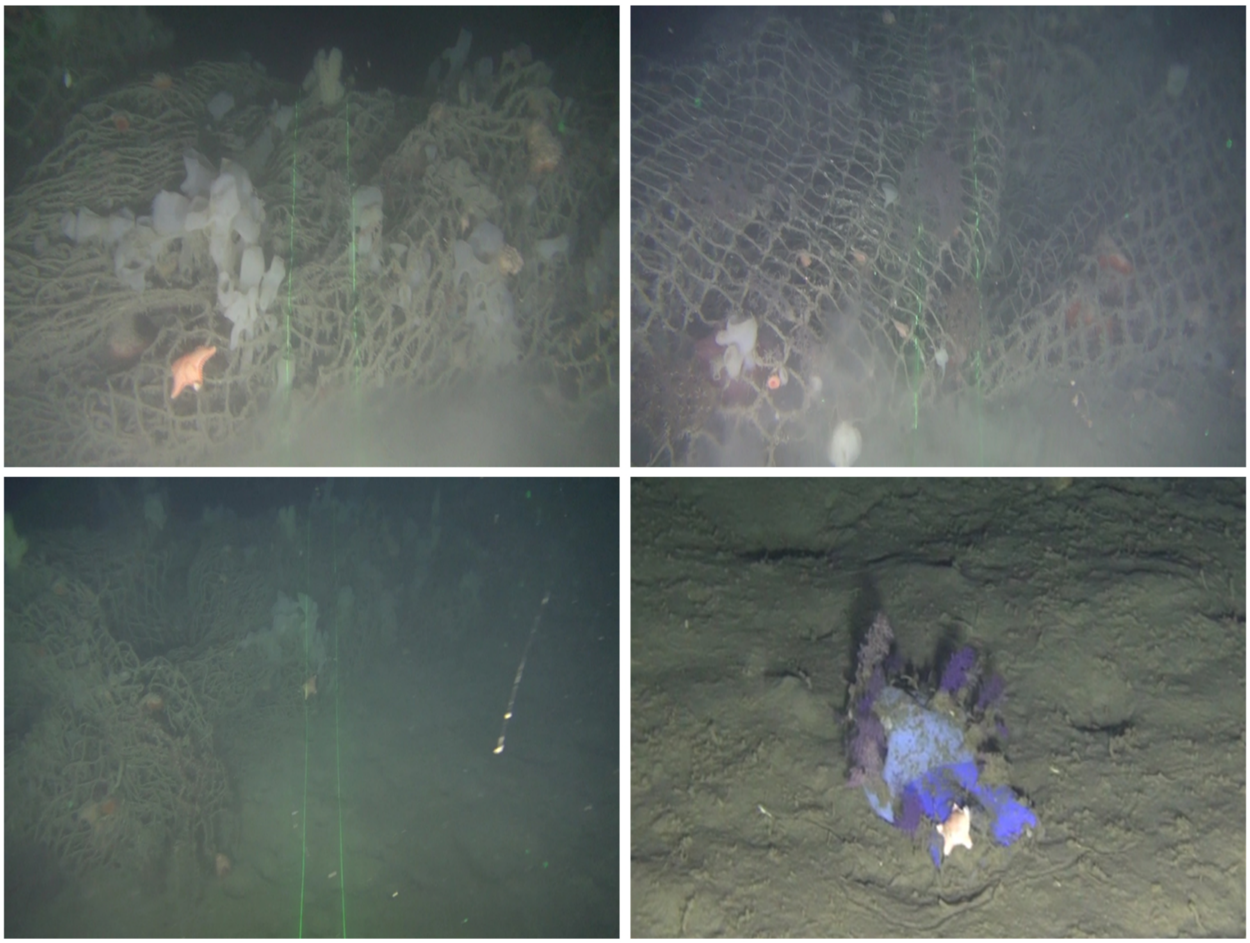

Figure 9-3 Abandoned fishing nets and a glove and associated anemones, soft corals, and glass sponges inside the NAFO fisheries closure area (Flemish Cap 10) observed during the Equinor 2018 Seabed Survey between 612-1,144 depth. Green scale lasers are set at 15 cm

The Change in Fish and Invertebrate Mortality, Injury and/or Health due to the subsea infrastructure installation would be adverse, as described above, but medium- to long-term, depending on species in the area and/or length of time for recolonization. The geographic extent of the change in mortality, injury and/or health would be within the immediate vicinity of the subsea infrastructure (i.e., less than 1 km²).The total area of subsea infrastructure is approximately 7 km², therefore the geographic extent of injury and/or mortality of benthic fish and invertebrates would be less than 10 km² within the Core BdN Development Area. The change in fish and invertebrate mortality or injury would occur with initial placement of infrastructure and therefore is characterized as occurring regularly during the construction season. While individual fish, coral or sponge mortality is not directly reversible, the overall effect to these populations is considered reversible, as it is predicted that similar communities will recolonize the area as described above. The zone of influence estimated to be 7 km² which represents approximately 1.5 percent of the 470 km² area available in the Core BdN Development Area, therefore the change in mortality / injury / health would be considered within the range of natural variability without affecting the viability of local populations and is therefore low. With the exception of timeframe for recovery, as discussed above, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, recovery of benthic communities in deep water is not well understood and the predicted time to recovery is based on studies in shallower marine waters, therefore the timeframe for recovery is made with a moderate level of confidence.

Mitigations to reduce the change in mortality, injury and/or health include no placement of well templates over *Lophelia pertusa* corals. If DFO determines that the placement of subsea infrastructure and/or protection measures requires an authorization pursuant to Section 35(2) of the *Fisheries Act*, offsetting measures, will mitigate fish and fish habitat losses. Equinor Canada will commence the DFO process for a “Request for Review” pursuant to the provisions of the *Fisheries Act* prior to the commencement of the Offshore Construction and Installation phase of the Project.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health from the installation of subsea infrastructure during Construction and Installation are predicted to be adverse, low in magnitude, with a geographic extent less than 10 km², of medium- to long-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with installation of subsea infrastructure

Seabed disturbance may result in mortality of fish and invertebrates on the seabed. Initial mortalities may result in a temporary increase in food for scavenging fish (e.g., longnose eel) and invertebrates (e.g., seastars) (Clark et al. 2016; Gale et al. 2013; Parzanini et al. 2017, 2018). Any loss in fish and invertebrates may be eventually offset with the addition of the artificial structures that may have localized positive effects with the addition of hard substrate and habitat complexity (See Section 9.3.2.1). Increased suspended particles in the water column could increase turbidity, potentially reducing visual cues for predator-prey interactions (De Robertis et al. 2003; Higham et al. 2015) and could affect benthic fishes (e.g., grenadiers, longnose eel, wolffish) in the area where subsea infrastructure is installed. However, these effects would only be temporary during the initial excavation or placement of infrastructure for turbidity effects or for the duration of construction with sound effects.

The change in food availability and/or quality associated with subsea infrastructure installation would be adverse, as described above, but short-term during the construction season. The geographic extent of the food availability would be localized to the location of the subsea infrastructure within the Core BdN Development Area. Overall, the subsea infrastructure covers approximately 7 km² of the seabed, however, installation and associated disturbance effects would not be occurring simultaneously along the entire footprint. Therefore, the overall geographic extent would be less than 1 km². The change in food availability would be regular during installation and reversible with eventual decommissioning of subsea infrastructure, or cessation of installation activities for disturbance effects. While the installation of subsea infrastructure may reduce food availability within a localized area of the seafloor, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with the installation of subsea infrastructure during Construction and Installation are predicted to be adverse, negligible in magnitude, with geographic extent less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the installation of subsea infrastructure and/or protection measures during Offshore Construction, Installation and HUC include placement of well templates to avoid *Lophelia pertusa* (A) and habitat offsetting measures, if required by DFO (C).

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the installation of subsea infrastructure. If DFO determines pursuant to the *Fisheries Act* that an authorization is required, habitat offsetting measures and a monitoring program will be developed.

9.3.1.4 Hook-up and Commissioning: HUC Discharges

The primary effects on Marine Fish and Fish Habitat, associated with discharges of test water during hook-up and commissioning are:

- Change in Fish and Invertebrate Mortality, Injury, and/or Health

Change in Fish and Invertebrate Mortality, Injury, and/or Health is a potential effect associated with the HUC-associated discharges during HUC activities.

Commissioning activities would likely involve the flooding and testing of infrastructure with treated seawater that would be eventually discharged to the marine environment. Test water may be chemically treated with biocides, which is used to prevent corrosion and inhibit bacterial growth of tested infrastructure. Microbiological communities, including bacteria, may induce corrosion of flowlines and production facilities (Hansen et al. 2009). In particular, sulphide producing bacteria accelerate corrosion processes as cast iron and steel alloys are corroded by sulphides (Hudgins 1992; Hansen et al. 2009). Biocides are introduced to production systems to prevent corrosion or fouling of equipment (Hudgins 1992; Okoro et al. 2016). However, introduction of biocides may have mortality effects on non-target species (Dafforn et al. 2011) depending on the type, quantity and biocide characteristics. If biocides or any chemicals used in HUC, they will be selected using Equinor's chemical selection system and consistent with the OCSG (NEB et al. 2009) and will be discharged in accordance with the OWTG (NEB et al. 2010). Within the Core BdN Development Area, this would mainly have effects on plankton, however it is not predicted to have associated effects on food availability. Test water would also be diluted in receiving waters and is not predicted to result in discernable effects to the overall population of planktonic species.

The change in fish and invertebrate mortality, injury and/or health due to the hook-up and commissioning would be adverse, as described above, but short-term during HUC activities. The geographic extent of the change in fish and invertebrate mortality would be less than 1 km² of discharge location. The change in fish and invertebrate mortality would be sporadic, as discharges depend on timing of leak testing, and reversible with cessation activities. While HUC discharges may cause a change in mortality for plankton within a localized area, it is unlikely with dispersion and dilution in the Project Area for this activity to have effects on the overall population in the Core BdN Development Area is not affected. The magnitude of this change would be considered within the range of natural variability and is, therefore, low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations such as screening of chemicals and adherence to the OWTG will reduce potential effects.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with HUC activities are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the HUC discharges include the treatment of discharges from the FPSO in accordance with the OWTG (E) and screening of chemicals in accordance with C-NLOPB requirements and Equinor's global practices (F)

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with HUC discharges in consideration of residual effects predictions.

9.3.2 Production and Maintenance Operations

Activities associated with production and maintenance operations, as described in Section 2.6.2, are those activities that are undertaken once HUC activities are complete when production operations commence on the FPSO. All activities are from the FPSO and therefore in a fixed location within the Core BdN Development Area.

Production and maintenance activities involve the various discharges and emissions which may interact with Marine Fish and Fish Habitat, including on light and sound emissions and marine discharges (e.g., produced water, cooling water, other waste discharges). There will be no flaring of gas during routine production and maintenance operations. However, start-up, regularly scheduled major shutdowns / turnarounds, well clean-up activities, and during upset process conditions, depressurization of process segments may be required for safety reasons, and gas will be sent to the flare. Production and maintenance operations for the Core BdN Development is expected to between 12 to 20 years.

9.3.2.1 Presence of FPSO and Subsea Infrastructure

The primary effects on Marine Fish and Fish Habitat associated with the presence of the FPSO and subsea infrastructure during Production and Maintenance Operations are:

- Change in Habitat Availability and/or Quality
- Change in Food Availability and/or Quality

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is primarily a secondary effect associated with change in habitat and/or change in food availability and is considered within these effects assessment discussions.

Changes in Habitat Availability and/or Quality is a potential effect associated with the presence of the FPSO and subsea infrastructure. The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area. Subsea infrastructure will offer hard substrate in an area comprised of mainly soft sediments and occasional boulders.

Presence of FPSO

The presence of the FPSO and the establishment of the anti-collision zone around the FPSO, which would be avoided by marine traffic, may provide a temporary refuge for fish (Franks 2000; Keenan et al. 2007; Macreadie et al. 2011; Cordes et al. 2016) and reduce effects on trawling disturbance on benthic communities (Heery et al. 2017) and thereby increasing the quality of the habitat. In these instances, fish and invertebrate species may benefit through increased availability of shelter and food for juveniles, and by the decreased fishing pressure on adults. Potential positive effects would last for the duration of the presence of the anti-collision zone and underwater infrastructure. The types of subsea infrastructure may have similar abundances and biomasses of colonized benthic organisms, however concrete structures have been shown to host more diverse benthic communities in comparison to structures comprised of steel (Bergström et al. 2014). The changes to benthic communities would be dependent on a variety of factors including local biotic communities, depths, oceanographic processes, structure design and configuration, material composition. During the 2018 Equinor Seabed Survey, anthropogenic objects (e.g., fishing nets) in the Flemish Pass were observed to be colonized by local sponges, anemones, and soft corals (Equinor 2020). Benthivore species, such as grenadiers or longnose eels, would also likely be attracted.

With respect to aquatic invasive species, organisms attaching to hard substrate are typically seen in nearshore and benthic environments, and their effects are likely more important to coastal communities compared to the open ocean (Templeman 2010 in Amec 2014). In offshore environments, species may be transmitted to the installation through ballast water or on the hull of vessels servicing the offshore area (Sammarco et al. 2004) or through local recruitment. The majority of published literature has focused on ballast water as an invasion vector, though hull fouling is acknowledged as a lesser vector for species. While ballast water typically contains mobile, pelagic forms of species that can colonize quickly, hull biofouling typically is made up of adult individuals which have a lower invasion potential (Drake and Lodge 2007). Additionally, fouling assemblages show a decrease in diversity with increasing distance from shore (van der Stap et al. 2016). Organisms attaching to hard substrate are typically seen in nearshore and benthic environments, and their effects are likely more important to coastal communities compared to the open ocean (Templeman 2010 in Amec 2014).The distance to shore will likely inhibit or slow the colonization by organisms adapted to rocky surfaces and inhabit any stepping-stone invasions in the same way Prevention is considered to be key in controlling the introduction and spread of aquatic invasive species, because control of established populations is often costly and ecologically risky (Bax et al. 2001). The likelihood that a Project vessel and/or installation will result in the introduction and spread of an invasive species is low, ballast water and hull fouling will be managed in consideration of applicable Canadian and international requirements to reduce the potential spread of invasive species. In addition, anti-fouling paint will be used on the hull of the FPSO.

Effects on fish habitat availability and/or quality due to the presence of the FPSO are predicted to be positive to adverse, as noted above and reversible once the FPSO leaves the area. The geographic extent is localized to the location of the FPSO, therefore less than 1 km^2. The change in habitat would be long term, and continuous, as the FPSO is on location for up to 12 to 20 years. The magnitude of the change in habitat would be negligible. While there is a potential interaction, the change in habitat relative to baseline conditions is negligible as it represents a small portion of the available habitat in the Core BdN Development Area. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

Presence of subsea infrastructure

Artificial structures introduced to environments can have local influences on invertebrate community structure, species diversity, and abundance through the addition of hard substrate and habitat complexity (Wolfson et al. 1979; Bomkamp et al. 2004; Apolinario and Coutinho 2009; Macreadie et al. 2011; Ajemian et al. 2015, Reynolds et al. 2018; Lacey and Haynes 2019). Initial installation of the subsea infrastructure may result in direct injury and mortality of fish and invertebrates (placement loss) within the footprint of the subsea infrastructure and short-term turbidity effects of natural sediments (Heery et al. 2017) as described in Section 9.3.1.4. Over time, there may be a shift from a soft bottom benthic invertebrate community (e.g., sea pens, sea urchins, infaunal species), to communities associated with hard substrate (e.g., sponges, soft corals, anemones). The presence of subsea infrastructure (i.e., flowlines, anchors, well templates, umbilicals, riser base) and potential protection measures (e.g., rock placement, wellhead protection, concrete mattresses) may locally increase habitat complexity through introduction of available hard structures for colonization by sessile species (Sargent et al. 2006; Bergström et al. 2014; Cordes et al. 2016; Lacey and Haynes 2019) including soft corals, sponges, and sea anemones, and shelter for mobile fish and invertebrate species.

Introduced subsea infrastructure provides stepping-stone habitat for colonizing benthic species to increase their distribution (Cordes et al. 2016). Deep-sea invertebrates use a variety of strategies to promote dispersal including delayed and slower egg development, and planktotrophic larvae with high parental investment (Young et al. 2018). As deep-sea larvae have been observed in the upper water column (Young et al. 2018), it suggests that certain species are able to disperse widely and may take advantage of temporary infrastructure structures for settling and colonization.

Effects on fish habitat availability and/or quality due to the presence of the subsea infrastructure are predicted to be adverse for soft bottom communities and positive for hard bottom communities, as noted above and reversible should subsea infrastructure be removed. The change in habitat would be long term and continuous, while the subsea infrastructure is in place. The geographic extent of the change in habitat would be approximately 7 km^2, the area of the seafloor occupied by the subsea infrastructure, which presents approximately 1.5 percent of the total 470 km^2 area of the Core BdN Development Area. The change in habitat is therefore considered within the range of natural variability and would be of low magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

As noted in Section 9.3.1.4, if DFO determines that a *Fisheries Act Authorization* is required for the placement of subsea infrastructure including the requirement for habitat offsetting measures, these measures would mitigate changes in fish habitat associated with the presence of subsea infrastructure. As noted above, Equinor Canada will commence the process for a "Request for Review" pursuant to the provisions of the *Fisheries Act* prior to the commencement construction and installation activities.

In summary and in consideration of the varying Changes in Fish Habitat Availability and/or Quality discussed above, and with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality from the presence of the FPSO and subsea infrastructure during Production and Maintenance Operations are predicted to be positive to adverse, negligible to low in magnitude, with a geographic extent less than 10 km^2 of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with the presence of the FPSO and subsea infrastructure. The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area. Subsea infrastructure will offer hard substrate in an area comprised of mainly soft sediments and occasional boulders.

The local enrichment associated with colonization of infrastructure and refuges for fish discussed above, may provide increased food availability for benthic fishes (e.g., grenadier, blue hake, longnose eel), and also decreased fishing pressure on adults. Potential positive effects would last for the duration of the presence of the FPSO and subsea infrastructure. As noted above, the presence of subsea infrastructure and potential protection measures may locally increase habitat complexity through introduction of available hard structures for colonization by sessile species. which may lead to localized organic enrichment or food subsides with natural dislodgement of settled sessile invertebrates and faecal pellets (Lacey and Haynes 2019) and material fluxes adjacent to the structures associated with dislodged shells and changes in local hydrodynamics (Heery et al. 2017). This would likely benefit benthivore fish species (e.g., grenadiers, longnose eels, wolffish), and opportunistic foragers such as seastars and crab. Studies have indicated that enrichment for oil and gas platforms is limited to within 100 m of the structure and within 500 m for material fluxes (Heery et al. 2017).

The subsea infrastructure may also attract invertebrate and fish species and provide food subsidies through fouling and colonization of infrastructure that may support higher trophic levels (Wolfson et al. 1979; Bomkamp et al. 2004; van der Stap 2016; Fujii 2016). For example, bivalves that colonize offshore platforms in the Pacific Ocean become dislodged with waves and storm events and form shell mounds underneath the structure providing food subsidies to benthic communities and additional hard substrate for other organisms to colonize (Bomkamp et al. 2004; Claisse et al. 2015). While this food subsidization scenario is unlikely at depths of Project activities, subsea infrastructure in a habitat-limited environment will have some level of food subsidization and habitat creation. During the 2018 Equinor Seabed Survey, anthropogenic objects (e.g., fishing nets) in the Flemish Pass were observed to be colonized by local sponges, anemones, and soft corals (see Figure 9-3 above) (Equinor 2020). Offshore drilling and production installations may provide unique feeding grounds for fish as demonstrated by pollock, haddock and cod that have been captured around a North Sea oil platform with distinct prey composition in their diets (Fujii 2016). The combination of fouling communities, combined with attraction of zooplankton to the platform, provides a range of prey types that support a variety of fish species (Fujii 2016). Benthivores in the Project Area (e.g., longnose eel, grenadier) would likely benefit from food subsidization from colonization of subsea structures. Changes to food quality associated with the presence of the FPSO are not are not anticipated.

The change in food availability due to the presence of the FPSO and subsea infrastructure would be positive to adverse, as described above, and long-term. The geographic extent of the change in food availability would be between 1 km² and than 10 km² (due to the footprint of the subsea infrastructure) within the Core BdN Development Area. The change in food availability would be continuous and reversible, should subsea infrastructure be removed at decommissioning and removal of the FPSO. While there may be a change food availability within a localized area of the FPSO, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability considered relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability from presence of the FPSO and subsea infrastructure are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality due to the presence of the FPSO and subsea infrastructure are predicted to be positive to adverse, negligible in magnitude, with a localized geographic extent between 1 km² and 10 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the presence of the FPSO and /or subsea infrastructure include habitat offsetting measures, if required by DFO (C), biofouling paint on the hull of the FPSO (J); ballast water management in consideration of applicable Canadian and international requirements (D)

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the Presence of the FPSO and/or subsea infrastructure. However, if DFO determines that habitat offsetting measures are required, a monitoring program may be required.

9.3.2.2 Light Emissions from the FPSO

The primary effects on Marine Fish and Fish Habitat due to the light emissions from the FPSO are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels. The presence of the FPSO during Production and Operations at the Core BdN Development Area would be a new source of artificial lighting in a region that is relatively free of nocturnal artificial lighting, as indicated in a world atlas of computed artificial night sky brightness (Falchi et al. 2016).

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with light emissions from the FPSO.

Swordfish and other pelagic fishes have been shown to be attracted to marine structures, including oil platforms, fish farms, and offshore wind turbines (Franks 2000; Fayram and de Risi 2007; Arechavala-Lopez et al. 2013). Swordfish may be attracted to these areas based on increased foraging opportunities and better lighting for predation (Franks 2000; Hazin et al. 2005; Hoolihan et al. 2014; Orbesen et al. 2017) and large pelagic species in the North Atlantic (e.g., tuna, swordfish, sharks) may respond similarly to the FPSO. Other fishes, such as cod, pollock, and mackerel have also been observed in higher numbers around offshore platforms in the North Sea (Valdermarsen 1979; Soldal et al. 2002), and similar attraction effects of Atlantic cod to the FPSO may occur. Conversely, as noted above, certain prey species (i.e., lanternfish) may avoid the lighted area to hide from predators.

The change in fish and invertebrate behavioural effects due to the light from the FPSO would be adverse, as described above, and long-term. The geographic extent of the change in behaviour would be less than 10 km² of the FPSO, as noted above, within the Core BdN Development Area. The change in fish behaviour would occur regularly at night and reversible with removal of the FPSO. As the change in behaviour is localized to the FPSO, which occupies a very small footprint in the 470 km² of the Core BdN Development Area (including if the FPSO and drilling installation were onsite at the same time), and does not affect fish behaviour in the larger Core BdN Development Area, the effects are considered to be within the range of natural variability without affecting the viability of affected fish populations and therefore of low magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations such as reduced lighting on the FPSO and no routine flaring would reduce overall light emissions and therefore may reduce the behavioural effects.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with light emissions from the FPSO during Production and Maintenance Operations are predicted to be adverse, low in magnitude, with a geographic extent less than 10 km², of long-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with light emissions from the FPSO.

Migrating individual of fish, plankton, and pelagic fish species may be attracted to the surface lighting caused by lights on the FPSO reflecting off the water's surface. The combination of FPSO colonization opportunities (see above) and artificial light emissions may create a "reef effect" in which fish may aggregate underneath or near the FPSO in response to increased foraging and shelter opportunities (Picken and McIntyre 1989; Røstad et al. 2006; Slabbekoorn et al. 2010; Reynolds et al. 2018). Keenan et al. (2007) examined the light field from two active platforms in the Gulf of Mexico on fish communities out to 250 m and up to 20 m depth from the platform. Lighting was generally concentrated around the structure and showed localized influence from the artificial lighting. Lighting from the platforms were detected at greater than 100 m away from the source, primarily near the surface (0.75 m depth) (Keenan et al. 2007). Light was detected from a platform with a flare at approximately 200 m from the source. The zone of influence was less than 1.5 km from the platforms as control stations for open water measurements were located approximately 1.5 km from the platform (Keenan et al. 2007). Light decreased with increasing depth as areas of background light level were reached in the sampling area (250 m from source) below 5 m and 10 m, depending on the site (Keenan et al. 2007). As light levels measured from the platform were lower than measured twilight light levels (Keenan et al. 2007), overall depth of artificial light is likely less than the natural photic zone. In another study of fish and platforms in the Gulf of Mexico, irradiance levels were similar between lit (active) and unlit (inactive) platforms from 10 m to 100 m depth (Foss 2016).

Lighting around the FPSO may attract phototaxic plankton and may provide increased opportunities for prey capture by fish and other species (Keenan et al. 2007; Cordes et al. 2016). This may in turn attract planktivorous (e.g., lanternfish) and plank-piscivorous (e.g., redfish) fish in the Core BdN Development Area. As noted in Section 9.3.2.1, the FPSO may provide new habitats for various organisms that increase overall food production in the area, leading to increased abundance as described above (Bomkamp et al. 2004; Sammarco et al. 2004; Punzo et al. 2015). Such positive and localized effects would continue while the FPSO was on location for the 12 to 20-year timeframe. Lanternfish are important mesopelagic prey species in the Project Area that use photophores to imitate ambient light and reduce visibility to predators (Peña 2019). Light sensitive fish such as lanternfish that depend on dark areas for predator avoidance would likely react to a light field with avoidance horizontally or vertically depending on other environmental effects and presence of prey species (e.g., plankton).

The change in food availability and/or quality due to light emissions from the FPSO would be positive and adverse, as described above, and long-term. The geographic extent of the change in food availability would be within 1.5 km of the FPSO based on range predicted for lighting effects within the Core BdN Development Area. The change in food availability would occur regularly at night and reversible once the FPSO leaves the area. While light emissions may change food availability within a localized area of the FPSO, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. Mitigations such as reduced lighting on the FPSO and no routine flaring would reduce overall light emissions and therefore may reduce the overall change in prey species availability at night. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality associated with light emissions from the FPSO are predicted to be positive and adverse, negligible in magnitude, with a geographic extent less than 10 km², of long-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the light emissions include reducing overall light emissions from the FPSO which do not compromise the worker safety and safe operations, per regulatory requirements (L) and no routine flaring (M).

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the light emissions from the FPSO in consideration of residual effects predictions.

9.3.2.3 Underwater Sound Emissions from the FPSO

The primary effects on Marine Fish and Fish Habitat associated with underwater sound emissions from the FPSO are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury, and/or Health
- Change in Food Availability and/or Quality

The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels. The positioning, presence and operation of a FPSO produces underwater sound emissions and vibrations from power generation, equipment operations, and DP systems (as required). Anthropogenic sound associated with production activities is transmitted through the water and seabed and may result in disturbances to marine biota similar to those assessed in Section 9.3.1.2.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with underwater sound emissions associated with Production and Maintenance Operations.

A variety of behavioural responses by marine fishes and invertebrates to anthropogenic underwater sound has been observed in studies as described in Section 9.3.5.3. These responses vary by, for example, species, life stage, received sound level, frequency of sound, type of sound (i.e., impulsive vs. continuous), and rise time. These behavioral effects include both temporary responses (e.g., startle/avoidance responses) and longer-term responses (e.g., larger-scale redistribution).

Given the transient nature of fish and the demonstrated avoidance behaviours of fish in response to sound (see Section 9.3.5.3) it is unlikely that fish would remain in the immediate area long enough (i.e., 12-hour and 48-hour periods indicated by Popper et al. (2014) for potential effects of exposure to continuous sound) to be affected. Norwegian experiments involving fish behaviour and vessel sound have suggested some degree of attraction of fishes to vessels with DP (Røstad et al. 2006).

Acoustic tracking of fishes indicated attraction of large fishes and schooling fishes to a vessel with limited lighting and continuous operation of DP (Røstad et al. 2006). Fish scattering and avoidance of the vessel was attributed to its shifting of position rather than to the continuous sound from the thrusters (Røstad et al. 2006). Changes to the spatial distribution of fish from underwater sound would likely be temporary as the fishes in the water column (e.g., lanternfish) are typically highly mobile and would likely return after cessation of the activity or removal of the sound source. Although egg and larval stages as well as juvenile and adult stages of low-mobility species may be exposed to underwater sound generated by FPSO operations for longer periods, it is improbable that direct physical damage to these biotas would occur (see Section 9.3.5.3). Lanternfish species in the Canary Islands have been shown to migrate deeper into the water column in response to turning on of vessel DP. Avoidance behaviour may be linked with the abruptness of turning on vessel DP relative to potential attraction of schooling fish to vessels with continuous DP (Røstad et al. 2006, Peña 2019).

There is potential for both FPSO and drillship activities to co-occur based on the current schedule of operations and drilling. Modelling of underwater sound and vibrations were modelled for a scenario whereby both the FPSO and a drilling installation are present at the same time (Table 9.10). As shown in the table, rms sound pressure level would still decrease to 160 dB re 1 µPa(rms) at less than 40 m from the FPSO during both February and August, and the rms sound pressure level would decrease to 140 dB re 1 µPa(rms) at less than 425 m from the FPSO and drillship during both times of the year. In both the FPSO only and FPSO and drillship scenarios, the rms sound pressure level would decrease to 150 dB re 1 µPa(rms) at less than 125 m during both times of the year. Based on the discussion of underwater sound emissions in Section 9.3.534, rms sound pressure levels less than 150 dB re 1 µPa(rms) would not likely cause potential fitness-related behavioural changes in swim bladdered fish species studied to date.

Table 9.10 Maximum and 95 Percent Horizontal Distances to Modelled Maximum-over-depth SPL Thresholds at Site S1 for FPSO and Drillship in February and August Propagation Conditions

$SPL_{(rms)}$ (dB re 1 µPa)	February		August	
	R_{max} (m)	$R_{95\%}$ (m)	R_{max} (m)	$R_{95\%}$ (m)
160	<40	<40	<40	<40
150	122	122	117	117
140	398	386	416	405
130	5,690	5,590	1,970	1,920
120	34,000	31,000	10,500	7,240

Source: Zykov (2018)

R_{max} denotes the maximum range at which a given sound level was encountered in the modelled maximum-over-depth sound field

$R_{95\%}$ denotes the maximum range at which a given sound level was encountered in the modelled maximum-over-depth sound field after excluding 5 percent of the farthest such points

The change in fish behaviour due to the FPSO sound would be adverse, as described above and long-term, while the FPSO is onsite. The geographic extent of the change in fish behaviour would be less than 1 km^2 of the location of the FPSO within the Core BdN Development Area, based on modelling estimates, and including if the FPSO and drilling installation were on site at the same time. The change in fish behaviour would be continuous while the FPSO was on-site, and reversible once the FPSO leaves the area. Underwater sound emissions zone of influence represents a very small footprint in the 470 km^2 Core BdN Development Area (including if both the FPSO and drilling installation were present at the same time). While underwater sound emissions may affect the presence and/or abundance of fish within the localized (less than 1 km^2) area of the FPSO, their abundance and or presence is not affected within the larger Core BdN Development Area and there is no change in abundance and/or presence considered relative to baseline conditions, therefore the magnitude of change is negligible. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in behaviour from underwater sound associated with the FPSO are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural effects) associated with underwater sound from the FPSO during Production and Operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Fish and Invertebrate Mortality, Injury and/or Health is a potential effect associated with underwater sound emissions associated with Production and Maintenance Operations.

There is no direct evidence of mortality to fishes and invertebrates as a result of exposure to continuous underwater sound as from boat engines. (Popper and Hastings 2009; Popper et al. 2014). For fishes with swim bladders that are involved in hearing, temporary threshold shifts (TTS) in hearing may be expected to occur following 12 hours of continuous exposure to sound pressure levels of 158 dB re 1 $\mu Pa_{(rms)}$ and recoverable injuries may occur following 48 hours of continuous exposure to sound pressure levels of 170 dB re 1 $\mu Pa_{(rms)}$ (Popper et al. 2014). Furthermore, the source SPLs for the FPSO (i.e., 183.7 dB re 1 $\mu Pa_{(rms)}$) would attenuate with increasing distance from the FPSO based on sound modelling for the Project. Refer to Appendix D (Zykov 2018) for the sound modelling report. According to the sound modelling (Table 9.11), the rms sound pressure level would decrease to 160 dB re 1 $\mu Pa_{(rms)}$ at less than 40 m from the FPSO during both February and August, and to 140 dB re 1 $\mu Pa_{(rms)}$ at less than 300 m from the FPSO during both times of the year.

Table 9.11 Maximum and 95 Percent Horizontal Distances to Modelled Maximum-over-depth SPL Thresholds at Site S1 for FPSO in February and August Propagation Conditions

$SPL_{(rms)}$ (dB re 1 μPa)	February		August	
	R_{max} (m)	$R_{95\%}$ (m)	R_{max} (m)	$R_{95\%}$ (m)
160	<40	<40	<40	<40
150	63	63	63	63
140	220	213	220	189
130	707	688	990	963
120	14,000	13,700	3,750	3,600

Source: Zykov (2018)
R_{max} denotes the maximum range at which a given sound level was encountered in the modelled maximum-over-depth sound field
$R_{95\%}$ denotes the maximum range at which a given sound level was encountered in the modelled maximum-over-depth sound field after excluding 5 percent of the farthest such points

The change in Change in Fish and Invertebrate Mortality, Injury and/or Health associated with underwater sound emissions would be adverse, as described above and long-term, while the FPSO is onsite. The geographic extent of the change in fish injury would be less than 1 km² of the location of the FPSO within the Core BdN Development Area, based on modelling estimates and in consideration of two installations on site concurrently. The potential change in injury would be sporadic if it occurred but unlikely considering the behavioural effects may cause them to move away. The potential change would be reversible once the FPSO leaves the area. Given the transient nature of fish and the demonstrated avoidance behaviours of fish in response to sound (see Section 9.3.5.4) it is unlikely that fish would remain in the immediate area long enough (i.e., 12-hour and 48-hour periods indicated by Popper et al. (2014) for potential effects of exposure to continuous sound) to be affected with a change in mortality and injury. There would be no change in injury or morality relative to baseline conditions and therefore of negligible magnitude. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in injury /mortality associated with underwater sound emissions from the FPSO are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with underwater sound emissions from the FPSO during Production and Operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of long-term duration, not likely to occur to occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with underwater sound emissions associated with Production and Maintenance Operations. The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels.

Behavioural effects including the avoidance of fish and invertebrates in the water column from underwater sound emissions are described above. Therefore, the displacement of fish may shift the spatial distribution of prey species and have effects on food availability. Changes to the spatial distribution of fish from underwater sound would likely be continuous while the FPSO was on site, and reversible as mobile fishes occurring in pelagic areas of the Core BdN Development Area (e.g., lanternfish) would likely return after cessation of the activity or removal of the sound source.

The change in food availability and/or quality due to the FPSO sound would be adverse, as described above and long-term while the FPSO was onsite. The geographic extent of the change in food availability would be less than 1 km^2 of the location of the FPSO within the Core BdN Development Area. The change in food availability would be continuous while the FPSO was on-site, and reversible once the FPSO leaves the area. While underwater sound emissions may affect food availability within a localized area of the FPSO, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality associated with underwater sound emissions are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound emissions from the FPSO during Production and Maintenance Operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with underwater sound emissions from the FPSO during Production and Maintenance Operations are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with underwater sound emissions during Production and Maintenance Operations in consideration of residual effects predictions.

9.3.2.4 Waste Discharges during Production and Maintenance

Produced water and cooling water, discharges with the greatest volume discharged during production operations, are the primary waste discharges to interact with Marine Fish and Fish Habitat. As stated in Section 9.1.5.1, other marine discharges (e.g., bilge water, deck drainages), as noted above would not have an effect on Fish and Fish Habitat.

The primary effects on Marine Fish and Fish Habitat associated with marine discharges during Production and Maintenance Operations are:

- Change in Habitat Availability and/or Quality
- Change in Fish and Invertebrate Mortality, Injury, and/or Health
- Change in Food Availability and/or Quality

Changes to fish and fish habitat associated with organic waste would be the same as those addressed in Section 9.3.1.3, except they would be of longer duration, and are not repeated here.

The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels. Produced water is the largest volume of waste discharged from the FPSO. Produced water will be treated using best treatment practices that are commercially available and economically feasible and discharged to the marine environment. Produced water is predicted to be 40°C at the discharge source and discharge volumes are estimated to range between 30,000 m^3/d and 50,000 m^3/d.

Produced Water Plume Dispersion Modelling

To provide additional Project-specific information and analysis related to the nature and extent of the produced water plume resulting from the Project, detailed produced water plume modelling using DREAM was carried out. June, which is considered the most sensitive month for when biological resources are most vulnerable, was chosen as the representative month to determine potential extent of the plume (DeBlois 2019 in Appendix J). The thermal plume was not assessed as part of the produced water discharge modelling as the discharge temperature and rates were much lower compared to other studies where modelled effects were estimated to be negligible (SINTEF 2014). Six scenarios for produced water release were simulated:

Scenarios simulated with a produced water release rate of 20,000 m^3/day:

Case 1: 15 ppm OIW concentration, no mixing with cooling water
Case 2: 30 ppm OIW concentration, no mixing with cooling water
Case 3: 15 ppm OIW concentration, mixing with cooling water
Case 4: 30 ppm OIW concentration, mixing with cooling water

Scenarios simulated with a produced water release rate of 50,000 m^3/day:

Case 5: 30 ppm OIW concentration, no mixing with cooling water
Case 6: 30 ppm OIW concentration, mixing with cooling water

The produced water plume for all six cases extended to the southeast or south and was generally restricted to the upper 50 m of the water column, with higher concentrations in the upper 10 m near discharge source. The footprint of oil concentrations over the threshold (70.5 µg/L) for Case 1 was less than half that of Case 2. Relative to Cases 2 and 4, Cases 5 and 6, with the influence of discharge volume of 50,000 m^3/d, had an increase in the footprint of oil concentrations over the threshold. The occurrence of concentrations over the threshold (70.5 µg/L) was reduced in Case 3, relative to Case 1, primarily because of mixing of produced water with cooling water (Figure 9-4).

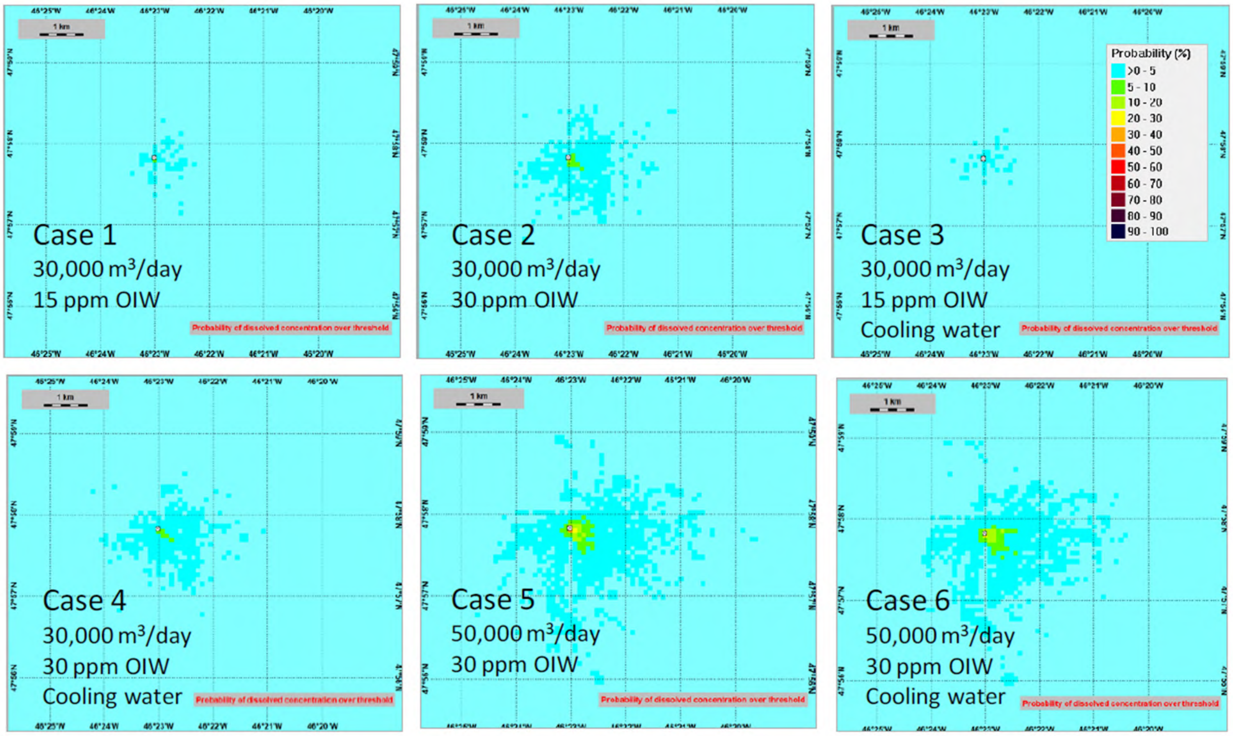

Figure 9-4 Probability that Dispersed Oil will Exceed a No-effects Concentration (PNEC) of 70.5 µg/L Based on a 30-day Simulation for No Dilution (Case 1: 15 ppm Dispersed Oil and Case 2: 30 ppm Dispersed oil) and Dilution with Cooling water (Case 3: 15 ppm Dispersed Oil and 4: 30 ppm Dispersed oil), and simulation for 50,000 m³/day with No Dilution (Case 5: 30 ppm) and Dilution with Cooling water (Case 6: 30 ppm)

The differences between Case 2 and Case 4, as well as, Case 5 and Case 6 respectively are not as apparent, and it is probable that the higher plume volumes caused produced water to expand over a larger area. With an initial dispersed oil concentration of 30 ppm, many model cells remained above the threshold (70.5 µg/L). These results varied for each constituent depending on their initial concentrations and respective thresholds; and constituents with similar concentrations between the 15 ppm and 30 ppm profiles and with low no-effects thresholds may show little change across the four cases. However, in general and as would be expected, mixing with cooling water decreases concentrations of constituents.

Case 5 represented the produced water plume with the highest dispersed oil concentrations and no mixing with cooling water. This case was further assessed as it had the highest potential for elevated concentrations of chemical constituents in the water. Concentrations of dispersed oil, some BTEX and 2-3 ring PAHs, and phenol occurred at concentrations above their no-effects concentration (see Section 9.1.3). For all of these, concentrations were highest within 100 m of discharge source; higher concentrations were more common to the southeast and within the top 10 m of the water column. Results within 100 m from discharge source indicated that concentrations could exceed no-effects concentrations up to 40 percent of the time for OIW, up to 60 percent of the time for 2-3 ring PAHs and phenol, and up to 60 percent of the time for BTEX. All concentrations decreased with distance. From 100 to 400 m of discharge source, OIW concentrations could exceed no-effects concentrations 10 to 20 percent of the time; and from 400 m to 1 km, concentrations could exceed no effects concentrations 5 to 10 percent of the time. For BTEX, 2-3 ring PAHs and phenol, concentrations could exceed no-effects concentrations 20 to 30 percent of the time from 100 to 400 m, 10 to 20 percent of the time from 400 m to 1 km, and 5 to 10 percent of the time from 1 to 2 km. Of remaining constituents only butylphenol and C4 alkyl phenols had 5 percent probability of occurrence over no-effects threshold within 1 km from the discharge source. Case 5 represents the worst case of the six cases and estimates of the potential zone of influence of produced water constituents discussed here can be regarded as conservative.

Cooling Water

During operations, cooling water will be reinjected into the reservoir as pressure support. However, during certain periods of the field life, cooling water demand will be higher than reinjection rates. Excess cooling water will be discharged into the ocean along with produced water as discussed above. Cooling water mixed with produced water is predicted to have maximum discharge rates of 30,000 m^3/d to 80,000[1] m^3/d and a temperature of 35°C at the discharge point.

Change in Habitat Availability and/or Quality is a potential effect associated with the marine discharges during Production and Maintenance Operations.

The discharge of produced water, cooling water and desalination brine may affect fish habitat quality in the immediate area of the FPSO. Associated effects with the change in habitat (changes in health, changes in prey quality, and/or behavioural effects) are addressed below.

Produced water is composed of both formation water and injection water. Its composition, therefore, depends on the geological characteristics of the reservoir and the injection water and show high variability in composition of different fields. Of concern are aromatic hydrocarbons, polycyclic aromatic hydrocarbons (PAH), related heterocyclic aromatic compounds, alkylphenols, heavy metals and naturally occurring radioactive materials (Neff et al. 2011; Bakke et al. 2013) in produced water affecting water quality when discharged. Other compounds that are present in produced water include a variety of production chemicals including biocides, corrosion inhibitors, oxygen scavengers, scale inhibitors and gas treatment chemicals that are injected into the reservoir to extract the oil (Furuholt 1995; Lee and Neff 2011). Produced water and associated treatment chemicals may have microbial stimulant effects or toxic effects in high concentrations to manage bacterial intrusions into the reservoir. However, overall concentrations of treated produced water chemicals are generally low (Lee and Neff 2011). Per Equinor's chemical management system, and in accordance with the OCSG (NEB et al. 2009), the chemical selection and management process enables the selection of chemicals that, once discharged at sea, would have the least effect on the receiving environment.

Produced water and cooling water discharges may be higher in temperature and salinity than receiving waters. High levels of salinity pose a challenge to the pre-disposal treatment of produced water; for example, Hibernia's produced water ranges from 46ppt to 195ppt (Baldoni-Andrey et al.

[1] This range is high and reflects uncertainty due to ongoing design.

2006). The mixing speed of produced water is dependent largely on temperature and salinity, as they can lead to stratification of the water column (Neff et al. 2011). Preliminary data indicate that cooling water associated with the BdN Development Project will be very similar to seawater (see Appendix J). Potential thermal impacts are predicted to occur when temperature increase exceeds 1°C (SINTEF 2007). However, potential effects of thermal plumes are dependent on discharge rates, and temperature differences between discharge and receiving waters. In a produced water modelling study for a Norwegian operation, discharges at higher temperatures (70°C) and discharge rates (150,000 m^3/day) relative to the produced water rates for the Project, were estimated to have negligible effects of excess temperature on the environment (SINTEF 2014). Produced water and associated treatment chemicals may have microbial stimulant effects or toxic effects in high concentrations to manage bacterial intrusions into the reservoir. However, overall concentrations of treated produced water chemicals are generally low (Lee and Neff 2011). The EEM program for Hibernia project collects samples within the 50 m of the platform where produced water can be detected (HMDC 2019). There are also water sampling stations at 100 m, 200 m and 16,000 m from source (HMDC 2019). Hibernia discharged produced water at rates of approximately 16,000-17,000 m^3/day in 2016 with temperatures of 82ºC (HMDC 2019). Overall, temperature profiles were generally similar across stations, but with different rates of change. The upper mixed layer of water has homogenous temperature values as a result of turbulent mixing processes (HMDC 2019). The temperature profile at the reference station is characterized by temperature decreases of approximately 13.3°C (-0.5°C to 12.8°C) (HMDC 2019) below the mixed layer between 30 and 60 m. At a station <50 m from the platform, the thermocline was not as steep with a decrease in temperature of approximately 7°C (6.1°C to 12.6°C) below the mixed layer from 27-32 m (HMDC 2019).This was followed by a decrease in a half degree to approximately 46 m and a sharp decrease of approximately 6°C (0.2°C to 6.1°C) near bottom at 70 m depth (HMDC 2019). Stations closest to the platform (<50 m) had two distinct decreases in temperature, an indicator of the produced water plume, whereas temperature only decreased sharply once for the 16,000 m station (HMDC 2019). The temperature profile at stations beyond 100 m had the same patterns as water monitoring stations 16,000 m away from the platform (HMDC 2019). Therefore, temperature follows a similar pattern as with other produced water constituents with rapid dilution and dispersion of the produced water plume. The Hibernia EEM results indicate that the "discharge of produced water did not have a detectable effect on surrounding seawater" (HMDC 2019).

The most common metals in produced water include arsenic, cadmium, copper, chromium, lead, mercury, nickel, zinc, barium and iron. Inorganic compounds have three possible destinations: be diluted if staying in solution, oxidise/precipitate into compounds that sink to the ground, or associate with oil droplets and rise to the water surface (Neff et al. 2011). There is no evidence that the levels of trace metals in fish and shellfish in areas where produced water is discharged are higher than the natural background concentrations (Neff et al. 2011).

Produced water contains generally much higher concentrations of 226RA and 228RA than naturally present in the seawater. The source of the Radium isotopes is the formation water brought up the well during the production (Neff et al. 2011). Thus, the Radium concentrations can vary according to the reservoir age and exploitation plan (Gäfvert et al. 2005).

The potential adverse effects of the produced water contaminants are generally limited to within 1 km from the discharge point based on environmental monitoring of oil and gas platform discharges in the North Sea (Sundt et al. 2008; Bakke et al. 2013). Environmental effects monitoring (EEM) programs at the existing production operations (e.g., Terra Nova, White Rose, Hibernia) in the Canada-NL Offshore Area have not detected changes in the water column related to produced water beyond 50 m from the discharge point (EMCP 2017).

Modelling of the produced water plume (Case 5, Figure 9-4) indicates that the extent plume is primarily within 1 km from the source with lower probabilities (e.g., 5-10% for BTEX) for patchy exceedances within 2 km (Deblois 2018 2019 in Appendix J), which would likely not cause effects.

The change in habitat availability and/or quality due marine discharges would be adverse, as described above and long-term. As noted above, the geographic extent of the change would be less than 10 km² of the discharge location on the FPSO based on probabilities of worst-case scenario modelling indicating potential no-effects concentration exceedances was mainly within 1 km. The change in habitat would be continuous while the FPSO was on-site, and reversible once the FPSO leaves the area. As the change in water quality is predicted to be less than 1 km from the discharge source and would not affect the water quality in the greater Core BdN Development Area, the change is considered within the range of natural variability and is, therefore, of low magnitude. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on produced water modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge or emissions modelled, therefore there is some uncertainty regarding the zone of influence of produced water and water quality predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent.

As stated above, all chemicals that would be discharged to the marine environment would be screened in accordance with the OCSG (NEB et al. 2009). Produced water will be treated using best treatment practices that are commercially available and economically feasible and discharged in accordance with the OWTG.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with marine discharges during Production and Maintenance Operations are predicted to be adverse, low in magnitude, with a geographic extent less than 10 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Fish and Invertebrate Mortality, Injury, Health is a potential effect associated with marine discharges during Production and Maintenance Operations.

As described above, the residual oil concentrations in produced water are reduced by the produced water treatment system, monocyclic aromatic hydrocarbons (BTEX: benzene, toluene, ethylbenzene, xylenes), PAH and related heterocyclic aromatic compounds are considered the most problematic toxicants in produced water (AMAP 2010, Neff et al. 2011) (DeBlois 2018 in Appendix J). Generally, BTEX are the least concern of this group, due to their propensity to evaporate from water, however, in close proximity they could have an effect. PAH are known to be carcinogens (especially 2-6 ring PAH). They have been found to cause DNA damage (Aas et al. 2000), oxidative stress (Sturve et al. 2006), cardiac function defects (Incardona et al. 2004) as well as embryotoxicity (Carls et al. 2008) in fish. Alkylphenols are water soluble compounds that naturally occur in crude oil (Bakke et al. 2013). As they are water soluble, they persist in the produced water after the water/oil separation but are rapidly degraded in the marine environment (Schmeichel 2017). Due to their potential to disrupt the endocrine system, alkylphenols are also of high concern (Arukwe et al. 2000, 2001; Soto et al. 1991).

The liver is an important site for the metabolization of hydrocarbon compounds with the associated Cytochrome P450 enzyme system important for detoxification of contaminants taken up by the organism (Široká and Drastichová 2004). While the contaminants are generally broken down into less toxic components that are easily eliminated from body tissues, metabolization can lead to formation of more toxic substances (Široká and Drastichová 2004). Polycyclic aromatic hydrocarbons have been shown to induce the production of Cytochrome P450 A1 (CYP1A) enzyme (Meier et al. 2010) and can be metabolised into carcinogenic compounds. Heightened levels of CYP1A enzyme activity has been found in Atlantic halibut, turbot, Greenland halibut, Atlantic salmon, and Atlantic cod exposed to dispersed polycyclic aromatic hydrocarbons after four weeks in the laboratory (Jonsson and Björkblom, 2011). Meier et al. (2010) showed similar results in juvenile and adult cod exposed under laboratory conditions, however, exposure to diluted produced water at 0.1 percent did not increase CYP1A levels. Meier et al. (2011) showed that enzymes from the P450 family, aromatases in particular, can convert androgens into estrogen, which causes disruption in the maturation and development of male fish in laboratory experiments. In the North Sea, recent studies have concluded that the environmental exposure of alkylphenols from produced water to fish populations is too low to affect reproduction in fish stocks (Bakke et al. 2013).

The EEM programs for the existing production operations offshore NL have been testing CYP1A enzymes in American plaice for at least 20 years in some locations and have detected occasional evidence of project-induced changes in CYP1A activity in liver samples for fish sample in close proximity to the production facilities (EMCP 2017). DNA adducts are DNA strands bound to a compound that can lead to carcinogenesis (Hemminki 1993) and may arise from exposure to PAH components of produced water. These may occur on a time scale of weeks after the exposure (Hylland 2006). Elevated formation of DNA adducts after exposure has been demonstrated in field collected Atlantic cod and haddock, but not in pollock (Hylland 2006; Balk et al. 2011).

The interruption of gonadal functions can take many forms, from altering spermatogenesis, impair oocyte development, to organ malformation during the maturation cycle, disruption of the hormone production. Alkylphenols have been shown to affect some of these reproductive traits, however polycyclic aromatic hydrocarbons can also have an effect on gonadal functions. Tollefsen et al. (2011) showed that complex mixtures of hydrocarbons could up or down regulate the endocrine balance in Atlantic cod laboratory experimentally exposed for 15 days. This is supported by Sundt and Björkblom (2011), who have found that egg production and estrogen levels are lower in pre-spawning female Atlantic cod that were exposed in the laboratory for 12 weeks. They did also notice that the testes of cod exposed to realistic concentrations of produced water, was affected. This resulted in reduced mature sperm, although spermatogonium and primary spermatocyte levels were up. EEM programs for existing production operation offshore NL have not detected evidence of project-induced changes related to gross pathology for American plaice sampled near the production facilities (EMCP 2017). Produced water will be treated using best treatment practices that are commercially available and economically feasible and discharged to the marine environment in consideration of the OTWG (NEB et al. 2010).

Low-level, long-term exposure is a concern and the assumption that organisms only in the proximity of the discharge point are affected is still debated (Wells 2005). The most common metals in produced water include arsenic, cadmium, copper, chromium, lead, mercury, nickel, zinc, barium and iron. There is no evidence that the levels of trace metals in fish and shellfish in areas where produced water is discharged are higher than the natural background concentrations (Neff et al. 2011). EEM of platforms on the Grand Banks have been testing body burden in American plaice, snow crab, and sea scallop around the Hibernia, Terra Nova and White Rose production facilities for at least 20 years in some locations. Icelandic scallops are the only taxa that have shown elevated hydrocarbon and metal (barium) concentrations in somatic tissues in close proximity (<1km) to a production installation (EMCP 2017). While this scallop species is not present in the Core BdN Development Area, this provides information on potential hydrocarbon and metal concentrations for bivalves within the Core BdN Development Area.

Plankton in the upper water column may be exposed to produced water, although effects, including those on connectivity, would be limited with the low spatial extent of the produced water plume. For cold water corals and sponges, the larval behaviour within the water column and larval durations are not well studied (Kenchington et al. 2019). Dispersal for these organisms have been estimated to be in the upper 100 m or deep water based on information on similar species in shallow waters (Kenchington et al. 2019). Due to the low mobility of many benthic invertebrates and the need for spatial proximity between spawning individuals, primary areas for invertebrate spawning are generally areas with high densities of invertebrates (see Section 6.1.7.8). As the extent of the produced water plume is limited, potential effects on larval stages of coral and sponges would be low. Species like Atlantic salmon do not migrate in large concentrations and preferred sea surface temperatures (SSTs) would likely limit habitat use to temporary movement corridors in the Project Area, limiting potential for interactions with produced water.

Intake of seawater for water injection, cooling and potable water may result in entrainment of marine organisms in the water column including passively drifting plankton, algae, eggs and larvae (Miller et al. 2015). However, the patchy nature of deep-sea communities may reduce potential effects on species (Boehlert and Gill 2010). Discharge of the desalination concentrate (high-temperature, elevated salinity) from the desalination plant may also cause mortality or injury to marine organisms in the water column due to exposure to extreme environmental parameters (Miller et al. 2015). For example, oysters exposed to thermal effluents (2.2 km) that were 6°C to 9°C higher than intake waters exhibited higher expression of heat shock proteins than individuals collected farther (4.7 km) from the source (Kim et al. 2017). Coastal communities in Brazil have shown decreased fish species richness and diversity in areas exposed to high temperature water discharges (average water temperature 32°C) produced from cooling activities compared to control sites (average water temperature 25°C to 26°C) (Teixeira et al. 2009). Observed decreases in fish diversity were observed approximately 500 m to 600 m away from the discharge source, however discharge rates (40 m^3/s to 80 m^3/s) were much higher than predicted for the FPSO (Teixeira et al. 2009). While these studies provide an indication of effects of thermal discharges, these projects were in coastal areas which would have much lower dilution rates relative to the deep waters of the Core BdN Development Area. Phytoplankton and zooplankton diversity and abundance and chlorophyll a have also been shown to decrease when exposed to higher temperature waters (increase of 0.9°C to 1.5°C compared to control sites) from heated effluent discharge (Lin et al. 2018) at flow rates of 115 m^3/s. In a produced water modelling study for a Norwegian operation, discharges at higher temperatures (70°C) and discharge rates (150,000 m^3/d), which are much higher than those estimated for the BdN Project, were estimated to have negligible effects of excess temperature on the environment (SINTEF 2014). The low potential for thermal effects is also consistent with projects in the Newfoundland and Labrador Offshore Region. The zone of influence for coolant waters for Hebron Project that had higher discharge rates (1.1 m^3/s) was estimated to be 500 m of the discharge source and within the produced water plume (Amec Foster Wheeler 2017).

The change in fish and invertebrate mortality, injury and/or health due to the marine discharges would be adverse, as described above and long-term. The change in fish mortality, injury and /or health would be continuous while the FPSO was on-site, and reversible once the FPSO leaves the area. As noted above, the produced water would be rapidly diluted with effects predicted to be within 1 km from the discharge source, therefore with a geographic extent less than 10 km^2 of the discharge location. As the change in injury, health and/or mortality is predicted to be less than 1 km from the discharge source and would not affect viability of the affected fish populations in the Core BdN Development Area, it is considered within the range of natural variability and is, therefore, of low magnitude. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge or emissions modelled, therefore there is some uncertainty regarding the zone of influence of produced water and water quality predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent.

As stated above, all chemicals that would be discharged to the marine environment would be screened in accordance with the OCSG (NEB et al. 2009). Produced water will be treated using best treatment practices that are commercially available and economically feasible and discharged in accordance with the OWTG.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury, and/or Health associated with marine discharges during Productions and Maintenance Operations are predicted to be adverse, low in magnitude, with a geographic extent less than 10 km^2 of long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with marine discharges from Production and Maintenance Operations.

As noted above, potential changes to water quality associated with produced water discharges may result in avoidance behaviour and changes in health of fish, which may affect prey species in pelagic areas in the upper 10 m, such as plankton and shrimp in the Core BdN Development Area. Discharge of higher temperature waters can have potential effects on fish and invertebrate community diversity (Teixeira et al. 2009; Kim et al. 2017) and plankton (Poornima et al. 2005; Lin et al. 2018) injury and mortality as described in above. Although thermal effluents can have an effect on food availability (plankton) and available fish habitat (Poornima et al. 2005; Teixeira et al. 2009; Kim et al. 2017; Lin et al. 2018), it is dependant on oceanographic processes and the quantities discharged during operations would likely be rapidly diluted in the deep-water environment, limiting potential effects on Marine Fish and Fish Habitat from the Project. As noted above, produced water plume modelling indicated that effects are likely limited to within 1 km from discharge.

The change in food availability and/or quality associated with produced water discharges would be adverse, as described above and long-term. The geographic extent of the change in water quality would be less than 10 km² of the location of the FPSO within the Core BdN Development Area based on probabilities of worst-case scenario modelling indicating potential no-effects concentration exceedances was mainly within 1 km. The change in food availability would be continuous while the FPSO was on-site, and reversible once the FPSO leaves the area. The magnitude of the changes in food within the predicted zone of influence would be negligible. While the discharge of produced water may change food availability within a localized area of the FPSO, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the change is negligible. These predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

As stated above, all chemicals that would be discharged to the marine environment would be screened in accordance with the OCSG (NEB et al. 2009). Produced water will be treated using best treatment practices that are commercially available and economically feasible and discharged in accordance with the OWTG.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality from produced water discharges from the FPSO during Production and Operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km², of long-term duration, occurring continuously, and reversible. These predictions are made with high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with marine waste discharges include treatment of wastes in consideration of OWTG discharge limits with the use of best treatment practices that are commercially available and economically feasible (E); selection and screening of chemicals in accordance with guidelines (F); treatment of marine discharges in consideration of the Canadian and international requirements (G, H); management of solid and hazardous wastes (I).

Follow-up Monitoring: in consideration of the residual effect predictions based on produced water plume dispersion modelling results, follow-up monitoring will include a component to confirm produced water plume dispersion model results. See Section 9.7 for additional information.

9.3.3 Drilling Activities

Drilling activities to be undertaken for the Core BdN Development are described in Section 2.6.3. Drilling will occur at set locations in the Core BdN Development Area, as illustrated in Figure 2-12. These set locations are illustrated on the figure as "well templates." Depending on final project design, wells will either be drilled using templates (multiple wells drilled in one location) or at individual well locations (satellite wells). Drilling will likely commence before the FPSO arrives on site and will overlap periodically during production operations.

The effects assessment will assume that multiple wells are to be drilled at set well template locations, which provides a more conservative estimate of effects than if a single well were drilled at these well template locations. Based on current Project design, well templates may be 4-, 6- or 8-slot templates, which means that either 4, 6 or 8 wells could be drilled at a single location, from the same well template. As noted in Table 9.1, it is estimated that 45-85 days are required to drill each well. Therefore, assuming eight wells are drilled consecutively, the drilling installation could be on a well template location between approximately one to two years, respectively. If number of wells per well template is less than eight, the time on location would be reduced accordingly. Drilling will likely not be carried continuously over the life of the project and may occur in phases, with a set number of wells drilled per drilling phase (or campaign). The drilling installation may be on-site before the FPSO arrives on site. There may be periods of time, throughout the life of the project where the drilling installation and FPSO are in the Core BdN Development Area at the same time.

As indicated in Table 9.6, the effects assessment in the following sections will focus on light and sound emissions, and marine discharges (e.g., drill cuttings, marine waste discharges) associated with drilling activities.

9.3.3.1 Light Emissions from the Drilling Installation

The primary effects on Marine Fish and Fish Habitat associated with light emissions from the drilling installation are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

Light emissions from the drilling installation would have the same effects on Marine Fish and Fish Habitat as the light emissions from the FPSO, which are assessed above in Section 9.3.2.2, although with a shorter duration. If the drilling installation arrives onsite prior to the FPSO, its presence would be a new source of artificial lighting in a region that is relatively free of nocturnal artificial lighting, as indicated in a world atlas of computed artificial night sky brightness (Falchi et al. 2016).

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with light emissions from the drilling installation. The behavioural effects associated with light emissions would be the same as those assessed in Section 9.3.2.2 for the FPSO but with a shorter duration.

As noted in Section 9.3.2.2, species within the Project Area including plankton and associated predators, and swordfish may be attracted to the area around the drilling installation due to light emissions. Conversely, as noted above, certain prey species (i.e., lanternfish) may avoid the lighted area to hide from predators. The change in fish and invertebrate behavioural effects due to the light emissions from the drilling installation would be adverse, as described above, and medium-term, as the drilling installation could be onsite for up to two years. The geographic extent of the change in behaviour would be within approximately 7 km² of the drilling installation at its well template location in the Core BdN Development Area. The change in fish behaviour occur regularly at night and reversible with removal of the drilling installation. The drilling installation footprint would occupy a very small area within the entire 470 km² Core BdN Development Area, even if more than one installation were present at the same time. As the change in behaviour is localized to the drilling installation, which occupies a very small footprint in the 470 km² of the Core BdN Development Area (including if more than one installation were onsite at the same time), and does not affect fish behaviour in the larger Core BdN Development Area, there is no change in fish behaviour relative to baseline conditions and is therefore negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in fish behaviour associated with light emissions from the drilling installation not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with light emissions from the drilling installation during Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km², of medium-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with light emissions from the drilling installation.

As noted in Section 9.3.2.2, migrating individuals, plankton, and pelagic species may be attracted to the lighting effect on the surface water caused by lights reflecting off water surface. As indicated above, the zone of influence for light attraction on surface waters could conservatively be less than 1.5 km from the installation. These light emissions may attract planktivorous (e.g., lanternfish) and plank-piscivorous fish in the Core BdN Development Area. Light sensitive fish such as lanternfish that depend on dark areas for predator avoidance would likely react to a light field with avoidance horizontally or vertically depending on other environmental effects and presence of prey species (e.g., plankton).

The change in food availability and/or quality associated with light emissions from the drilling installation would be positive and adverse, as described above, and medium-term. The geographic extent of the change in food availability would be within approximately 1.5 km of the drilling installation (within 7 km² area) at the well template location in the Core BdN Development Area. The change in food availability would occur regularly at night and reversible with removal of the drilling installation. The drilling installation footprint would occupy a very small area within the entire 470 km² Core BdN Development Area, even if more than one installation were present at the same time. While light emissions may change food availability within a localized area of the drilling installation, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability associated with the presence of the drilling installation are not proposed.

In summary, the residual environmental effects of a change in food availability and/or quality associated with light emissions from the drilling installation during drilling activities are predicted to be positive and adverse, negligible in magnitude, with a geographic extent less than 10 km², of medium-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the light emissions from drilling installations are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the light emissions from the drilling installation in consideration of residual effects predictions.

9.3.3.2 Underwater Sound Emissions from the Drilling Installation

The primary effects on Marine Fish and Fish Habitat associated with underwater sound emissions from the drilling installation are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury, and/or Health
- Change in Food Availability and/or Quality

The positioning, presence and operation of the drilling installation produces underwater sound and vibrations from power generation, equipment operations, and DP systems (as required). Anthropogenic sound associated with production activities is transmitted through the water and seabed and may result in disturbances to marine biota similar to those assessed in Section 9.3.2.3.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with underwater sound emissions from Drilling Activities.

As indicated in Section 9.3.2.3 for the FPSO, fish may respond with avoidance or attraction responses to underwater sound emissions. The interaction would be the same with underwater sound from a drilling installation. Changes to the spatial distribution of fish from underwater sound would likely be temporary as the fishes in the water column (e.g., lanternfish, tuna), which are present in the Core BdN Development Area, are typically highly mobile and would likely return after cessation of the activity or removal of the sound source.

As noted in Section 9.3.2.3, there is potential for both FPSO and drillship activities to co-occur based on the current schedule of operations and drilling. Modelling of underwater sound and vibrations were modelled for a scenario whereby both the FPSO and a drilling installation are present at the same time, a worst-case scenario. According to the sound modelling (Table 9.10, Section 9.3.2.3), the root-mean-square (rms) sound pressure level would decrease to 160 dB re 1 $\mu Pa_{(rms)}$ at less than 40 m from the FPSO and drilling installation during February and August, and to 140 dB re 1 $\mu Pa_{(rms)}$ at less than 400 m from the drillship during both times of the year. Based on the discussion in Section

9.3.5.4, root-mean-square sound pressure levels less than 150 dB re 1 μ$Pa_{(rms)}$ would not likely cause potential fitness-related behavioural changes in swim bladdered fish species (e.g., Atlantic cod) studied to date.

The change in fish behaviour associated with underwater sound emissions from the drilling installation would be adverse, as described above and medium-term. The geographic extent of the change in fish behaviour would be less than 1 km² of the location of the drilling installation within the Core BdN Development Area, based on underwater sound modelling. The change in fish behaviour would be continuous while the drilling installation was on-site, and reversible once the drilling installation leaves the area. Underwater sound emissions zone of influence represents a very small footprint in the 470 km² Core BdN Development Area (including if another installation were present at the same time). While underwater sound emissions may affect the presence and/or abundance of fish within the localized (less than 1 km²) area of the drilling installation, their abundance and/or presence is not affected within the entire Core BdN Development Area, there is no change in abundance and/or presence relative to baseline conditions and is therefore considered negligible magnitude. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change fish behaviour are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural effects) associated with underwater sound emissions from Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of medium-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality, Injury and/or Health is a potential effect associated with underwater sound emissions from Drilling Activities.

The changes in mortality / injury / health would be the same as those assessed for the FPSO (Section 9.3.2.3). As noted in Section 9.3.2.3, there is no evidence of mortality associated with underwater sound emissions. The primary effects from underwater sound are injury to fish hearing ability. As noted in Section 9.3.2.3, based on sound modelling, injury effects are likely to occur within close proximity to the drilling installation (less than 1 km²). Given the transient nature of fish and the demonstrated avoidance behaviours of fish in response to sound (see Section 9.3.5.4) it is unlikely that fish would remain in the immediate area long enough (i.e., 12-hour and 48-hour periods indicated by Popper et al. (2014)) for potential effects of exposure to continuous sound.

As noted above, while there is likely an interaction, it is unlikely that fish would remain in the area long enough for potential exposure-effects therefore the change in fish injury is negligible in magnitude. The change would be medium-term while the drilling installation is onsite and reversible once the drilling installation leaves its location. The geographic extent of the change in fish injury would be less than 1 km² of the location of the drilling installation at its well template location within the Core BdN Development Area, based on modelling estimates and in consideration of two installations on site concurrently. The potential change in injury would be sporadic if it occurred but unlikely considering the behavioural effects may cause them to move away. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in injury from underwater sound associated with the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with underwater sound emissions during Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of medium-term duration, not likely to occur to occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with underwater sound emissions from Drilling Activities.

Effects on food availability would be similar to those assessed for the FPSO in Section 9.3.2.3. As noted above, fish may respond with avoidance or attraction responses to underwater sounds. Therefore, the displacement of fish may shift the spatial distribution mobile fishes occurring in pelagic areas of the Project Area (e.g., redfish, lanternfish) in the Core BdN Development Area and affect food availability. Changes to the spatial distribution of fish from underwater sound emissions would likely be temporary as the prey species are typically highly mobile and would likely return after cessation of the activity or removal of the sound source.

The change in food availability and/or quality associated with underwater sound emissions from the drilling installation would be adverse, as described in Section 9.3.2.3 and medium-term. Based on modelling predictions, the geographic extent of the change in food availability would be less than 1 km² of the location of the drilling installation at its well template location within the Core BdN Development Area. The change in food availability would be continuous while the drilling installation was on-site, and reversible once the drilling installation leaves the area. Underwater sound emissions zone of influence represents a very small footprint in the 470 km² Core BdN Development Area (including if another installation were present at the same time). While underwater sound emissions may affect food availability within a localized area of the drilling installation, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality associated with underwater sound emissions are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound emissions during Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of medium-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the sound emissions from Drilling Activities are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the sound emissions from the Drilling Activities in consideration of the residual effects predictions.

9.3.3.3 Waste Discharges during Drilling Activities

The primary effects on Marine Fish and Fish Habitat associated with waste discharges from the drilling installation are:

- Change in Habitat Availability and/or Quality
- Change in Fish and Invertebrate Mortality, Injury, and/or Health
- Change in Food Availability and/or Quality

Drill cuttings is the largest volume of waste discharged from the drilling installation. The treatment and discharge of drill cuttings will be in consideration of the OWTG (NEB et al. 2010) and regulatory discharge limits. The use of best treatment practices that are commercially available and economically feasible will be implemented. As described in Section 2.7.5, chemicals that may be discharged to the marine environment – including those used in drilling fluids and well clean-up – will be screened and selected in consideration of the OCSG (NEB et al. 2009) and Equinor Canada's chemical selection and screening processes. As noted in Section 2.6.2, WBM and SBM will be used in the drilling of injector, producer and pilot wells for the Project.

As stated in Section 9.1.5.1, other marine discharges (e.g., bilge water, deck drainages), would not have an effect on Fish and Fish Habitat.

Drilling solids (cuttings) are the particles of crushed rock produced from the grinding action of the drill bit as it penetrates subsurface rocky formations (Neff et al. 2000; Peralba et al. 2010). The particle size, minerology and chemistry of drill cuttings depend on the geologic strata being penetrated (Neff et al. 2000). Once formed, the drill cuttings are carried from the bottom of the well to the surface in a suspension of drilling fluid (Holdway 2002; Peralba et al. 2010). Drill cuttings are typically regarded as toxicologically inert, however adhered drilling fluids may be toxic depending on the type of drilling fluid being used (Neff et al. 2000; Neff 2008). Furthermore, the interaction with suspended particles in the water may result in physical damage, especially in suspension feeding organisms such as corals and sponges (IOGP 2016). The information presented below is an updated summary to the effects assessment provided in the Drilling EIS (Statoil 2017).

Water-Based Muds

WBMs are primarily comprised of seawater, along with other additives including bentonite (clay), barite and potassium chloride (Neff 2008; 2010). Other approved chemicals are also added as required to control and achieve the required fluid properties (Trefry et al. 2013; Whiteway et al. 2014).

WBMs have varied effects on marine organisms, but due to the non-toxic nature of the drilling fluid components (Neff 2010), WBMs are not likely to result in chemical toxicity (Holdway 2002; Trannum et al. 2010, 2011; Bakke et al. 2013; Purser 2015). Exposure to WBMs at concentrations (10 mg/L) selected to represent field conditions more than 1 km downstream from a discharge site has, for example, not shown acute toxicity to sea scallops (Cranford et al. 1999). These drill cuttings concentrations used in the laboratory are more representative of long-term exposure as measured exposure in field experiments were short-term and episodic (Frost et al. 2014). Various exposure studies as summarized by Neff (2010) on polychaetes, amphipods, shrimp and various other fish species indicate that WBMs have little to no toxicity and potential effects are primarily associated with the physical abrasive effects of ingesting mud particles. The acute toxicity potential in relatively high concentrations of barite was also tested and found to be non-toxic to capelin, snow crab larvae or planktonic jellyfish after 24 hours of continuous exposure (Payne et al. 2006). Possible sublethal effects, including reduced growth and survival rates, and altered foraging behaviours, have been observed in crustaceans, scallops and haddock that were continuously exposed WBMs or its components for 96 hours to 68 days (Cranford et al. 1999; Neff 2010). While dependent on local hydrodynamics and particle properties, elevated levels of barium originating from drill fluids have been observed up to 600 m from the well in some drilling operations (Ragnarsson et al. 2017).

Due to the physical properties of the drilling mud components, associated metals are not readily incorporated into tissues, limiting the availability of metals for bioaccumulation (Neff 2010, Edge et al. 2016), although this may be somewhat species-specific. Infaunal species, including polychaetes and bivalves that have limited ability to migrate away from the area, may accumulate metals from WBMs (Neff et al. 1985; Schaanning et al. 2002; Ruus et al. 2005) and *L. pertusa* corals have been shown to incorporate barite particles as far away as 600 m from the drill site (Ragnarsson et al. 2017). However, mobile benthic feeders, including snow crab are not expected to accumulate metals from WBM because of the potentially small area affected from drilling programs compared to the wider home range of the species (Ennis et al. 1990; Trannum et al. 2010; Bakke et al. 2013). EEM data have also indicated that the area of WBM effect where there was an increase in metal levels is generally limited to less than 1 km to 2 km of the drill site (Gates and Jones 2012; Deblois et al. 2014; Gates et al. 2017). EEM of the Terra Nova offshore oil development on the Grand Banks observed barium contamination of sediments at sampling stations mainly within 2 km of the production platform with decreased levels further from source (Deblois et al. 2014). Similarly, in a review of all the offshore production platforms on the Grand Bank for the Hebron oil development project monitoring design, the spatial extent of barium was largely within 2 km of the discharge source and was consistent with a project-induced change (EMCP 2017).

Whole water-based mud (WBM) would be released during drilling of the conductor and surface hole sections. WBM discharge can be estimated based on recent well design information for the Project and from Equinor's global drilling experience. Typically, in Equinor's global drilling operations, the initial sections of a well are drilled with a WBM/seawater (60 percent muds and 40 percent seawater). The conductor hole is likely to be drilled over 6-8 hour timeframe with approximately 270 m^3 (162 m^3 mud / 108 m^3 seawater) of whole WBMs discharged and the surface hole is likely to be drilled over 24-26 hour timeframe with approximately 800 m^3 (480 m^3 mud / 320 m^3 seawater) of whole WBMs discharged. Effects on smothering and/or burial associated with drilling discharges are discussed below.

Synthetic-Based Muds

SBMs were originally developed to replace oil-based muds that were historically used in drilling activities. The toxic components of the oil-based muds have been essentially removed in the synthetic based fluids, resulting in drilling fluids that have lower acute toxicity (Tsvetnenko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016). Although the specific SBMs that will be used for this Project have yet to be determined, potential base fluids for SBMs may include esters, poly alpha olefins, internal olefins, linear alpha olefins and others.

Acute toxicity of SBMs is considered to be relatively low based on laboratory experiments and field evaluations of SBM-associated drill cuttings piles (Still et al. 2000; Tsvetnenko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016). Lobsters exposed to high levels of SBM fluid in laboratory experiments, for example, did not change aspects of lipid and protein metabolism or have other adverse health effects after approximately 20 days (Hamoutene et al. 2004). Toxicity experiments with fish indicated that acute toxicity of SBMs was generally low (96-h LC50 toxicity of greater than 30,000 mg/L, Jagwani et al. 2011), but there were potential health effects with chronic exposure to SBM associated cuttings (Jagwani et al. 2011; Gagnon and Baktyar 2013; Vincent-Akpu 2013). Gagnon and Bakhtyar (2013) investigated the effects of ester-based, isomerized olefin-based and linear alpha olefin-based drilling fluids on juvenile pink snapper under laboratory conditions. Exposure to these synthetic-based fluids resulted in EROD induction, accumulation of biliary metabolites and increase in stress proteins which are biomarkers for exposure to contaminants (Gagnon and Bakhtyar 2013). While these experimental studies indicate potential for chronic effects from synthetic based fluids, the exposure levels are not necessarily reflective of field conditions. Potential effects are likely to be temporary in nature as SBMs biodegrade within a few years (Terrens et al. 1998; Ellis et al. 2012; IOGP 2016). Laboratory studies of SBM fluid on marine sediments indicated that total petroleum hydrocarbon (TPH) levels degraded by approximately 31 percent and 14 percent in fresh and recycled synthetic-based fluids respectively after incubation at 5ºC for four weeks (COOGER and Lee 2009). While degradation at seafloor temperatures would likely be slower, bacteria adapted to the cold-water environments may facilitate hydrocarbon degradation of in synthetic-based fluids (COOGER and Lee 2009). However, as degradation of the organic components of SBMs can lead to eutrophication and creation of anoxic environments that may have injury and mortality effects on benthic organisms (Schaanning et al. 2008; Ellis et al. 2012; Nguyen et al. 2018). The faster degradation rate of SBMs indicates that associated anoxic environmental effects may occur at a faster rate for SBM drilling cuttings deposition areas in comparison to areas of WBM cuttings deposition. However, a review of biological and physical effects from drill cuttings release indicated that the minimum and maximum areas of effect were higher for WBM cuttings discharge compared to SBM cuttings discharged (Ellis et al. 2012). Potential effects on fish have also been suggested to be limited due to finfish mobility (CNSOPB 2005).

The distance of biological effect varies with drilling programs as demonstrated by the results of a DFO study (Payne et al. 2006) in the Jeanne d'Arc Basin area on the Grand Banks, which found that substantial sediment toxicity stemming from the use of synthetic based drilling fluids in this area should be confined to a range of tens of meters from any cuttings pile deposited on the seabed.

Suspended Sediments and Sedimentation

Depending on the receiving environment, the addition of SBM and WBM drill cuttings may change the substrate composition of the seabed, altering benthic community composition as it responds to changing fish habitat (Smit et al. 2006, 2008). WBM drill cuttings as low as 2.5 mm may reduce bioturbation in benthic environments, a key geochemical process in transport of organic matter and nutrients in the upper sediment layer (Trannum 2017). In deep water environments drill cuttings are generally well dispersed with potential for redistribution with bottom currents (Rajnauth et al. 2005; Pivel et al. 2009). The degradation of organic components in SBMs by bacteria increases local oxygen demand resulting in low oxygen or anoxic environments in areas of cuttings piles (Schaanning et al. 2002, 2008; Trannum et al. 2010; IOGP 2016; Tait et al. 2016; Stout and Payne 2017; Nguyen et al. 2018). Macrofauna surveys of a drilling operation in the Faroe-Shetland Channel, found that smothering and burial of organisms was primarily within 100 m from the drill cuttings source with maximum cuttings pile heights of 1.5 m, with lesser effects up to 250 m (Gates and Jones 2012). WBM associated drill cuttings layer thickness (3 mm to 24 mm) has also been negatively correlated with species abundance and diversity associated with eutrophication and oxygen depletion from degradation of WBM organic components over a six-month mesocosm experiment (Trannum et al. 2010). The overall result of these potential effects is a localized decreased species abundance and diversity of benthic organisms within approximately one kilometre of the source (Neff et al. 2000; Holdway 2002; Schaanning et al. 2008; Trannum et al. 2010; Gates and Jones 2012; Larsson et al. 2013; Cordes et al. 2016; Tait et al. 2016).

The discharge of drill cuttings into the water is predicted to result in localized and temporary suspended sediments and turbidity (Smit et al. 2008), however due to the low toxicity of drill cuttings and rapid dilution and dispersion, the risk to pelagic organisms is considered low (IOGP 2016). In a modelling study of drill cuttings in the South China Sea, discharged suspended drill cuttings were estimated to drift greater than 200 m from the source (Koh and Teh 2011). Suspended solid levels in the water column returned to background levels within two hours of discharge cessation indicating potential effects are non-persistent and temporary (Koh and Teh 2011). Elevated turbidity levels may decrease light exposure to phytoplankton required for photosynthesis, however such suspended solids concentrations would be limited to within 25 m of the discharge source (IOGP 2016). Another modelling study characterized the potential effects of drill cuttings suspended particles and turbidity for the Norwegian Continental Shelf from oil and gas platforms in an average of 167 m water depth (Veltman et al. 2011). The potential effects of suspended particles from oil and gas platforms had minor effects on the water column with limited contribution to impacts at regional (2 percent) and global scales (0.6 percent) (Veltman et al. 2011). Suspended solid effects would likely be comparatively lower for the Core-BdN area as increased water depths may allow for further dispersion and dilution. Furthermore, mobile finfish and invertebrates are able to avoid areas of suspended drill cuttings, minimizing exposure and potential effects (IOGP 2016).

While exposure studies have not been specifically conducted regarding drilling fluids and cuttings on corals and sponge species found in the Flemish Pass, the potential effects can be inferred from international coral and sponge studies on sedimentation exposure, drill cuttings exposure, injury and regeneration, and coral and sponge ecology. Corals and sponges are considered biogenic habitat as described in Section 6.1.7.6, and have ecological characteristics (sessile, suspension feeding and slow growing) that indicate they are sensitive to suspended drill cuttings and mud particles and burial in the marine environment (Raimondi et al. 1997; Larsson and Purser 2011; Allers et al. 2013; Bell et al. 2015; Purser 2015; Järnegren et al. 2016; Ragnarsson et al. 2017; Larsson et al. 2013; Liefmann et al. 2018; Vad et al. 2018, Buhl-Mortensen et al. 2015; Baussant et al. 2018). However, coral and sponge species that occur in areas with fine sediments similar to the Core BdN Development Area and the Project Area are naturally exposed to episodic pulses of suspended particles. Therefore, they likely have mechanisms for tolerating exposure to suspended particles (e.g., Allers et al. 2013; Bell et al. 2015) even if the specific mechanisms for tolerance for all species is not well understood. The deep-sea cold-water coral *L. pertusa* has been studied extensively in response to drill cuttings in the North Sea and Gulf of Mexico (i.e., Larsson and Purser 2011; Allers et al. 2013; Purser 2015; Baussant et al. 2018). While *L. pertusa* has limited distribution in Atlantic Canada and has not been found in the LSA, previous studies on this species provides an indication of potential cold-water coral response to cuttings discharge. Laboratory experiments indicate that coral larvae are more sensitive to suspended drill cuttings than adults (Larsson and Purser 2011; Larsson et al. 2013). Exposure to sediment concentrations of 40 ppm resulted in clogging of cilia in five-day old individuals, inhibiting movement and caused larval mortality (Järnegren et al. 2017). Preliminary studies with 28-day old *L. pertusa* larvae indicated that mortality was high after four days of drill cuttings exposure of 25 mg/L (Larsson et al. 2013). Larval mortality was low and similar to control treatments at 5 mg/L drill cuttings exposure (Larsson et al. 2013).

Conversely, adult corals are often able to tolerate short-term exposure to certain amounts of suspended particles, smothering effects and anoxic conditions without visible detrimental short-term effects or mortality due to their efficient sediment clearing mechanisms through particle transport or mucous shedding (Slattery and Bockus 1997; Brooke et al. 2009; Allers et al. 2013; Larsson et al. 2013; Purser 2015). Brook et al. (2009) compared responses of *L. pertusa* to drill cuttings between a heavily calcified morphotype compared to a more fragile morphotype. Burial of the coral fragments indicated complete survival after 24 hours of exposure that decreased to almost 100 percent mortality after four days (Brook et al. 2009). Increased sediment loads beyond 54 mg/L also resulted in mortality in both morphotypes (Brook et al. 2009). *L. pertusa* coral fragments exposed to fine fraction drill cuttings (< 63 µm) over three weeks had a higher extent of smothered tissue and polyp mortality with sediment cover thickness of 19 mm compared to 6.5 mm sediment cover thickness (Larsson and Purser 2011). Although mortality was low at sediment cover thickness of 6.5 mm, a large proportion of the coral was smothered leading to injury (Larsson and Purser 2011). Drill cuttings concentrations up to 10 mg/L have been suggested to be a threshold for which changes to coral condition in *L. pertusa* are reversible (Baussant et al. 2018). Drill cuttings concentrations beyond the 10 mg/L resulted in decrease in tissue covering the skeleton and increased accumulation and smothering by drill cuttings (Baussant et al. 2018). Larsson et al. (2013) observed that drill cuttings accumulate on skeletal areas lacking tissue, resulting in eventual smothering of tissue and mortality of polyps (2.2 percent) at suspended drill cuttings exposure levels of 25 mg/L. Chronic or high level suspended sediment exposure may lead to sublethal effects including reduced growth rates and smaller oocyte size (Larsson et al. 2013), however field observations have not shown degradation of *L. pertusa* coral reefs exposed to suspended drill cuttings (greater than 25 ppm) over time (Buhl-Mortensen et al. 2015; Purser 2015).Physical injury from abrasive sediments may also reduce recovery from sedimentation and burial in corals (Slatterly and Bockus 1997; Henry et al. 2003; Henry and Hart 2005; Liefmann et al. 2018). Studies with suspended mine tailings on the soft coral *Duva florida,* which occurs in the Flemish Pass, and a gorgonian coral *Primnoa resedaeformis* that can be found in the Northwest Atlantic, indicated that small sharp sediment particles were more harmful than smooth edged particles to corals and resulted in changes in feeding behaviour and increased loss of polyps (Liefmann et al. 2018). However, there were no mortalities over the three-month exposure for either species and Liefmann et al. (2018) suggest that these species can withstand low levels of turbidity (8 mg/L from anthropogenic sources). While corals have the ability to regenerate injured areas, it is energetically costly and may result in impairments to growth, reproduction, and predation defence (Henry and Hart 2005).

Potential effects of sedimentation on sponges may include clogging of feeding structures, smothering, and abrasion (Bell et al. 2015; Vad et al. 2018). Sponge tolerance for suspended and settled sediments vary with habitat, with species adapted to soft bottom habitats having a higher tolerance for re-suspended sediments (Bell et al. 2015; Kutti et al. 2015). *Geodia barretti*, a habitat forming solid/massive sponge distributed on the slopes of the Flemish Cap and in the Flemish Pass (Knudby et al. 2013), is adapted to cope with suspended sediments (greater than 100 mg/L) by reducing filter feeding and thus decreasing their intake of sediment particles (Tjensvoll et al. 2013; Kutti et al. 2015). However, introduction of sediment sizes atypical from natural conditions may reduce organism condition (Kutti et al. 2015). Exposure of *G. barretti* to the particulate barite (as suspended particles) component of WBMs, resulted in evidence of toxic, cellular, and stress effects (Edge et al. 2016). Cellular effects were observed at barite concentrations at 30 mg/L for both continuous and intermittent exposure over 14 days. However, no-effects were observed on *Geodia* exposed continuously to 10 mg/L barite and short-term exposures to bentonite did not have any effects on the sponges up to 100 mg/L (Edge et al. 2016). Long-term experiments where the *Geodia* sponges were cyclically exposed to suspended sediments (50 mg/L) resulted in permanent decrease oxygen consumption and metabolism (Kutti et al. 2015). While, shorter exposures (4 hour) resulted in decrease in oxygen consumption, the rate recovered after cessation of sedimentation (Kutti et al. 2015). Larval sponges are more sensitive to suspended sediment, resulting in higher larval mortality and decreased settlement (Maldonado et al. 2008; Bell et al. 2015).

In summary corals and sponges may be resistant to short-term exposure to suspended drill cutting particles with potential effects on adults related to chronic exposure or high suspended sediment and burial. Early life stages also show sensitivity to suspended sediments and burial. This supports that benthic effects from drilling discharges are likely localized to the drill cuttings deposition area and that further areas where there may be low thickness and/or patchy and discontinuous cuttings deposition are unlikely to have injury and mortality effects.

The spatial footprint of drilling discharges is typically limited to spatial scales of 100's of metres to kilometres, however this varies with the volume of cuttings and drilling fluids discharged, discharge depth, local oceanographic processes, PSD, flocculant formation extent and time after discharge (IOGP 2016). Previous studies indicate that suspended sediment and burial effects from drilling fluids and cuttings on benthic invertebrates have mainly been localized to the vicinity of a drill cuttings pile area (Neff et al. 2000; Holdway 2002; Schaanning et al. 2008; Trannum et al. 2010; Gates and Jones 2012; Larsson et al. 2013; Cordes et al. 2016; Tait et al. 2016; Gates et al. 2017). An average well drilled on the Norwegian shelf, for example, where approximately 300 tons of cuttings were discharged, resulted in a cuttings pile radius of 50 m around the well head (Ragnarsson et al. 2017).

Recovery and Recolonization

Recovery of areas of biological effect from SBM and WBM discharge varies considerably, as it is influenced by disturbance size and frequency, distance to source colonizers and local environmental conditions (Gates and Jones 2012). For example, well sites associated with hydrocarbon drilling activity in the deep-sea Faroe-Shetland Channel produced cuttings depositional areas distributed within 250 m from the source with a maximum thickness of 1.5 m that resulted in smothering and burial of benthic organisms (Jones et al. 2012). The cuttings piles were considerably smaller three years after the disturbance due to high current events, and fauna diversity was found to be similar as at undisturbed sites (Jones et al. 2012). Increased recovery of megafauna diversity and densities were observed after 10 years at the site; however, drill cuttings effects were still apparent indicating the area had not fully recovered (Jones et al. 2012). Also, a drilling site in the Norwegian Sea that produced a cuttings pile distributed over 100 m from the well with cuttings depth of less than 0.5 m had reduced cuttings pile area and similar megafaunal densities to pre-drilling and background surveys three years after the deposition (Gates and Jones 2012). Cochrane et al. (2019) measured the visible deposition of drill cuttings near wells drilled across almost 30 years (1987 to 2015) in Norway in approximately 300-400 m water depth, and found cuttings from the newest wellsite (2015) were restricted to 150-200 m from the wellsite while at the oldest sites cuttings piles were only visible within 50 m of the drilled well. Cochrane et al. (2019) also note that many of the older projects in their study used oil-based drilling muds which had greater toxicity and effect on fauna, and which are now banned in Norway. Henry et al. (2017) found that sites (20-140 m water depth) with visible deposition piles took 6-8 years to exhibit recovery signs, while sites with smaller footprints and more disturbance-tolerant taxa showed signs within a year. Gates and Jones (2012) also noted that the effects of the exploratory drilling on invertebrate density and diversity were confined to the extent of the cuttings pile itself. At a drilling operation in the northeast Atlantic, polychaete pioneer species were observed colonizing the drill cuttings piles one year after the initial discharge and experimental evidence indicates similar species initially colonized WBM drill cuttings in Norway (Gates et al. 2017). As cuttings are typically discharged near the seafloor, the zone of influence, as noted in these studies, may be similar for the Project. These studies indicate recovery and recolonization of drill cuttings areas in relatively shallower waters, and it is estimated that recovery timescales would likely be longer in the deeper waters of the Core BdN Development Area.

Examining the results from ongoing EEM programs for the offshore production operations, specifically Terra Nova and Hibernia, these EEM programs showed recovery at drilling locations where drilling had ceased, and cuttings were no longer discharged. The Terra Nova Project discharged WBM drill cuttings (54,622 m^3) and SBM drill cuttings (6,320 m^3) from 2000 to 2009 (Deblois et al. 2014a). There was an overall decrease in hydrocarbon and barium level within 1 km of the drill centers, consistent with reduction in drilling activities from 2006-2008 and suggests post-drilling recovery from degradation or sediment transport (Deblois et al. 2014a,b). For the Hibernia

Platform, hydrocarbon and barium levels have generally declined after installation of a cuttings reinjection system in 2002 to 2014 where SBM cuttings are not discharged into the environment, indicating recovery. A slight increase in these parameters was observed in 2016 and was likely associated with limited SBM discharges in 2015-2016 for certain situations to ensure the integrity of the cuttings re-injection system (HMDC 2019). Although the BdN Project is in deeper waters than the production projects on the Grand Banks, cuttings would be discharged in similar ways with WBM cuttings discharged near the seafloor and SBM cuttings discharged near the surface. Considering that the volumes are much lower for an eight well template (approximately 4,144 m^3 WBM drill cuttings and 1,464 m^3 SBM cuttings) than what is discharged for the Terra Nova Project, and there would be relatively higher dilution for SBM cuttings released near the surface at the Core BdN Development Area depths, the overall zone of influence would for drill cuttings deposition would likely be less than 1 km. Although, recovery and recolonization timescales would likely be longer in the deep waters of the Core BdN Development Area.

Bottom currents may further aid in cuttings dispersion in some areas, minimizing potential for long-term effects due to burial. Mobile benthic organisms (such as shrimp) will also quickly recolonize a disturbed area if water quality is not permanently affected (Tait et al. 2016). Opportunistic species that may be tolerant to pollutants like some polychaete and nematodes have also been shown to colonize in cuttings depositional areas within months (Kingston 1992). SBM components in drill cuttings have been observed to degrade quickly, with a greater than 40 percent biodegradation over 7-8 months after the cessation of drilling activity, thereby reducing toxicity over time (Daan et al. 1996; Trannum et al. 2010; Tait et al. 2016). As discussed in Lelchat et al. (2020), microfauna capable of metabolizing compounds in drill cuttings rapidly colonize cuttings piles, though the rates and timelines for a return to natural conditions aren't well studied in the deep sea. Terrens et al. (1998) indicated that there was an absence of SBM esters in sampling sites 11 months after cessation of drilling, and recovery of crustaceans and nematodes was observed after only four months. The initial decrease in diversity and density of invertebrates was also limited to the drill cuttings pile that was within 100 m from the well site (Terrens et al. 1998).

Drill Cuttings Modelling

An average burial depth threshold of 6.3 mm is considered the PNET for non-toxic sedimentation based on benthic invertebrate species tolerances to burial, oxygen depletion and change in sediment grain size (Smit et al. 2008). This PNET (6.3 mm) was updated based on the work performed by Kjeilen-Eilertsen et al. 2004 and Smit et al. 2006, that derived a PNET of 6.5 mm. However, as some species may be more susceptible to shallower burial depths, an average PNET burial depth of 1.5 mm is suggested to be a more conservative approach to assessing drilling discharges (Kjeilen-Eilertsen et al. 2004). Burial effects on invertebrates are also predicted to occur between depositions at 1.5 mm to 6.5 mm sediment thickness, as evidenced by damage to *L. pertusa* coral observed with deposited drill cuttings of 6.5 mm (Larsson and Purser 2011) and reduced sediment reworking by invertebrates occurring with deposition of WBM drill cuttings of 2.5 mm (Trannum 2017). Given that species may be susceptible to different thresholds, both the 1.5 mm and 6.5 mm thresholds are considered in this assessment.

Section 9.1.3 provides a summary of the modelling undertaken and the modelling report is located in Appendix I (Wood 2018). The following is a summary of the eight-well model simulations which represents the worst-case scenario for drilling at any one location. Model simulations assumed a single discharge point for the eight wells, which results in higher potential thicknesses. During drilling activities, cuttings discharges will likely be redirected to reduced accumulations near the template, therefore the modelling approach is deemed very conservative to support the effects assessment. Drill cuttings dispersion modelling modelled a single well or multiple wells using WBM (i.e., riserless drilling), and therefore included the possibility of drilling a pilot well.

Drill cutting piles in the base case with flocculation are estimated to be thickest near the source and decrease with distance. The majority of drill cuttings released (approximately 75 percent) settle within 100 m of the wellsite (Table 9.12). Median (most likely) thickness of the cuttings pile between 10 m to 100 m away from the wellsite where the majority of cutting settle (approximately 68 percent), is estimated to be 199 mm with maximum thicknesses of 1,993 mm. Beyond 100 m from the wellsite, median cuttings pile thicknesses range from less than 0.01 mm to 2 mm with maximum thicknesses of less than 0.01 mm and 46 mm. Settled cuttings from 100 m to 23 km from the wellsite account for less than five percent of total cuttings. Cuttings deposition more than 200 m away from the wellsite are estimated to drift towards the south and would be patchy and discontinuous and therefore not likely to form appreciable thicknesses (<1.5 mm) to have effects on benthic environments. Approximately 22 percent of drill cuttings are highly dispersed and drift more than 23 km away from the wellsite, outside the model domain. These cuttings depositions would be patchy and discontinuous and not likely to form appreciable thicknesses (<1.5 mm) to have effects on benthic environments. Stochastic simulations of the base case (flocculation) (85 percent probability for exceedances PNET) indicated that the footprint would be localized to within 200 m of the wellsite for 1.5 mm and 6.5 mm thresholds. The estimated area for which total cuttings thicknesses are greater than 1.5 mm for the base case (flocculation), ranges from 0.051 km² to 0.059 km² with an average of 0.055 km². The corresponding estimated area for which total cuttings thicknesses are greater than 6.5 mm ranges from 0.034 km² to 0.038 km² with an average of 0.036 km² (approximately 230 m²).

Table 9.12 Total Cuttings Material Settled (percent), Average Cuttings Thickness (mm) and Maximum Cuttings Thickness by Distance from the Wellsite, Eight Wells

Simulation	Distance from Wellsite								
	Wellsite	10-100m	100-200m	200-500m	500m-1km	1-2km	2-5km	5-23km	Unsettled
Percent Material Settled									
Base case with flocculation	7.2	68.1	1.9	<0.01	<0.01	0.0	0.1	0.4	22.3
Troll A, average PSD	33.1	34.1	1.1	2.7	4.0	2.8	3.4	10.1	8.7
Median Cuttings Thickness (mm)									
Base case with flocculation	2,633	199	2	<0.01	<0.01	<0.01	<0.01	<0.01	n/a
Troll A, average PSD	11,699	100	1	0.4	0.2	<0.01	<0.01	<0.01	n/a

Table 9.12 Total Cuttings Material Settled (percent), Average Cuttings Thickness (mm) and Maximum Cuttings Thickness by Distance from the Wellsite, Eight Wells

Simulation	Distance from Wellsite								
	Wellsite	10-100m	100-200m	200-500m	500m-1km	1-2km	2-5km	5-23km	Unsettled
Maximum Cuttings Thickness (mm)									
Base case with flocculation	2,682	1,993	46	1	<0.01	<0.01	<0.01	<0.01	n/a
Troll A, average PSD	11,725	1,180	14	2	2	2	0.7	0.1	n/a
Note: slumping of the larger cuttings piles near the wellsite will likely occur resulting in smaller thicknesses.									

Drill cutting piles in the Troll A platform case (average PSD) are estimated to be thickest near the source and decrease with distance. This case represents a scenario of larger particle sizes profile relative to the base case with flocculation and therefore provides a range of potential deposition areas. Approximately 67 percent of drill cuttings settle within 100 m of the wellsite (Figure 9-5). Median thickness of the cuttings pile up to 100 m away from the wellsite is estimated to range from 100 mm to 1,699 mm with maximum thicknesses of 1,180 mm to 11,725 mm. The maximum cuttings thickness (11,725 mm) was within 10 m of the wellsite at the discharge source. Approximately 24 percent of drill cuttings settle within 100 m to 23 km from the wellsite. Median cuttings pile thicknesses beyond 100 m from the wellsite, range from less than 0.01 mm to 1 mm with maximum thicknesses of 0.1 mm to 14 mm. Cuttings deposition more than 100 m away from the wellsite are estimated to distribute non-uniformly around the wellsite with drifting towards the south. Therefore, between 100 m to 23 km from the source, drill cuttings deposition is patchy and discontinuous and is not likely to form appreciable thicknesses (<1.5 mm) to have effects on benthic environments. The remaining 9 percent of drill cuttings are highly dispersed and drift more than 23 km away from the wellsite, outside the model domain, and are not likely to form appreciable thicknesses to have effects on benthic environments.

Stochastic simulations of the base case (flocculation) (85 percent probability for exceedances PNET) indicated that the footprint was localized to within 125 m for the 6.5 mm threshold and with 200 m of the wellsite for the 1.5 mm thresholds. The estimated area for which total cuttings thicknesses are greater than 1.5 mm for the Troll A platform case ranges from 0.045 km² to 0.067 km² and averages 0.050 km². The corresponding estimated area for which total cuttings thicknesses are greater than 6.5 mm ranges from 0.025 km² to 0.028 km² and averages 0.031 km² (approximately 176 m²).

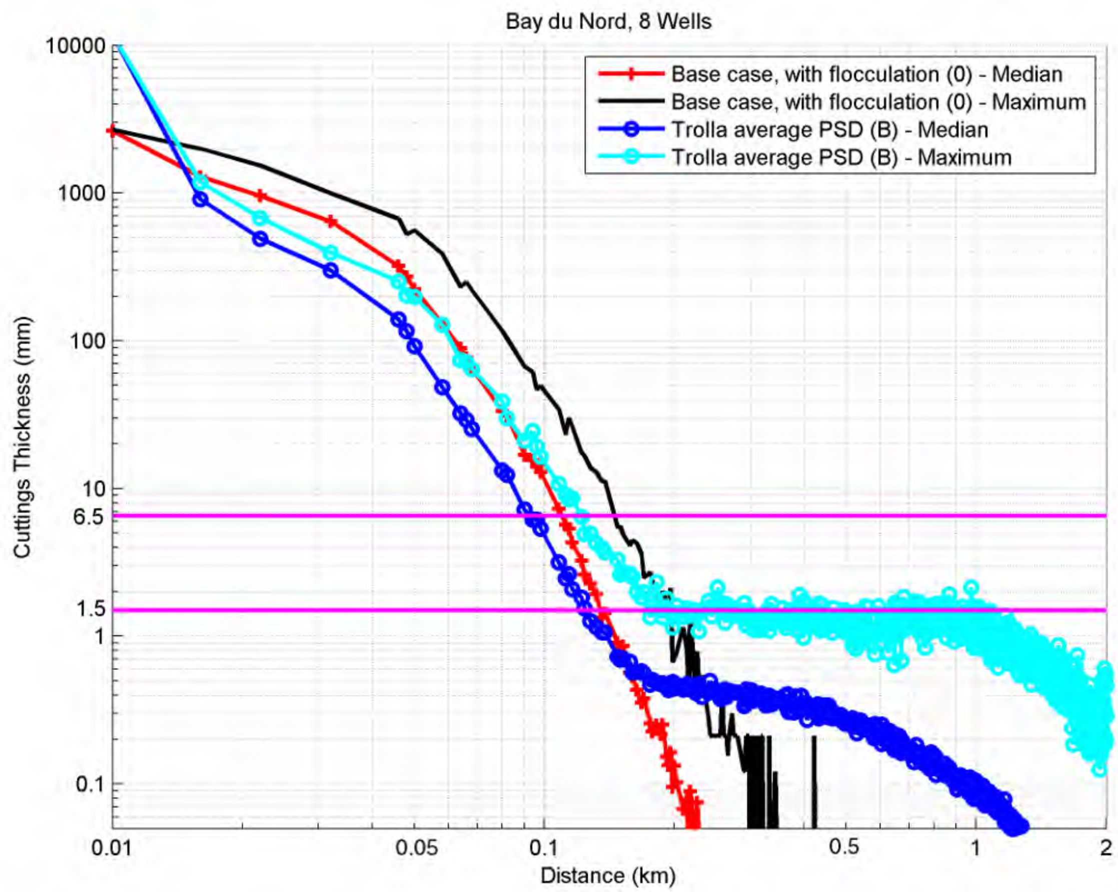

Figure 9-5 Median and Maximum Total Drill Cuttings (WBM and SBM) Thickness for Base Case with Flocculation and Troll A Platform Case relative to the 1.5 mm and 6.5 mm PNET

Assessment of the base case (flocculation) indicated that median drill cuttings thickness decrease below the 6.5 mm PNET approximately 100 m from the wellsite and below the 1.5 mm PNET at less than 200 m away from the wellsite (Figure 9-5). The drill cuttings in the modelled Troll A platform case settle faster than the base case (flocculation) and median thicknesses decrease below the 6.5 mm PNET at less than 100 m from the wellsite and below the 1.5 mm PNET at less than 200 m away from the wellsite. Maximum drill cuttings thicknesses for both cases are similarly below the 6.5 mm PNET less than 200 m from the wellsite. However, the maximum cuttings thickness for the Troll A platform case from 200 m to 1 km from the wellsite is around the 1.5 mm PNET. While maximum cuttings values extend up to 1 km from the wellsite, as noted above, they are generally patchy in nature. While the Troll A platform case shows a larger areal extent relative to the base case (flocculation), areas above the 1.5 mm PNET remain mainly within 1 km from the wellsite.

In summary, discharged volumes of drill cuttings will be highly localized to the well template locations with low quantities dispersing widely. The predicted small footprint limits smothering effects on benthic species to approximately 200 m around the template location. The remaining quantities of cuttings dispersed beyond 200 m are not predicted to have potential interactions with Marine Fish and Fish Habitat due to the expected low concentration in the water column and lack of accumulation on the seabed. In accordance with the OWTG (NEB et al. 2010), released SBM drill cuttings will be treated using best treatment practices that are commercially available and economically feasible.

Final layout and well template locations have yet to be finalized. A combination of single wells or multi-well templates (4-slot, 6-slot and/or 8-slot) will be drilled. Modelling considered the worst-case scenario for highest cuttings deposition, an 8-slot well template. Based on the drilling of 8-slot well template at a single location, the maximum extent of drill cuttings deposition for 1.5 mm was within 200 m from the source. Conservatively, if a 400 m radius from the center of a template was assumed, which considers use of a cuttings transport system and the 200 m cuttings zone of influence, the total area that could be affected by drilling per well template would be approximately 0.5 km². Assuming five templates for the Core BdN Development, the total area per well template potentially affected by drilling in the Core BdN Development Area is estimated to be 2.5 km². This represents approximately 0.5 percent of the Core BdN Development Area. Using the potential subsea layout (Section 2.5.3.2), should an 8-slot well template be drilled anywhere within the Core BdN Development Area, cuttings deposition would likely remain within the boundaries of the Core BdN Development Area and there is little or no potential for these environmental releases from individual wells or multiple wells to interact or accumulate beyond the Core BdN Development Area. Based on the potential subsea layout, the closest distance between well template locations is approximately 1.2 km. At this distance the potential spatial overlap of cuttings between well templates is low due to the patchy nature of cutting and limited deposition at more than 200 m from the discharge source.

Change in Habitat Availability and/or Quality is a potential effect associated with the discharge of drill cuttings during Drilling Activities. Based on cuttings modelling results discussed above, the zone of influence of drill cuttings discharge is approximately 200 from the well template location. Assuming the worst-case scenario in which eight wells are drilled at each template, the zone of influence per template would be 0.5 km², or 2.5 km² for all templates, representing approximately 0.5 percent of the Core BdN Development Area.

As noted in the discussion above regarding the discharge of WBM cuttings and/or SBM cuttings, the discharge of cuttings would result in a change in water quality (cuttings particles in the water column, suspended particles). Alterations to seabed characteristics (cuttings deposition, potential seabed disturbance and burial, smothering habitat) and injury or mortality to biogenic habitat are likely to result from discharge of drill cuttings would be localized to the deposition area of thicknesses above PNET and be within 200 m from the cuttings discharge location.

The change in habitat availability and/or quality associated with to the drill cuttings discharges would be adverse, as described above. However, based on the modelling results, the potential interaction with these species would be limited to within 200 m from the template location. Based on recovery rate estimates noted above, there is evidence of recovery in shallower waters occurring on time scales of three and 10 years and in deeper water it is predicted that recolonization would likely occur over a longer timeframe. Therefore, it is estimated that the effects on the change in habitat from drill cuttings would be medium- to long-term in duration, but reversible, once recovery occurs. As noted above, the predicted zone of influence for drill cuttings is approximately 200 m from the well template location or 0.5 km² per well template (2.5 km² in total for all well templates), as noted above. The change in habitat would be continuous while the drilling was ongoing, and reversible with eventual recovery and recolonization. The drill cuttings footprint would occupy a very small area, less than 0.5 present of the entire 470 km² Core BdN Development Area. Drill cutting deposition will likely interact with corals and sponges, including soft corals, sea pens, glass sponges, and demosponges in the Core BdN Development Area (Section 6.1.7.6) within the 200 m zone of influence of drill cuttings deposition on the sea floor. However, given that the cumulative zones of influence represent approximately 0.5 percent of available habitat in the Core BdN Development Area, there will likely not be an overall effect on fish habitat in the Core BdN Development Area. As the change in habitat represents approximately 0.5 percent of total habitat available within the Core BdN Development Area, the change in habitat is considered to be within the range of natural variability, therefore the magnitude of change in habitat would be low. In consideration of the subsea infrastructure zone of influence (approximately 1.5 percent) and drill cuttings zone of influence (0.5 percent), the cumulative, intra-project zones of influence for fish habitat is approximately 2 percent of available habitat within the Core BdN Development Area, which would be considered within the range of natural variability and is therefore low. With the exception of geographic extent and timeframe for recovery, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on drill cuttings modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of drill cuttings deposition predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, the timeframe for recovery is made with a moderate level of confidence.

Mitigations to reduce the changes in habitat include adhering to C-NLOPB guidance regarding the avoidance of *Lophelia pertusa* and/or coral colonies of 5 or more corals in 100 m² with heights greater than 30 cm within 100 m of the drill cutting discharge location. SBM cuttings will be treated with the use of best treatment practices that are commercially available and economically feasible and discharged in adherence to minimum discharge limits in the OWTG. For chemicals that may be discharged, per Equinor's chemical management system, and in accordance with the OCSG (NEB et al. 2009), the chemical selection and management process enables the selection of chemicals that, once discharged at sea, would have the least effect on the receiving environment.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with the discharge of drill cuttings during Drilling Activities are predicted to be adverse, low in magnitude, with a geographic extent between less than 1 km² to less than 10 km², of medium- to long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Fish Invertebrate Mortality, Injury and/or Health is a potential effect associated with the discharge of drill cuttings during Drilling Activities. Based on cuttings modelling results discussed above, the zone of influence of drill cuttings discharge is approximately 200 from the well template location. Assuming the worst-case scenario in which eight wells are drilled at each template, the zone of influence per template would be 0.5 km², or 2.5 km² for all templates, representing approximately 0.5 percent of the Core BdN Development Area.

As discussed in detail above, the discharge of drill cuttings can cause burial and/or smothering of benthic invertebrates and corals and sponges. Within the Core BdN Development Area, this may include soft corals, sea pens and solid/massive sponges (e.g., *Geodia* sp.) and benthic invertebrate groups such as polychaetes, bivalves, and echinoderms. The interaction with suspended particles in the water may result in physical damage, especially in suspension feeding organisms such as corals and sponges (IOGP 2016), including soft corals, sea pens and solid/massive sponges in the Core BdN Development Area. Chemicals associated with drill cuttings may increase chemical toxicity and result in the bioaccumulation (uptake of contaminants by fish and/or the presence or perception of taint). Drill cuttings are typically regarded as toxicologically inert, however adhered drill fluids may be toxic depending on the type of drilling fluid being used (Neff et al. 2000; Neff 2008). Sea pens, soft corals (e.g., *Duva florida*) and Geodid sponge species in the Core BdN Development Area, may be resistant to short-term exposure to suspended drill cutting particles with potential effects on adults related to chronic exposure or high suspended sediment and burial.

The initial high settling of particles and relatively low quantities of dispersed cuttings beyond two kilometres also indicates that there will not be a substantial interaction with pelagic species (e.g., squid, redfish). The Project Area depths are also beyond the photic zone and it is therefore also not expected that there will be an interaction with marine macroflora species. Discharge of drill cuttings particles may form aggregates with phytoplankton resulting in rapid settling of plankton to the seafloor (Pabortsava et al. 2011). However, due to the low quantities, it is unlikely that there will be high settling or turbidity effects that may adversely affect suspended phytoplankton species.

As described above, WBM and SBMs fluids are of low toxicity and bioaccumulation potential. The primary interactions that may result in changes to fish mortality, injury and/or health are associated with burial, smothering and creation of anoxic environments from the deposition of drill cuttings. Based on drill cuttings modelling, discharged volumes of drill cuttings that can cause smothering and burial effects will be localized to within 200 m the well template locations. As discussed in detail above, based on data from shallower waters where recovery is evident between three to 10 years, in the deeper waters of the Core BdN Development Area recovery is likely to take longer.

The change in Fish and Invertebrate Mortality, Injury, and/or Health associated with the discharge of drill cuttings at well template locations in the Core BdN Development Area would be adverse, as described above and medium- to long-term in duration. The change in mortality / injury / health would be continuous during drilling and reversible, with eventual recovery and recolonization. The geographic extent of the change mortality / injury / health is approximately 200 m from the well template location or a conservative 0.5 km^2 area per well template or 2.5 km^2 for the Core BdN Development. The cumulative zone of influence (2.5 km^2) represents approximately 0.5 percent of the 470 km^2 area available in the Core BdN Development Area, therefore the change in mortality / injury / health would be considered within the range of natural variability without affecting the viability of local populations and is therefore of low magnitude. With the exception of geographic extent and timeframe for recovery, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on drill cuttings modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of drill cuttings deposition predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, the timeframe for recovery is made with a moderate level of confidence. Mitigations to reduce the change mortality / injury / health are the same as those described above in the discussion on change in in habitat availability and/or quality.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Change in Fish and Invertebrate Mortality, Injury, and/or Health associated with the discharge of drill cuttings during Drilling Activities are predicted to be adverse, low in magnitude, with a geographic extent between less than 1 km² to less than 10 km², of medium- to long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with the discharge of drill cuttings during Drilling Activities. Based on cuttings modelling results discussed above, the zone of influence of drill cuttings discharge is approximately 200 from the well template location. Assuming the worst-case scenario in which eight wells are drilled at each template, the zone of influence per template would be 0.5 km², or 2.5 km² for all templates, representing approximately 0.5 percent of the Core BdN Development Area.

The discharge of cuttings may result in benthic fish and invertebrates including grenadiers, blue hake, longnose eel, wolffish, shrimp, and crab, avoiding the area and a loss or reduction of prey species (e.g., bivalves, polychaetes) associated with changes in fish habitat characteristics. As described above, the discharge of drill cuttings into the water is predicted to result in localized and temporary suspended sediments and turbidity (Smit et al. 2008), however due to the low toxicity of drill cuttings and rapid dilution and dispersion, as noted above, the risk to pelagic organisms such as squid, or lanternfish, is considered low (IOGP 2016). Fish (e.g., redfish, lanternfish) are also typically highly mobile and would likely return after cessation of cuttings discharges. In a modelling study of drill cuttings in the South China Sea, discharged suspended drill cuttings were estimated to drift >200 m from the source (Koh and Teh 2011). The initial deposition of drill cuttings may also result in smothering of benthic invertebrate species (e.g., polychaetes, bivalves, echinoderms) that benthivorous fish (e.g., grenadier, wolffish, blue hake) prey upon. Initial prey losses may be offset by recolonization by pioneer polychaete species that can occur in as little as one year after drill cuttings discharge (Gates et al. 2017).

The Change Food Availability and/or Quality associated with the discharge of drill cuttings at well template locations would be adverse, as described above and medium-to long-term in duration. The effects of drill cuttings are localized to the deposition area of thicknesses above PNET that may occur up to 200 m from the drilling template. Therefore, the geographic extent of the change in food availability would be less than 1 km² of the location of the drill template location within the Core BdN Development Area, or approximately 2.5 km² for the entire Core BdN Development Area. The change in food availability would be continuous during drilling and reversible, with eventual recovery and recolonization. The drill cuttings footprint would occupy a very small area (~2.5 km² assuming five templates) within the entire 470 km² Core BdN Development Area. While there may be a change in food availability within 200 m of the well template location, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. With the exception of geographic extent and timeframe for recovery, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on drill cuttings modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of drill cuttings deposition predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, the timeframe for recovery is made with a moderate level of confidence. Mitigations to reduce changes in food availability are the same as those listed above to reduce changes in habitat availability.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality associated with the discharge of drill cuttings during Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent between less than 1 km² to less than 10 km², of medium-to long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with drill cuttings discharge include adherence to C-NLOPB requirements for the avoidance of *Lophelia pertusa* complexes and/or coral colonies of 5 or more corals in 100 m² area with heights greater than 30 cm within 100 m of the discharge location (B); treatment and discharge of all discharges in accordance with the OWTG (E); selection and screening of chemicals in accordance with the OCSG and Equinor Canada’s chemical selection and management processes (F).

Follow-up Monitoring: In consideration of the residual effects predictions based on drill cuttings dispersion modelling results, follow-up monitoring will include a component to validate the drill cutting model with respect to the zone of influence for cuttings dispersion. Section 9.7 for additional information.

9.3.4 Supply and Servicing

Activities associated with Supply and Servicing are described in Section 2.6.4. Supply and servicing to support the Project will involve marine vessels and aircraft transiting to, from and within the Core BdN Development Area and Project Area at all times of the year throughout the Project duration.

As described in Section 2.6.4.2, the volume of vessel traffic associated with Core BdN Development activities represents a small increase to the overall vessel traffic off eastern Newfoundland. At a maximum, when Project phases overlap, albeit for a short duration, it is estimated that up to six support vessels could supporting project activities and up to 16 vessels transits per month could occur. Of the total annual transits recorded servicing offshore oil and gas activities, these 16 transits per month (or 192 per year) represents and estimated 20 percent increase to offshore oil and gas related traffic or 12 percent of all traffic in the port of St. John’s. During normal operational timeframe, when only one Project activity is occurring at any one time, for instance Production and Maintenance, up to three support vessels would be supporting the Project, representing eight transits per month. This typical level of supply and servicing traffic represents an estimated 10 percent increase in offshore oil and gas related traffic and 10 percent increase in all vessel traffic in the port of St. John's. Supply and support vessels supporting the Project will transit in a straight-line approach to and from port to the Project location, a common industry practice for energy efficiency employed for over 30 years by operators with facilities offshore NL.

Marine discharges from offshore vessels (e.g., bilge and ballast water, deck drainage, organic waste) are treated in accordance with international and regulatory requirements prior to discharge. Solid and hazardous wastes are disposed of onshore at approved waste management facilities, thereby avoiding potential interactions with the marine environment.

With regards to helicopter support traffic, helicopters will be used for the transport of crew and supplies to and from the Project. As described in Section 2.6.4.3 up to 15 trips per week are estimated at a maximum when multiple activities are occurring such as HUC and drilling. When only production activities are ongoing, up to five helicopter transits per week are estimated. Of the total annual transits for helicopter flights servicing NL offshore oil and gas activities, at a maximum15 helicopter trips per week would represent an estimated 27 percent of annual helicopter traffic when activities are simultaneous and 11 percent of annual helicopter traffic during normal production timeframe. Note that the maximum helicopter flights would only occur for a short period of time while HUC and drilling carried out simultaneously.

The vessel traffic route overlaps areas of relatively high abundance or biomass of fishes, mainly on the slopes and shelf of the NL Shelf, and the slopes of the Flemish Pass. Fish that are well distributed on the slopes are primarily demersal species with limited potential interaction with vessel traffic, including wolffish, Greenland halibut, and grenadiers. Fish species that occupy the water column and are distributed along the vessel traffic route based on Canadian RV surveys include capelin, Atlantic cod, and redfish species. These species have potential to interact with vessel traffic, but also have higher capability for avoidance. Furthermore, species like Atlantic salmon do not migrate in large concentrations and preferred sea surface temperatures (SSTs) would likely limit habitat use to temporary movement corridors in the Project Area, limiting potential for interactions with offshore supply vessels (OSVs). Pelagic early life stages of various fish and invertebrates have limited avoidance capabilities as they generally drift passively on ocean currents. The overall effects are on larvae and adults are limited due to the transitory and environmentally non-intrusive nature of the vessel traffic.

As indicated in Table 9.6, only vessel presence will directly interact with Marine Fish and Fish Habitat as a result of the associated light and sound emissions and marine discharges while the vessel is in transit within the vessel traffic route, or at location within the Core BdN Development Area. In the Core BdN Development Area, support vessels will maintain their location through dynamic positioning which will introduce underwater sound. Interactions between Marine Fish and Fish Habitat and helicopter use is not anticipated and therefore will not have an effect on this VC.

9.3.4.1 Light Emissions from Vessels

The primary effects on Marine Fish and Fish Habitat, associate with light emissions from vessels engaged in Supply and Servicing activities for the Core BdN Development are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with light emissions from supply and support vessels while on-site at the Core BdN Development Area or while in transit in the vessel traffic corridor.

The change to fish behaviour due the light emission from the supply vessels would be similar to effects assessed in Section 9.3.1.1 and 9.3.2.2 for vessels and the FPSO on-site within the Core BdN Development Area. The stand-by vessel (SBV) must remain on-site within a set distance of the FPSO and/or drilling installation (long-term), other supply and support vessels onsite would only be onsite while carrying out their duties (cargo transport, crew change, etc.) and therefore would be short-term. Changes in behaviour from transiting vessels would also be short-term.

Lighting from vessels may result in the attraction or avoidance by fish and invertebrate species as described above with potential behavioural effects limited to less than 1 km² of the location of the vessel in the Core BdN Development Area or while transiting in the vessel traffic corridor. The change in fish behaviour due to the vessel lighting would be adverse, as described above. The duration of the effect would be short-term for transiting vessels and long-term for the SBV in the Core BdN Development Area. The change in fish behaviour would be sporadic for transiting vessels and regular for the SBV (occurring only at night) and reversible once the vessel(s) leaves the area. As the change in behaviour is localized to the vessel location, which occupies a very small footprint in the 470 km² of the Core BdN Development Area (including if more than one vessel were onsite at the same time), or along the vessel traffic route, and in consideration of the SBV which is onsite longer term, it would not affect fish behaviour in the larger Core BdN Development Area or along the vessel traffic route. The change in behaviour associated with the long-term interactions of the SBV is considered to be within the range of natural variability without affecting the viability of affected fish populations and therefore is of low magnitude. For vessels in transit, the magnitude of change is predicted to be negligible; there is no change in fish behaviour relative to baseline conditions along the vessel traffic route. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in fish and invertebrate presence and/or abundance are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with light emissions from vessels engaged in Supply and Servicing are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km², of short- to long-term duration, occurring sporadically to regularly, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with light emissions from supply and support vessels while on-site at the Core BdN Development Area supporting Project activities. Light emissions from transiting vessels would not contribute to a change in food availability due to the short-term and transitory nature of the activity. They are not likely to attract prey species while they are in transit.

The change to food availability due the light emission from the supply vessels would be similar to effects assessed in Section 9.3.1.1 and 9.3.2.2 for vessels and the FPSO on-site within the Core BdN Development Area. The stand-by vessel (SBV) must remain on-site within a set distance of the FPSO and/or drilling installation (long-term), other supply and support vessels onsite would only be onsite while carrying out their duties (cargo transport, crew change, etc.) and therefore would be short-term.

As noted in Sections 9.3.1.1 and 9.3.2.2, light emissions form vessels may result in the attraction or avoidance by fish and invertebrate species. Light sensitive fish such as lanternfish that depend on dark areas for predator avoidance would likely react to a light field with avoidance horizontally or vertically depending on other environmental effects and presence of prey species (e.g., plankton). Within the Project Area the lighting from vessels may generally result in some degree of attraction by phototaxic plankton and avoidance by krill, and lanternfish. Individual behavioural responses may vary depending upon the species, and reproductive and foraging states involved with effects to food availability would be limited to less than 1 km^2 of the vessel.

The change in food availability and/or quality due to light emission from vessels would be adverse, as described above and long-term for the SBV on site. The geographic extent of the change in food availability would be less than 1 km^2 of the location of the vessel, within the Core BdN Development Area. The change in food availability would occur regularly at night while vessels were on-site and reversible once the vessel(s) leaves the area. The change in food availability is localized to the location of the vessel and given that the overall food availability within the entire Core BdN Development Area is not affected, the change in the food availability would be negligible relative to baseline conditions. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with light emissions from vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2 of long-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with light emissions from vessels engaged in Supply and Servicing are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with light emissions from of vessels engaged in Offshore Construction, Installation and HUC in consideration of the residual effects predictions.

9.3.4.2 Underwater Sound Emissions from Vessels

The primary effects on Marine Fish and Fish Habitat, associated with underwater sound from vessels engaged in Supply and Servicing are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

As noted in Section 9.3.1.2, Changes to Fish and Invertebrate Mortality, Injury and/or Health are not predicted.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with sound emissions from vessels engaged in Supply and Servicing.

The change to fish behaviour due the underwater sound emissions from the supply vessels would be similar to effects assessed in Section 9.3.1.2 and 9.3.2.3 for vessels and the FPSO on-site within the Core BdN Development Area. The SVB must remain on-site within a set distance of the FPSO and/or drilling installation (long-term), other supply and support vessels onsite would only be onsite while carrying out their duties (cargo transport, crew change, etc.) and therefore would be short-term duration. Changes in behaviour associated with vessels in transit would also be short term. Fish may respond with avoidance or attraction responses to vessel sounds as described above. Behavioural reactions from fish from underwater sound would likely be temporary as the fishes in the water column (e.g., lanternfish) are typically highly mobile and would likely return after cessation of the activity or removal of the sound source.

The change in fish behaviour due to underwater sound emissions from vessels would be adverse, as described above. Change in behaviour would be short-term for transiting vessels and long-term for the SBV at the Core BdN Development Area. The geographic extent of the change in behaviour would be less than 1 km² of the location of the vessel either in the Core BdN Development Area or in the vessel traffic route. The change in fish behaviour would be continuous while vessels were on-site, sporadic for transiting vessels, and reversible once the vessel(s) leaves the area. While underwater sound emissions may affect the presence and/or abundance of fish within the localized (less than 1 km²) area of the vessel, their abundance and or presence is not affected within the entire Core BdN Development Area (including if more than one vessel were on site) or along the vessel traffic route. There would be no change in the abundance and/or presence of fish relative to baseline condition and is therefore the magnitude of the change in behaviour is considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in fish behaviour are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with underwater sound emissions from vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km² of short- to long-term duration, occurring sporadically to continuously, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with underwater sound emissions from vessels engaged in Supply and Servicing.

The change to food availability due the underwater sound emissions from the supply vessels would be similar to effects assessed in Section 9.3.1.2 and 9.3.2.3 for vessels and the FPSO on-site within the Core BdN Development Area. The SVB must remain on-site within a set distance of the FPSO and/or drilling installation (long-term), other supply and support vessels onsite would only be onsite while carrying out their duties (cargo transport, crew change, etc.) or in transit and therefore would be short-term.

Fish may respond with avoidance or attraction responses to vessel sounds as described above and the displacement of fish may shift the spatial distribution of lanternfish or redfish and affect food availability as described above. Changes to the spatial distribution of fish from underwater sound would likely be temporary as the fishes in the water column (e.g., lanternfish) are typically highly mobile and would likely return after the vessel leaves the area.

The change in Food Availability and/or Quality due to the underwater sound emissions from vessels would be adverse, as described above. Change in food availability would be short-term for transiting vessels and long-term for the SBV at the Core BdN Development Area. The geographic extent of the change in food availability would be less than 1 km² of the location of the vessel either while in transit or at site within the Core BdN Development Area. The change in food availability would be sporadic while vessels are transiting, continuous for the SBV on site -site, and reversible once the vessel(s) leaves the area. As the change in food availability is localized to the vessel and given that the overall food availability within the entire Core BdN Development Area or along the vessel traffic route is not affected, the change in the food availability would be negligible relative to baseline conditions. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound from vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short- to long-term duration, occurring sporadically to continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with underwater sound emissions from vessels engaged in Supply and Servicing are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with light emissions from of vessels engaged in Supply and Servicing in consideration of the residual effects predictions.

9.3.5 Supporting Surveys

As described in Section 2.6.5, throughout the Project, surveys may be required to support all Project activities. These surveys include geophysical surveys (e.g., 2D/3D/4D seismic, VSP, wellsite geohazard), geotechnical and/or geological surveys, environmental surveys, and ROV/AUV/video surveys. Surveys will be carried out in the Core BdN Development Area and/or Project Area should Project Area Tiebacks be undertaken.

Geohazard/wellsite surveys typically take between five and 21 days to complete, but the overall duration can be shorter or longer depending on the data requirements and weather /operational delays. They may involve the use of seismic sound sources, multibeam echosounder (MBES), sidescan sonar (SSS), synthetic aperture sonar (SAS) subbottom profiler (SBP), video and other non-invasive equipment. The equipment is deployed either as hull-mounted equipment, on a towfish or on ROV / AUVs. Equipment may be autonomous, towed by the vessel or hull-mounted. These surveys may occur at any time of the year over the temporal scope of the Project.

Geophysical surveys that may occur over the life of the Project and include 2D/3D/4D seismic surveys or VSP surveys. Any required survey will take place within the Project Area. As noted in Section 2.6.5, 2D seismic surveys are not anticipated. For 3D/4D surveys, multiple sound source arrays can be used, and the vessel could tow between eight and 16 streamers containing hydrophones, also called conventional seismic surveys. Another option for 4D surveys is to place the hydrophones on the seabed, in either nodes or cables. If nodes/cables are used and installed on the seafloor it is called ‘permanent reservoir monitoring’; the nodes/cables are removed at the end of the Project. The Project is considering permanent reservoir monitoring or conventional seismic. Permanent reservoir monitoring is estimated to take approximately two weeks to complete and could be carried out twice per year. Conventional seismic surveys could be between two and four weeks and occur as frequently as once per year in early Project life, with reduced frequency in later years. If permanent reservoir monitoring is chosen, the area occupied on the seabed by the installed OBC/OBN could be approximately 150 km^2. Timing and duration of these seismic surveys are estimated and will be finalized during Project design.

VSP is a tool used to further define the depth of geological features and potential petroleum reserves by obtaining high resolution images of the target. As stated in Section 2.6.5, it is estimated that one to two VSP surveys could be carried out for the Core BdN Development Area. VSP is conducted in a vertical wellbore using hydrophones inside the wellbore and a sound source near the surface at or near the well; a VSP is quieter and more localized than a surface geophysical survey, being smaller in size and volume. A VSP usually taking less than 48 hours per well to complete. VSP surveys may be carried out at any time of the year.

Environmental surveys are used to collect samples to characterize the physical, chemical, and biological aspects of the selected area. Sampling is typically carried out from an OSV or dedicated vessel suitable to the survey. Environmental surveys may occur throughout Project life at any time of the year using vessels of opportunity associated with the Project, typically taking five to 21 days to complete.

Geotechnical or geotechnical surveys measure the physical properties of the seabed and subsoil through the collection of sediment samples and in-situ testing. Geotechnical surveys may occur throughout the Project life at any time of the year, using dedicated vessels provided by marine geotechnical specialist suppliers.

ROV or AUV surveys are used to conduct visual inspections (camera equipped) of seafloor, facilities and/or carry out repairs of subsea equipment. They may also be used during any or all of the surveys described above. They will be conducted throughout the Project-life at any time of the year using vessels of opportunity associated with the Project.

In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of project activities is based on those discharges/activities "with the greatest potential to have environmental effects." For supporting surveys, the interaction with the greatest potential to have effects on Fish and Fish Habitat is underwater sound emissions from geophysical activities. Other interactions, such as light emissions and waste discharges would be the same as those assessed in Sections 9.3.1 and 9.3.4 and are summarized below. Where there may be differences in the characterization of effects (i.e., magnitude, duration, etc.) it will be noted and explained. With regard to towed equipment and equipment contact with the seabed, while there may be an interaction with Fish and Fish Habitat, there would not be no discernible effects. The effects assessment associated underwater sound emissions from geophysical equipment is provided below.

9.3.5.1 Light Emissions from Vessels Engaged in Supporting Surveys

The primary effects on Marine Fish and Fish Habitat associated with light emissions from vessels engaged in Supporting Surveys are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

As noted above, the effects of light emissions from survey vessels would be the same as assessed in Section 9.3.1.1. Mitigations to reduce these effects are not proposed.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with light emissions from vessels engaged in Support Surveys. The behaviour effects associated vessel lighting would be the same as assessed in Section 9.3.1.1. Deep-sea fishes at depths more than 500 m may be photosensitive to artificial lights from ROVs as they have been observed to avoid areas of illumination within their light detection range reducing potential effects (Raymond and Widder 2007; Stoner et al. 2008). The species potentially temporarily displaced would depend on the depth of equipment ranging from redfish and lanternfish in pelagic areas to grenadiers, and shrimp in benthic areas. While there is some degree of avoidance, it would be short-term and transient as the ROV moves through the water.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with light emissions from vessels engaged in Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with light emissions from vessels and ROV/AUV equipment used in Support Surveys. Effects on food availability associated vessel lighting would be the same as assessed in Section 9.3.1.1.

Deep-sea fishes with varying light and sound sensitivities have a range of responses to ROVs such as those that are typically used throughout offshore drilling programs, including avoidance, aggregation or no reaction (Uiblein 2011). For example, during the Equinor seabed survey grenadiers, longnose eel and skates were regularly observed. Deep-sea fishes at depths more than 500 m may be photosensitive to artificial lights from the ROV as they have been observed to avoid areas of illumination within their light detection range reducing potential effects (Raymond and Widder 2007; Stoner et al. 2008).

The residual environmental effects of a Change in Food Availability and/or Quality associated with light emissions from vessels engaged in Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with light emissions from vessels and equipment engaged in Supporting Surveys are not proposed

Follow-up Monitoring for the effects on Marine Fish and Fish Habitat associated with light emissions from vessels and equipment engaged in Supporting Surveys engaged is not proposed.

9.3.5.2 Underwater Sound Emissions from Vessels Engaged in Supporting Surveys

The primary effects on Marine Fish and Fish Habitat, associated with underwater sound emissions from vessels engaged in Supporting Surveys are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

As noted above, the effects of underwater sound emissions from survey vessels would be the same as assessed in Section 9.3.1.2. Mitigations to reduce these effects are not proposed.

The residual environmental effects of a **Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)** associated with underwater sound emissions during Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

The residual environmental effects of a **Change in Food Availability and/or Quality** associated with underwater sound emissions from vessels engaged in Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with underwater sound emissions from vessels engaged in Supporting Surveys are not proposed

Follow-up Monitoring for the effects on Marine Fish and Fish Habitat associated with underwater sound emissions from vessels engaged in Supporting Surveys engaged is not proposed.

9.3.5.3 Underwater Sound Emissions from Geophysical Equipment

The primary effects on Marine Fish and Fish Habitat associated with underwater sound emissions from geophysical equipment used in Supporting Surveys are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury, and/or Health
- Change in Food Availability and/or Quality

Section 2.6.5 provides an overview of the types of geophysical surveys likely to be carried out to support the Project. As noted above, there is greater likelihood that 4D surveys (which is a 3D survey over a previously surveyed area) will be undertaken than 2D surveys. Therefore, the focus of this effects assessment is on underwater sound emissions from geophysical equipment used in 4D surveys. Separation of transects is less for 3D surveys so chronic exposure of fishes and invertebrates to air source sound is usually higher during 3D surveys compared to 2D surveys. The potential effects of underwater sound emissions on Marine Fish and Fish Habitat can be categorized as either physical (e.g., physiological changes, injury, mortality) or behavioural (e.g., acute short-term behavioural effects such as startle response, or longer-term larger-scale re-distributional movement from the ensonified area).

Although scientific focus on the effects of exposure to underwater sound on fishes and invertebrates has increased understanding of these effects, data gaps remain. Based on scientific studies to date, there is variability in effects of sound, both between species and within species. Considering there are more than 32,000 known species of fish and many more species of invertebrates (Hawkins et al. 2015), research into the effects of acoustic exposure on fish and invertebrates has examined only a fraction of the species. Currently, there appears to be scientific consensus that behavioural effects of exposure to sound on Marine Fish and Fish Habitat is of higher concern than potential physical effects. Of the list of potential supporting activities that may be carried out over the Project, 2D/3D/4D seismic surveys likely has more potential to cause effects on Marine Fish and Fish Habitat given the higher energy sound sources and longer durations associated with these surveys compared to those for geohazard and vertical seismic profiling surveys, and to a much lesser extent for the other surveys.

It is important to note that there are two principal components of underwater sound: (1) sound pressure, and (2) particle motion. Sound is generated by the movement or vibration of an immersed object in a medium like air or water (Kinsler et al. 1999). Sound pressure is measured as pressure fluctuations in the medium above and below the local hydrostatic pressure, and particle motion refers to the back and forth motion of the medium. Sound pressure, a scalar quantity, acts in all directions and can be described in terms of its magnitude and its temporal and frequency characteristics. Particle motion, a vector quantity, is an oscillation back and forth in a particular direction and can be described by specifying both the magnitude and direction of the motion as well as its temporal and frequency characteristics (Popper and Hawkins 2016). It is critical to understand that while many species of fish are able to detect sound pressure (i.e., those with air-filled spaces such as swim bladders), particle motion is likely important to most fishes (lateral line) and all invertebrates (mechanoreceptors), especially for locating sound sources through directional hearing (Nedelec et al. 2016).

Effects on fish and invertebrates will depend on the characteristics of the sound to which they are exposed. In addition to amplitude levels expressed in terms of peak or averaged values, the characteristics of the received sound stimulus in terms of parameters including rise time, duration, repetition rate and duty cycle are also important. There are a number of metrics used to describe underwater sounds and the choice of metric can be a issue in trying to describe and understand the effects of anthropogenic sounds (Ainslie and de Jong 2016 in Popper and Hawkins 2016) as well as comparing results of different studies For example, the metrics applied to continuous sounds, such as sound generated by marine vessels, might include the rms sound pressure (i.e., SPL_{rms}), peak sound pressure (i.e., $SPL_{0\text{-}p}$), and sound particle motion in three dimensions. Impulsive sounds, such as those generated by seismic air sources, may be expressed in terms of their peak or rms levels but these alone do not sufficiently characterize the energy in short impulsive sounds. Instead, the use of the sound exposure level (i.e., SEL), the time integral of the pressure squared for a single event, has been proposed as a metric for setting criteria for impulsive sounds (Popper and Hastings 2009 in Popper and Hawkins 2016). Many researchers in this area advocate the use of both SEL and peak levels to describe impulsive sounds (Popper et al. 2014). It is necessary to consider the potential effects not only in terms of exposure to a single event (e.g., single air source array discharge) but also to accumulated energy from exposure to multiple discharges over a specified period of time. The metric typically used for this is the cumulative SEL (SEL_{cum}) determined at the position of the receiving animal (i.e., received level), not at the sound source. For impulsive seismic air source sound, SEL_{cum} can be estimated from the energy in a representative single exposure SEL (i.e., SEL_{ss}) and the number of exposures. However, this accumulation assumes that all exposures have the same received SEL_{ss}, which is unlikely given the animal and sound source are moving relative to one another. Adding to the complexities of using SEL_{cum} is that the actual effects may vary depending on the time interval between impulses during which there may be physical recovery from effects of a single signal exposure.

The particle motion component of sound can be either water-borne or substrate-borne. Fish and invertebrates that live in contact with the seabed could experience both types of particle motion. The effect of seabed vibration on these animals has been largely neglected thus far although many anthropogenic activities involve direct contact with the seabed (e.g., drilling). These activities produce substrate-borne vibrations that can travel as compressional (longitudinal), transverse (shear) or surface (Rayleigh or ‘ground roll’) waves (Aicher and Tautz 1990 in Roberts et al. 2016). The energy of the low frequency Rayleigh waves may travel large distances from the source, trapped within the surface seabed with minimal attenuation (Hazelwood and Macey 2016). Therefore, fish and invertebrates in contact with the seabed may be affected by vibration at some distance from a sound source. Given the lack of existing data on levels of detection and the levels produced by such sources, it is difficult to ascertain the potential effects of substrate-borne particle motion on fishes and invertebrates in contact with the seabed. However, potential effects would likely be minimal compared to those associated with exposure to higher energy seismic sound. Particle motion is typically described as either particle displacement (m), particle velocity (m/s), or particle acceleration (m/s^2).

Most fishes and invertebrates studied to date appear to be more sensitive to low-frequency sound (< 1 kHz) (Popper et al. 2014). Most of the energy in sound emitted by seismic air sources, marine vessels and drilling is within this low-frequency range. Some fishes with morphological designs that include either a direct or proximate mechanical link between the swim bladder and the inner ear are also sensitive to higher frequencies (i.e., ultrasound).

The following subsections provide literature reviews pertaining to the potential behavioural effects of exposure to underwater sound on fishes and invertebrates. Studies involving fish and invertebrates known to occur in the Project Area are also discussed. The potential effects of underwater sound on fishes and invertebrates have been widely studied, however it is important to note constraints in this field of research. Many of the underwater sound exposure studies were either conducted under laboratory conditions or in the field with captive animals. Early underwater sound exposure studies were deficient with respect to both the reporting of received levels associated with observed effects and the use of appropriate metrics. The reporting of received levels of particle motion in studies on this issue have also been sparse to date.

Sound Modelling

Sound modelling conducted for a 5,085 in^3 air source array at two locations within the Project Area: (1) S1 in the eastern portion of the Project Area where the water depth is 1,180 m; and (2) S2 in the western portion of the Project Area where water depth is 500 m (Zykov 2018 in Appendix D). Five 150 km long transects of different bearings per modelling location were included in the modelling. Most transects are characterized by a wide range of water depths (Figure 9-6). Section 9.1.3 provides more details on the how sound modelling most relevant to Marine Fish and Fish Habitat was conducted.

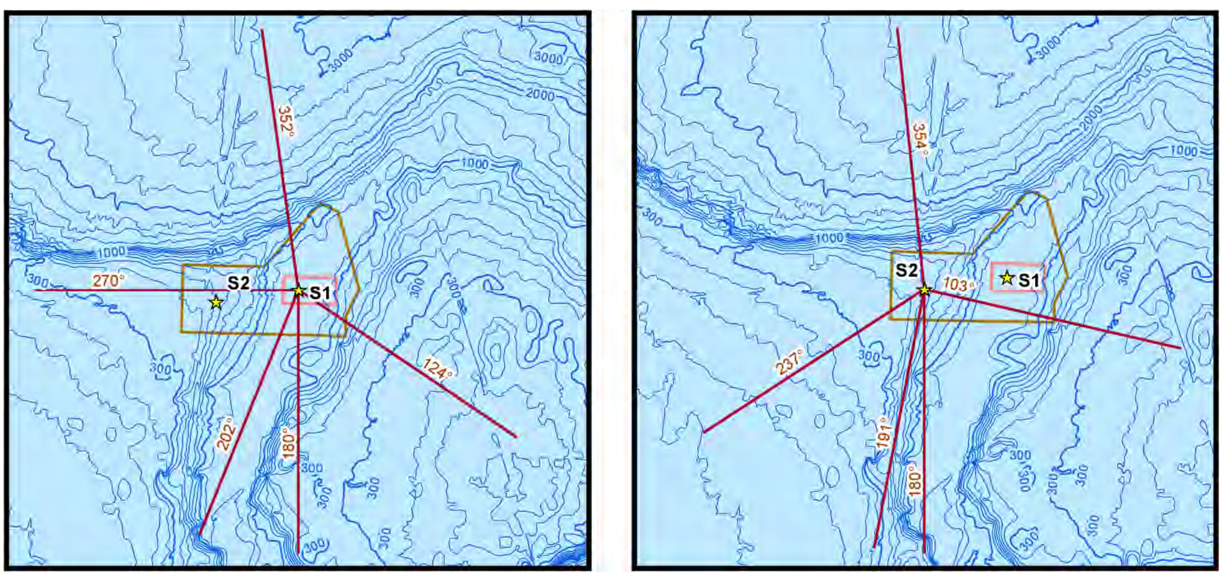

Figure 9-6 Profiles used for full waveform modelling. The degree values indicate the azimuth of each profile. The length of each profile is 150 km (Zykov 2018).

Received SPL data generated by the modelling were provided for eight locations along each transect; 50 m, 500 m, 1 km, 10 km, 25 km, 50 km, 100 km and 150 km from source location. At each of these locations, the maximum received SPL in the water column and the received SPL at the seabed were provided. The depth of the maximum SPL in the water column was also indicated. The sound pressure metrics provided include $SPL_{(0-p)}$, $SPL_{(rms)}$, and SEL. Only $SPL_{(0-p)}$ and $SPL_{(rms)}$ levels are considered for fishes since most relevant literature uses these metrics. Modelling was conducted for both February and August.

Table 9.13 provides the modelling results that pertain to Marine Fish and Fish Habitat. Predicted sound levels are provided for horizontal distances out to 50 km. Beyond 50 km, predicted received levels would not likely cause behavioural effects.

As indicated in Table 9.13, sound propagation from both S1 (Core BdN Development Area) and S2 (Project Area) is quite complex given the variability in water depth within and between modelling transects. In some cases, the maximum received sound levels predicted by the modelling occurs in the upper water column where pelagic fishes with swim bladders (e.g., Atlantic salmon, capelin, Atlantic herring) would be most susceptible to behavioural effects due to exposure to seismic sound. In other cases, the maximum received sound levels predicted by the modelling occurs in the lower portion of the water column where demersal fishes (e.g., Atlantic cod) would be most likely affected behaviourally. Given the substantial variability in behaviour effect sound level thresholds between and within fish species (see literature review provided above under "Behavioural Effects", 160 dB re 1 µPa $_{(0-p)}$ is a sensible choice as the minimum peak SPL that could cause behavioural effects on fish with swim bladders. Based on using this sound level as the behavioural effect threshold, the modelling results indicate potential of behavioural effects as distant as 50 km from the sound source (e.g., S1 transect 180 in February; S2 transect 180 in February). For August modelling, the maximum distance from source where the received peak SPL is predicted to be at least 160 dB re 1 µPa $_{(0-p)}$ is 25 km (e.g., S1 transect 180 in August; S2 transect 180 in August).

2D/3D/4D Geophysical Surveys

Summary of Potential Effects of Anthropogenic Underwater Sound on Fishes and Invertebrates

Some studies have shown that various life stages of certain fishes can be physically affected by exposure to air source sound. In all these cases, the fish subjects were subjected to exposures that would not likely occur under natural conditions. Studies that demonstrated physical effects on fishes typically involved either captive juvenile/adult subjects that were unable to move away from the sound source or passive fish and invertebrate eggs and larvae and zooplankton that were located within a few metres of the sound source. The focus of study related to the potential effects of exposure to air source sound on fishes has shifted to behavioural effects, particularly those that could result in a decrease in catch rate of the fishes. Fishes will exhibit both subtle and more overt behavioural changes in response to air source sound and these effects appear to be quite variable between and within species. Generally, the behavioural effects are localized and temporary, but can result in short-term effect on catch rates. Recent work in Norway suggests that, in the future, acoustic-biological models may be used in the design and planning of seismic surveys in order to reduce disturbance to fishing (Hovem et al. 2012).

Table 9.13 Signal Levels at Specific Ranges from the Modelled Seismic Air Source Array for February and August Propagation Conditions

Source Location	Transect Azimuth (°)	Month	Horizontal Distance from Source (m)	Water Depth (m)	Maximum Received Sound Pressure Level/Depth of Occurrence				Received Sound Pressure Levels at Ocean Bottom	
					SPL(o-p) (dB re 1 µPa)	Depth (m)	SPL(rms) (dB re 1 µPa)	Depth (m)	SPL(o-p) (dB re 1 µPa)	SPL(rms) (dB re 1 µPa)
S1	124	February	50	1,182	211.3	25	201.2	50	192.9	184.4
	124	February	500	1,184	192.1	250	180.9	250	186.7	177.6
	124	February	1,000	1,185	186.0	500	175.4	700	184.8	175.0
	124	February	10,000	1,173	166.7	15	156.7	15	165.0	155.0
	124	February	25,000	1,032	158.7	250	149.5	75	158.4	147.1
	124	February	50,000	406	153.4	300	145.3	50	151.0	138.1
	124	August	50	1,182	211.1	25	201.1	50	193.2	184.5
	124	August	500	1,184	192.2	300	181.5	350	186.8	177.6
	124	August	1,000	1,185	186.1	600	175.3	800	184.9	175.0
	124	August	10,000	1,173	166.7	20	156.7	20	164.7	154.1
	124	August	25,000	1,032	158.0	20	147.0	50	155.4	146.1
	124	August	50,000	406	149.0	20	140.6	100	146.2	136.1
S1	180	February	50	1,182	213.8	20	200.0	10	191.5	182.5
	180	February	500	1,185	193.5	200	181.0	350	186.8	176.7
	180	February	1,000	1,189	187.2	250	174.7	600	183.6	173.7
	180	February	10,000	1,170	174.4	50	163.1	50	165.9	156.1
	180	February	25,000	1,164	170.6	20	158.0	20	158.6	147.6
	180	February	50,000	1,103	165.8	25	154.0	25	153.2	141.8
	180	August	50	1,182	213.5	25	199.9	50	191.6	182.5
	180	August	500	1,185	193.6	150	181.0	150	187.3	176.6

Table 9.13 Signal Levels at Specific Ranges from the Modelled Seismic Air Source Array for February and August Propagation Conditions

Source Location	Transect Azimuth (°)	Month	Horizontal Distance from Source (m)	Water Depth (m)	Maximum Received Sound Pressure Level/Depth of Occurrence				Received Sound Pressure Levels at Ocean Bottom	
					SPL(o-p) (dB re 1 µPa)	Depth (m)	SPL(rms) (dB re 1 µPa)	Depth (m)	SPL(o-p) (dB re 1 µPa)	SPL(rms) (dB re 1 µPa)
S1	180	August	1,000	1,189	188.1	250	175.3	250	184.1	173.8
	180	August	10,000	1,170	171.1	10	159.8	10	167.5	154.9
	180	August	25,000	1,164	162.3	10	149.7	15	158.9	148.9
	180	August	50,000	1,103	156.6	15	144.0	10	149.5	139.7
S1	202	February	50	1,181	209.4	25	198.9	50	191.6	182.5
	202	February	500	1,184	189.1	250	179.1	350	185.2	175.8
	202	February	1,000	1,183	183.0	600	172.9	800	181.7	172.7
	202	February	10,000	1,167	164.6	15	155.6	25	161.0	152.6
	202	February	25,000	1,174	158.2	150	148.4	150	152.1	143,8
	202	February	50,000	1,166	154.1	50	143.5	50	146.7	138.4
	202	August	50	1,181	209.5	25	198.7	50	191.7	182.5
	202	August	500	1,184	189.2	250	179.0	350	185.1	175.8
	202	August	1,000	1,183	183.2	450	172.8	800	181.8	172.6
	202	August	10,000	1,167	165.2	15	155.5	25	161.0	152.0
	202	August	25,000	1,174	156.4	400	145.0	25	150.9	143.4
	202	August	50,000	1,166	149.9	100	142.1	100	144.9	137.1
S1	270	February	50	1,181	213.2	20	200.6	50	193.3	183.5
	270	February	500	1,180	193.8	200	180.9	300	185.4	177.1
	270	February	1,000	1,180	187.6	400	174.9	600	184.7	174.3
	270	February	10,000	1,155	169.9	75	156.7	50	165.3	155.9

Table 9.13 Signal Levels at Specific Ranges from the Modelled Seismic Air Source Array for February and August Propagation Conditions

Source Location	Transect Azimuth (°)	Month	Horizontal Distance from Source (m)	Water Depth (m)	Maximum Received Sound Pressure Level/Depth of Occurrence				Received Sound Pressure Levels at Ocean Bottom	
					$SPL_{(o-p)}$ (dB re 1 µPa)	Depth (m)	$SPL_{(rms)}$ (dB re 1 µPa)	Depth (m)	$SPL_{(o-p)}$ (dB re 1 µPa)	$SPL_{(rms)}$ (dB re 1 µPa)
S1	270	February	25,000	824	165.7	15	152.2	75	158.7	147.7
	270	February	50,000	487	160.3	50	149.2	50	149.6	138.4
	270	August	50	1,181	212.9	25	200.4	50	193.5	183.6
	270	August	500	1,180	193.5	200	180.9	300	185.5	177.1
	270	August	1,000	1,180	187.6	500	174.9	700	184.6	174.4
	270	August	10,000	1,155	167.6	15	155.6	20	165.2	155.5
	270	August	25,000	824	159.6	25	147.4	15	157.0	145.9
	270	August	50,000	487	148.8	15	140.5	75	147.4	136.6
S1	352	February	50	1,181	212.4	25	199.4	50	191.6	182.4
	352	February	500	1,174	192.2	250	180.0	300	186.9	176.4
	352	February	1,000	1,168	186.1	450	174.1	700	183.3	173.2
	352	February	10,000	1,158	173.5	50	161.5	50	165.0	154.9
	352	February	25,000	1,050	167.6	75	155.9	20	160.4	150.6
	352	February	50,000	1,797	161.8	50	151.2	50	154.4	141.6
	352	August	50	1,181	212.6	25	199.4	50	191.5	182.5
	352	August	500	1,174	192.4	200	180.0	400	186.3	176.3
	352	August	1,000	1,168	186.5	300	174.1	250	183.4	173.2
	352	August	10,000	1,158	171.7	100	159.0	100	165.0	154.3
	352	August	25,000	1,050	163.2	1,000	152.5	1,000	163.2	152.5
	352	August	50,000	1,797	152.7	900	141.3	900	150.7	139.3

Table 9.13 Signal Levels at Specific Ranges from the Modelled Seismic Air Source Array for February and August Propagation Conditions

Source Location	Transect Azimuth (°)	Month	Horizontal Distance from Source (m)	Water Depth (m)	Maximum Received Sound Pressure Level/Depth of Occurrence				Received Sound Pressure Levels at Ocean Bottom	
					SPL(o-p) (dB re 1 µPa)	Depth (m)	SPL(rms) (dB re 1 µPa)	Depth (m)	SPL(o-p) (dB re 1 µPa)	SPL(rms) (dB re 1 µPa)
S2	103	February	50	515	213.0	25	201.9	50	195.9	186.3
	103	February	500	533	193.1	400	182.3	350	192.9	182.0
	103	February	1,000	539	186.2	350	176.5	450	186.2	176.4
S2	103	February	10,000	685	168.7	75	157.9	75	166.2	155.8
	103	February	25,000	948	164.2	700	152.0	75	160.0	150.3
	103	February	50,000	1,174	160.8	600	148.2	600	156.5	146.1
	103	August	50	515	213.0	25	201.8	50	196.0	186.4
	103	August	500	533	192.9	400	182.2	350	192.8	182.0
	103	August	1,000	539	186.6	400	176.2	450	186.4	176.2
	103	August	10,000	685	168.9	25	157.0	25	166.1	155.1
	103	August	25,000	948	159.7	900	149.1	900	159.7	149.1
S2	180	February	50	514	213.8	20	200.0	10	194.2	183.8
	180	February	500	519	193.5	200	180.8	350	191.9	179.3
	180	February	1,000	523	187.1	500	174.4	200	187.1	173,7
	180	February	10,000	571	174.8	50	163.6	50	168.3	156.7
	180	February	25,000	708	170.6	20	158.1	20	163.1	151.0
	180	February	50,000	1,058	165.4	50	153.6	50	156.4	143.3
	180	August	50	514	213.5	25	199.9	50	194.1	183.8
	180	August	500	519	193.6	150	181.0	150	190.6	179.5
	180	August	1,000	523	187.9	250	175.3	250	187.5	172.7

Table 9.13 Signal Levels at Specific Ranges from the Modelled Seismic Air Source Array for February and August Propagation Conditions

Source Location	Transect Azimuth (°)	Month	Horizontal Distance from Source (m)	Water Depth (m)	Maximum Received Sound Pressure Level/Depth of Occurrence				Received Sound Pressure Levels at Ocean Bottom	
					$SPL_{(o\text{-}p)}$ (dB re 1 μPa)	Depth (m)	$SPL_{(rms)}$ (dB re 1 μPa)	Depth (m)	$SPL_{(o\text{-}p)}$ (dB re 1 μPa)	$SPL_{(rms)}$ (dB re 1 μPa)
S2	180	August	10,000	571	171.3	10	159.6	15	167.7	156.5
	180	August	25,000	708	163.5	700	152.1	700	163.5	152.1
	180	August	50,000	1,058	158.1	900	145.4	900	155.8	144.1
S2	191	February	50	514	211.9	25	199.2	50	193.9	183.6
	191	February	500	516	191.4	200	179.8	350	189.7	178.1
	191	February	1,000	518	185.6	500	173.4	450	185.6	172.6
	191	February	10,000	517	171.4	50	160.2	50	167.0	155.4
	191	February	25,000	553	165.1	20	154.8	25	158.9	147.3
	191	February	50,000	611	160.4	50	149.9	50	155.6	143.1
	191	August	50	514	211.8	25	199.1	50	193.8	183.6
	191	August	500	516	191.6	250	179.7	450	189.5	178.2
	191	August	1,000	518	185.8	500	173.0	450	185.8	172.1
	191	August	10,000	517	169.3	15	157.3	15	167.0	156.0
	191	August	25,000	553	159.2	500	147.3	300	159.2	147.2
	191	August	50,000	611	154.0	600	143.1	600	154.0	143.1
S2	237	February	50	512	210.6	25	200.2	50	192.5	184.5
	237	February	500	502	191.9	300	181.1	500	191.3	181.1
	237	February	1,000	496	184.7	450	174.4	450	184.7	174.4
	237	February	10,000	384	166.7	300	156.1	20	165.2	155.6
	237	February	25,000	343	156.5	50	149.3	50	153.5	145.2

Table 9.13 Signal Levels at Specific Ranges from the Modelled Seismic Air Source Array for February and August Propagation Conditions

Source Location	Transect Azimuth (°)	Month	Horizontal Distance from Source (m)	Water Depth (m)	Maximum Received Sound Pressure Level/Depth of Occurrence				Received Sound Pressure Levels at Ocean Bottom	
					$SPL_{(o\text{-}p)}$ (dB re 1 µPa)	Depth (m)	$SPL_{(rms)}$ (dB re 1 µPa)	Depth (m)	$SPL_{(o\text{-}p)}$ (dB re 1 µPa)	$SPL_{(rms)}$ (dB re 1 µPa)
S2	237	February	50,000	283	152.9	150	144.4	150	148.5	141.1
	237	August	50	512	210.5	50	200.1	50	192.9	184.6
	237	August	500	502	191.7	350	181.0	500	191.5	181.0
	237	August	1,000	496	184.3	450	174.0	450	184.3	174.0
	237	August	10,000	384	165.1	300	155.3	300	163.0	155.0
	237	August	25,000	343	153.6	100	145.4	100	151.2	141.4
	237	August	50,000	283	148.7	75	140.3	75	141.7	135.5
S2	354	February	50	513	213.2	25	199.6	50	193.9	183.7
	354	February	500	505	192.4	200	180.4	350	190.5	180.0
	354	February	1,000	498	186.5	400	173.5	200	186.4	173.5
	354	February	10,000	519	173.7	50	162.4	50	169.8	157.7
	354	February	25,000	824	168.5	25	156.7	20	156.1	144.5
	354	February	50,000	1,942	163.3	50	152.1	50	144.5	137.5
	354	August	50	513	212.6	20	199.6	50	193.4	183.6
	354	August	500	505	193.0	200	180.3	350	190.7	180.1
	354	August	1,000	498	187.0	350	174.5	250	186.5	173.0
	354	August	10,000	519	170.5	10	157.0	10	168.0	155.5
	354	August	25,000	824	159.9	500	147.7	450	155.7	144.9
	354	August	50,000	1,942	158.1	200	144.1	200	146.2	138.2

While certain studies have suggested that some marine invertebrates are affected physically by exposure to air source sound, the degree of the suggested effects is small. In addition, the suggested physical effects were observed when constrained marine invertebrates were exposed to air source sound at close range, resulting in exposures unrepresentative of those that would occur under natural conditions. Behavioural effects of exposure to air source sound have also been observed in studies but, the marine invertebrates that exhibited the behavioural changes were constrained and unable to freely move away from the sound source.

The above brief descriptions of some of the key studies conducted thus far on the potential effects of exposure to underwater sound on fishes and invertebrates provide a sense of the variability associated with this issue. Notable scientific review papers on this topic include Popper (2003), Payne (2004), Worcester (2006), Popper and Hastings (2009), Hawkins et al. (2015), Carroll et al. (2017), and Popper and Hawkins (2016). Detailed discussion on the potential effects of exposure to underwater sound is provided below.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with underwater sound emissions from geophysical equipment used in Supporting Surveys.

The primary mitigations to be during 2D/3D/4D geophysical surveys, which are intended to reduce effects on Marine Fish and Fish Habitat are the mitigations outlined in the SOCP (DFO 2007). Per the SOCP (DFO 2007) a seismic survey must be planned to avoid ‘dispersing aggregations of spawning fish from a known spawning area’, and ‘diverting aggregations of fish from known migration routes or corridors if it is known there are no alternate migration routes or corridors, or that if by using those alternate migration routes or corridors, the aggregations of fish would incur adverse effects’. Other mitigations listed in the SOCP (DFO 2007) include ramp-up of the sound source over time, use of seismic sources with either a minimized energy output or proven minimized environmental impact (e.g., with changed frequency distribution) when technically feasible, and temporal and spatial avoidance of marine fish.

In Popper et al. (2014), behavioural effects thresholds for fishes exposed to seismic sound were briefly discussed (Table 9.3). They provided relative risk criteria ratings for fishes at three qualitative distances from the sound source: (1) near (tens of metres); (2) intermediate (hundreds of metres); and (3) far (thousands of metres). The criterion rating for all fishes at the ‘near’ distance from the sound source was high relative risk. At intermediate distances from the sound source, the relative risk for fishes without swim bladders and fishes with swim bladders not involved in hearing was moderate, while for fishes with a swim bladder involved in hearing, the rating remained high. At far distances from the sound source, the relative risk for fishes without swim bladders and fishes with swim bladders not involved in hearing was low, while for fishes with a swim bladder involved in hearing, the rating was moderate.

Studies described in this subsection suggest that effects on fish and invertebrate behaviour due to exposure to air source sound are temporary in nature, and that response thresholds for various are quite variable. Generally speaking, there are three different methods of studying the effects of anthropogenic sound on fish behavior, each with their own advantages and disadvantages. These methods include: (1) captive indoor (laboratory studies where fish and invertebrate subjects are maintained in tanks); (2) captive outdoor (field studies where fish and invertebrate subjects are constrained within a cage in their natural environment); and (3) free-range outdoor (field studies on free-ranging fishes and invertebrates. The experimental control associated with these study methods is greatest for captive indoor, diminishing in studies conducted in the field. The validity of measured acoustics and observed behaviour in relation to natural conditions is greater for the field study methods than the captive indoor method because they better simulate realistic interactions between anthropogenic sound sources and biota (Slabbekoorn 2016).

Some of the scientific studies of fish and invertebrate behaviour in response to anthropogenic sound involve species known to occur in the Project Area. The species include Greenland halibut (Løkkeborg et al. 2012), redfish (Pearson et al. 1992; Skalski et al. 1992), Atlantic cod (Engås et al. 1993, 1996; Løkkeborg and Soldal. 1993), snow crab (Christian et al. 2003, Morris et al. 2018), and shrimp (Andriguetto-Filho et al. 2005). While some of the observed responses are temporary startle responses to the anthropogenic sound, others are longer-term larger scale redistributional responses. These latter responses are directly relevant to reported effects on commercial fishery catches.

Løkkeborg et al. (2012) described a 2009 study of the effect of exposure to seismic sound on commercial fishes. Both gillnet and longline vessels fished for Greenland halibut, redfish, pollock and haddock for 12 days before the onset of seismic surveying, 38 days during seismic surveying, and 25 days after cessation of seismic surveying. Acoustic surveying was also conducted during these times. Gillnet catches of Greenland halibut and redfish increased during seismic operations and remained higher after cessation of seismic surveying than they had been before the onset of seismic surveying. Longline catches of Greenland halibut decreased during seismic operations but increased again after the seismic surveying was completed. Gillnet catches of pollock decreased during seismic operations and remained low during the 25-day period following the seismic surveying. Longline catches of haddock before and during seismic operations were not significantly different although catches did decline as the seismic vessel approached the fishing area. The haddock fishery was conducted in an area with lower ensonification (exposure to sound energy) compared to the fishery areas of the other three species. Follow up surveys showed that the pollock had partly left the area, while the distributional changes of the other three species were not observed. Løkkeborg et al. (2012) suggested that an increase in swimming activity as a result of exposure to seismic sound might explain why gillnet catches increased and longline catches decreased.

A study by Pearson et al. (1992) also showed that behavioural effects were temporary in nature. They investigated the effects of seismic air source sound on the behavior of captive rockfishes exposed to the sound of a single stationary air source at a variety of distances. The air source used in the study had a source SPL at 1 m of 223 dB re 1 μPa · m0-p, and measured received SPLs ranged from 137 to 206 dB re 1 μPa0-p. The authors reported that rockfishes reacted to the air source sounds by exhibiting varying degrees of startle and alarm responses, depending on the species of rockfish and the received SPL. Startle responses were observed at a minimum received SPL of 200 dB re 1 μPa0-p, and alarm responses occurred at a minimum received SPL of 177 dB re 1 μPa0-p. Other observed behavioral changes included the tightening of schools, downward distributional shift, and random movement and orientation. Some fishes ascended in the water column and commenced to mill (i.e., “eddy”) at increased speed, while others descended to the bottom of the enclosure and remained motionless. Pre-exposure behavior was re-established from 20 to 60 min after cessation of seismic air source discharge. Pearson et al. (1992) concluded that received SPL thresholds for overt rockfish behavioral response and more subtle rockfish behavioral response are 180 dB re 1 μPa0-p and 161 dB re 1 μPa0-p, respectively.

Using an experimental hook and line fishery approach, Skalski et al. (1992) studied the potential effects of a moving seismic air source sound on the distribution and catchability of rockfishes. The source SPL of the single air source used in the study was 223 dB re 1 μPa · m 0-p, and the received SPLs at the bases of the rockfish aggregations ranged from 186 to 191 dB re 1 $\mu Pa_{0\text{-}p}$. Characteristics of the fish aggregations were assessed using echosounders. During seismic air source discharge, there was an overall downward shift in fish distribution. The authors also observed a substantial decline in total catch of rockfishes during seismic discharge. It should be noted that this experimental approach was quite different from an actual seismic survey, in that duration of exposure was much longer.

Engås et al. (1993, 1996) and Løkkeborg and Soldal (1993) also examined the effects of seismic air source sound on demersal fish catches, including Atlantic cod. Observations included catch rate decreases that continued for a period of days over an area that extended kilometres from the ensonified areas. Acoustic surveys and experimental fishing were the methods used to study behavioural changes in these studies.

Christian et al. (2003) investigated the behavioural effects of exposure to sound from seismic surveys on snow crabs. Eight animals were equipped with ultrasonic tags, released, and monitored for multiple days prior to exposure and after exposure. Received SPL and SEL were approximately 191 dB re 1 μPa0-p and less than 130 dB re 1 $\mu Pa^2 \cdot s$, respectively. Snow crabs were exposed to 200 discharges from a fixed source over a 33-minute period. None of the tagged animals left the immediate area after exposure. Five animals that were exposed were captured in the snow crab commercial fishery the following year, one at the release location, one 35 km from the release location, and three at intermediate distances (5 km to 35 km) from the release location. This study also investigated the pre- and post-exposure catchability of snow crabs during a commercial fishery. Received SPLs and SELs were not measured directly and likely ranged widely considering the area fished. Maximum SPL and SEL were likely to be similar to those measured during the telemetry study. There were seven pre-exposure and six post-exposure trap sets. Unfortunately, there was considerable variability in set duration because of poor weather. Results indicated that the catch-per-unit-effort did not decrease after the crabs were exposed to seismic survey sound.

Morris et al. (2018) conducted a two-year (2015 to 2016) study examining the effects of seismic surveys on catch rates of snow crab along the eastern continental slope of the Grand Banks of NL (Lilly Canyon and Carson Canyon). The air source array used during both years of the study was operated from a commercial seismic exploration vessel. The array had a total volume of 4,880 cu. in., with an operational pressure of 2,000 psi, a horizontal zero-to-peak SPL of 251 dB re 1 μPa @ 1 m, and a source SEL of 229 dB re 1 $\mu Pa^2 \cdot s$ @ 1m. The closest that the seismic source came within the vicinity of the sound recorders of the study area was 1,465 m in 2015, while it passed within only 100 m of the sound recorders in 2016. Overall, the findings of the study indicated that the sound from the commercial seismic survey did not substantially reduce snow crab catch rates in the short-term (i.e., days) or long-term (i.e., weeks) in which the study took place. For this study, the researchers attribute the natural temporal and spatial variations in the marine environment as a greater influence on observed differences of catch rates of snow crab between control and experimental sites.

Andriguetto-Filho et al. (2005) investigated the impact of sound from seismic surveys on traditional shrimp fisheries off Brazil. Bottom trawl yields were measured before and after multiple-day activation of an air source array with a source SPL of 196 dB re 1 µPa·@ 1 m. Water depth in the experimental area ranged between two and 15 m. Results of the study did not indicate any impact on shrimp catches.

As described above, fish, in particular species with swim bladders such as lantern fish in the Core BdN Development Area, may respond with avoidance responses to underwater geophysical sounds, therefore, this displacement may shift the spatial distribution of fish in the area of the geophysical activity. Changes to the spatial distribution of fish from underwater sound would be temporary as described above and fish would likely return after cessation of the activity.

The change in fish behaviour due to underwater sound emissions during geophysical surveys would be adverse, as described above and short-term. Based on sound modelling, assuming the furthest potential behavioural effects may extend out to 50 km based on estimated minimum avoidance levels for fishes with swim bladders (160 dB re 1 µPa $_{(0\text{-}p)}$), the geographic extent of the behavioural effects would between 1,000 km² and 10,000 km² of the location of underwater sound source within the Core BdN Development Area. The temporary change in behaviour, would be considered within the range of natural variability without affecting the overall viability of affected fish species. Therefore, the magnitude of the change in fish behaviour would be low. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations, as noted above and listed in the SOCP (DFO 2007), should reduce overall effects on fish behaviour.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural effects) associated with underwater sound emissions during geophysical surveys are predicted to be adverse, low in magnitude, with a geographic extent ranging between less than 1,000 km² to less than 10,000 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Fish and Invertebrate Mortality, Injury and/or Health is a potential effect associated with underwater sound emissions during geophysical surveys.

The potential physical effects of exposure to underwater sound on fishes and invertebrates can be categorized as physiological, non-lethal injury and lethal injury. Physiological effects are those that involve temporary changes in an animal's biochemistry (e.g., cortisol levels). Non-lethal and lethal injury effects are self-explanatory.

Popper et al. (2014) discuss exposure threshold guidelines for fish and eggs/larvae in terms of both non-lethal injury (i.e., recoverable injury) and lethal injury (i.e., mortality and potential mortal injury) caused by exposure to seismic air source sound. They point out that the guidelines they present are derived from data from various sources, but they are principally based on predictions derived from effects of other impulsive sounds, especially pile driving. There are no quantified data for seismic air sources. The guidelines for both non-lethal and lethal injury presented by Popper et al. (2014) include:

- Fishes without a swim bladder: SPL_{peak} = 213 dB re 1 μPa
- Fishes with swim bladder: SPL_{peak} = 207 dB re 1 μPa
- Eggs and larvae: SPL_{peak} = 207 dB re 1 μPa

Data presented by Popper et al. (2014) in relation to exposure thresholds associated with continuous sound (i.e., vessel sound, drilling sound) are even less quantified than those for seismic air source. Only non-lethal injury for fishes with swim bladders used in hearing is given a threshold number (i.e., SPL_{rms} = 170 dB re 1 μPa over a 48-hour period).

Physiological Effects

Various marine fishes and invertebrates have been included in studies that have investigated the physiological effects of exposure to continuous and impulsive underwater sound, including sound from seismic air sources. Examples include Atlantic cod (Sierra-Flores 2015), European sea bass (Santulli et al. 1999; Buscaino et al. 2010; Radford et al. 2016). American lobster (Payne et al. 2007), snow crab (Christian et al. 2003, 2004), spiny lobsters (Day et al. 2016a, 2016b, 2017; Fitzgibbon et al. 2017), and blue mussels (Spiga et al. 2016). Results of the studies including Atlantic cod and snow crab are relevant to the Project given their occurrence in the Project Area.

Using cortisol as a biomarker, Sierra-Flores (2015) investigated sound as a short-term stressor in Atlantic cod through laboratory study. The first experiment included continuous sound being emitted in a 10-second linear sweep through a frequency range of 100 Hz to 1,000 Hz resulting in received RMS sound pressure levels ranging from 104 to 110 dB re 1 μPa. Results of this exposure included the rapid increase in plasma cortisol levels with a return to baseline levels 20 minutes to 40 minutes post-exposure. The second experiment examined the effects of long-term exposure (6 weeks) to a similar intensity and frequency sound range on cod spawning performance. Male and female cod were exposed to six sound events per day, each one lasting one hour. Each exposure resulted in rms received levels of approximately133 dB re 1 μPa. Cod eggs were collected daily and analyzed for quality and cortisol levels. While total volume, diameter and weight of the eggs were unaffected, fertilization rate and viable egg productivity were reduced by 40 percent and 50 percent, respectively, compared to the control group. The mean cortisol level in exposed eggs was 34 percent greater than that in control eggs. Elevated cortisol levels inhibit reproductive physiology in males and can result in a greater frequency of larval deformities.

Other studies on fishes also observed physiological changes in the subjects although these effects were typically temporary (Santulli et al. 1999; Buscaino et al. 2010; Radford et al. 2016). Radford et al. (2016) conducted long-term exposures (12 weeks) using both impulsive and continuous sound and observed habituation of the seabass to both types of sound.

Christian et al. (2003, 2004) conducted a controlled field pilot study that examined various potential effects of exposure to seismic air source sound on snow crab. One component of the pilot study involved the assessment of potential chemical indicators of stress in the haemolymph including serum protein levels, serum enzyme activity, and haemocyte types. During each experiment, both sub-legal- and legal-sized male snow crab were exposed to 200 seismic air source discharges over a period of 33 minutes. Received peak sound pressure levels ranged from 197 dB re 1 µPa to 221 dB re 1 µPa. Haemolymph was sampled from most of the crab immediately after exposure. Some exposed crab along with their controls were returned to the laboratory and later examined for chronic physiological effects. No substantial differences in levels of the various chemical indicators were observed between exposed crab and control crab, regardless of the magnitudes of the received sound pressure levels and timing of haemolymph sampling (i.e., immediately after exposure vs. seven months post-exposure). Particle motion measurements were not conducted.

The physiological changes observed in studies using invertebrates were also typically temporary in duration (Price 2007; Payne et al. 2007, 2015; Day et al. 2016a, 2016b, 2017; Fitzgibbon et al. 2017). Most of the observed physiological effects were related to changes in haemolymph biochemistry (e.g., levels of protein, enzymes and calcium).

Non-Lethal Injury

There are also examples of scientific studies that observed non-lethal injury to fishes (McCauley et al. 2000a, 2000b, 2003; Andrews et al. 2014) and invertebrates (Christian et al. 2003, 2004; Payne et al. 2015) exposed to underwater sound. Atlantic salmon and snow crab were used as experimental animals in two of these studies.

Andrews et al. (2014) conducted functional genomic studies on the inner ear of juvenile Atlantic salmon following exposure to sound from seismic air sources. Captive juvenile salmon were exposed to 50 air source discharges over a period of 8 minutes under laboratory conditions, the average received peak sound pressure level being approximately 200 dB re 1 µPa. They observed various genetic changes in the ear tissues that were related to oxygen transport, the glycolytic pathway, the Krebs cycle and the electron transport chain. Their results support the potential utility of molecular biomarkers to evaluate the effect of exposure to seismic sound on fishes.

Evidence for seismic air sound-induced non-lethal injury to fish ears has been provided in studies using pink snapper (as subjects (McCauley et al. 2000a, 2000b, 2003). In these experiments, fish were caged and exposed to the sound of a single moving seismic air source every 10 s over a period of 1 h and 41 min. The source SPL at 1 m was approximately 223 dB re 1 µPa · $m_{p\text{-}p}$, and the received peak-peak SPLs ranged from 165 dB re 1 µPa to 209 dB re 1 µPa. The sound energy was highest over the 20 Hz to 70 Hz frequency range. Pink snapper were exposed to more than 600 seismic air source discharges during the study. In some individual fish, the sensory epithelium of the inner ear sustained extensive damage as indicated by ablated hair cells. Damage was more extensive in fish examined 58 days post-exposure compared to those examined 18 hours post-exposure. There was no evidence of repair or replacement of damaged sensory cells up to 58 days post-exposure. McCauley et al. (2000a, 2000b, 2003) included the following caveats in the study reports: (1) fish were caged and unable to swim away from the seismic source, (2) only one species of fish was examined, (3) the impact on the ultimate survival of the fish is unclear, and (4) seismic air source exposure specifics required to cause the observed damage were not obtained (i.e., a few high SPL signals or the cumulative effect of many low to moderate SPL signals).

As part of a pilot study, Christian et al. (2003) exposed fertilized snow crab eggs to seismic air source sound and then monitored their development and compared it to the development of fertilized eggs from the same female that were not exposed to seismic sound. The fertilized eggs were exposed to 200 air source discharges over a 33-minute period, the average received peak sound pressure level being approximately 221 dB re 1 µPa. Significant differences were found between the two groups in terms of both mortality rate ($p=0.034$) and development rate (<0.001 to 0.002), with exposed fertilized eggs showing a higher mortality rate and a lower development rate. However, it should be noted that both egg masses came from a single female crab and any measure of natural variability was unattainable.

Payne et al. (2015) conducted two pilot studies which (i) examined the effects of a seismic air source recording in the laboratory on lobster mortality, gross pathology, histopathology, serum biochemistry, and feeding; and (ii) examined prolonged or delayed effects of seismic air source pulses in the laboratory on lobster mortality, gross pathology, histopathology, and serum biochemistry. For experiment (i), lobsters were exposed to peak-to-peak and rms received sound levels of 180 dB re 1 µPa and 171 dB re 1 μPa_{rms} respectively. Overall, there was no mortality, loss of appendages, or other signs of gross pathology observed in the treatment lobsters. No differences were observed in haemolymph, feeding, ovary histopathology, or glycogen accumulation in the hepatopancreas. The only observed differences were greater degrees of tubular vacuolation and tubular dilation in the hepatopancreas of the treatment lobsters when compared to the control lobsters. For experiment (ii), lobsters were exposed to 20 air source discharges per day for five successive days in a laboratory setting. The peak-to-peak and rms received sound levels ranged from approximately176 to 200 dB re 1 µPa and 148 to 172 dB re 1 μPa_{rms} respectively. The lobsters were returned to their aquaria and examined six months later. No differences in mortality, gross pathology, loss of appendages, hepatopancreas/ovary histopathology or glycogen accumulation in the hepatopancreas were observed between treatment and control lobsters. The only observed difference was a slight statistically significant difference for calcium-protein concentration in the haemolymph, with lobsters in the treatment group having a lower concentration than the control group.

Lethal Injury

Numerous studies have also examined the potential of lethal injury/mortality to various life stages of fishes and invertebrates as a result of exposure to anthropogenic underwater sound. Most of these studies used seismic air source sound for the exposure experiments (e.g., Kostyvchenko 1973; Booman et al. 1996; Christian et al. 2003, 2004; de Soto et al. 2013; Payne et al. 2015). Note that these studies used exposure scenarios that were more extreme than typical exposures in during seismic surveys. The scientific evidence collected to date suggests that egg and larval stages of fishes and invertebrates are more susceptible to lethal injury/mortality as a result of exposure to seismic air source energy than are juveniles and adults. There is no evidence to support lethal injury/mortality to juvenile and adult fishes and invertebrates that are unconstrained and able to move away from a seismic air source.

In uncontrolled experiments, Kostyvchenko (1973) exposed the eggs of numerous fish species (anchovy, red mullet, crucian carp, blue runner) to various sound sources, including seismic air sources. With the seismic air source discharged as close as 0.5 m from the eggs, over 75 percent of them survived the exposure. Egg survival rate increased to over 90 percent when placed 10 m from the air source. The range of received SPLs was approximately 215 dB re 1 µPa0-p to 233 dB re 1 µPa0-p.

In a field study, Pearson et al. (1994) exposed Stage II larvae of the Dungeness crab to single discharges from a seven-air source array and compared their mortality and development rates with those of unexposed larvae. For immediate and long-term survival and time to molt, this study did not reveal any statistically significant differences between the exposed and unexposed larvae, even those exposed within 1 m of the seismic source.

Eggs, yolk sac larvae, post-yolk sac larvae, post-larvae, and fry of various commercially important fish species (cod, saithe, herring, turbot, and plaice) were exposed to received SPLs ranging from 220 dB re 1 µPa to 242 dB re 1 µPa (unspecified measure type) (Booman et al. 1996). These received levels corresponded to exposure distances ranging from 0.75 m to 6 m. The authors reported some cases of injury and mortality but most of these occurred as a result of exposures at close range.

The exposure of fertilized snow crab eggs to seismic air source sound by Christian et al. (2003) also compared the mortality level of the exposed fertilized eggs with that of control fertilized eggs. Significant differences were found between the two groups in terms of both mortality rate ($p=0.034$) and development rate (<0.001 to 0.002), with exposed fertilized eggs showing a higher mortality rate and a lower development rate. However, it should be noted that both egg masses came from a single female crab and any measure of natural variability was unattainable.

A laboratory study involved the exposure of wild New Zealand scallop larvae to recorded seismic pulses. Results indicated developmental delays, with 46 percent of the larvae exhibiting body abnormalities. It was suggested that the malformations could be due to cumulative exposure (de Soto et al. 2013).

In a recent study, McCauley et al. (2017) conducted an experiment whereby they exposed zooplankton off the coast of Tasmania to a 150 cu.in. air source. Observations from the study indicate that seismic surveys may have a greater effect on zooplankton communities than previously understood. Treatment samples of zooplankton exposed to the air source exhibited an increase of two to three-fold greater mortality than with the control group and impacts on zooplankton were observed as far as 1.2 km away from the air source. The sample size and number of replications was relatively small, however, since the study occurred over just two days. More sampling is required to determine the full extent of the impact that seismic may have on zooplankton mortality.

A companion study completed by Richardson et al. (2017) attempted to model the impact of a seismic survey on zooplankton over a larger temporal and spatial scale than what was originally considered by McCauley et al. (2017). In total, the modeled survey area was 2,880 km², with a water depth range of 300 m o 800 m. Air source impact, measured as mortality or absence from area, was considered for a 35-day period during which seismic was conducted. Modelling results indicate that impacts to zooplankton populations would most likely occur only at a local scale, with less of an impact on a larger spatial scale, contradictory to results obtained by McCauley et al. (2017). Richardson et al. (2017) attributes potential avoidance behavior of the zooplankton as a possible reason why McCauley et al. (2017) observed such a marked decrease in zooplankton abundance during their study. Furthermore, direct experimental studies of the effects of seismic activities on *Calanus finmarchicus* copepods observed significantly higher immediate mortality adjacent to the sound source (5 m) relative to controls but not at distances greater than 5 m (Fields et al. 2019). Fields et al. (2019) indicated no mortality at a range of 25 m from the sound source where SEL was 186 dB re 1 mPa² s, contrary to McCauley et al. (2017) observations of zooplankton mortality 509-658 m from the source where SEL was 156 dB re 1 mPa² s.

The Change in Fish and Invertebrate Mortality, Injury and/or Health due to underwater sound emissions from geophysical sound sources would be adverse, as described above and short-term. Based on sound modelling for S1, the geographic extent of the change in fish injury/mortality and/or health would be within 50 m of the sound source based on minimum peak for mortality and potential injury of 207 dB re 1 μPa $_{(0\text{-}p)}$ for fishes with swim bladders (e.g., Atlantic cod, redfish, lanternfish, capelin), Therefore, the geographic extent would be within 1 km² of the location of the underwater sound source within the Core BdN Development Area. As described above, fish would have to remain in the area of underwater sound emissions for extended periods of time for injury/mortality effects to occur. The potential change would be sporadic if it occurred but unlikely considering the behavioural effects may cause them to move away. Effects would be reversible with cessation of the activity. The change in fish mortality / injury would be considered within the range of natural variability without affecting the overall viability of affected fish species, therefore, the magnitude of the change in fish mortality / injury would be low. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations, as noted above and listed in the SOCP (DFO 2007), should reduce overall changes to fish mortality / injury / health.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury, and/or Health from the geophysical sound are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km² of short-term duration, not likely to occur to occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with underwater sound emissions produced by geophysical activities.

As noted above, the displacement of fish may shift the spatial distribution of prey species and have effects on food availability. Changes to the spatial distribution of fish such as lanternfish from underwater sound emissions would be temporary as described above and would likely return after cessation of the activity or removal of the sound source. The change in food availability and/or quality due to geophysical sound would be adverse, as described above and short-term. Based on sound modelling and estimated minimum avoidance levels for fishes with swim bladders (160 dB re 1 μPa

$_{(0\text{-}p)}$), the geographic extent of behavioural effects would be between 1,000 km² and 10,000 km² of the location of the sound source within the Core BdN Development Area for seismic activities. As indicated above, the change in behavioural effects are predicted to be a low magnitude, therefore the predicted change in food availability, which would be affected by behavioural changes, would be the same. The change in food availability would be sporadic during geophysical activities, and reversible with cessation of the activity. As the effect is short-term and sporadic, and food for predator species is available within the Core BdN Development Area, the change in food availability would be considered within the range of natural variability without affecting its overall availability and therefore of low magnitude. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations, as noted above and listed in the SOCP (DFO 2007), should reduce overall changes to food availability.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound emissions from geophysical surveys are predicted to be adverse, low in magnitude, with a geographic extent between 1,000 km² and 10,000 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Geohazard / Wellsite and Seabed Surveys

The primary effects on Marine Fish and Fish Habitat due to underwater sound emissions from geohazard/wellsite and/or seabed surveys are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with underwater sound emissions from equipment used in geohazard/wellsite and/or seabed surveys. Possible types of sonar that could be used during other geophysical surveys in support of the Project include MBES, SSS, SAS, and SBP. All of these instruments typically use ultrasound during operations (frequencies >20 kHz). These frequencies are well above the hearing ranges of most fishes and invertebrates, with the exception of some clupeid fishes (e.g., shads, menhaden) which can detect and respond to ultrasonic frequencies (Dunning et al. 1992; Mann et al. 1997). Studies using low- and mid-frequency (<1 kHz to 10 kHz) naval sonars have shown no tissue damage in fishes although there is potential for temporary hearing loss in some individuals (Popper et al. 2007; Kane et al. 2010; Halvorsen et al. (2012a).

Sound modelling was conducted for a multi-beam echosounder and a sub-bottom profiler that could potentially be used during environmental, geotechnical and geological surveys. Table 9.14 provides the modelling results.

Table 9.14 Maximum Horizontal Distances to Modelled Maximum-over-depth SPL Thresholds Associated with MBES / SBP use at S1 in February Propagation Conditions

$SPL_{(rms)}$ (dB re 1 µPa)	MBES (m)		SBP (m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	<5	<5	-	-
190	5	5	-	-
180	20	20	<5	<5
170	65	60	7	7
160	150	135	30	30
150	275	240	99	96
140	430	368	279	269
130	715	567	623	586
120	900	783	3,920	3,830

Source: Zykov (2018)

R_{max} denotes the maximum range at which a given sound level was encountered in the modelled maximum-over-depth sound field

$R_{95\%}$ denotes the maximum range at which a given sound level was encountered in the modelled maximum-over-depth sound field after excluding 5 percent of the farthest such points

The frequencies associated with the sound emitted from both the MBES and the SBP are higher than those that most fishes are known to be capable of detecting, especially the 200 kHz for the MBES. In terms of the received $SPL_{(rms)}$, predicted by the modelling, received sound levels with potential to cause behavioural effects on fishes with swim bladders (e.g., lanternfish) would not occur beyond 300 m from source.

The change in fish behaviour associated with underwater sound emissions from equipment used in geohazard/wellsite and/or seabed surveys would be adverse, as described above, but of short-term duration. Based on sound modelling, the geographic extent of the change in fish behaviour resulting in potential displacement from fish habitat would be less than 1 km² of the location of the equipment used in the survey within the Core BdN Development Area for seismic activities. The change in behaviour would be sporadic while the survey was ongoing and reversible with cessation of the activity. The change in behaviour would be considered within the range of natural variability for the area but would not affect the overall viability of affected fish species. Therefore, the magnitude of the change in fish behaviour would be low. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in behaviour associated with sound emissions from equipment used in geohazard/wellsite and/or seabed surveys are not proposed.

In summary, the residual environmental effects of a Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with underwater sound emissions from equipment used in geohazard/wellsite and/or seabed surveys are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with underwater sound emissions from equipment used in geohazard/wellsite and/or seabed surveys.

As noted above there may be some behavioural effects from underwater sound emissions from equipment used in geohazard/wellsite and/or seabed surveys. This in turn may have the same effect on prey availability of species such as lanternfish in the Core BdN Development Area. Given the localized (less than 300 m) and the short-term nature of the effect on behaviour, while there would be an interaction associated with the underwater emissions, there would be no change in the overall prey availability relative to prey availability in the Core BdN Development Area. Therefore, the effect would be adverse and negligible in magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability associated with underwater sound emissions from equipment used in geohazard/wellsite and/or seabed surveys are not proposed

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound emissions from equipment used in geohazard/wellsite and/or seabed surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with underwater sound emissions from equipment used in Supporting Surveys include mitigation outlined in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (K).

Follow-up Monitoring for the effects on Marine Fish and Fish Habitat associated with underwater sound emissions from equipment used in Supporting Surveys engaged is not proposed.

9.3.6 Decommissioning

As described in Section 2.6.7, at end of field-life the Project, either at the end of the Core BdN Development or the end of Project life should Project Area Tiebacks be undertaken, will be decommissioning in accordance with regulatory requirements in place at the time of decommissioning. A decommissioning plan will be submitted to the C-NLOPB for review and acceptance. Depending on the activity undertaken, decommissioning may occur seasonally or at any time of the year. It is anticipated that decommissioning will be carried out over multiple seasons, similar to Offshore Construction and Installation (Section 9.3.1) and be completed within a two to four-year timeframe. Decommissioning of the FPSO may occur at any time of the year.

As a base case, the FPSO will be decommissioned and removed from the Project location. It is likely that the FPSO will be decommissioned and sail away from site in the initial phases of decommissioning. As noted above, vessels may be engaged to support decommissioning of the FPSO. All floating equipment (turret, mooring lines) will be removed. The FPSO, once the moorings and turret are disconnected is a marine vessel and will transit under its own power to its next destination. As the FPSO at this stage a vessel in transit, the interactions with fish and fish habitat would be the same as vessels in transit discussed in Section 9.3.4. Discharges, up to the point of the FPSO transit, will be similar to those under Production and Maintenance, with the same mitigations and treatment in place. Therefore, the interactions with fish and fish habitat would be the same as Production and Maintenance and are not considered an interaction under Decommissioning.

Subsea infrastructure, including flowlines and well templates may be removed or left in place. As noted in Section 2.6.7, these options will be further examined at the time of decommissioning.

Wells will be abandoned in accordance with regulatory requirements and as described in Section 2.6.7.2. Depending on water depth, the wellhead will either be removed during decommissioning or left in place. Well decommissioning may be carried out with a drilling installation (internal cutting of the well casing), which typically occurs at shallower water depths, or in deeper waters via a vessel and ROV-equipped with a mechanical cutter (external cutting of wellhead). Explosives will not be used to remove wellheads.

Activities associated with decommissioning are the same as described and the above sections, including vessels engaged in decommissioning activities, supply and servicing, helicopter supply and servicing, ROV / AUV surveys. Marine vessel and aircraft support activity levels during decommissioning would likely be similar to the construction and installation phase of the Project. Environmental, geotechnical, and/or geological surveys may be required during decommissioning.

As noted in Table 9.3 the primary interactions during these activities are vessel-related and include light and sound emissions and marine discharges from vessels. These vessel-related interactions would be the same as those assessed for vessel engaged in construction and installation and supply and servicing activities and the effects assessment would be the same as presented in Sections 9.3.1, and 9.3.4 and 9.3.5. It is anticipated that the number of vessels on site during decommissioning would be similar to that during construction and installation. The assessment of these interactions is not repeated below.

In consideration of the interaction and associated effects of vessel-based interactions, as noted above, the effects assessment of decommissioning will focus on removal of subsea infrastructure and wellheads.

9.3.6.1 Decommissioning of Subsea Infrastructure

Subsea infrastructure, including flowlines and well templates may be removed or left in place. These options will be further examined at the time of decommissioning in consultation with C-NLOPB and other regulatory authorities such as DFO, particularly if habitat has been created with the presence subsea infrastructure. Over time, and depending on potential protection measures, infrastructure may have become fish habitat and the effects of removing them would have to be assessed.

As the Core BdN Development will last 12 to 20 years, subsea infrastructure will likely be colonized by sessile invertebrates. As discussed in Section 9.2.2.1, the presence of subsea infrastructure may provide new habitat for benthic species colonization as well as the attraction of fish due to increase in habitat features. These positive effects would continue should subsea infrastructure remain in place. In consideration of the greatest potential effect, the removal of subsea infrastructure is assessed.

The primary effects on Marine Fish and Fish Habitat, associated with the decommissioning of the subsea infrastructure are:

- Change in Habitat Availability and/or Quality
- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury and/or Health
- Change in Food Availability and/or Quality

Changes in Habitat Availability and/or Quality is a potential effect associated with the decommissioning of subsea infrastructure.

If subsea infrastructure is removed, the positive effects associated with the presence of hard substrate and subsequent habitat complexity, as discussed in Section 9.3.1.4 and 9.3.2.1, would be reversed. Removal of the infrastructure will likely result in a localized decline in sessile or low-mobile invertebrates that were supported by the associated food and habitat subsidies, but mobile opportunistic species would be supported for a short time. Bomkamp et al. (2004) observed a difference in predatory gastropods and sea stars that were dependent on the bivalve food subsidies between present and former oil platform sites. Crab species were not different between the sites, indicating that mobile opportunistic species were not negatively affected (Bomkamp et al. 2004). Some small disturbances in deep-sea areas are also suggested to enhance diversity in deep-sea environments (Grassle and Morse-Porteous 1987). There may also be short-term localized suspended particle and sedimentation disturbance effects to Marine Fish and Fish Habitat similar to initial construction activities (see Section 9.3.1) potentially resulting in localized temporary avoidance. Recovery and recolonization of the area would only be enhanced if the infrastructure supported connectivity to areas that were previously inaccessible by benthic invertebrates. While, there would be a reduction in hard bottom substrates, removal of the subsea infrastructure would reverse to baseline conditions where soft bottom substrate would be available for colonization by sea pens.

The change in habitat availability and/or quality associated with the removal of the subsea infrastructure would be neutral, as conditions would be reversed to baseline described above, and long-term. The geographic extent of the change in habitat would be less than 10 km², based on the footprint of the subsea infrastructure within the Core BdN Development Area. The magnitude of change in habitat would be negligible as it represents a reversal to baseline conditions that would not affect the overall viability of the habitat in the area, as the effects are limited to a 7 km² area in the entire 470 km² of available habitat in the Core BdN Development Area. With the exception of timeframe for recovery of benthic communities, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, there is a moderate level of confidence associated with recovery timeframe. Mitigations to reduce the change in habitat availability and/or quality from removal of subsea infrastructure are not proposed.

The residual environmental effects of a Change in Habitat Availability and/or Quality associated with the decommissioning of subsea infrastructure is predicted to be neutral as described above, negligible in magnitude, with a geographic extent less than 10 km², of long-term duration, and occurring once. These predictions are made with a moderate to high level of confidence.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with decommissioning of the subsea infrastructure. The removal of habitat complexity and refuge provided by anti-collision zones would remove potential positive effects of subsea infrastructure. Fish and invertebrates previously attracted to the subsea infrastructure would redistribute within the area.

The change in fish behaviour due to decommissioning of subsea infrastructure would be neutral with return to baseline conditions as described above, and long-term. As the attraction to infrastructure would be localized to the subsea infrastructure, the geographic extent of the change in fish behaviour from decommissioning would be less than 10 km² within the Core BdN Development Area. The magnitude of effects would be negligible, as it is a return to baseline conditions. With the exception of timeframe for benthic community recovery, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, there is a moderate level of confidence regarding recovery timeframe. Mitigations to reduce the change in fish behaviour associated with decommissioning of subsea infrastructure are not proposed.

The residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with decommissioning of subsea infrastructure is predicted to be neutral, negligible in magnitude, with a geographic extent less than 10 km², of long-term duration, and occurring once. These predictions are made with a moderate to high level of confidence.

Change in Fish and Invertebrate Mortality, Injury and/or Health is a potential effect associated with decommissioning of the subsea infrastructure. Removal of the infrastructure will likely result in a localized decline in sessile or low-mobile invertebrates as described above in Section 9.3.1.3.

The change in mortality / injury / health associated with decommissioning of subsea infrastructure is predicted to be neutral with return to baseline, negligible in magnitude with a return to baseline conditions, with a localized effect to the infrastructure, therefore a geographic extent less than 10 km², of long-term duration, and occurring once. These predictions are made with a moderate to high level of confidence based on uncertainties in benthic recovery, the limited scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in injury/mortality associated with the removal of subsea infrastructure are not proposed.

The residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with decommissioning of subsea infrastructure is predicted to be neutral, negligible in magnitude, with a geographic extent less than 10 km², of long-term duration, and occurring once. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and /or Quality is a potential effect associated with decommissioning of the subsea infrastructure.

Removal of the infrastructure will likely result in a localized decline in sessile or low-mobile invertebrates that were supported by the hard substrate and/or associated food and habitat subsidies. For example, decline in benthic invertebrate communities may reduce food availability for species such as grenadiers, longnose eel, and wolffish. There may also be short-term localized suspended particle and sedimentation disturbance effects to Marine Fish and Fish Habitat similar to initial construction activities (see Section 9.3.1) potentially resulting in localized temporary avoidance during the actual decommissioning activities.

The change in food availability and/or quality due to decommissioning of subsea infrastructure would be neutral with return to baseline conditions, as described above, and long-term. As the food subsidies would be localized to the subsea infrastructure, the geographic extent of the change in food availability from decommissioning would be less than 10 km² of the location of the infrastructure within the Core BdN Development Area. The magnitude of the change in food availability associated with the removal of the subsea infrastructure would be negligible as it a return to baseline conditions. With the exception of timeframe for recovery of benthic communities, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, there is a moderate level of confidence regarding the recovery timeframe. Mitigations to reduce the change in food availability and/or quality associated with the removal of subsea infrastructure are not proposed.

The residual environmental effects of a Change in Food Availability and/or Quality decommissioning of subsea infrastructure is predicted to be neutral, negligible in magnitude, with a geographic extent less than 10 km², long-term, and occurring once. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with decommissioning of subsea infrastructure include submission of a decommissioning plan to the C-NLOPB (N).

Follow-up Monitoring for the effects on Marine Fish and Fish Habitat associated with decommissioning of subsea infrastructure is not proposed.

9.3.6.2 Well Decommissioning

At the end of field life, well template protection and wellheads will likely be removed. Wellhead decommissioning activities are described in Section 2.6.7.2. As noted in Section 2.6.7.2, wellheads can be removed by internal cutting of the wellbore via the drilling installation or external cutting via an ROV from a support vessel. Effects on fish and fish habitat associated with a drilling installation or a vessel equipped with an ROV would be the same as those assessed in Sections 9.3.3 and 9.3.5. The focus of the effects assessment of well decommissioning is associated with the removal of the wellhead itself.

The primary effects on Marine Fish and Fish Habitat associated with well decommissioning are:

- Change in Habitat Availability and/or Quality

Changes in Habitat Availability and/or Quality is a potential effect associated with well decommissioning.

Wellhead removal at shallower depths using conventional wellhead removal via internal cutting tools from a drilling installation, will have minimal environmental disturbance. Wellhead removal would be short-term (approximately 1 to 2 days per well). Internal cutting removes the wellhead below the seabed resulting in no remaining infrastructure on the seabed. Explosives will not be used in the removal of wellheads. Decommissioned wells will be inspected in accordance with applicable regulatory requirements.

At water depths in the Core BdN Development Area (approximately 1,100 m) wellheads could be removed by external cutting via a vessel equipped with an ROV. The cutting of the wellheads above the seafloor will result in a portion of the casing (pipe stub) above the sea floor. The pipe stub would likely have a maximum height of approximately 0.85 m, but with cutting as close to the seafloor as possible, the height can be reduced. Remaining wellhead structures left in place after decommissioning (500 to over 1500 m) may provide localized increased habitat structures in the Core BdN Development Area as discussed in Section 9.3.2.1. There may be sedimentation at the wellhead created by the external cutting, but it would be temporary and short-term. The effects of sedimentation are captured in Section 9.3.1 and would be similar during well head decommissioning. Effects would be of negligible magnitude relative to baseline conditions, given the small area affected in relation to the overall 470 km² Core BdN Development Area. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with well decommissioning is predicted to be adverse as described above, negligible in magnitude, with a geographic extent less than 1 km², of long-term duration, and occurring once. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with well decommissioning include not using explosives (O); submission of a decommissioning plan to the C-NLOPB (N); inspection of the decommissioned well in accordance with regulatory requirements (P).

Follow-up Monitoring for the effects on Marine Fish and Fish Habitat associated with well decommissioning is not proposed.

9.4 Project Area Tiebacks

Over the life of the Project, Equinor Canada may choose to undertake additional exploration activities (e.g., exploration, appraisal, delineation drilling, 2D, 3D/4D seismic) to search for and possibly develop economically recoverable reserves. Should additional economically and technically recoverable reserves be discovered within the Project Area, they could be processed on the BdN FPSO through the installation of additional subsea templates and flowlines ("subsea tiebacks") as described in Section 2.6.6. Between one and five well templates could be tied-back to the FPSO and/or existing well templates via flowlines and may include the drilling of up to 20 additional wells within the additional well templates. Activities associated with Project Area Tiebacks would be the same as those described in Section 2.6.6 and summarized below.

- Installation of subsea tieback(s) (well templates and flowlines)
- Continuation of production and maintenance operations from the existing FPSO
- Drilling activities associated with the drilling of up to 20 additional wells (total) in well templates
- Continuation of supply and servicing
- Additional supporting surveys, if required
- Decommissioning

The Core BdN Development has a field life of 12 to 20 years. Should Project Area Tiebacks occur, the field life of the Project may be extended while maximum daily potential production rates would remain the same. Tiebacks may be feasible up to a distance of approximately 40 km from the FPSO and/or template location. Figure 9-7 illustrates examples of tieback layouts that could occur, should Project Area Tiebacks be undertaken. Tiebacks could be direct to the FPSO and/or connected to existing well templates. For the purposes of environmental effects assessment, it is assumed that the timeframe for Project Area Tiebacks would the same as those listed for the Core BdN Development. For instance, it is assumed that offshore construction and installation of well templates and flowlines, and HUC activities of the new subsea infrastructure could occur over several seasons; production and maintenance operations, supply and servicing and supporting surveys occurring during the Core BdN Development would continue until 30-year end of Project life (an additional 10 to 18 years). Mitigation measures, as described in Section 9.1.5.2 and Table 9.3 and implemented for the Core BdN Development would be applied to activities undertaken should Project Area Tiebacks occur.

An overview of fish and fish habitat for the Project Area is provided in Section 9.2. The northern areas of the Project Area have similar water depths to the Core BdN Development Area whereas water depths in the western areas of the Project Area are shallower, especially on the shallower slope areas between the Grand Banks and Flemish Pass. Slope areas within the Project Area would likely have more hard substrates for colonization relative to deep waters of the Flemish Pass. Sessile species associated with hard substrates (e.g., soft corals, vase sponges) would likely be more prevalent in these areas than in the Core BdN Development Area. Shallower water groundfish such as capelin, redfish, and cod would also likely occur on slope areas and species such as lanternfish and blue hake would likely occupy deeper waters. As the slopes of the Grand Banks are important upwelling areas for nutrients, it may also be an important area for plankton. Therefore, potential effects on fish and invertebrate species and fish habitat as described for the Core BdN would be similar to potential effects in the Project Area but also encompass Grand Bank slope species and habitats. In the shallower waters of the Project Area, especially where bottom trawling occurs at higher intensity than in the Core BdN Development Area, fish habitat in these areas is likely degraded by ongoing fishing activities.

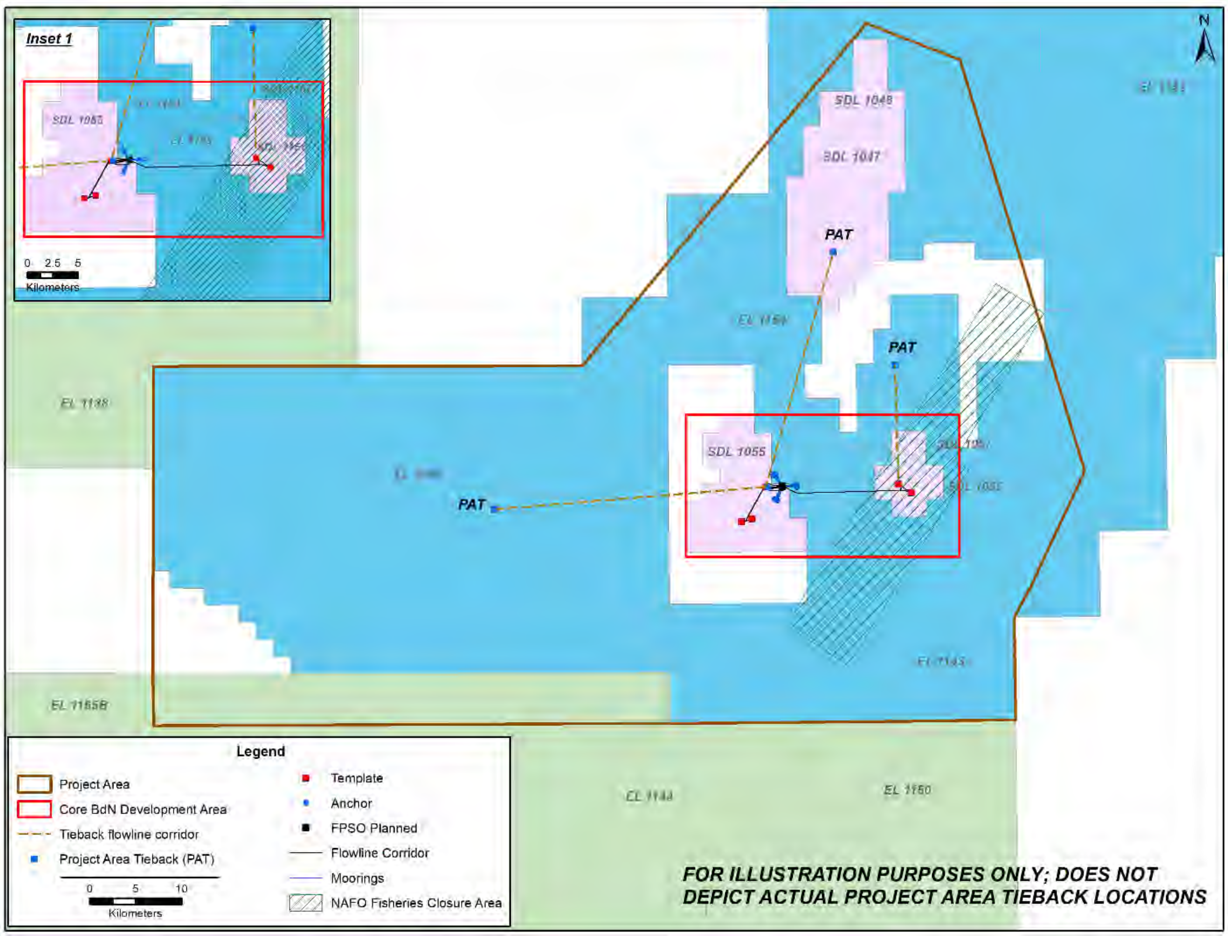

Figure 9-7 Illustration of Examples of Potential Project Area Tiebacks

9.4.1 Offshore Construction and Installation, Hook-up, and Commissioning

Project Area Tiebacks of up to five additional subsea tiebacks (flowlines, well templates) may involve seabed surveys and site preparation, installation of subsea infrastructure, and eventual HUC of newly installed well templates and flowlines, similar to those described in Section 9.3.1. Activities would occur at locations within the Project Area but would likely be seasonal and may occur over multiple years as with similar activities for the Core BdN Development. Offshore construction and installation and HUC of Project Area Tiebacks may occur at the same time as ongoing production and/or drilling operations for the Core BdN Development.

As discussed in Section 9.3.1, the primary interactions with Marine Fish and Fish Habitat during this phase are associated with vessels (light and sound emissions) and installation of seabed infrastructure. Project Area Tiebacks may include the installation of flowlines in different locations within the Project Area The potential interactions and effects of offshore construction and installation, and HUC for Project Area Tiebacks would be the same as those assessed in Section 9.3.1 for the Core BdN Development.

9.4.1.1 Light Emissions from Vessels

Should Project Area Tiebacks occur, as noted and assessed in Section 9.3.1.1, the primary effects on Marine Fish and Fish Habitat, associated with light emissions from vessels engaged in Offshore Construction and Installation, and HUC activities are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with light emissions from vessels engaged in Construction and Installation and HUC activities for Project Area Tiebacks. Interactions described and assessed for the Core BdN Development (Section 9.3.1.1) would be the same for Project Area Tiebacks. Light emissions from vessels may cause the attraction or avoidance of fish and invertebrate species, such as plankton, shrimp, capelin, Atlantic cod, and redfish, which are also in the Project Area.

The changes in behaviour associated with light emissions from vessels would be adverse, as described in Section 9.3.1.1, but short-term during the construction season. The geographic extent of the change in behaviour would be less than 1 km² of the location of the vessel within the Project Area. The change in behaviour would be regular at night while vessels were on-site, and reversible once the vessel(s) leaves the area. As the change in behaviour is localized to the vessel, which occupies a very small footprint in the 4,900 km² of the Project Area (including if more than one vessel were onsite at the same time), and does not affect fish behaviour in the larger Project Area, there is no change in fish behaviour relative to baseline conditions and is therefore negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in behaviour and/or quality are not proposed.

The residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with light emissions from vessels engaged in Offshore Construction and Installation and HUC activities, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with light emissions from vessels engaged in Construction and Installation and HUC activities for Project Area Tiebacks. Interactions described and assessed for the Core BdN Development (Section 9.3.1.1) would be the same for Project Area Tiebacks. Light emissions from vessels may cause the attraction or avoidance of fish and invertebrate prey species, such as plankton, krill, shrimp, capelin, Atlantic cod, lanternfish, and redfish, which are also in the Project Area. As noted in Section 9.3.1.1, lanternfish is important mesopelagic prey species in the Project Area that use photophores to imitate ambient light and reduce visibility to predators (Peña 2019). Light emissions may cause their migration to deeper in the water column, reducing their availability to predators.

The change in food availability and/or quality due to the light emissions from vessels would be adverse, as described in Section 9.3.1.1, but short-term during the construction season. The geographic extent of the change in food availability would be less than 1 km² of the location of the vessel within the Project Area. The change in food availability would be regular at night while vessels were on-site, and reversible once the vessel(s) leaves the area. While light emissions likely reduce food availability within a localized area of the vessel, the overall food availability in the Project Area is not affected and is available for predator species. There would be no change in food availability relative to baseline conditions and is, therefore, negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with the presence of vessels during Offshore Construction and Installation and HUC activities, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent of less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with light emissions from vessels engaged in Offshore Construction, Installation and HUC activities are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with light emissions from of vessels engaged in Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions.

9.4.1.2 Underwater Sound Emissions from Vessels

As noted and assessed in Section 9.3.1.2, the primary effects on Marine Fish and Fish Habitat, due to the sound from vessels during Offshore Construction and Installation, and HUC are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with sound emissions from vessels engaged in construction and installation activities and HUC activities for Project Area Tiebacks. Interactions described and assessed for the Core BdN Development (Section 9.3.1.2) would be the same for Project Area Tiebacks. Sound emissions may cause a variety of behavioural responses in fish, such as capelin, Atlantic cod, lanternfish, and redfish, which are also in the Project Area. As noted in Section 9.3.1.2, if displacement of mobile fish in the Project Area (e.g., capelin, redfish, tuna) occurs, it would likely be short-term as fish would return once the vessel leaves the area.

The change in fish presence and/or abundance due underwater sound emissions from vessels would be adverse, as described above, but short-term during the construction season. The geographic extent of the change in behaviour would be less than 1 km² of the location of the vessel within the Project Area. The change in behaviour would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. While underwater sound emissions may affect the presence and/or abundance of fish within the localized (less than 1 km²) area of the vessel, their abundance and or presence is not affected within the entire Project Area, there is no change in abundance and/or presence relative to baseline conditions and is therefore considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in behaviour and/or quality are not proposed.

The residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with sound emissions from vessels engaged in Offshore Construction and Installation and HUC activities, should Project Area Tiebacks be undertaken are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with sound emissions from vessels engaged in construction and installation activities and HUC activities for Project Area Tiebacks. Interactions described and assessed for the Core BdN Development (Section 9.3.1.2) would be the same for Project Area Tiebacks. Sound emissions may cause avoidance and/or attraction of prey species, thereby affecting their availability to predators. The displacement of fish may shift the spatial distribution of prey species and have effects on food availability. Changes to the spatial distribution of fish from underwater sound would likely be temporary as the fishes in the water column (e.g., capelin, redfish, tuna) are typically highly mobile and would likely return after cessation of the activity or removal of the sound source.

The change in food availability and/or quality associated with underwater sound emissions from vessels are predicted to be adverse, as described in Section 9.3.1.2, but short-term during the construction season. The geographic extent of the change in food availability would be less than 1 km² of the location of the vessel within the Project Area. The change in food availability would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. While underwater sound emissions likely reduce food availability within a localized area of the vessel, the overall food availability in the Project Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed.

The residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound emissions from vessels engaged in Offshore Construction and Installation and HUC activities, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities are not proposed

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions.

9.4.1.3 Installation of Subsea Infrastructure (including Potential Protection)

As noted and assessed in Section 9.3.1.4, the primary effects on Marine Fish and Fish Habitat, due to the installation of subsea infrastructure during Offshore Construction and Installation are:

- Change in Habitat Availability and/or Quality
- Change in Fish and Invertebrate Mortality, Injury, Health
- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Food Availability and/or Quality

Should Project Area Tiebacks occur, well templates, flowlines, umbilicals and/or cables (and associated protection measures, if required) would likely be installed on the seafloor in the Project Area in the same manner as described and assessed for the Core BdN Development in Section 9.3.1.4. The installation of tieback infrastructure would have the same interactions with Fish and Fish Habitat as described in Section 9.3.1.4 for the Core BdN Development. Figure 9-7 provides an illustration of examples of subsea tiebacks in the Project Area. Assuming five tiebacks were undertaken, each at separate locations, the footprint of the five tiebacks is estimated to be approximately 15 km². Considering the footprint of the subsea infrastructure in Core BdN Development Area at 7 km², combined with the footprint of potential Project Area Tiebacks (15 km²), the total footprint in the Project area would be 22 km², representing approximately 0.5 percent of the seabed in the Project Area.

The discussion below will consider fish and fish habitat species and features that are in the broader Project Area, as described above in section 9.4, including those that occur in the shallower waters and along the slopes in the western area of the Project Area.

Change in Habitat Availability and/or Quality is a potential effect associated with the installation of subsea infrastructure at potential locations within the Project Area should Project Area Tiebacks occur. As discussed in Section 9.3.1.4, the primary interactions associated with subsea infrastructure installation are changes to seabed characteristic and creation of suspended particles in the water column near seabed.

As discussed in Section 9.3.1.4, site preparation and installation of subsea infrastructure may include the disturbance and direct physical interaction with the seabed. Coral densities have been shown to decrease in areas of disturbance (i.e., trawling), however, some sea pen species have been able to re-anchor themselves into sediment after dislodgement (Malecha and Stone 2009; NAFO 2011). In fine mud substrate habitat, common in the Flemish Pass (Murillo et al. 2016b), including the Project Area, installation of subsea infrastructure may resuspend sediments. Increased suspended particles may clog feeding structures of filter feeding organisms (Bell et al. 2015; Liefmann et al. 2018; Vad et al. 2018), such as sea anemones, soft corals, sea pens, and sponges found in the Project Area and reduce visibility for benthic fish (e.g., Atlantic cod, Greenland halibut, grenadiers, longnose eel, wolffish) through increased turbidity (De Robertis et al. 2003; Higham et al. 2015). Seabed interactions in slope areas may affect soft corals, sea anemones, and hard substrate associated sponges (e.g., leaf/vase sponges). Effects on soft corals, sea pens, and sponges associated with fine substrate (e.g., solid/massive sponges) in deeper waters of the Flemish pass would be similar to those noted for the Core BdN Development Area. On the slope and shallower waters (western areas of the Project Area), where bottom-trawling fishing intensity is higher than in the Core BdN Development Area as described in Section 7.1.4 and 7.1.5, benthic fish habitat in these areas is likely relatively more degraded.

Excavation of sediments may also introduce sediment particles of different shapes and sizes relative to surficial sediments not normally encountered in the area thereby potentially resulting in changes in habitat quality which may affect feeding behaviour and organism injury (Liefmann et al. 2018) and may result in a local change in benthic community composition. Offshore construction and installation activities, as noted above, will likely be seasonal, thereby reducing overall duration and allowing for recovery between activity years, especially in the shallower waters where recovery is likely faster than in the deeper waters.

As noted in Section 9.3.1.3, placement of protection measures, if required, would have similar environmental interactions as site preparation and installation of subsea infrastructure. The potential adverse effects may be offset as the rock protection, subsea infrastructure itself, may have localized positive effects with the addition of hard substrate and habitat complexity creating additional habitat. These potential positive long-term effects due to the presence of subsea infrastructure as habitat are addressed in Section 9.3.2.1 and Section 9.4.2.1.

The change in habitat availability and/or quality associated with subsea infrastructure installation would be adverse, as described above, but short-term during the construction season. The geographic extent of the change in habitat would be less than 1 km² of the location of the subsea infrastructure within the Project Area, or approximately 15 km² considering the footprint should five tiebacks occur. As noted above, the overall seabed footprint assuming five tiebacks are undertaken, combined with the footprint of the Core BdN Development, would be approximately 0.5 percent of the Project Area. The change in habitat would range from sporadic for turbidity effects to regular for changes to seabed effects during installation and reversible once construction activities cease. The change in habitat represents approximately 0.5 percent of total habitat available within the Project Area. Baseline fish habitat in shallower areas with higher intensity of bottom-trawling is likely already affected. In consideration of the limited area of the Project Area affected and likely affected existing fish habitat, the change in habitat is considered to be within the range of natural variability, therefore the magnitude of change in habitat would be low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

Mitigations to reduce the change in habitat availability and/or quality include no placement of well templates over *Lophelia pertusa* corals. If the installation of subsea infrastructure in the Project Area is determined by DFO to require a *Fisheries Act* Authorization, a habitat offsetting program will be developed in conjunction with DFO as a mitigation measure for the net loss of fish habitat resulting from the Project. Should Project Area Tiebacks be undertaken, Equinor Canada will commence the DFO process for a “Request for Review” pursuant to the provisions of the *Fisheries Act* prior to the commencement of the offshore construction and installation phase of the tiebacks.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with the installation of subsea infrastructure, should Project Area Tiebacks be undertaken are predicted to be adverse, low in magnitude, with a geographic extent between 10 km² and 100 km² (i.e., approximately 22 km²), of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with temporary avoidance of fish and invertebrates to suspended particles and installation activities. As discussed in Section 9.3.1.4, these effects would only be temporary with the initial excavation or placement of infrastructure for turbidity effects.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) associated with the installation of subsea infrastructure during Construction and Installation should Project Area Tiebacks be undertaken are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring regularly during construction, and reversible. These predictions are made with a high level of confidence.

Change in Fish and Invertebrate Mortality, Injury, Health is a potential effect associated with the installation of subsea infrastructure at potential locations within the Project Area should Project Area Tiebacks occur. As discussed in Section 9.3.1.4, injury or mortality of benthic organisms may result from burial, smothering and/or an increase in suspended particles in the water during installation of subsea infrastructure.

As discussed in Section 9.3.1.4, sessile or low mobility benthic organisms, such as echinoderms, sea anemones, corals, and sponges in the Project Area, are vulnerable to physical disturbance due to their low avoidance capabilities (Clark et al. 2016; Cordes et al. 2016). The placement of suction anchors or other subsea infrastructure can disturb bottom habitats and cause injury or mortality to benthic invertebrates, including corals and sponges (Davis et al. 1982; Cordes et al. 2016; Ragnarsson et al. 2017), from soft coral and sea pen groups, and solid/massive sponge groups noted in Section 6.1.7.6 for Project Area. As noted above, in fine mud substrate habitat installation of subsea infrastructure may resuspend sediments. Increased suspended particles may clog feeding structures of filter feeding organisms (Bell et al. 2015; Liefmann et al. 2018; Vad et al. 2018).

Coral and sponge biogenic habitats, as indicated in Section 9.3.1.4, are of concern due to their fragile nature and slow recovery (Henry and Hart 2005; Cordes et al. 2016; NAFO 2016). As noted, anthropogenic objects (e.g., fishing nets) in the Core BdN Development Area observed to be colonized by local sponges, anemones, and soft corals (Figure 9-3) and colonizing organism groups may be similar for the Project Area. While it is not possible to identify timescales for colonization, it indicates that hard structures may be colonized by hard substrate limited species, such as sea anemones, soft corals, and glass sponges in the Core BdN Development Area. Furthermore, the study by Edgell et al. (2019) discussed in Section 9.3.1.4, showed benthic recovery after disturbance in shallow waters. For shallower waters of the Project area, such recovery is expected to be similar. In the deeper water, however, recovery and recolonization timescales would likely be longer.

The change in fish and invertebrate mortality, injury and/or health associated with the installation of subsea infrastructure in the Project Area would be adverse, as described in above and in Section 9.3.1.4. Based on the time for recolonization discussed in Section 9.3.1.4, the duration of the change in mortality / injury could be short-term in the shallower waters of the Project Area and medium- to long-term in the deeper waters. The geographic extent of the change in injury would be within the immediate vicinity of the subsea infrastructure (i.e., less than 1 km²). However, the total area of subsea infrastructure in the Project Area, including the Core BdN Development Area, is approximately 22 km², therefore the geographic extent of injury and/or mortality of benthic fish and fish habitat would be between 10 km² and 100 km² for the Project. The change in fish and invertebrate mortality and injury would occur with initial placement of infrastructure and therefore is characterized as occurring regularly during the construction season. While individual fish, coral or sponge mortality is not directly reversible, the overall effect to these population is considered reversible, as it is predicted that similar communities will recolonize the area, as described above. The zone of influence estimated to be 15 km² (or 22 km² including the Core BdN Development Area subsea infrastructure) which represents less than 0.5 percent of the 4,900 km² area available in the Project Area, therefore the change in mortality / injury / health would be considered within the range of natural variability without affecting the viability of local populations and is therefore low. With the exception of timeframe for benthic recovery, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed in Section 9.3.1.3, recovery of benthic communities in the deep water is not well understood and the predicted time to recovery is based on studies in shallower marine waters, therefore the timeframe for recovery is made with a moderate level of confidence.

Mitigations to reduce the change in mortality / injury / health include no placement of well templates over *Lophelia pertusa* corals. If the installation of subsea infrastructure in the Project Area is determined by DFO to require a *Fisheries Act* Authorization, a habitat offsetting program will be developed in conjunction with DFO as a mitigation measure for the net loss of fish habitat resulting from the Project. Should Project Area Tiebacks be undertaken, Equinor Canada will commence the DFO process for a “Request for Review” pursuant to the provisions of the *Fisheries Act* prior to the commencement of the offshore construction and installation phase of the tiebacks.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with the installation of subsea infrastructure should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent between 10 km² and 100 km² (i.e., approximately 22 km²) of short- to long-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with the installation of subsea infrastructure at potential locations within the Project Area should Project Area Tiebacks occur. As discussed in Section 9.3.1.4 and below, changes to habitat and injury/mortality to fish and invertebrate species associated with installation of subsea infrastructure may result to changes in food availability and/or quality, should Project Area Tiebacks be undertaken.

Similar to changes in food availability and/or quality discussed in Section 9.3.1.4, the change in food availability and/or quality associated with subsea infrastructure installation would be adverse and short-term during the construction season. The geographic extent of the change in food would be less than 1 km² of the location of the subsea infrastructure within the Project Area. The change in food availability would be continuous during installation and reversible with eventual decommissioning of subsea infrastructure, or cessation of installation activities for disturbance effects. While the installation of subsea infrastructure may reduce food availability within a localized area of the seafloor, the overall food availability in the Project Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the change is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality are not proposed

In summary, residual environmental effects of a Change in Food Availability and/or Quality associated with the installation of subsea infrastructure should Project Area Tiebacks be undertaken are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the installation of subsea infrastructure and/or protection measures during Offshore Construction, Installation and HUC include placement of well templates to avoid *Lophelia pertusa* (A) and habitat offsetting measures, if required by DFO (C).

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the installation of subsea infrastructure. If DFO determines pursuant to the *Fisheries Act* that an authorization is required, habitat offsetting measures and a monitoring program will be developed.

9.4.1.4 Hook-up and Commissioning

As noted and assessed in Section 9.3.1.5, the primary effects on Marine Fish and Fish Habitat, associated with discharges of test water during hook-up and commissioning are:

- Change in Fish and Invertebrate Mortality, Injury, and/or Health

Change in Fish and Invertebrate Mortality, Injury, and/or Health is a potential effect associated with the discharge of test waters from subsea tieback flowlines during HUC activities. As described Section 9.3.1.6, commissioning activities would likely involve the flooding and testing of subsea infrastructure with treated seawater that would be eventually discharged to the marine environment. Within the Project Area, this would mainly have effects on plankton, and the effects would the be same as assessed in Section 9.3.1.4. and it is not predicted to have associated effects on food availability.

The change in fish and invertebrate mortality, injury and/or health associated with hook-up and commissioning would be adverse, as described in Section 9.3.4.5, but short-term during HUC activities. The geographic extent of the change in fish and invertebrate mortality would be less than 1 km² of discharge location. The change in fish and invertebrate mortality would be sporadic, as discharges depend on timing of leak testing, and reversible with cessation activities. While HUC discharges may cause a change in mortality for plankton within a localized area, it is unlikely with dispersion and dilution in the Project Area for this activity to have effects on the overall population in the Core BdN Development Area is not affected. The magnitude of this change would be considered within the range of natural variability and is, therefore, low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations such as screening of chemicals and adherence to the OWTG will reduce potential effects.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with HUC activities are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the HUC discharges include the screening of chemicals in accordance with C-NLOPB requirements and Equinor's global practices (F) and treatment of discharges in accordance with the OWTG (E).

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with HUC discharges in consideration of residual effects predictions.

9.4.2 Production and Maintenance Operations

The addition of subsea developments and wells may extend the life of the Project (12 to 20 years) to 30 years (total). The potential effects of production and maintenance operations are detailed in Section 9.3.2. The FPSO would remain on its location in the Core BdN Development Area. As there would be no changes to the light and sound emissions, marine discharges, produced water discharge, the potential effects would be the same as that described and assessed for the Core BdN Development. The extended life would increase timeframe for the interactions to occur.

The effects associated with the presence of the FPSO, as assessed in Section 9.3.2.1, would be the same for Project Area Tiebacks as the FPSO would remain in its position in the Core BdN Development Area. The only change is that the FPSO could be on-station until end of Project at 30 year, verses the estimated 12- to 20-year timeframe for the Core BdN Development. While the timeframe is extended, the duration of effects would remain as long term. All other effects characterizations would be the same as assessed for the Core BdN Development. Effects assessment for interactions associated with the FPSO (presence, lighting, sound, discharges) would not change should Project Area Tiebacks be undertaken. The effects assessment for these interactions are provided in Section 9.3.2. Mitigation measures, as applicable, employed for the Core BdN Development would continue for Project Area Tiebacks.

Should Project Area Tiebacks occur, additional subsea infrastructure, as described and assessed in Section 9.4.1.3 would be installed in the Project Area and would be in addition to the subsea infrastructure already in place for Core BdN Development Area. This additional subsea infrastructure would contribute to additional interactions with Fish and Fish Habitat in the Project Area and would be the primary interactions associated with Project Area Tiebacks. There would be no difference in potential species and habitat affected for production should Project Area Tiebacks occur relative to what has been previously described and assessed for the Core BdN Development Area. Therefore, the effects assessment for Production and Maintenance for Project Area Tiebacks will be focused solely on the presence of subsea infrastructure. As noted in Section 9.4.1.3, it is estimated that the area of the seafloor occupied by subsea infrastructure for Project Area Tiebacks should five tiebacks be undertaken would be approximately 15 km².

9.4.2.1 Presence Subsea Infrastructure

As noted above, and assessed in Section 9.3.2.1, the primary effects on Marine Fish and Fish Habitat associated with the presence of subsea infrastructure during Production and Maintenance Operations are:

- Change in Habitat Availability and/or Quality
- Change in Food Availability and/or Quality

Changes in Habitat Availability and/or Quality is a potential effect associated with the presence of subsea infrastructure.

As described in Section 9.3.2.1, artificial structures introduced to environments can have local influences on invertebrate community structure, species diversity, and abundance through the addition of hard substrate and habitat complexity (Wolfson et al. 1979; Bomkamp et al. 2004; Apolinario and Coutinho 2009; Macreadie et al. 2011; Ajemian et al. 2015, Reynolds et al. 2018; Lacey and Haynes 2019). The presence of subsea infrastructure, including potential protection measures, may locally increase habitat complexity through introduction of available hard structures for colonization by sessile species (Sargent et al. 2006; Bergström et al. 2014; Cordes et al. 2016; Lacey and Haynes 2019).

Effects on fish habitat availability and/or quality due to the presence of the subsea infrastructure are predicted to be adverse for soft bottom communities and positive for hard bottom communities, as noted above and reversible should subsea infrastructure be removed. Soft corals and sponges associated with hard substrate (e.g., leaf vase sponges, thin-walled complex) dominate hard substrates on the slope areas of the Project Area therefore these species would likely benefit from the addition of subsea infrastructure on the seabed. As noted above, the geographic extent of the change in habitat would be approximately 15 km², the area of the seafloor occupied by the subsea infrastructure in the Project Area. The change in habitat would be long term, and continuous, while the subsea infrastructure is in place. With the Core BdN Development Area infrastructure, the entire seabed to be occupied by subsea infrastructure within the Project Area would be an estimated 22 km², which represents approximately 0.5 percent of the seafloor in the Project Area. The change in habitat is therefore considered within the range of natural variability and would be of low magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

As noted in Section 9.3.1.4 and Section 9.4.2.1, if DFO determines that a *Fisheries Act Authorization* is required, for the placement of subsea infrastructure, including the requirement for habitat offsetting measures, these measures would mitigate changes in fish habitat associated with the presence of subsea infrastructure. As noted above, Equinor Canada will commence the process for a “Request for Review” pursuant to the provisions of the *Fisheries Act* prior to the commencement construction and installation activities.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with the presence of subsea infrastructure during Production and Maintenance Operations should Project Area Tiebacks be undertaken are predicted to be positive to adverse, low in magnitude, with a between 10 km² and 100 km² (i.e., approximately 22 km²) of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with the presence of the subsea infrastructure.

As noted in Section 9.3.2.1, the presence of subsea infrastructure may locally increase habitat complexity through introduction of available hard structures for colonization by sessile species, which may lead to local organic enrichment. The change in food availability and/or quality due to the presence subsea infrastructure would be positive, as described in Section 9.3.2.1, and long-term. This would likely benefit benthivores fish species (e.g., Atlantic cod, grenadiers, longnose eels, wolffish), and opportunistic foragers such as seastars and crab. The geographic extent of the change in food would be approximately 15 km², due to the footprint of the subsea infrastructure within the Project Area. The change in food availability would be continuous and reversible, should subsea infrastructure be removed at decommissioning. The magnitude of the change in food availability would negligible. While there may be a change food availability within a localized area of the subsea infrastructure, the overall food availability in the Project Area is not affected and is available for predator species. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability from presence subsea infrastructure are not proposed.

In summary, the residual environmental effects of a in Change in Food Availability and /or Quality associated with the presence of subsea infrastructure should Project Area Tiebacks be undertaken, are predicted to be positive, negligible in magnitude, with a geographic extent between 10 km² and 100 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the presence of subsea infrastructure include habitat offsetting measures, if required by DFO (C), biofouling paint on the hull of the FPSO (I); ballast water management in consideration of applicable Canadian and international requirements (D)

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the presence of subsea infrastructure. However, if DFO determines that habitat offsetting measures are required, a monitoring program may be required.

9.4.3 Drilling Activities

As stated in Section 2.6.6, should potential Project Area Tiebacks be undertaken, up to 20 additional wells may be drilled at either individual wells or in well templates (4-, 6- or 8-slot) at locations within the Project Area. Drilling activities could occur at any time of the year, and as noted in Section 9.3.3, the drilling installation could be site at a well template location for up to two years if eight wells were drilled consecutively. Drilling activities under Project Area Tiebacks phase will likely occur while ongoing production at the FPSO is occurring.

As identified in Section 9.1.5 and assessed in Section 9.3.3, potential interactions from drilling activities on Fish and Fish Habitat includes, light and sound emissions and marine discharges from the drilling installation. Fish species present in the Project Area would be the same as those present in the Core BdN Development Area. Coral and sponge community presence within the larger Project Area is similar to that described for the Core BdN Development Area (see Section 6.1.6.5). In the western portion of the Project Area, in shallower waters and near the slopes soft corals, and stony corals are likely present. In the northern parts of the that are of similar depths to the Core BdN Development Area, solid/massive sponges (e.g., *Geodia sp.*), soft corals, and sea pens are likely present.

Drill cuttings dispersion modelling from the Drilling EIS (Statoil 2017) provide an estimation of cuttings dispersion a shallower depth of approximately 360 m, which is comparable to the shallower depths of the Project Area (approximately 340 m). Modelling at 360 m depth on the northeast slope of the Grand Banks indicated that released drill cuttings settled primarily between 100 m to 1 km away from the wellsite across seasonal scenarios at maximum thicknesses of 1 mm to 80 mm and average thicknesses of less than 5 mm (Statoil 2017). From 1 km to 2 km average thickness ranged from 0.6 mm to 2mm for WBM cuttings and less than 0.01 for SBM cuttings. Drill cuttings thicknesses were less than 0.01 mm across seasonal scenarios beyond 2 km for WBM and SBM drill cuttings indicating no appreciable thicknesses of drill cuttings or effects to the benthic environment at this range. Based on the furthest extent of drill cuttings above 1.5 mm PNET of within 2 km from the release site, the geographic extent would be approximately 13 km^2.

Drill cuttings modelling for the Core BdN Development Area at approximately 1,200 m indicated that cuttings were mainly localized to within 200 m of the wellsite. In general drill cuttings overlap among sites 1 km away from the wellsite would be unlikely due to the patchy nature of discharged cuttings at this distance.

9.4.3.1 Light Emissions from the Drilling Installation

As noted and assessed in Section 9.3.3.2, the primary effects on Marine Fish and Fish Habitat due to the lighting of the drilling installation are:

- Change in Food Availability and/or Quality
- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)

Light emissions from the drilling installation at potential well template locations in the Project Area would have the same effects on Fish and Fish Habitat as light emissions assessed for the Core BdN

Development (Section 9.3.3.2). The drilling installation would be a new source of artificial lighting in broader Project Area, a region that is relatively free of nocturnal artificial lighting. Species in the Project Area likely to be affected by light emissions include plankton, redfish, lanternfish, similar to species noted in Section 9.3.3.2 for drilling in the Core BdN Development Area.

Change in Food Availability and/or Quality is a potential effect associated with light emissions from the drilling installation.

As noted in Section 9.3.3.2, migrating individuals, plankton, and pelagic species may be attracted to the lighting effect on the surface water caused by lights reflecting off water surface. These light emissions may attract planktivorous (e.g., capelin) and plank-piscivorous (e.g., redfish) fish in the Project Area. Light sensitive fish such as lanternfish that depend on dark areas for predator avoidance would likely react to a light field with avoidance horizontally or vertically depending on other environmental effects and presence of prey species (e.g., plankton). As noted in Section 9.3.3.2, the effect is conservatively within 1.5 km of the drilling installation (approximately 7 km² zone of influence) at its location in the Project Area, at any one well template. The change in food availability would be regular, occurring at night and reversible with removal of the drilling installation. Change in food availability would occur while the drilling installation was on site and therefore is of medium duration. The drilling installation footprint would occupy a very small area within the entire 4,900 km² Project Area, even if the drilling installation and FPSO were present at the same time. While there may be a change in food availability associated with the light emissions from the drilling installation, the change represents a small percentage of the overall food availability within the Project Area and is considered negligible relative to baseline conditions. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability associated with the presence of the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with light emissions from the drilling installation, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km², of medium-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) with light emissions from the drilling installation.

As noted in Section 9.3.3.2, fish, such as capelin, redfish, and Atlantic cod may be attracted to the area around the drilling installation due to light emissions. Conversely, as noted above, certain prey species (i.e., lanternfish) may avoid the lighted area to hide from predators. The behavioural effects associated with light emissions from the drilling installation would be adverse, as described in Section 9.3.3.2, and medium-term. The geographic extent of the change in behaviour would be within approximately 7 km² of the drilling installation at its well template location in the Project Area. The change in fish behaviour would be regular and reversible upon removal of the drilling installation. As the change in behaviour is localized to the drilling installation, which occupies a very small footprint in the 470 km² of the Core BdN Development Area (including if more than one installation were onsite at the same time), and does not affect fish behaviour in the larger Core BdN Development Area, there is no change in fish behaviour relative to baseline conditions and is therefore negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in fish behaviour associated with light emissions from the drilling installation not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)associated with light emissions from the drilling installation, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km², of medium-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the light emissions from drilling installations are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the light emissions from the drilling installation in consideration of residual effects predictions.

9.4.3.2 Underwater Sound Emissions from the Drilling Installation

As noted in Section 9.3.3.3, the primary effects on Marine Fish and Fish Habitat associated with underwater sound emissions during Drilling Activities are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury, and/or Health
- Change in Food Availability and/or Quality

Underwater sound emissions from the drilling installation at potential well template locations in the Project Area would have the same effects on Fish and Fish Habitat as underwater sound emissions assessed for the Core BdN Development (Section 9.3.3.3). Fish species in the Project area likely to be affected by underwater sound emissions are capelin, Atlantic cod, lanternfish, and redfish, with some similar species noted in Section 9.3.3.3 for drilling in the Core BdN Development Area.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with the underwater sound emissions during Drilling Activities.

As noted and assessed in Section 9.3.3.3, fish may respond with avoidance or attraction responses to underwater sound emissions. Changes to the spatial distribution of fish from underwater sound would likely be temporary as the fishes in the water column (e.g., Atlantic cod, capelin, redfish, tuna in shallow waters and lanternfish in deeper waters), common in the Project Area, are typically highly mobile and would likely return after cessation of the activity or removal of the sound source. The change in fish behaviour associated with underwater sound emissions from the drilling installation would be adverse, as described in Section 9.3.3.3 and medium-term. The extent of the change in fish behaviour would likely be less than 1 km² of the location of the drilling installation for both shallow and deeper water depths in the Project Area. The change in fish behaviour would be continuous while the drilling installation was on-site, and reversible once the drilling installation leaves the area. Underwater sound emissions zone of influence presents a very small footprint in the 4,900 km² Project Area (including if the FPSO were present at the same time). While underwater sound emissions may affect the presence and/or abundance of fish within the localized (less than 1 km²) area of the drilling installation, their abundance and or presence is not affected within the entire Core BdN Development Area, there is no change in abundance and/or presence relative to baseline conditions and is therefore considered negligible. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for discharge / emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in fish behaviour are not proposed

The residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural effects) associated with underwater sound emissions during Drilling Activities, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of medium-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality, Injury and/or Health is a potential effect associated with underwater sound emissions from Drilling Activities.

As noted in Section 9.3.3.3, the primary effects from underwater sound are injury to fish hearing ability. Based on sound modelling, injury effects are likely to occur within close proximity to the drilling installation (less than 1 km²). However, given the transient nature of fish and the demonstrated avoidance behaviours of fish in response to sound (see Section 9.2.5.1) it is unlikely that fish would remain in the immediate area long enough (i.e., 12-hour and 48-hour periods indicated by Popper et al. (2014)) for potential effects of exposure to continuous sound. Therefore, the change in fish injury is neutral and negligible in magnitude. The change would be medium-term while the drilling installation is onsite and reversible once the drilling installation leaves its location. The geographic extent of the change in fish injury would be less than 1 km² of the location of the drilling installation at its well template location within the Project Area. The potential change in injury would be sporadic if it occurred but unlikely considering the behavioural effects may cause them to move away. Underwater sound emissions zone of influence represents a very small footprint in the 4,900 km² Project Area (including if another installation were present at the same time). With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for discharge / emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in injury from underwater sound associated with the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with underwater sound emissions during Drilling Activities, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of medium-term duration, unlikely to occur to occurring sporadically , and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with is a potential effect associated with underwater sound emissions from Drilling Activities.

As indicated in above and in Section 9.3.3.3, fish may respond with avoidance or attraction responses to underwater sounds. Therefore, the displacement of fish may shift the spatial distribution of prey species, such as capelin in shallow waters and lanternfish in deep waters in the Project Area and affect food availability. Changes to the spatial distribution of fish from underwater sound emissions would likely be temporary as the prey species are typically highly mobile and would likely return after cessation of the activity or removal of the sound source.

The change in food availability and/or quality associated with underwater sound emissions from the drilling installation would be adverse, as described in Section 9.3.3.3 and medium-term. As noted above, the geographic extent of the change in food availability would be less than 1 km² of the location of the drilling installation at its well template location within the Project Area. The change in food availability would be continuous while the drilling installation was on-site, and reversible once the drilling installation leaves the area. Underwater sound emissions zone of influence represents a very small footprint in the 4,900 km² Project Area (including if another installation were present at the same time). While underwater sound emissions may affect food availability within a localized area of the drilling installation, the overall food availability in the Project Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on modelling predictions, scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability and/or quality associated with underwater sound emissions are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from the sound from the drilling installation during Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of medium-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with the sound emissions from Drilling Activities are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Fish and Fish Habitat associated with the sound emissions from the Drilling Activities in consideration of the residual effects predictions.

9.4.3.3 Waste Discharges during Drilling: Drill Cuttings

As noted and assessed in Section 9.3.3.4, the primary effects on Marine Fish and Fish Habitat associated with waste discharges from the drilling installation are:

- Change in Habitat Availability and/or Quality
- Change in Food Availability and/or Quality

- Change in Fish and Invertebrate Mortality, Injury, Health
- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)

Section 9.3.3.4 provides a detailed discussion of the potential effects on fish and fish habitat, including corals and sponges, associated with the discharge of water-based muds, WBM cuttings and SBM cuttings, associated sedimentation effects from cuttings discharge, including recovery and recolonization based on scientific literature and environmental effects monitoring programs.

As noted in Section 9.3.3.4, corals and sponges are sensitive to the discharge of cuttings and associated suspended particles in the water column. Exposure studies have not been specifically conducted regarding whole WBMs on corals and sponge species in the Flemish Pass. However, the potential effects can be inferred from coral and sponge studies on sedimentation exposure, drill cuttings exposure, injury and regeneration, and coral and sponge ecology. As described in the EIS, corals and sponges have ecological characteristics (sessile, suspension feeding and slow growing) that indicate they are sensitive to suspended drill cuttings and mud particles and burial in the marine environment (Raimondi et al. 1997; Larsson and Purser 2011; Allers et al. 2013; Bell et al. 2015; Purser 2015; Järnegren et al. 2016; Ragnarsson et al. 2017; Larsson et al. 2013; Liefmann et al. 2018; Vad et al. 2018, Buhl-Mortensen et al. 2015; Baussant et al. 2018). However, coral and sponge species that occur in areas with fine sediments similar to the Project area are naturally exposed to episodic pulses of suspended particles. Therefore, they likely have mechanisms for tolerating exposure to suspended particles (e.g., Allers et al. 2013; Bell et al. 2015) even if the specific mechanisms for tolerance for all species is not well understood. Based on coral and sponge data presented in Section 6.1.6.5, primarily soft corals in slope areas and soft corals and sea pens in deeper waters are the most likely species to be found in the Project Area. Sponges are typically in slope and deep water areas of the Project Area.

Drill modelling from Statoil drilling EIS indicate that the furthest extent of drill cuttings above 1.5 mm PNET is within 2 km from the release site, indicating a geographic extent of approximately 13 km². Drilling in deep water areas of the Project Area would likely be lower with the furthest extent for median cuttings above 1.5 mm PNET is within 200 m from the release site.

Using similar assumptions provided in Section 9.3.3.4 regarding the potential seabed zone of influence from drill cuttings discharges, should Project Area Tiebacks occur, the following zones of influence in the Project Area are estimated. For wells drilled in deeper waters, similar to the Core BdN Development Area (approximately 1,100 m water depth), the conservative estimated zone of influence would be the same as presented in Section 9.3.3.4, approximately 0.5 km² of seabed per well template location. For wells drilled in shallower waters of the Project area, using the estimated zone of influence from drill cuttings model, which predicts cuttings discharge within 2 km from the well location, assuming a cuttings transport system is used, the total seabed area per well template that could be affected by drilling in shallower waters is approximately 13 km². This is a conservative estimate and assumes the entire radius surrounding the well template location will be affected, whereas modelling indicates that drill cuttings will likely be deposited in a certain direction from the well template (i.e., southwest, north, etc.). Assuming, conservatively, there are three tiebacks in shallower waters and two in deeper waters, the total seabed area potentially affected by drilling in the Project Area is estimated to be 40 km², or less than 1 percent of the 4,900 km² Project Area. Cumulatively, a conservative estimate of the potential seabed area affected by drilling for the Core

BdN Development (2.5 km² estimate; see Section 9.3.3.4) and from Project Area Tiebacks (40 km²; see above) would be 42.5 km², or less than 1 percent of the Project Area. Based on these zones of influence and drill cuttings modelling, should drilling be carried out at any location within the Project Area, cuttings deposition would likely remain within the boundaries of the Project Area and there is little or no potential for these environmental releases from individual wells or multiple wells to interact or accumulate beyond the Project Area.

SBM associated drill cuttings will be treated using best treatment practices that are commercially available and economically feasible, in accordance with the OWTG prior to discharge. Furthermore, as noted above and described in Section 2.7.5, chemicals that may be discharged to the marine environment – including those used in drilling fluids and well clean-up – will be screened and selected in consideration of the OCSG (NEB et al. 2009) and Equinor Canada's chemical selection and screening processes.

Change in Habitat Availability and/or Quality is a potential effect associated with the discharge of drill cuttings during Drilling Activities.

In shallower waters of the Project Area, as noted above, the potential area affected by drill cuttings discharge is approximately 2 km from well template locations, and 200 m from well template locations in deeper waters. The zone of influence per template is therefore predicted to be 13 km² (shallow water) and 0.5 km² (deeper water) or less than 1 percent of the Project Area, including the Core BdN Development Area and if all tiebacks were undertaken.

As discussed in Section 9.3.3.4, the discharge of WBM- and SBM-associated cuttings would result in a change in water quality (cuttings particles in the water column, suspended particles) and seabed characteristics (cuttings deposition, potential seabed disturbance and burial, smothering habitat) from discharge of drill cuttings. These change in habitat availability and/or quality associated with drill cuttings discharges would be adverse, as described above. Based on recovery rate estimates noted above, recovery in shallower waters occurred between 3 and 10 years and in deeper water it predicted that it would likely occur over a longer timeframe. Therefore, it is estimated that the effects on the change in habitat from drill cuttings would be short-to medium term in shallower waters and medium- to long-term in deeper waters, but reversible, once recovery occurs. The change in habitat would be continuous while drilling was ongoing, and reversible with eventual recovery and recolonization. The drill cuttings footprint would occupy a very small area (~40 km² assuming five tiebacks; 42.5 km² include Core BdN Development Area) within the entire 4,900 km² Project Area. Drill cutting deposition will likely interact with corals and sponges, including soft corals, sea pens, glass sponges, and demosponges (Section 6.1.7.6) within the zones of influence of drill cuttings deposition on the sea floor for deep and shallow waters. However, given that the cumulative zones of influence of drilling discharges represent approximately less than 1 percent of available fish habitat in the Project Area, there will likely not be an overall effect on fish habitat in the Project Area. The change in habitat is considered to be within the range of natural variability, without affecting viability of fish habitat, therefore the magnitude of change in habitat would be low. With the exception of geographic extent and timeframe for recovery, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on drill cuttings modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of drill cuttings deposition predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, a moderate level of confidence for recovery timeframe.

Mitigations to reduce the changes in habitat include adhering to C-NLOPB guidance regarding the avoidance of *Lophelia pertusa* and/or assemblages of 5 or more corals in 100 m² with heights greater than 30 cm within 100 m of the drill cutting discharge location. SBM cuttings will be treated with the use of best treatment practices that are commercially available and economically feasible and discharged in adherence to minimum discharge limits in the OWTG. For chemicals that may be discharged, per Equinor's chemical management system, and in accordance with the OCSG (NEB et al. 2009), the chemical selection and management process enables the selection of chemicals that, once discharged at sea, would have the least effect on the receiving environment.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with the discharge of drill cuttings during Drilling Activities, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent per template approximately 13 km² for shallow waters, or 0.5 km² for deeper waters (or less than 100 km² and less than 1 km², respectively), of short- to medium-term duration in shallow waters and to medium- to long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Fish and Invertebrate Mortality, Injury and/or Health is a potential effect associated with the discharge of drill cuttings during Drilling Activities.

Based on cuttings modelling results discussed above, the potential area affected by drill cuttings discharge is approximately 2 km from well template locations in shallow waters and 200 m in deeper waters. The zone of influence per template is therefore predicted to be 13 km² (shallow water) and 0.5 km² (deeper water) or approximately less than percent of the Project Area.

As discussed in detail in Section 9.3.3.4, the discharge of drill cuttings can cause burial and/or smothering of benthic invertebrates and corals and sponges. The interaction with suspended particles in the water may result in physical damage, especially in suspension feeding organisms such as corals and sponges (IOGP 2016), including soft corals, sea pens, solid/massive sponges in the Project Area. Chemicals associated with the drill cutting may chemical toxicity and result in the bioaccumulation (uptake of contaminants by fish and/or the presence or perception of taint). Corals and sponges, such as *Duva florida*, *Primnoa* sp., sea pens, and *Geodia* sp. in the Project Area, may be resistant to short-term exposure to suspended drill cutting particles with potential effects on adults related to chronic exposure or high suspended sediment and burial. Suspended solids in the upper water column from SBM cuttings discharge near surface would be limited to disturbance effects in the mobile pelagic species, such as plankton, capelin, and lanternfish, and is not predicted to result in changes to fish injury or mortality for these species.

As described in Section 9.3.3.3, the primary interactions that may result in changes to fish mortality, injury and/or health are associated with the burial, smothering and creation of anoxic environments from the deposition of drill cuttings. Based on drill cuttings modelling, discharged volumes of drill cuttings that can cause smothering and burial effects will be localized to within 200 m the well template locations in deeper waters and 2 km in shallower waters. Recovery, as noted above is between three and 10 years in shallower waters and likely longer in deeper waters.

The change in fish mortality / injury / health associated with the discharge of drill cuttings at well template locations in the Project Area would be adverse, as described above and short- to medium -term duration for shallow waters and medium- to long-term duration for deeper waters. The change in mortality / injury / health would be continuous, during drilling and reversible, with eventual recovery and recolonization. The geographic extent of the change mortality / injury / health would be within 13 km² of each shallow water template and 0.5 km² for deep water templates, or less than 1 percent for the Project Area. The cumulative zone of influence represents approximately one percent of the 4,900 km² area available in the Core BdN Development Area, therefore the change in mortality / injury / health would be considered within the range of natural variability without affecting the viability of local populations and is therefore low. With the exception of geographic extent and timeframe for recovery, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on drill cuttings modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of drill cuttings deposition predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, a moderate level of confidence for the recovery timeframe.

Mitigations to reduce the change mortality / injury / health are the same as those described above in the discussion on change in in food habitat and/or quality.

The residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with the discharge of drill cuttings should Project Area Tiebacks be undertaken are predicted to be adverse, low in magnitude, with a geographic extent per template approximately 13 km² for shallow waters, or 0.5 km² for deeper waters (or less than 100 km² and less than 1 km², respectively), of short- to medium term duration in shallow waters and medium- to long-term duration in deeper waters, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with the discharge of drill cuttings during Drilling Activities.

Based on cuttings modelling results discussed above, the potential area affected by drill cuttings discharge is approximately 2 km from well template locations in shallow waters and 200 m in deeper waters. The zone of influence per template is therefore predicted to be 13 km² (shallow water) and 0.5 km² (deeper water) or approximately less than 1 percent of the Project Area.

As noted in Section 9.3.3.4, the discharge of cuttings may result in prey species avoiding the area such as sea anemones and a loss or reduction of prey species (e.g., bivalves, polychaetes) associated with changes in fish habitat characteristics. The discharge of drill cuttings into the water is predicted to result in localized and temporary suspended sediments and turbidity (Smit et al. 2008), however due to the low toxicity of drill cuttings and rapid dilution and dispersion, the risk to pelagic organisms including plankton, lanternfish, and capelin is considered low (IOGP 2016). The initial deposition of drill cuttings may also result in smothering of prey species. As noted above, recovery of the benthic community may be longer than a three- to 10-year timeframe in observed in shallower waters. The estimated area affected by drill cuttings is approximately 42.5 km² or less than1 percent of the of the Project Area, including areas within the Core BdN Development Area.

The change in food availability and/or quality at well template locations associated with the discharge of drill cuttings would be adverse, as described above and short- to medium- term duration for shallow water areas and medium- to long-term in duration for deeper waters. The geographic extent of the change in food availability would be less than 1 km² of the location of the well template in deeper waters within the Project Area, or approximately 13 km² in shallower waters. The change in food availability would be continuous during drilling and reversible, with eventual recovery and recolonization. The drill cuttings footprint would occupy a very small area (less than 1 percent of the entire 4,900 km² Project Area. The small change in food availability (represented by less than 1 percent of the Project Area) relative to food availability in the 4,900 km² Project Area is considered negligible relative to baseline conditions. With the exception of geographic extent and timeframe for recovery, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on drill cuttings modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of drill cuttings deposition predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. As noted above, there is some uncertainty associated with the timeframe for recolonization of benthic habitats in deep water and, therefore, a moderate level of confidence for the recovery timeframe. Mitigations to reduce changes in food availability are the same as those listed above to reduce changes in habitat availability noted above.

The residual environmental effects of a Change in Food Availability and/or Quality associated with the discharge of drill cuttings should Project Area Tiebacks be undertaken are predicted to be adverse, negligible in magnitude, with a geographic extent per template approximately 13 km² for shallow waters, or 0.5 km² for deeper waters (or less than 100 km² and less than 1 km², respectively), of short- to medium term duration in shallow waters and medium- to long-term duration in deeper waters, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with drill cuttings discharge include adherence to C-NLOPB requirements for the avoidance of *Lophelia pertusa* complexes and/or coral colonies of 5 or more corals in 100 m² area with heights greater than 30 cm within 100 m of the discharge location (B); treatment and discharge of all discharges in accordance with the OWTG (E); selection and screening of chemicals in accordance with the OCSG and Equinor Canada's chemical selection and management processes (F).

Follow-up Monitoring: In consideration of the residual effects predictions based on drill cuttings dispersion modelling results, follow-up monitoring will include a component to validate the drill cutting model with respect to the zone of influence for cuttings dispersion. Section 9.7 for additional information.

9.4.4 Supply and Servicing

The addition of subsea tiebacks may extend the life of the Project (12 to 20 years) to 30 years. Supply and servicing operations, as described in Section 2.6.4 and as assessed for the Core BdN Development in Section 9.3.4 would be the same should Project Area Tiebacks be undertaken but would be carried out for an additional 10 to 18 years. The vessel and aircraft traffic route to the Project Area would be same as for Core BdN Development. Vessel traffic in the Project Area would be the same as vessel traffic in the Core BdN Development Area. Depending on the distance between the drilling installation in the Project Area and the FPSO at its fixed location, a second SBV may be required, which would be short-term while the drilling installation was on location. The zone of influence (light and sound emissions and marine discharges) from a single SBV would be approximately 1 km², as discussed in Section 9.3.4, and 2 km² if two SBVs were present. The 2 km² represents a very small percentage (less than 0.05 percent) of the entire 4,900 km² Project Area.

As indicated in Table 9.6, only vessel presence will directly interact with Marine Fish and Fish Habitat as a result of the associated light and sound emissions and marine discharges while the vessel is in transit within the vessel traffic route, or at location within the Project Area. All other effects characterizations would be the same as assessed for the Core BdN Development. Effects assessment for interactions associated with Supply and Servicing would not change should Project Area Tiebacks be undertaken. The effects assessment for these interactions are provided in Section 9.3.4. Mitigation measures, as applicable, employed for the Core BdN Development would continue for Project Area Tiebacks.

9.4.5 Supporting Surveys

As with the Core BdN Development, supporting surveys, including geophysical activities, environmental, geotechnical, geological and ROV / AUV surveys may be required should Project Area Tiebacks be undertaken. Should supporting surveys be required, the interactions associated with light emissions and underwater sound emissions from vessels would be the same for the Project Area as discussed for Core BdN Development and are not repeated here. Refer to Section 9.3.5.1 and 9.3.5.2 for these effects assessment.

Should 4D seismic surveys be required to assess changes in reservoir properties from potential new reservoirs being exploited at the tieback locations, it is anticipated that the type and frequency of surveys would be the same as described in Section 9.3.5. While the locations of these surveys would be within the broader Project Area, in which water depths range from over 300 m to 1,200 m, the interaction with marine fish and fish habitat would be the same as discussed and assessed in Section 9.3.5.4.

With regards to sound from equipment used in geophysical surveys, the effects assessment is presented below and considers the modelled sound attenuation in shallow waters (Appendix D). In the event that 4D seismic surveys are required at the tieback locations, it is likely that all locations would be surveyed within the same survey season. The overall duration of seismic activity may be longer to include multiple locations, the time at each location would likely be within the two- to four-week timeframe noted in Section 2.6.5.

9.4.5.1 Underwater Sound Emissions from Geophysical Equipment

As noted and assessed in Section 9.3.5.4, the primary effects on Marine Fish and Fish Habitat associated with underwater sound emissions from geophysical equipment used in Supporting Surveys are:

- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury and/or Health
- Change in Food Availability and/or Quality

The primary mitigations to be implemented during geophysical surveys, which are intended to reduce effects on Marine Fish and Fish Habitat are the mitigations outlined in the SOCP (DFO 2007). Per the SOCP (DFO 2007) a seismic survey must be planned to avoid 'dispersing aggregations of spawning fish from a known spawning area', and 'diverting aggregations of fish from known migration routes or corridors if it is known there are no alternate migration routes or corridors, or that if by using those alternate migration routes or corridors, the aggregations of fish would incur adverse effects'. Other mitigations listed in the SOCP (DFO 2007) include ramp-up of the sound source over time, use of seismic sources with either a minimized energy output or proven minimized environmental impact (e.g., with changed frequency distribution) when technically feasible, and temporal and spatial avoidance of marine fish.

Section 9.3.5.4 provided a detailed discussion of the effects of underwater sound from geophysical equipment on fish, including air source arrays, MBES and side scan sonar. The interactions and effects would be the same for fish species in the broader Project Area. As these fish species are also found in the Core BdN Development Area. As noted in Section 9.3.5.4, there appears to be scientific consensus that behavioural effects of exposure to sound on Marine Fish and Fish Habitat is of higher concern than potential physical effects. Therefore, since behavioural effects associated with 2D/3D/4D surveys were predicted to be greater than with MBES / side scan sonar surveys, as indicated in Section 9.3.5.4, the focus of the assessment for Project Area Tiebacks is on geophysical surveys using air source arrays.

Sound modelling was conducted at a shallow water location in the Project Area and a deep-water location in the Core BdN Development Area, as summarized in Section 9.3.5.4.

Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects) is a potential effect associated with underwater sound emissions from geophysical equipment used in Supporting Surveys.

As described in Section 9.3.5.4, fish with swim bladders, such as Atlantic cod, capelin, redfish, and lanternfish in the Project Area may respond with avoidance responses to underwater geophysical sounds, therefore, this displacement may shift the spatial distribution of fish in the area of the geophysical activity. Changes to the spatial distribution of fish from underwater sound would be temporary as described above and fish would likely return after cessation of the activity.

The change in fish behaviour due to underwater sound emissions during geophysical surveys would be adverse, as described in Section 9.3.5.4 and short-term. Based on sound modelling, assuming the furthest potential behavioural effects may extend out to 50 km in shallow or deep waters, the geographic extent of the behavioural effects would be between 1,000 km² and 10,000 km² of the location of underwater sound source within the Project Area. The change in fish behaviour would be sporadic during geophysical activities, and reversible with cessation of the activity. The temporary change in behaviour is considered within the range of natural variability for the without affecting the overall viability of affected fish species. Therefore, the magnitude of the change in fish behaviour would be low. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations, as noted above and listed in the SOCP (DFO 2007), should reduce overall effects on fish behaviour.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Presence and/or Abundance (Behavioural effects) associated with underwater sound emissions from geophysical activities should Project Area Tiebacks be undertaken are predicted to be adverse, low in magnitude, with a geographic extent less than 10,000 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Fish and Invertebrate Mortality, Injury, Health is a potential effect associated with underwater sound emissions from geophysical equipment used in Supporting Surveys

The potential physical effects of exposure to underwater sound on fishes and invertebrates can be categorized as physiological, non-lethal injury and lethal injury. Section 9.3.5.4 discusses each of these effects and would be the same should geophysical surveys be undertaken in the Project Area.

Changes in fish mortality, injury and/or health due to underwater sound emissions from geophysical sound sources would be adverse, as described in Section 9.3.5.4, and short-term. Based on sound modelling for S2 (shallow water) and S1 (deep water), the geographic extent of the change in fish injury/mortality and/or health would be within 50 m of the vessel based on minimum peak for mortality and potential injury of 207 dB re 1 μPa $_{(0\text{-}p)}$ for fishes with swim bladders (e.g., Atlantic cod, redfish, capelin). Therefore, the geographic extent would be less than 1 km² of the location of the underwater sound source within the Project Area. As described above, fish would have to remain in the area of underwater sound emissions for extended periods of time for injury/mortality effects to occur. The change in fish mortality / injury and/or health would unlikely to be sporadically occurring during geophysical activities, and reversible with cessation of the activity. The change in fish mortality / injury would be considered within the range of natural variability but would not affect the overall viability of affected fish species, therefore, the magnitude of the change in fish mortality / injury would be low. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/ emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations, as noted above and listed in the SOCP (DFO 2007), should reduce overall changes to fish mortality / injury / health.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Fish and Invertebrate Mortality, Injury and/or Health associated with underwater sound emissions from geophysical surveys, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km² of short-term duration, not likely to occur to occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Food Availability and/or Quality is a potential effect associated with underwater sound emissions from geophysical equipment used in Supporting Surveys.

As noted above, the displacement of fish may shift the spatial distribution of prey species and have effects on food availability. Changes to the spatial distribution of fish such as lanternfish and capelin from underwater sound emissions would be temporary as described above and would likely return after cessation of the activity or removal of the sound source. The change in food availability and/or quality due to underwater sound emissions from geophysical surveys would be adverse, as described above and short-term. Based on sound modelling, the geographic extent of behavioural effects would be between 1,000 km² and 10,000 km² of the location of the vessel within the Project Area for seismic activities. As indicated above, the change in behavioural effects are predicted to be a low magnitude, therefore the predicted change in food availability, which would be affected by behavioural changes, would be the same. The change in food availability would be sporadic during geophysical activities, and reversible with cessation of the activity. As the effect is short-term and sporadic, and food for predator species is available within the Core BdN Development Area, the change in food availability would be considered within the range of natural variability without affecting its overall availability and therefore of low magnitude. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations, as noted above and listed in the SOCP (DFO 2007), should reduce overall changes to food availability.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality associated with underwater sound emissions from geophysical surveys, should Project Area Tiebacks be undertaken are predicted to be adverse, low in magnitude, with a geographic extent less than 10,000 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

9.4.6 Decommissioning

At end of field-life, which will either be at the end of the Core BdN Development or at the end of Project life, should Project Area Tiebacks be undertaken, the Project will be decommissioned in accordance with regulatory requirements in place at the time of decommissioning. Section 9.3.6 provides an effects assessment of decommissioning activities on Marine Fish and Fish Habitat. The timeframe for decommissioning, whether at the end of the Core BdN Development or at the end of Project life is anticipated to be the same.

Species that may potentially be affected by decommissioning of subsea infrastructure and wells would be benthic communities associated with hard substrates along the shelf slope and deep waters of the Flemish Pass including soft corals, sponges, and sea anemones.

9.4.6.1 Decommissioning of Subsea Infrastructure

The primary effects on Marine Fish and Fish Habitat, associated with the decommissioning of the subsea infrastructure are:

- Change in Habitat Availability and/or Quality
- Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)
- Change in Fish and Invertebrate Mortality, Injury and/or Health
- Change in Food Availability and/or Quality

The residual environmental effects of a **Change in Habitat Availability and/or Quality** associated with decommissioning of subsea infrastructure should Project Area Tiebacks occur is predicted to be neutral, as conditions would be reversed to baseline as described above, negligible in magnitude, with a geographic extent between 10 km² and 100 km² (i.e., approximately 22 km²), of long-term duration, and occurring once. These predictions are made with a moderate to high level of confidence.

The residual environmental effects of a **Change in Fish and Invertebrate Mortality, Injury and/or Health** associated with decommissioning of subsea infrastructure is predicted to be neutral as described above, negligible in magnitude with a return to baseline conditions, with a localized effect to the infrastructure, therefore a geographic extent between 10 km² and 100 km² (i.e., approximately 22 km²), permanent, and occurring once. These predictions are made with a moderate to high level of confidence.

The residual environmental effects of a **Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)** associated with decommissioning of subsea infrastructure is predicted to be neutral as described above, negligible in magnitude, with a geographic extent between 10 km² and 100 km² (i.e., approximately 22 km²), of long-term duration, and occurring once. These predictions are made with a moderate to high level of confidence.

The residual environmental effects of a **Change in Food Availability and/or Quality** associated with decommissioning of subsea infrastructure is predicted to be neutral as described above, negligible in magnitude with a return to baseline conditions, with a geographic extent between 10 km² and 100 km² (i.e., approximately 22 km²), of long-term duration, and occurring once. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with decommissioning of subsea infrastructure include submission of a decommissioning plan to the C-NLOPB (N).

Follow-up Monitoring for the effects on Marine Fish and Fish Habitat associated with decommissioning of subsea infrastructure is not proposed.

9.4.6.2 Well Decommissioning

The primary effects on Marine Fish and Fish Habitat associated with well decommissioning are:

- Change in Habitat Availability and/or Quality

The residual environmental effects of a **Change in Habitat Availability and/or Quality** associated with well decommissioning is predicted to be adverse as described above, negligible in magnitude, with a geographic extent less than 1 km², of long-term duration, and occurring once. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

Mitigations to reduce potential effects to Marine Fish and Fish Habitat associated with well decommissioning include not using explosives (O); submission of a decommissioning plan to the C-NLOPB (N); inspection of the decommissioned well in accordance with regulatory requirements (P).

Follow-up Monitoring for the effects on Marine Fish and Fish Habitat associated with well decommissioning is not proposed.

9.5 Species at Risk: Overview of Potential Effects and Mitigation Measures

A total of 23 fish species that are known or likely to occur within the RSA have been designated as SAR and have associated protections under provincial or national legislation (SARA, NL ESA), or have otherwise been identified as being of special conservation concern by COSEWIC or under other processes. These include several wolffish species, Atlantic cod, cusk, American eel, Atlantic salmon, American plaice, Bluefin tuna, and a number of species of grenadier, redfish, sharks, and skates. As with secure fish species, SAR may interact with Project activities based on occupation of various habitats at different life history stages (see Table 9.15). However, as detailed above in Section 9.3, many of the offshore activities and associated disturbances that will occur as a result of this Project will be either relatively localized at a specific location or transient, though of a long-term nature.

Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these SAR is provided in Table 9.16. Further species information is presented based on SAR designation, species of cultural or other significance to Indigenous groups, range overlap with the Project Area, or a combination of these reasons as was discussed in Section 6.1.9. Only five species are listed under NL ESA or SARA legislation including the white shark (SARA:

Endangered), northern (broadhead) wolffish (SARA*:* Threatened), spotted wolffish (SARA: Threatened) and striped (Atlantic) wolffish (SARA: Special Concern) and American eel (NL ESA: Vulnerable). Striped, northern and spotted wolffish also have ranges that overlap with the Project Area. American eel and Atlantic salmon were further described as they are species of social, cultural and traditional importance. Eleven other species have ranges distributions that may potentially overlap with the Project Area or adjacent areas including Atlantic cod, white hake, thorny skate, grenadier species, redfish species, shark species, and Atlantic bluefin tuna based on COSEWIC Assessment and Status reports. However, species range extents within the Project Area may not necessarily be areas of high utilization. Project interaction and environmental effects for these species are discussed below.

Table 9.15 Marine Fish Species at Risk: Potential Interactions with Project Components by Life History Stage

Eggs	Larvae	Juveniles / Adults	Project Component Potential Interaction
Marine – Demersal Species			
Northern wolffish Spotted wolffish Striped wolffish Thorny skate	Thorny skate	Acadian redfish Atlantic cod Deepwater redfish Northern wolffish Roughhead grenadier Roundnose grenadier Spotted wolffish Striped wolffish Thorny skate White hake	Offshore Construction and Installation and HUC Production and Maintenance Operations Drilling Activities Decommissioning
Marine – Pelagic Species			
Atlantic cod Roughhead grenadier Roundnose grenadier White hake	Acadian redfish American eel Atlantic cod Deepwater redfish Northern wolffish Roughhead grenadier Roundnose grenadier Spotted wolffish Striped wolffish White hake	Acadian redfish American eel Atlantic bluefin tuna Atlantic salmon Basking shark Deepwater redfish Porbeagle Shortfin mako White shark	Offshore Construction and Installation and HUC Production and Maintenance Operations Drilling Activities Supply and Servicing Supporting Surveys Decommissioning

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Striped (Atlantic) wolffish	Special Concern	Special Concern	• Long lived and slow growing species that mainly inhabit bottom habitats • Common between 150 m to 350 m depths • Year-round presence in the Project Area. Average migrations <8 km to several hundreds of kilometres • Spawns September and October. May undergo seasonal spawning migrations; Egg clusters laid on the bottom and are guarded by adults. Pelagic larvae • Abundant (approximately 1 to 6 individuals per Canadian RV tow) in Flemish Pass and on continental slopes in Project Area • Potential life stage interactions include eggs (demersal), larvae (pelagic), and juveniles/adults (demersal) • No critical habitat established for this species • Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Northern (broadhead) wolffish	Threatened	Threatened	• Long lived and slow growing species that mainly inhabit bottom habitats • Common between >500 m to 1,000 m depths • Year-round presence in the Project Area. Aggregated in Flemish Pass and northeast slopes. Areas of high abundance (approximately 3 to 6 individual per Canadian RV tow) in Project Area • Average migrations <8 km to 800 km • Spawns September through November. Pelagic larvae and relatively pelagic adults • Potential life stage interactions include eggs (demersal), larvae (pelagic), and juveniles/adults (demersal) • Critical habitat established along northern shelf and slopes of NL and Labrador Shelf • Limited potential for interaction (mobile species, Project mitigation measures, and critical habitats on continental slopes is outside Core BdN and Project Tieback Areas)

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Spotted wolffish	Threatened	Threatened	• Long lived and slow growing species that mainly inhabit soft bottom habitats • Common between 200 m to 750 m depths • Year-round presence in the Project Area. Common on Flemish Cap, eastern Grand Banks, and NL Shelf. Areas of low abundance (1 to 2 individuals per Canadian RV tow) in Project Area • Spawning aggregations on the Northeast Shelf and Slope EBSA in the spring. Spawns from June, July, and August. Egg clusters laid on the bottom and are guarded by adults. Pelagic larvae • Potential life stage interactions include eggs (demersal), larvae (pelagic), and juveniles/adults (demersal) • Critical habitat along northern shelf and slopes of NL and Labrador Shelf • Limited potential for interaction (mobile species, Project mitigation measures, and critical habitat is outside Core BdN and Project Tieback Areas)
American eel	-	Threatened	• Designated as Vulnerable under NL ESA • Catadromous species. Adults undergo oceanic spawning migrations in the fall along the continental shelf to spawning areas in the Sargasso Sea • Seasonal/Intermittent presence in Project Area. Adults / larvae may pass through Project Area or interact with vessels during migrations to or from spawning areas • Larvae drift along the Gulf Stream to coastal areas before migrating into freshwater. Larvae and juveniles are concentrated in the water column in the upper 140 m at night and 350 m during the day • Potential life stage interactions include larvae (pelagic) and juveniles/adults (pelagic) • No critical habitat established for this species • Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Atlantic cod (Newfoundland and Labrador population)	-	Endangered	• Adult cod occupy a diverse range of habitats with no particular depth or bottom substrate preferences • Mainly observed at depths <500 m offshore • Year-round presence in the Project Area; localized area of low abundance (approximately <59 individuals per Canadian RV tow) in Project Area Distributed on the northeast and southeast tips of the Grand Bank and on the Flemish Cap • Broadcast spawner. Eggs in the water column from April to November. Pelagic larvae • May pass through Project Area during seasonal migrations • No critical habitat established for this species • Potential life stage interactions include eggs (pelagic), larvae (pelagic), and juveniles/adults (demersal) • Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
White hake	-	Threatened	• White hake are mainly distributed in areas of fine mud substrates from 50 m to 360 m. • Year-round presence in the Project Area with Localized area of low abundance (approximately <9 individuals per Canadian RV tow) in the Project Area. Distributed on the northeast shelf and slope of the Grand Banks. • Broadcast spawner. Spawning estimated to occur between spring and summer. Pelagic eggs and larvae. • Potential life stage interactions include eggs (pelagic), larvae (pelagic), and juveniles/adults (demersal) • No critical habitat established for this species • Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Thorny skate	-	Special Concern	• Slow-growing species that occupies depths of 18 m to 1,400 m and inhabits a broad range of substrates including sand, shell, gravel and mud • Year-round presence in the Project Area. Undergoes limited seasonal migrations (approximately 100 km) • Areas of low abundance (approximately <16 individuals per Canadian RV tow) in Project Area. Widespread species on Grand Banks in shelf and slope areas • Skates lay egg capsules on the seafloor year-round and all life stages occupy demersal habitats • No critical habitat established for this species • Potential life stage interactions include eggs (demersal), larvae (demersal), and juveniles/adults (demersal) • Limited potential for interaction (Project mitigation measures, no critical habitat)
Roughhead grenadier	-	Special Concern	• Roughhead grenadiers are long lived and slow growing benthopelagic species. These characteristics indicate this species may have lesser potential for recovery in response to adverse effects • Captured at depths between 200 m and 2,000 m and mainly observed between 400 m to 1,200 m • Year-round presence in Project Area. Limited dispersal and movements. Areas of moderate abundance (approximately up to 152 individuals per Canadian RV tow) in Project Area • Mainly distributed on northeast and eastern slopes of the Grand Banks. Spawning grounds suggested to lie on the southern and southeastern slopes of the Grand Bank • Spawning occurs in winter and early spring. Pelagic eggs • Potential life stage interactions include eggs (pelagic), larvae (pelagic), and juveniles/adults (demersal) • Potential for long-term adverse effects with large-scale accidental events • No critical habitat established for this species • Limited potential for interaction (mobile species, no critical habitat, Project mitigation measures)

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Roundnose grenadier	-	Endangered	• Roundnose grenadiers are long lived and slow growing benthopelagic species. These characteristics indicate this species may have lesser potential for recovery in response to adverse effects • Year-round presence in Project Area. Limited dispersal and movements. Areas of high abundance (approximately 321 to 675 individuals per Canadian RV tow) in Project Area • Captured at depths between 180 m and 2,200 m and mainly observed at 400 to 1,200 m depths • Common on the Flemish Cap and nose of the Grand Banks • Spawning occurs throughout the year. Mesopelagic eggs and juveniles • Potential life stage interactions include eggs (pelagic), larvae (pelagic), and juveniles/adults (demersal) • Potential for long-term adverse effects with large-scale accidental events • No critical habitat established for this species • Limited potential for interaction (mobile species, no critical habitat, Project mitigation measures)
Acadian redfish (Atlantic population)	-	Threatened	• Prefers the shelf slopes and deep channel areas, but undergoes large vertical diurnal migrations • Year-round presence in the Project Area. Areas of high abundance (approximately <9,160 individuals per Canadian RV tow for Acadian and deepwater redfish) along the slopes of the NL Shelf in the Project Area. Common on the Northeast NL Shelf and Flemish Cap • Internal fertilization. Larval release between spring and summer and are primarily found in surface waters • No critical habitat established for this species. Habitats made up of anemones and coral beds may be linked to redfish survival • Potential life stage interactions include larvae (pelagic), and juveniles/adults (demersal / pelagic) • Limited potential for interaction (mobile species, project mitigation measures) • 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

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Deepwater redfish (Northern Population)	-	Threatened	• Prefers the shelf slopes and deep channel areas, but undergoes large vertical diurnal migrations • Year-round presence in the Project Area. Areas of high abundance (approximately <9,160 individuals per Canadian RV tow for Acadian and deepwater redfish) along the slopes of the NL Shelf in the Project Area. Common on the Northeast NL Shelf and Flemish Cap • Internal fertilization. Larval release between spring and summer and are primarily found in surface waters • No critical habitat established for this species. Habitats made up of anemones and coral beds may be linked to redfish survival • Potential life stage interactions include larvae (pelagic), and juveniles/adults (demersal / pelagic) • Limited potential for interaction (mobile species, Project mitigation measures) • 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
Atlantic bluefin tuna	-	Endangered	• Seasonal/intermittent presence in Project Area. May migrate through Project Area in search of food. Tuna move southward in the fall for spawning • Individuals captured in continental shelf waters of the Gulf of St. Lawrence, Scotian Shelf and the Grand Bank • May form schools of <50 individuals • No critical habitat established for this species • No known spawning or rearing habitats for early life stages in Canadian waters • Potential life stage interactions include juveniles/adults (pelagic) • Limited potential for interaction (mobile species, Project mitigation measures)
White shark (Atlantic Population)	Endangered	Endangered	• Occurs in inshore to offshore waters • Seasonal/intermittent presence in Project Area. May migrate through Project Area with summer feeding migrations in Canadian waters • Recorded in NL waters from the Northeast NL Shelf and the St. Pierre Bank. Individuals have been tracked to the Flemish Cap • No critical habitat established for this species • Potential life stage interactions include juveniles/adults (pelagic) • Limited potential for interaction (mobile species, Project mitigation measures)

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Atlantic salmon (South Newfoundland, Quebec Eastern North Shore, Quebec Western North Shore, Anticosti Island, Inner St. Lawrence, Gaspe-Southern Gulf of St. Lawrence, Eastern Cape Breton, Nova Scotia Southern Upland)	-	Threatened (South Newfoundland Population); Special Concern (Quebec Eastern North Shore, Quebec Western North Shore, Inner St. Lawrence, Gaspe-Southern Gulf of St. Lawrence); Endangered (Eastern Cape Breton, Nova Scotia Southern Upland, Outer Bay of Fundy, Anticosti Island)	• Anadromous species; spawns in freshwater, growth phase in marine environments • Intermittent presence in Project Area. May migrate through the Project Area or interact with coastal and offshore service vessels. Mainly occupies upper 5 m to 10 m of water column with some deeper feeding migrations • Sampling near the Flemish Pass in winter and summer-autumn captured no salmon. Low catches (over 0.0-1.0 fish per mile-hour of drift gillnet) of adult salmon were recorded during the spring • Post-smolt from rivers in Maine, Bay of Fundy, Atlantic coast of Nova Scotia, and some rivers in NL migrate near the coast of eastern NL, arriving near the Funk Islands in the southern Labrador Sea in early August • Adult salmon have been found in abundance in two general locations during their spring spawning migration; approximately 480 km east of the Strait of Belle Isle and slightly east of the 200 m isobath (depth contour) along the eastern edge of the Grand Bank • Freshwater critical habitat areas have been established for inner Bay of Fundy Population • Potential life stage interactions include juveniles/adults (demersal) • Limited potential for interaction (mobile species, Project mitigation measures, no critical habitat)
Basking shark (Atlantic Population)	-	Special Concern	• Seasonal/intermittent presence in Project Area. May migrate through Project Area with summer feeding migrations in Canadian waters • Aggregates in areas where zooplankton are concentrated • Basking sharks occur throughout Atlantic continental shelf including the Bay of Fundy, Scotian Shelf, and Grand Banks. This species has also been captured from the Flemish Cap and the Northeast slope of the NL Shelf • No critical habitat established for this species • Potential life stage interactions include juveniles/adults (pelagic) • Limited potential for interaction (mobile species, Project mitigation measures)

Table 9.16 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA	COSEWIC	Summary of Presence and Potential Interactions
Shortfin mako (Atlantic Population)	-	Special Concern	• Seasonal/intermittent presence in Project Area. May migrate through Project Area • with summer feeding migrations in Canadian waters • Associated with warm waters (17°C to 22°C) in and around the Gulf Stream including the continental shelf of Nova Scotia, Grand Banks and the Gulf of St. Lawrence • Sharks in Canadian waters are at the northern extent of the population and considered a small portion of the total population • No critical habitat established for this species • Potential life stage interactions include juveniles/adults (pelagic) • Limited potential for interaction (mobile species, Project mitigation measures)
Porbeagle	-	Endangered	• Abundant on the continental shelf of the Grand Bank. Rarely captured at surface or depths >200 m • Seasonal/intermittent in presence in Project Area. Distribution spans the Project Area on the continental shelf • No critical habitat established for this species. However, mating grounds are present off Southern NL, the entrance to the Gulf of St. Lawrence and the Georges Bank • Mating occurs during the summer and early fall and sharks migrate to pupping grounds in the Sargasso Sea • No critical habitat established for this species • Potential life stage interactions include juveniles/adults (pelagic) • Limited potential for interaction (mobile species, Project mitigation measures)

9.5.1 Wolffish Species

Wolffish eggs and adults are associated with bottom habitats and the larvae live pelagically (COSEWIC 2012a, 2012b, 2012c). The general biology and distribution of wolffish species are discussed in Section 6.1.9.1. Critical habitat has been identified in a recovery strategy for northern and spotted wolffish based on areas of occurrence (Figure 9-8 and Figure 9-9 (DFO 2020)). The areas are located on the edge of the Grand Banks and Labrador Shelf, northeast of the Project Area. The northern wolffish critical areas range from 118 m to 636 m and range in temperature from 2.3°C to 5.1°C whereas the spotted wolffish critical areas range from 82 m to 346 m and range in temperature from 0.1°C to 4.2°C (DFO 2020). No critical habitat has been established for Atlantic wolffish as it is not a requirement of Special Concern SARA designation (DFO 2020). The wolffish recovery strategy indicates that oil and gas exploration and production may have potential environmental effects on wolffish associated with operational discharges, however it notes that any potential effects would be highly localized and minor at the population level (DFO 2020). Project associated activities could potentially interact with areas of known wolffish occurrence; primarily for northern wolffish and to a lower extent spotted and Atlantic wolffish. The high aggregations of wolffish species outside the Project Area and use of planned and proposed mitigation measures will avoid or reduce any such adverse interactions with these species.

9.5.2 Grenadiers and Thorny Skate

Grenadier and skate species are typically associated with bottom habitats. The general biology and distribution of thorny skate and grenadier species are discussed in Sections 6.1.9.5 and 6.1.9.8. Project activities interacting with the water column have potential to interact with the pelagic larvae of grenadier species and activities with demersal or benthic interactions may potentially interact with adult grenadier species and all life stages of thorny skate. Roundnose grenadiers are suggested to form discrete and dense spawning aggregations that would be expected to lead to a highly patchy distribution of eggs and larvae (Neat 2017) and limiting potential effects on early life history stages. Critical habitat has not been established for the roundnose grenadier due to lack of information of habitat associations in relation to life history stages (DFO 2010). No critical habitat been established for roughhead grenadier, however spawning grounds for this species are suggested to lie on the southern and southeastern slopes of the Grand Banks (Scott and Scott 1988; COSEWIC 2007). No critical habitat for thorny skate has been established, but areas of high aggregation include the NL Shelf and Slopes (COSEWIC 2012d).

The areas of high aggregation and limited distributions of grenadier species indicate that potential interaction with and adverse effects on this species are predicted to be moderate. Although there are no interactions with critical habitat for grenadier species, these fish are long lived and slow growing benthopelagic species and indicate may have lesser potential for recovery in response to adverse effects. Due to the low distribution of Thorny skate in the Project Area, areas of high abundance outside the Project Area and localized nature of many of the Project activities, no interaction with critical habitats, the potential for interaction with and adverse effects on this species is predicted to be limited.

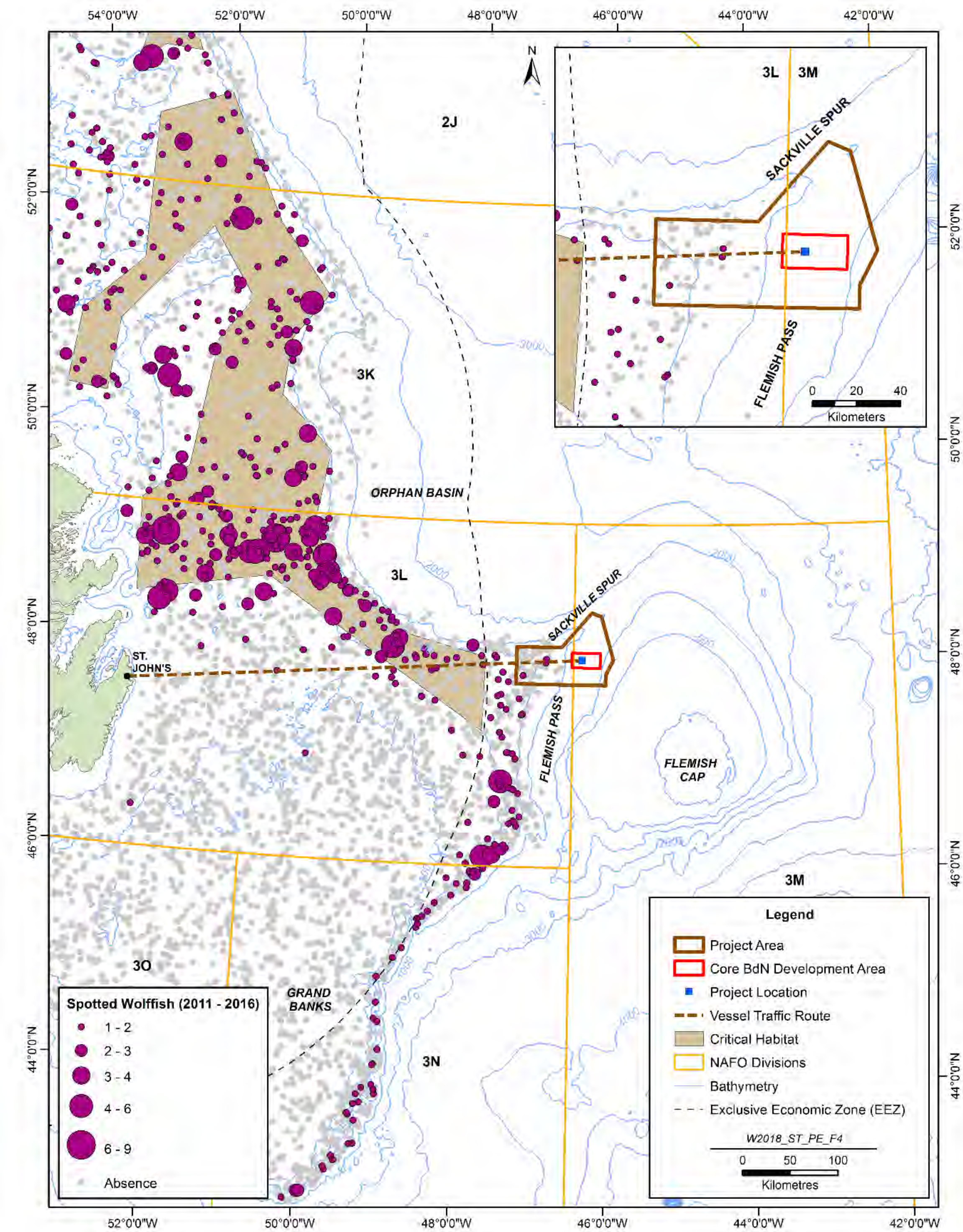

Figure 9-8 Spotted wolffish distribution based on Canadian RV surveys (2011 to 2016) and Critical Habitat (DFO 2018)

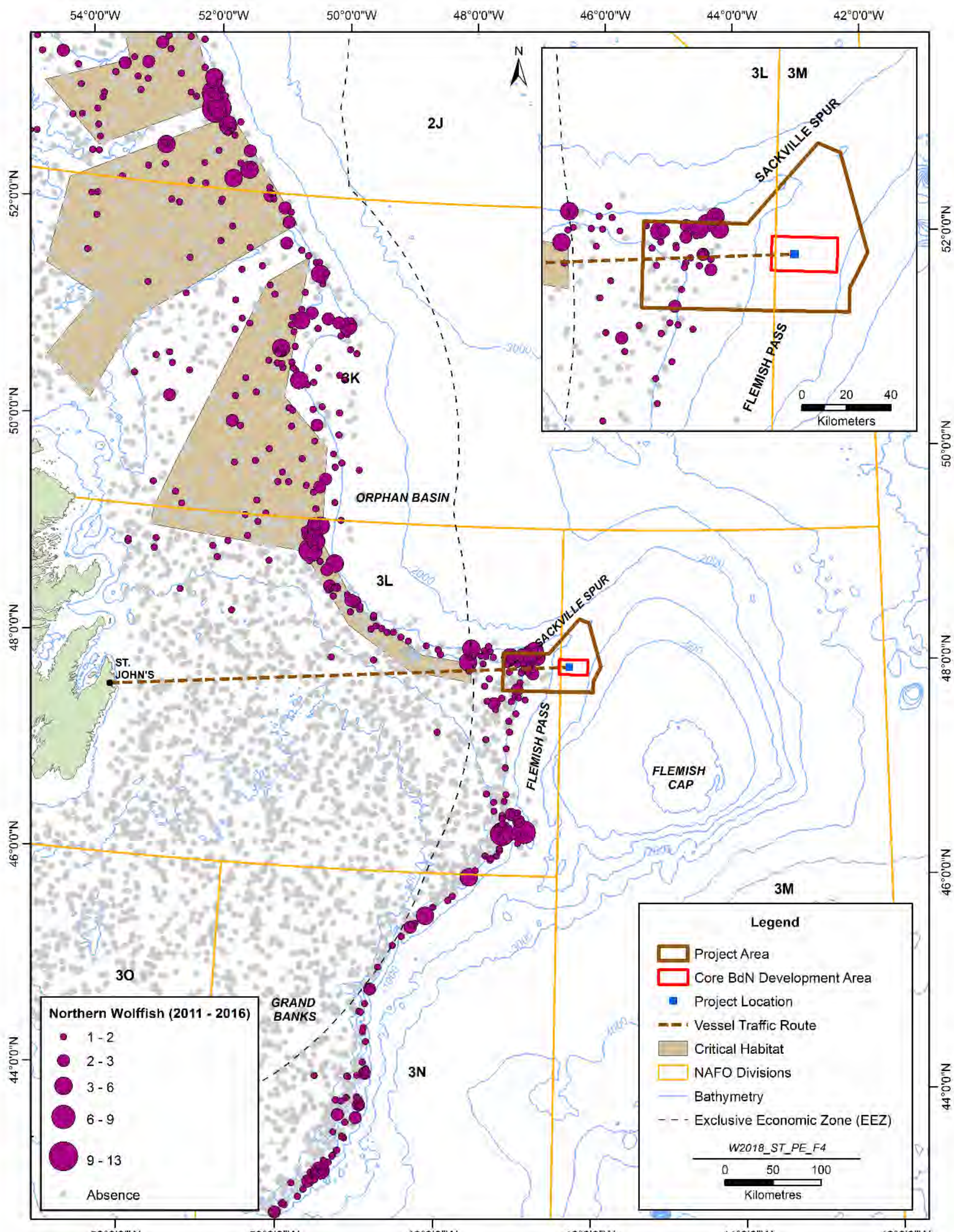

Figure 9-9 Northern wolffish distribution based on Canadian RV surveys (2011 to 2016) and Critical Habitat (DFO 2018)

9.5.3 Atlantic Cod

The general biology and distribution of Atlantic cod is discussed in Section 6.1.9.9. Currently no critical habitat has been established for Atlantic cod. Project activities interacting with the water column and bottom habitats have the potential to interact with larval and adult fish. As Atlantic cod is mobile and the Project Area is an area of low aggregation for this species as outlined in Table 9.14, Project effects on its biotic interactions would be low. As predicted while Project-related disturbances are relatively localized and long-term, mitigation measures will be implemented to avoid or reduce potential effects; therefore, there is limited potential for interaction with these species. Furthermore, adults of these species are highly mobile. The mobile adult stages would also be able to avoid affected areas and would likely be able to avoid any Project-related disturbances, minimizing any potential exposure to Project activities and thus, possible adverse effects.

9.5.4 White Hake

The general biology and distribution of white hake is discussed in Section 6.1.9.10. Currently no critical habitat has been established for white hake. Areas of white hake aggregation, including the Laurentian Chanel and Southwest Shelf Edge and Slope EBSAs are distant from Project activities. The primary threat to white hake populations are fishing mortality from directed fisheries or as bycatch (COSEWIC 2013). Project activities interacting with the water column and bottom habitats have the potential to interact with larval and adult fish. As white hake is mobile and the Project Area is an area of low aggregation for this species as outlined in Table 9.14, Project effects on its biotic interactions would be low. As predicted while Project-related disturbances are relatively localized and long-term, mitigation measures will be implemented to avoid or reduce potential effects; therefore, there is limited potential for interaction with these species. Furthermore, the mobile adult stages would also be able to avoid affected areas and would likely be able to avoid any Project-related disturbances, minimizing any potential exposure to Project activities and thus, possible adverse effects.

9.5.5 Atlantic Salmon

Atlantic salmon interact with freshwater and marine environments. Atlantic salmon migrate to freshwater to spawn and juveniles migrate to marine waters for their growth phase (COSEWIC 2010c). The general biology and distribution of this species is discussed in Section 6.1.9.6.

There are 16 Atlantic salmon populations across five regions delineated in terms of natal river destination and categorized as Designatable Units (DU) (Section 6.1.9.6). To date, there has not been any critical habitat established for this species, however freshwater habitat is considered a limitation to salmon production (COSEWIC 2010c). Each regional group assessed below has its own migration routes and overwintering patterns in marine waters.

Labrador and Nunavik Populations

There are 89 rivers in Labrador with known salmon populations; although it is noted that many of rivers have never been surveyed and therefore their status in unknown (Reddin et al. 2010). Nunavik and Labrador Atlantic salmon populations are listed as Data Deficient and Not at Risk under

COSEWIC, respectively. Marine survival of smolt through to returning adult salmon to the Sand Hill River in 2013 was estimated at two percent, which included both natural mortality as well as that from fisheries at sea (CSAS 2015). The route of post-smolt migration in the Atlantic Ocean varies by population and geographic location of their home river; however, age analysis of salmon captured in the Labrador Sea, West Greenland, and off the east Grand Banks, indicate that post-smolt and adult salmon from Labrador generally feed and overwinter in the Labrador Sea and are not migrating or using habitat off the east Grand Banks. Multi-sea winter salmon also migrate to the north Labrador Sea and west Greenland during their second year to complete their growth prior to returning to home rivers to spawn. Genetic analysis of Atlantic salmon captured in coastal Labrador by fisheries indicated that the majority (85 to 98 percent) of individuals harvested over 2006 to 2011 were of Labrador origin and that those intercepted from more southern, non-local populations (e.g., Maritimes and Gaspe Peninsula) were rare and occurred primarily in southern Labrador, consistent with discrete migrations pathways through the Strait of Belle Isle (CSAS 2015).

Given that the river ages of salmon located off the east Grand Banks are younger than those typical from Labrador rivers, the data suggests that most salmon from the Labrador region do not likely migrate to the more southern area of congregation and therefore interaction of these populations with the Project Area would be considered negligible.

Insular Newfoundland Populations

There are 305 rivers with known salmon populations in NL (Reddin et al. 2010). Atlantic salmon populations listed as Not at Risk under COSEWIC include the Northeast NL Population, Southwest NL Population, and Northwest NL Population. The South NL Population is designated as Threatened. River age data suggests that salmon along the eastern edge of the Grand Banks would, at least, be partially of NL origin (particularly the southern portion of the Island). This would indicate that salmon of NL origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Banks in spring prior to completing their spawning migration back to their natal rivers (Figure 9-10). Catch data indicates that post-smolt do not overwinter in the Flemish Pass area (Reddin and Friedland 1993; Reddin 2006). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, prevailing currents along eastern NL and the Grand Banks are generally a southern flow, therefore smolt energy expenditure would be higher, particularly in the higher southerly flows of the Flemish Pass. It is likely that smolt would avoid these areas of increased southern flow while migrating north to the Labrador Sea and follow a generally more coastal route (CSAS 2013) before moving offshore. Acoustic tracking of smolt and kelt (CSAS 2013) from Conne River, NL confirms this route. Based on tag recaptures, post-smolt from rivers in NL migrate near the coast of eastern NL, arriving in the southern Labrador Sea in early August (Reddin and Friedland 1993). Tagging studies show that adult salmon migrating southward from feeding and overwintering areas to southern NL rivers in the spring first move into NL coastal waters and then move coastwise in a southerly and then in a westerly direction along the NL coast (Reddin and Friedland 1993).

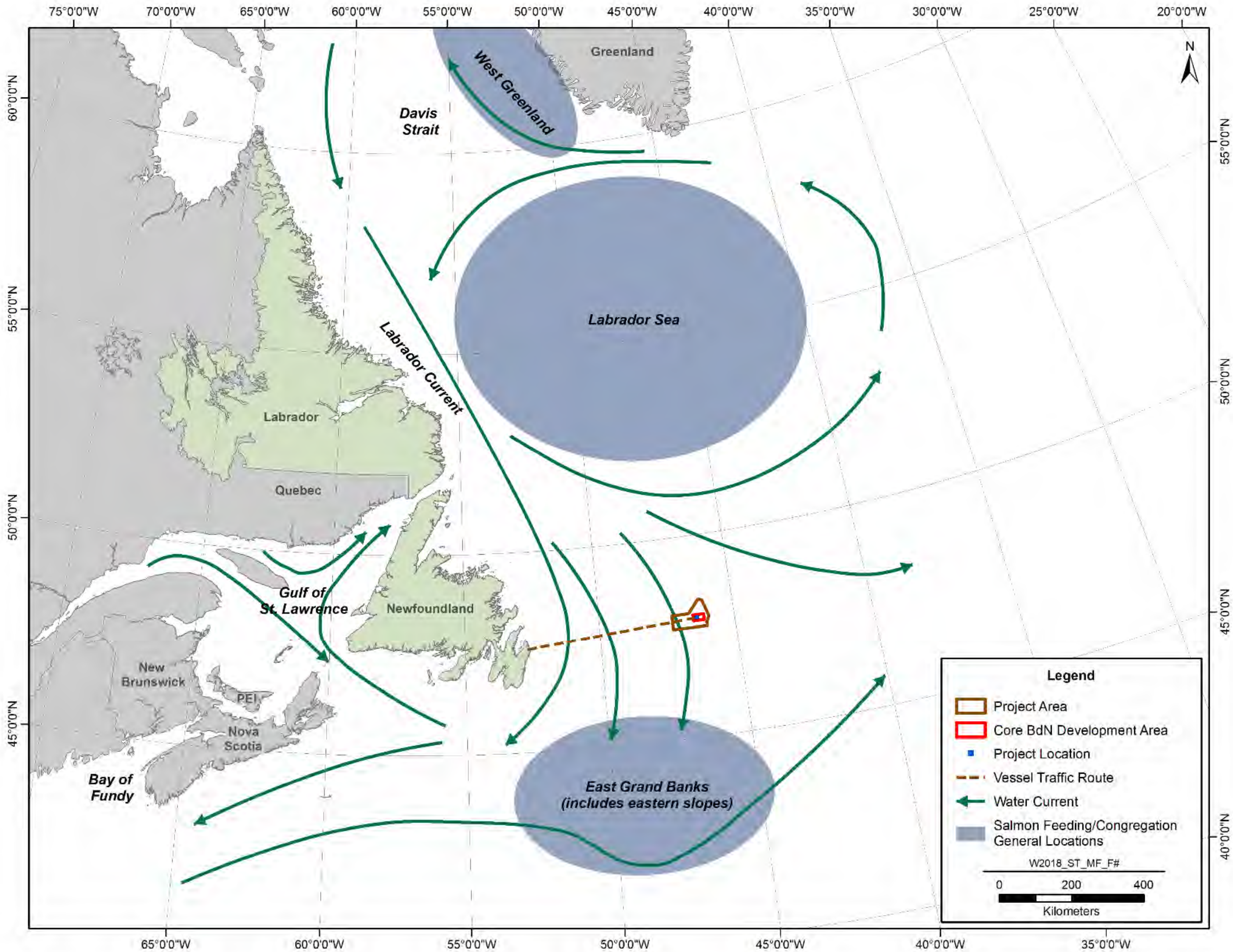

Figure 9-10 Atlantic Salmon: General Location of Currents and Summary Geographic Locations

In terms of habitat preferences, it has been shown that avoidance of lower water temperatures, (i.e., below 3°C) can play a predictive role in habitat use near the Grand Banks and Flemish Pass. Statistical summaries of sea temperature were derived from the Ocean Data Inventory (ODI) of the Bedford Institute of Oceanography (DFO 2016) for a rectangular area surrounding the Project Area, querying the period 1900 to 2016 for depths down to 3,000 m. For the area, mean Sea Surface Temperatures (SSTs) range from 1.6°C in March to 5.3°C in October. Minimum temperatures at the surface range from -1.8°C in January to 1.1°C in August and September. Maximum SSTs range from 4.0°C in March to 11.8°C in August. This seasonal temperature cycle is observed down to 250 m, where temperatures are higher in the summer than in winter. As shown, mean SST values greater than 3°C occur between July and November and the preferred range (4°C to 8°C) can occur between July and October. Minimum SSTs for each month are below 3°C.

The summary of available data regarding insular NL populations indicates that a portion of salmon spending one winter at sea (1SW) and multiple winters at sea adults, primarily from the southern NL population, congregate off the east Grand Banks prior to their spring spawning migration back to their natal river. Since the majority of known post-smolt overwintering occurs in the Labrador Sea, migration to the east Grand Banks area must occur; however, the exact migration route is not known and may be influenced by SST during the time of migration. For example, the monthly SST values around the Project Area are a general indication that Atlantic salmon would not use the area outside the months July through to November and based on the SST temperatures recorded, if salmon use the area during the summer/autumn period (22 June to 22 December), it would likely be limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were low (0.0 – 1.0 fish per nautical mile (NM) of drift gillnet fished per hour) while efforts during winter had no catches near the Project Area. No life stage of Atlantic salmon is dependent upon the Project Area and any utilization is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3°C.

Given the available data, there is likely low interaction with spring migration of adults within and near the Project Area. While Project activities are relatively long-term, potential interactions with the Project are reduced by the localized nature of activities, planned mitigation measures to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

Gulf of St. Lawrence Populations

Gulf of St. Lawrence Populations includes the Quebec Eastern North Shore Population, Quebec Western North Shore Population, Inner St. Lawrence Population and Gaspe-southern Gulf of St. Lawrence Population that are designated as Special Concern. Other populations include the Anticosti Island Population that is designated as Endangered and the Lake Ontario Population that is Extinct. As noted above, post-smolt are distributed according to prevailing surface currents and that strong currents act as transportation vectors that facilitate migration to marine feeding areas (Jonsson et al. 1993) to reduce energy needs. This process appears to influence the migratory pathway for post-smolt within the Gulf of St. Lawrence region. For example, post-smolt from the north shore of the Gulf of St. Lawrence, as well as the Miramichi, Restigouche, and Cascapedia rivers, follow the coast eastward and use the Strait of Belle Isle as their major pathway during emigration to the North Atlantic

(Lefevre et al. 2012). Post-smolt from other rivers farther south on the Gaspe Peninsula have been recaptured near both the Strait of Belle Isle and Cabot Strait.

Caron (1983) and Dutil and Coutu (1988) concluded that some Gulf of St. Lawrence stocks delayed migration from the Gulf and that at least some post-smolt remained there until late autumn. Post-smolt have been captured as by-catch in herring gear in the northern Gulf of St. Lawrence in late summer (COSEWIC 2010c; CSAS 2012) and the winter destination of these late migrations remains unknown. Post-smolt within the Gulf of St. Lawrence were also recorded as spending more time in near-shore coastal habitat than smolt from other regions, which spend little time in or near estuary habitat (COSEWIC 2010c). Once moving to open sea, post-smolt from the Gulf tend to head in a general northward direction (COSEWIC 2010c). This information suggests that post-smolt from the Gulf of St. Lawrence travel to the Labrador Sea primarily in a northerly route through the Strait of Belle Isle and eastward around the Island of NL. They may also delay migration away from estuary habitat and the Gulf in general until late fall and may overwinter in the Gulf area for their first winter.

CSAS (2012) indicates that the west Greenland fishery has captured salmon from Gulf of St. Lawrence rivers with an estimated harvest of three to ten percent of total sea winter salmon being from the region (2006 to 2011). River age data suggests that salmon along the eastern edge of the Grand Banks would at least be partially of Gulf of St. Lawrence origin (particularly the southern portion of the Gulf of St. Lawrence). Similar to Atlantic salmon from the Southern NL population, salmon of Gulf of St. Lawrence origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Banks in spring prior to completing their spring spawning migration back to natal rivers. Post-smolt from this region would also be similar to those of insular NL in that they would not overwinter in the Flemish Pass area (Reddin and Friedland 1993). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, it would also be likely that they follow a generally coastal route along NL before moving offshore (Reddin and Friedland 1993; CSAS 2013). Returning adults to the Gulf of St. Lawrence in the spring would also tend to move into NL coastal waters and then move coastwise in a southerly and then westerly direction along the NL coast (Reddin and Friedland 1993).

While spring migration through and near the Project Area is possible, salmon from the Gulf of St. Lawrence would be influenced by SST similar to other Atlantic salmon populations previously noted. Monthly SST values around the Project Area are a general indication that Atlantic salmon would not use the area outside the months July through to November and based on the SST temperatures recorded, if Gulf of St. Lawrence salmon use the area, it would likely be limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were low (0.0 – 1.0 fish per NM of drift gillnet fished per hour) while efforts near the Project Area during winter produced no catches. No life stage of Atlantic salmon is dependent upon the Project Area and utilization is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3°C. However, it should be noted that surveys of the area are limited and regional variations in abundance have been reported.

Given the available data, there is a low potential for spring migration of adults to interact with the Project Area. While Project activities are relatively long-term, potential interactions with the Project are reduced by the localized nature of activities, planned mitigation to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

Eastern - Southern Nova Scotia and Outer Bay of Fundy Populations

In terms of marine use and distribution data, the Eastern – Southern Nova Scotia and Outer Bay of Fundy Atlantic salmon populations cannot be differentiated from that of Southern NL or the Gulf of St. Lawrence populations, except when reporting on adult kelt salmon that are returning to the marine environment after successfully spawning at least once in their home river (discussed further below). All these Atlantic salmon populations, including the Eastern Cape Breton, Nova Scotia Southern Upland, and Outer Bay of Fundy populations are designated as Endangered under COSEWIC. Post-smolt migrating to the Labrador Sea and adults returning to natal streams in the spring would follow similar patterns of movement as described above; however, there is no evidence that post-smolt delay migration to the Labrador Sea.

Therefore, it can be assumed that salmon of this region feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Banks in spring prior to completing their spring spawning migration back to natal rivers. Post-smolt from this region would not overwinter in the Flemish Pass area (Reddin and Friedland 1993). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, it would also be likely that they follow a more general coastal route along the coast of NL (CSAS 2013; Reddin and Friedland 1993). Returning adults to the Gulf of St. Lawrence in the spring would also tend to move into NL coastal waters and then move coastwise in a southerly and then westerly direction along the NL coast (Reddin and Friedland 1993).

Although spring migration through and near the Project Area is possible, salmon from the Eastern – Southern Nova Scotia and Outer Bay of Fundy populations would be influenced by SST similar to other Atlantic salmon populations previously noted. Monthly SST values around the Project Area are a general indication that Atlantic salmon would not use the area outside the months July through to November and based on the SST temperatures recorded, if Gulf of St. Lawrence salmon use the area, it would likely be limited.

As shown in Reddin and Shearer (1987), Atlantic salmon captures during the spring were low (0.0 – 1.0 fish per NM of drift gillnet fished per hour) while efforts near the Project Area during winter produced no catches. No life stage of Atlantic salmon is dependent upon the LSA and any utilization is likely restricted to limited migration at low densities in those years when spring water temperatures exceed 3°C.

A summary of marine habitat use by adult kelt salmon (Lacroix 2013) provides some information related to the movement of kelt salmon from the Bay of Fundy (both outer and inner Bay of Fundy populations) using satellite pop-up tags. Kelt are adult salmon that have returned to spawn in their natal river and have survived to re-enter the marine environment to recondition and return to spawn again, either the next immediate fall (consecutive spawning) or the following year (alternate spawning).

Lacroix (2013) provides valuable information, particularly related to salmon stocks from the Bay of Fundy (BoF). The research included tagging kelts on their return to the marine environment. Kelts from the inner Bay of Fundy (iBoF) and the outer Bay of Fundy (oBoF) were tagged and tracked. Individual tracks documented swim direction, speed, water temperature, and depth of activity. Light/dark was also recorded so that estimates of geolocation could be generated. Home ranges were also generated for iBoF and oBoF salmon. Kelts from the oBoF and iBoF groups with tracks greater than 60 days at sea generally provided excellent examples of the differences in migration behaviour of inner and outer BoF salmon. IBoF salmon remained primarily in the Bay of Fundy, northern Gulf of Maine, and around the southern tip of Nova Scotia, regardless of season of migration (Lacroix 2013).

Predicted home ranges were modelled to provide 50 percent and 75 percent utilization distributions (UD) to indicate where the majority of kelt activity was concentrated. The oBoF kelt 50 percent UD extended through the outer BoF and northern Gulf of Maine, around the southern tip of Nova Scotia on the western Scotian Shelf and to some extent onto the eastern Scotian Shelf. The 75 percent UD extended along the length of the Scotian Shelf to the south coast of NL. An additional 75 percent UD was located on the southern edge of the Grand Bank (refer to Figure 13 in Lacroix 2013).

Lacroix (2013) indicates that one of the tagged kelt from the oBoF migrated northward to Labrador via the Grand Bank and a second remained on the eastern edge of the Grand Bank until July prior to the tag detaching. This area on the eastern edge of the Grand Bank is similar in location to the area previously described above where adult salmon congregate in the spring as they return to their home rivers. These data corroborate that this area may be a feeding area prior to return migrations. No tags were shown migrating through the Project Area and the 99 percent UD for oBoF also does not include the Project Area (refer to Figure 13 in Lacroix 2013).

Given the available data, there is a low potential for spring migration of adults to interact with the Project Area. While Project activities are relatively long-term, potential interactions with the Project are reduced by the localized nature of activities, planned mitigation to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

Inner Bay of Fundy Population

The Atlantic salmon population of the iBoF have been listed as Endangered on Schedule 1 of SARA (CSAS 2016) and by COSEWIC and is the only population listed under the SARA. Post-smolt from rivers in the iBoF have been observed to remain in the Bay of Fundy until late summer and while the exact overwintering location is unknown, lack of tag recoveries from distant intercept fisheries indicate the iBoF salmon do not go as far north as other salmon stocks and few are caught outside the Bay itself (COSEWIC 2010c). In 2013, DFO reviewed and evaluated the available iBoF salmon data to identify important marine and estuarine habitat needed to complete all life history stages (DFO 2013).

As stated above for outer Bay of Fundy salmon above, Lacroix (2013) provides valuable information, particularly related to salmon stocks from the BoF. Some of the highest return rates for kelts have been recorded for salmon populations within the iBoF (Jessop 1986; Ritter 1989; Cunjak et al. 1998).

Kelts from the iBoF remained primarily in the BoF, northern Gulf of Maine, and around the southern tip of Nova Scotia, regardless of season of migration (Lacroix 2013).

Predicted home ranges were modelled to provide 50 percent and 75 percent UD to indicate where the majority of kelt activity was concentrated. For iBoF kelt, the 50 percent and 75 percent UDs were limited to the BoF, the northern Gulf of Maine extending down the coast of Maine, along the southwest shore of Nova Scotia, and onto the western Scotian Shelf (refer to Figure 13 in Lacroix 2013).

While the data available to determine habitat important for overwintering for all stages (November to April) is limited for iBoF salmon, overwintering is suggested to be off the Scotian Shelf or the southern portion of the Gulf of Maine (Lacroix 2013; CSAS 2016). As a result, interaction with the Project Area is unlikely.

9.5.6 American Eel

American eels spawn in marine waters and larvae drift towards coastal environments where they enter freshwater systems to grow (COSEWIC 2012e). The general biology and distribution of this species is discussed in Section 6.1.9.2.

Spawning migrations for adult American eels in Canada occur in the fall and follow the continental shelf before travelling across open ocean to the Sargasso Sea (COSEWIC 2012e; Béguer-Pon et al. 2015). In tracking studies in Atlantic Canada, adult eels were observed to migrate in two phases. Eels first travel in shallow waters along the continental shelf and edge. Telemetry data indicates that adult eels undergo some exploratory behavior on their way to the Sargasso Sea, which is assumed to be for detection of cues or other migrants (Béguer-Pon et al. 2015). In the second phase of migration, the eels travel in deep waters directly south towards the Sargasso Sea, which includes crossing the Gulf Stream (Béguer-Pon et al. 2015). After spawning from February to April, the larvae in the Sargasso Sea drift north with the Gulf Stream, with some directional swimming (Rypina et al. 2014; Westerberg et al. 2017). Variations in strength of the Gulf Stream and other ocean circulation patterns may influence success rates of larvae reaching coastal waters (Rypina et al. 2016; Westerberg et al. 2017).

The main threats to this species are largely in freshwater systems including habitat degradation and fragmentation, food web changes, fisheries and chemical and biological contamination (COSEWIC 2012e; Chaput et al. 2014). Changes and variations in oceanographic processes are considered the main threat to ocean survival of larvae (Knights 2003; COSEWIC 2012; Chaput et al. 2014). Seismic activities are suggested to result in localized stress and mortality of larval stages, however Chaput et al. (2014) indicated that there is no indication that the larval densities at sea that may encounter seismic activities would result in effects on the population.

As migration routes for American eel through the Project Area are possible but of low likelihood, potential for Project interactions would be limited and overall risk is considered low to these species. Potential interactions with the Project are also reduced by the planned mitigation measures to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the highly mobile nature of the species.

9.5.7 Redfish Species

Acadian and deepwater redfish are species with COSEWIC status designations that are well distributed in the Flemish Pass and Flemish Cap. To date, no critical habitats have been established for these species, however it has been suggested that habitats made up of anemones and coral beds may be linked to redfish survival (COSEWIC 2010b). The general biology and distribution of these species are presented in Section 6.1.9.11. Previous studies indicate that adult redfish are able to avoid areas of disturbance (Popper and Hastings 2009).

Although there is potential for interaction with these species, areas of relatively high aggregation on the slopes outside the Project Area limits potential regional population effects on these species. In summary, potential interactions with the Project and redfish species are reduced by the planned mitigation measures to avoid or reduce potential effects, lack of Project interactions with critical habitats, and the mobile nature of the species.

9.5.8 Pelagic Species (Sharks and Tuna)

Shark species (basking, porbeagle, shortfin mako, and white sharks) and bluefin tuna that have COSEWIC status are highly mobile, pelagic seasonal species in Canadian waters. The general biology and distribution of these species in Canadian waters is described in Sections 6.1.93, 6.1.9.4 and 6.1.9.7.

Atlantic bluefin tuna migrate to Canadian waters in summer in search of food and move southward in the fall. The closest tuna spawning area to the Project Area is the open ocean areas east of the mid-Atlantic states of the United States, referred to as the Slope Sea (Richardson et al. 2016), which is more than 500 km from the Project Area limiting potential effects on early life history stages. Tuna spawning in the Slope Sea are younger individuals with migration patterns that span the east coast of the US and generally remain outside Canadian waters (Richardson et al. 2016). Adult tuna in Canadian waters are generally larger individuals that undertake large migrations to spawn in the Gulf of Mexico (DFO 2012; Richardson et al. 2016). Critical habitat has not been established for Atlantic bluefin tuna (COSEWIC 2011) and considering this species has ocean-basin distributions and can move at scales of approximately 100 km per week, interactions with Project activities would be limited (Hazen et al. 2016)

Basking, shortfin mako, and white sharks occur in Canadian waters in summer months, indicating they may be associated with the seasonal shift of warm Gulf Stream toward the coast. To date, no critical habitat has been established for these species (COSEWIC 2006a, 2006b; 2009). For porbeagle sharks In Canadian waters, early, juvenile, and adult life stages are abundant on or near the continental shelf (COSEWIC 2014). Their distribution spans the LSA on the continental shelf. They are rarely captured at the surface or at depths greater than 200 m in Canadian waters. No critical habitat has been established for this species, however there are mating grounds that lie outside the Project Area on the Grand Banks off southern NL, the entrance to the Gulf of St Lawrence, and the Georges Bank. Porbeagle sharks mate in this area in the summer and early fall and migrate south in the winter to the pupping grounds in the Sargasso Sea (COSEWIC 2014). Historical fisheries that overexploited shark species, bycatch mortality, and slow recovery affect these shark populations. Vessel collisions have been suggested to be a source of potential mortality for basking sharks due to their slow surface movements, but information regarding the importance of this threat is considered anecdotal (COSEWIC 2009).

Tuna and shark species are highly mobile, pelagic species that may seasonally migrate though the LSA. With the implementation of Project mitigation measures, potential adverse effects would be unlikely.

9.6 Significance of Residual Environmental Effects

This section summarizes the residual environmental effects of the Project on the Marine Fish and Fish Habitat and presents the determination of significance.

9.6.1 Ecosystem Component Linkages

The interconnections between the physical, biological and human environment have been considered in the EIS and are summarized in Table 9.17. Overall, the EIS is based on the interactions between project activities and select VC's using source-pathway-receptor relationships as addressed in Section 9.1. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not affect significance determinations, as the potential effects (via direct and indirect pathways) on marine fish and fish habitat have been assessed.

Table 9.17 Ecosystem Linkages Marine Fish and Fish Habitat

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Offshore Construction and Installation, Hook-Up and Commissioning (in Core BdN and Project Area Tiebacks)			
Presence of Vessels	• Light • Sound • Marine discharges	**Core BdN and Project Area Tiebacks – PA** • Migrating individuals, plankton, and pelagic species may be attracted to the lighting effect on the surface water caused by lights reflecting off water surface, and invertebrates may become attached to the subsea structure as it provides a surface for colonization • Anthropogenic sound is transmitted through the water and seabed and may result in disturbances to marine biota • Marine discharges (anticipated to affect Marine Fish and Fish Habitat due to the lack of an effect pathway) • Air emissions are not anticipated to affect Marine Fish and Fish Habitat due to the lack of an effect pathway.	Avoidance/attraction behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and/or quality of marine fish in commercial-communal harvesting areas.
Installation of subsea infrastructure	• Disturbance of the seafloor and benthic habitats and fauna • Suspended sediments and introduction of sediments of different shapes and sizes	**Core BdN and Project Area Tiebacks – PA** • These activities may result in exposure, injury, burial and/or mortality of benthic organisms if present. • Suspended sediment may clog feeding structures of filter-feeding organisms (e.g., corals, sponges and sea pens)	Benthic habitats provide refuge for small planktonic and benthic invertebrates. Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.

Table 9.17 Ecosystem Linkages Marine Fish and Fish Habitat

Component / Activity	Interaction	Pathway	Ecosystem Linkages
HUC Activities	• Light • Sound • Marine discharges	**Core BdN and Project Area Tiebacks – PA** • Migrating individuals, plankton, and pelagic species may be attracted to the lighting effect on the surface water caused by lights reflecting off water surface, and invertebrates may become attached to the subsea structure as it provides a surface for colonization • Anthropogenic sound is transmitted through the water and seabed and may result in disturbances to marine biota • Marine discharges associated with HUC activities could affect fish health • Other marine discharges and air emissions are not anticipated to affect Marine Fish and Fish Habitat due to the lack of an effect pathway.	Avoidance/attraction behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and quality of marine fish in commercial-communal harvesting areas.
Production and Maintenance Operations (in Core BdN and Project Area Tiebacks)			
Presence of FPSO and Subsea Infrastructure	• Light • Sound	**Core BdN and Project Area Tiebacks – PA** • Migrating individuals, plankton, and pelagic species may be attracted to the lighting effect on the surface water caused by lights reflecting off water surface, and invertebrates may become attached to the subsea structure as it provides a surface for colonization • Anthropogenic sound is transmitted through the water and seabed and may result in disturbances to marine biota	Avoidance/attraction behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and quality of marine fish in commercial-communal harvesting areas.

Table 9.17 Ecosystem Linkages Marine Fish and Fish Habitat

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Waste Management	• Produced water • Marine discharges	**Core BdN and Project Area Tiebacks – PA** • Produced water could result in behavioural changes (attraction or avoidance) for mobile fish and invertebrates • Produced water discharges could result in changes in fish and invertebrate health, injury or mortality • Marine discharges and air emissions are not anticipated to affect Marine Fish and Fish Habitat due to the lack of an effect pathway.	Attraction or avoidance behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and/or quality of marine fish in commercial-communal harvesting areas.
Drilling Activities (in Core BdN and Project Area Tiebacks)			
Presence of Drilling Installation	• Light • Sound	**Core BdN and Project Area Tiebacks – PA** • Migrating individuals, plankton, and pelagic species may be attracted to the lighting effect on the surface water caused by lights reflecting off water surface, and invertebrates may become attached to the subsea structure as it provides a surface for colonization. • Anthropogenic sound is transmitted through the water and seabed and may result in disturbances to marine biota	Attraction or avoidance behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and quality of marine fish in commercial-communal harvesting areas.

Table 9.17 Ecosystem Linkages Marine Fish and Fish Habitat

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Waste Management	• Drill cuttings • Marine discharges • Air emissions	**Core BdN and Project Area Tiebacks – PA** • Discharge of SBM and WBM cuttings could result in increased larval mortality and change in feeding behaviour of benthic species up to 200 m from drill site. • Suspended sediment could clog the feeding structures of filter-feeding organisms (e.g., corals, sponges and sea pens) • Deposition of drill cuttings could result in mortality of benthic species through burial, up to 200 m from drill site. • Marine discharges and air emissions are not anticipated to affect Marine Fish and Fish Habitat due to the lack of an effect pathway.	Benthic habitats provide refuge for small planktonic and benthic invertebrates. Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
Supply and Servicing (in Core BdN and Project Area Tiebacks)			
Marine Vessels	• Vessel traffic • Light emissions • Sound emissions	**Core BdN and Project Area Tiebacks – PA** • Migrating individuals, plankton, and pelagic species may avoid or be attracted to the lighting effect on the surface water caused by lights reflecting off water surface • Anthropogenic sound from vessels is transmitted through the water and seabed and may result in disturbances to marine biota.	Avoidance/attraction behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and quality of marine fish in commercial-communal harvesting areas.

Table 9.17 Ecosystem Linkages Marine Fish and Fish Habitat

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Supporting Surveys (in Core BdN and Project Area Tiebacks)			
Geophysical surveys	• Presence of vessels • Lighting • Sound	**Core BdN and Potential Development – PA** • Migrating individuals, plankton, and pelagic species may avoid or be attracted to the lighting effect on the surface water caused by lights reflecting off water surface • Anthropogenic sound from vessels is transmitted through the water and seabed and may result in disturbances, injury or mortality to marine biota • Presence of vessels, lighting and sound could result in behavioural changes (attraction or avoidance) by mobile fish and invertebrates.	Avoidance/attraction behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and quality of marine fish in commercial-communal harvesting areas.
Env, Geotech, Geo and ROV/AUV	• Presence of vessels • Lighting • Sound	**Core BdN and Potential Development – PA** • Migrating individuals, plankton, and pelagic species may avoid or be attracted to the lighting effect on the surface water caused by lights reflecting off water surface • Anthropogenic sound from vessels is transmitted through the water and seabed and may result in disturbances to marine biota • Suspended sediment may clog feeding structures of filter-feeding organisms (e.g., corals, sponges and sea pens) • Presence of vessels, lighting and sound could result in behavioural changes (attraction or avoidance) by mobile fish and invertebrates.	Attraction or avoidance behaviours could result in change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles; and change in abundance, distribution and quality of marine fish in commercial-communal harvesting areas. Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.

Table 9.17 Ecosystem Linkages Marine Fish and Fish Habitat

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Decommissioning (in Core BdN and Project Area Tiebacks)			
Decommissioning	• Decommissioning of FPSO • Removal of subsea infrastructure • Well decommissioning	**Core BdN and Project Area Tiebacks – PA** • Removal of subsea infrastructure will result in decline is sessile or low-mobility benthic invertebrates that were supported by the infrastructure • Suspended sediment could clog the feeding structures of filter-feeding organisms (e.g., corals, sponges and sea pens)	Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.

9.6.2 Residual Environmental Effects Summary

Project activities for the Core BdN Development Area and Project Area Tiebacks have the potential to adversely affect Marine Fish and Fish Habitat. Many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized at a specific location, or temporary and short-term in nature. For most of the interactions, the zone of influence will occupy a very small area within the entire 470 km² Core BdN Development Area and 4,900 km² Project Area. The implementation of the mitigation measures outlined throughout this EIS are predicted to reduce direct or indirect potential effects on the existing species, and environmental characteristics and conditions of these areas.

The installation of subsea infrastructure is predicted to have disturbance effects on the environment. However, the overall increase in hard structures may have localized positive effects on fish abundance and diversity by creating a "reef effect" that aggregates plankton and increases invertebrate colonization of hard substrate, resulting in increased local productivity and food sources. This effect may be more pronounced in an area of low seabed complexity as in the Project Area but may also reduce fish habitat for soft bottom communities. The overall effects would last for the length of the Project activity, but the combination of increased colonization opportunities and local enrichment may support faster recovery in an otherwise slow recovering environment. If DFO determines that a *Fisheries Act* Authorization is required respecting the HADD of fish habitat associated with the installation of subsea infrastructure, and habitat offsetting is required, a habitat offsetting program will be developed in conjunction with DFO as a mitigation measure for the net loss of fish habitat resulting from the Project.

Potential adverse effects from marine discharges would be highly localized. Produced water discharges will be rapidly dispersed in the receiving environment, minimizing potential thermal or chemical environmental effects. In modelling of produced water conditions with the highest potential for environmental effects, the area of effect was localized to within 100 m of the FPSO. For deeper waters within the Core BdN Development and/or Project Areas, drill cuttings, using worst case 8-slot well template, are predicted to accumulate in exceedance of 1.5 mm and 6.5 mm thresholds within 200 m of the drilling location, with potential for localized sedimentation effects within this area. For shallower waters, drill cuttings deposition in exceedance of the threshold are predicted to be within 2 km. of the well location. Mitigation measures to reduce potential impacts from drilling include C-NLOPB guidance requirements regarding setback distances of well locations from corals aggregations and *Lophelia pertusa*, use of subsea cuttings transport and treatment of drill cuttings in accordance with the OWTG (NEB et al. 2010) using best treatment practices that are commercially available and economically feasible.

Marine vessel and helicopter traffic servicing the FPSO and drilling installation will be inherently transient in nature, reducing potential environmental effects associated with discharges, light and sound, to any one location. Sound generated by supply and servicing vessels could elicit avoidance behaviours in pelagic fishes, but these effects would be temporary and localized to within 1 km² of vessels. Based on the scientific literature, rms sound pressure levels below 150 dB re 1 $\mu Pa_{(rms)}$ would not likely cause potential fitness-related behavioural changes in swim bladdered fish species studied to date. Sound levels above this behavioural effect threshold were limited to less than 150 m from the source for the drillship (100 m to 102 m behavioural effect distance), FPSO (63 m behavioural effect distance), and combined drillship and FPSO (117 m to 122 m behavioural effect distance).

Geophysical surveys within the Project Area, particularly 2D/3D/4D seismic surveys, will likely cause behavioural effects on fishes with swim bladders used in hearing, as well as those with higher sensitivities to particle displacement in the water column. Given the complex bathymetry in the Project Area, behavioural effects, based on sound modelling results, could extend as far as 50 km from the seismic source, depending on where the air sources are being discharged. Sound modelling also indicated that maximum received sound levels could occur at various depths within the water column. 4D seismic surveys might also involve the deployment of receivers on the seabed, resulting in temporary, small-scale interaction with the benthic habitat. Environmental and geotechnical surveys are predicted to have similar transient and sporadic environmental effects with limited interactions with the seabed. Therefore, the ecological, social and/or economic value of any fish that exhibits behavioural responses to Project-related sound will not be compromised.

Tables 9.18 and 9.19 summarize the environmental effects assessment for Core BdN Development and Project Area Tiebacks, respectively, that comprise the Project being assessed under CEAA 2012.

9.6.3 Determination of Significance

It is predicted that the Project will not result in significant residual adverse effects on Marine Fish and Fish Habitat. This conclusion has been reached with a moderate to high level of confidence based on the nature and scope of the Project, knowledge about the existing environment within the LSA and RSA, and current understanding of the effects of similar projects on the VC and relevant, planned mitigation measures. Given the variable nature of the data on response of fish and invertebrates to underwater sound emissions from geophysical activities, and recovery and recolonization in of benthic habitat in deep sea areas, a moderate level of confidence was prescribed to the effects determination for geophysical activities, installation of subsea infrastructure, drill cuttings discharges and decommissioning activities.

The primary mechanisms of interaction that may have effects on this VC include the marine discharges, sound, and light emissions associated with the Project, including those that may result in direct interaction with and effects on the seabed and sensitive benthic organisms or habitats.

Table 9.18 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat (including SAR) – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Marine Vessels										
Light Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	R	Y	H		
Underwater Sound Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H		
Installation of Subsea Infrastructure	Change in Habitat Availability and/or Quality	A	L	<10 km²	S	R	Y	H	A, C	Monitoring under Offsetting Plan, if required
	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H		
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<10 km²	M-L	R	Y	M - H		
	Change in Food Availability and/or Quality	A	N	< 1 km²	S	R	Y	H		
Hook up and Commissioning										
HUC Discharges	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<1 km²	S	S	Y	H	E, F	Not Proposed
PRODUCTION AND MAINTENANCE OPERATIONS										
FPSO and Subsea Infrastructure										
Presence of FPSO and Subsea Infrastructure	Change in Habitat Availability and/or Quality	P - A	N-L	<10 km²	L	C	Y	H	C, D, J	Monitoring under Offsetting Plan, if required
	Change in Food Availability and/or Quality	P - A	N	<1 – 10 km²	L	C	Y	H		
Light Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	L	<10 km²	L	R	Y	H	L, M	Not Proposed
	Change in Food Availability and/or Quality	P - A	N	<10 km²	L	R	Y	H		
Underwater Sound Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	L	C	Y	M - H	Not Proposed	Not Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	N	<1 km²	L	N - S	Y	M - H		
	Change in Food Availability and/or Quality	A	N	<1 km²	L	C	Y	H		
Waste Discharges from FPSO										
Produced Water	Change in Habitat Availability and/or Quality	A	L	<10 km²	L	C	Y	M - H	E, F	Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<10 km²	L	C	Y	M - H		
	Change in Food Availability and/or Quality	A	N	<10 km²	L	C	Y	H		
DRILLING ACTIVITIES										
Drilling Installation										
Light Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<10 km²	S	R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<10 km²	S	R	Y	H		

Table 9.18 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat (including SAR) – Core BdN Development

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-Up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		
ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Underwater Sound Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	C	Y	M - H	Not Proposed	Not Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	N	<1 km²	S	N – S	Y	H		
	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H		
Waste Discharges from Drilling Installation										
Drill Cuttings	Change in Habitat Availability and/or Quality	A	L	< 1 km² - <10 km²	M - L	C	Y	M - H	B, E, F	Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	< 1 km² - <10 km²	M - L	C	Y	M - M		
	Change in Food Availability and/or Quality	A	N	< 1 km² - <10 km²	M - L	C	Y	M - H		
SUPPLY AND SERVICING										
Light Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N - L	<1 km²	S - L	S - R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	L	R	Y	H		
Underwater Sound Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S - L	S - C	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S - L	S - C	Y	H		
SUPPORTING SURVEYS										
Light Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	R	Y	H		
Underwater Sound Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H		
Underwater Sound Emissions from Geophysical Survey Equipment	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	L	<1,000 km² - <10,000 km²	S	S	Y	M - H	K	Not Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<1 km²	S	N - S	Y	M - H		
	Change in Food Availability and/or Quality	A	L	<1,000 km² - <10,000 km²	S	S	Y	M - H		
Geohazard / Wellsite Surveys	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	L	<1 km²	S	S	Y	M - H	K	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	S	Y	H		Not Proposed

Table 9.18 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat (including SAR) – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY											
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
DECOMMISSIONING										
Decommissioning of Subsea infrastructure	Change in Habitat Availability and/or Quality	N	N	<10 km²	L	O	N/A	M - H	N	Not Proposed
	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<10 km²	L	O	N/A	H		
	Change in Fish and Invertebrate Mortality, Injury and/or Health	N	N	<10 km²	L	O	N/A	H		
	Change in Food Availability and/or Quality	N	N	<1 km²	L	O	N/A	H		
Well Decommissioning	Change in Habitat Availability and/or Quality	A	N	<1 km²	L	O	Y	H	N, O, P	

Evaluation of Significance

- Based on the overall nature and characteristics of the Project and the existing environment for this VC within the LSA, and with the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine Fish and Fish Habitat.
- Overall, Project-related activities may result in some localized, long-term interactions with fish and fish habitat in the Project Area and/or the LSA, the number of individuals and habitat areas that may be affected, and the short- long-term and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects and will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area.
- For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant residual adverse effects on marine fish species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Table 9.19 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Marine Vessels										
Light Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	R	Y	H		
Underwater Sound Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H		
Installation of Subsea Infrastructure	Change in Habitat Availability and/or Quality	A	L	<10 km² - <100 km²	S	R	Y	H	A, C	Monitoring under Offsetting Plan, if required
	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H		
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<10 km² - <100 km²	S - L	R	Y	M - H		
	Change in Food Availability and/or Quality	A	N	< 1 km²	S	R	Y	H		
Hook up and Commissioning										
HUC Discharges	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<1 km²	S	S	Y	H	E, F	Not Proposed
PRODUCTION AND MAINTENANCE OPERATIONS										
Presence of FPSO – No Change from Core BdN Development										
Light Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	L	<10 km²	L	R	Y	H	L, M	Not Proposed
	Change in Food Availability and/or Quality	P - A	N	<10 km²	L	R	Y	H		
Underwater Sound Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	L	C	Y	M - H	Not Proposed	Not Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	N	<1 km²	L	N - S	Y	M - H		
	Change in Food Availability and/or Quality	A	N	<1 km²	L	C	Y	H		
Waste Discharges from FPSO – No Change from Core BdN Development										
Produced Water	Change in Habitat Availability and/or Quality	A	L	<10 km²	L	C	Y	M - H	D, E, F, G, H, I	Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<10 km²	L	C	Y	M - H		
	Change in Food Availability and/or Quality	A	N	<10 km²	L	C	Y	H		
Subsea Infrastructure										
Presence	Change in Habitat Availability and/or Quality	P - A	L	<10 km² - <100 km²	L	C	Y	H	C	Monitoring under Offsetting Plan, if required
	Change in Food Availability and/or Quality	P	N	<10 km² - <100 km²	L	C	Y	H		

Table 9.19 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY											
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
DRILLING ACTIVITIES										
Drilling Installation										
Light Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<10 km²	S	R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<10 km²	S	R	Y	H		
Underwater Sound Emissions	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	C	Y	M - H	Not Proposed	Not Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	N	<1 km²	S	N – S	Y	H		
	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H		
Waste Discharges from Drilling Installation										
Drill Cuttings	Change in Habitat Availability and/or Quality	A	L	< 1 km² - <100 km²	S - M - L	C	Y	M - H	B, E, F	Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	< 1 km² - <100 km²	S - M - L	C	Y	M - M		
	Change in Food Availability and/or Quality	A	N	< 1 km² - <10 km²	S -M - L	C	Y	M - H		
SUPPLY AND SERVICING – No change from Core BdN Development										
Light Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N - L	<1 km²	S - L	S - R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	L	R	Y	H		
Underwater Sound Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S - L	S - C	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S - L	S - C	Y	H		
SUPPORTING SURVEYS										
Light Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	R	Y	H		
Underwater Sound Emissions from Vessels	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H		

Table 9.19 Environmental Effects Assessment Summary: Marine Fish and Fish Habitat (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY											
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
Underwater Sound Emissions from Geophysical Survey Equipment	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	L	<1,000 km² - <10,000 km²	S	S	Y	M - H	K	Not Proposed
	Change in Fish and Invertebrate Mortality, Injury and/or Health	A	L	<1 km²	S	N - S	Y	M - H		
	Change in Food Availability and/or Quality	A	L	<1,000 km² - <10,000 km²	S	S	Y	M - H		
Geohazard / Wellsite Surveys	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	A	L	<1 km²	S	S	Y	M - H		
	Change in Food Availability and/or Quality	A	N	<1 km²	S	S	Y	H		
DECOMMISSIONING										
Decommissioning of Subsea infrastructure	Change in Habitat Availability and/or Quality	N	N	<10 km² - <100 km²	L	O	N/A	M - H	N	Not Proposed
	Change in Fish and Invertebrate Presence and/or Abundance (Behavioural Effects)	N	N	<10 km² - <100 km²	L	O	N/A	H		
	Change in Fish and Invertebrate Mortality, Injury and/or Health	N	N	<10 km² - <100 km²	L	O	N/A	H		
	Change in Food Availability and/or Quality	N	N	<10 km² - <100 km²	L	O	N/A	H		
Well Decommissioning	Change in Habitat Availability and/or Quality	A	N	<1 km²	L	O	Y	H	N, O, P	Not Proposed

Evaluation of Significance

- Based on the overall nature and characteristics of the Project and the existing environment for this VC within the LSA, and with the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine Fish and Fish Habitat.
- Overall, Project-related activities may result in some localized, long-term interactions with fish and fish habitat in the Project Area and/or the LSA, the number of individuals and habitat areas that may be affected, and the short- long-term and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects and will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area.
- For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant residual adverse effects on marine fish species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

In consideration of the overall nature and characteristics, geographic extent and short- to long-term duration of the various planned components and activities associated with this Project, along with the offshore and dynamic marine environment involved and the planned implementation of standard and effective mitigation measures, the Project is not likely to result in significant residual adverse effects on Marine Fish and Fish Habitat. Although Project-related components, activities and discharges and emission interact with fish and fish habitat, the zones of influence would occupy a very small area within the entire Core BdN Development and/or Project Areas and would not contribute to an overall decline in fish abundance or change the spatial and/or temporal distribution of fish populations within the RSA. Project activities and discharges will interact with fish habitat, however the effects on fish habitat would not result in the harmful alteration, disruption or destruction of fish habitat in the Project Area that cannot be adequately compensated by offsetting.

For fish SAR, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA. The Project will therefore not have implications for the overall abundance, distribution, or health of these species nor its eventual recovery.

9.7 Environmental Monitoring and Follow-up

Equinor Canada will obtain the required authorizations for the Project, and comply with applicable regulations, guidelines, and mitigation measures as identified and committed to in the preceding sections, the implementation of which will be planned, managed, and monitored in accordance with existing operational procedures and policies.

If DFO determines that a *Fisheries Act* authorization is required, fish habitat/coral and sponge data may need to be collected in support of this authorization. Additionally, if a *Fisheries Act* Authorization is required, a monitoring program regarding offsetting measures may be required. The details of a monitoring program regarding offsetting will be determined in consultation with DFO.

A follow-up monitoring program will be designed and submitted to the C-NLOPB for review and acceptance as part of the Operations Authorization (OA) process. Section 18.4.2 provides an overview of the objectives of a follow-up monitoring program. The follow-up program will be designed to reflect the final Project design and will consider the conclusions of the effects assessment, provided herein, and the requirements outlined in the EIS Guidelines. In particular, Equinor Canada will engage with regulatory agencies, Indigenous groups and key stakeholders for additional information or further input into EEM plans. The purpose of the program would be to determine the effectiveness of mitigation measures for Marine Fish and Fish Habitat and verification of modelling zones of influence. In keeping with adaptive management, the effects monitoring program will be designed such that monitoring parameters can be modified or discontinued over time, for instance if the zone of influence of a certain discharge is verified or if no effects are detected. Options for this program will consider technology-based verses person-based sampling efforts and will build upon Equinor's global experience in effects monitoring.

Based on predicted residual environmental effects, and in consideration of uncertainties regarding these effects predictions the follow-up monitoring program will include the following general parameters:

- Produced water plume dispersion – verification of modelling predictions; verification of effects on receiving environment
- Drill cuttings discharge – verification of modelling predictions regarding zone of influence of cuttings dispersion; verification of effects on receiving environment (i.e., effects on benthic habitat)

Details regarding specific objectives and methodologies to be employed, components to be analysed, etc., will be developed in consultation with appropriate regulatory agencies, Indigenous groups and stakeholders as noted above.

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10.0 MARINE AND MIGRATORY BIRDS: ENVIRONMENTAL EFFECTS ASSESSMENT

A variety of bird species occur within the marine and coastal environments off eastern Newfoundland at various times of the year, including seabirds and other avifauna that inhabit the region for breeding, feeding, migration and other activities according to their individual life histories and habitat requirements. A number of important habitats for birds have also been identified at locations along the coastline of Newfoundland and Labrador (NL).

Birds are important from an ecological, social, and economic perspective, because they often function near the top of the food chain and may be relatively vulnerable to certain types of environmental disturbance. Some species are also an important resource for recreational and tourism-related pursuits. Most birds found in Canada are also protected under the *Migratory Birds Convention Act* (MBCA) and its associated Regulations, which implement the terms of the Migratory Birds Convention of 1916 between Canada and the United States. Further, wildlife in NL (including certain species not protected under the MBCA) are managed under the provincial *Wild Life Act* and associated Regulations. Avian species at risk (SAR) and their habitats, including some species that are known or have potential to occur in the Project Area and surrounding marine environments, are protected by both federal (*Species at Risk Act* (SARA)) and provincial (*Endangered Species Act* (ESA)) legislation. This valued component (VC) integrally considers avian SAR that are listed under SARA and NL ESA and other species that are otherwise considered to be of special conservation concern (SOCC).

10.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

The following sections define the spatial and temporal context within which potential environmental effects on Marine and Migratory Birds are assessed. These have been established to direct and focus the environmental effects assessment for each VC.

10.1.1 Spatial Boundaries

Four spatial assessment boundaries have been defined for the environmental effects assessment of this VC. They reflect the Core Bay du Nord (BdN) Development, the Project Area Tiebacks, and the varying ways in which the Project and VC may interact. The boundaries are informed by the nature, scale, timing, and other characteristics of the Project and the existing environmental setting, and potential environmental interactions. These Study Areas are defined as follows and are illustrated in Figure 10-1.

Core BdN Development Area: The Core BdN Development Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbance to the marine environment may occur. It occupies an offshore area of approximately 470 km², encompassing the planned location of the floating production, storage and offloading (FPSO) and supporting subsea infrastructure and activities. The actual seabed footprint of Project facilities within the Core BdN Development Area is approximately 7 km².

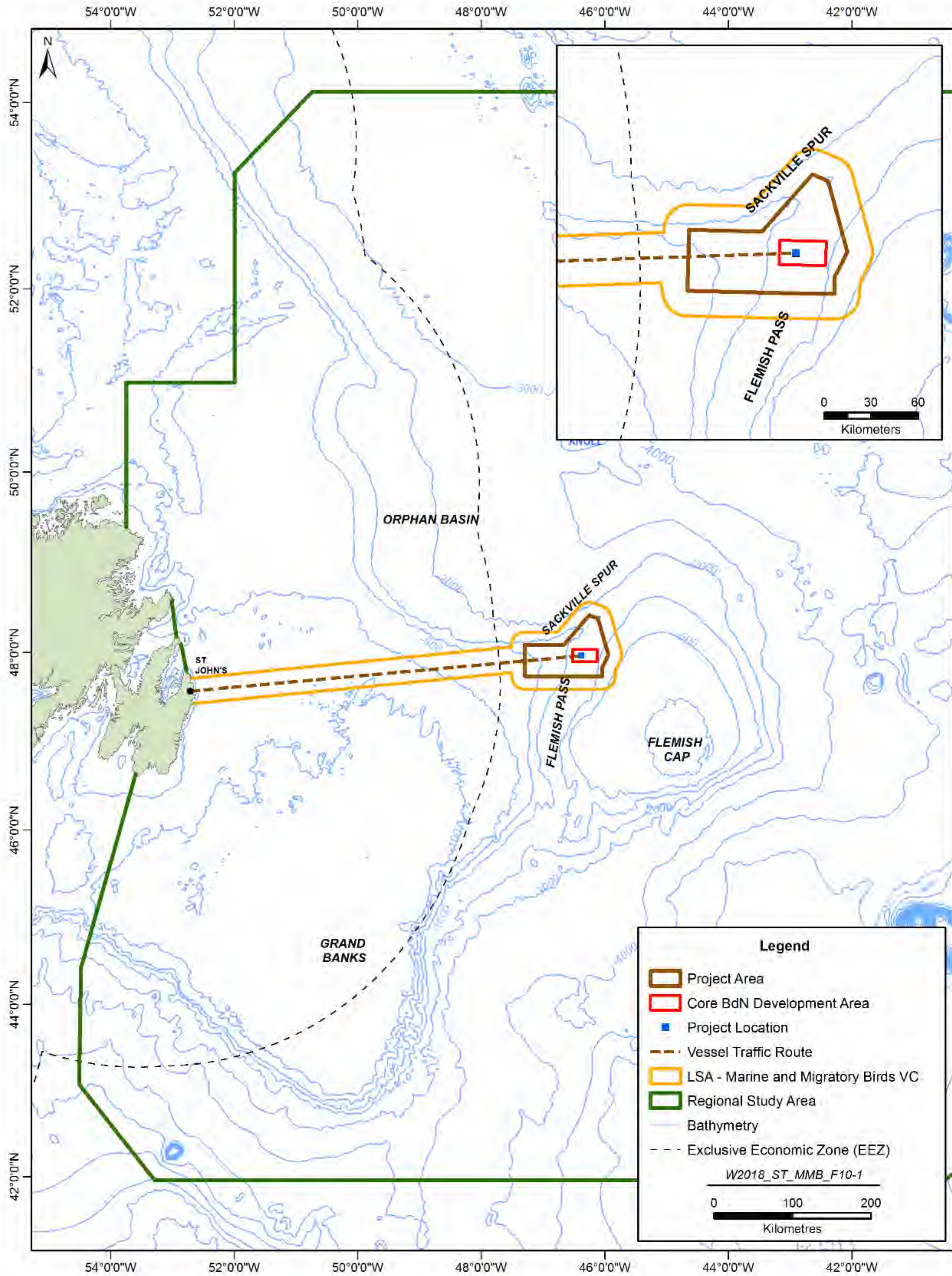

Figure 10-1 Environmental Assessment Study Areas: Marine and Migratory Birds

Project Area: The broader Project Area is where Project Area Tiebacks (as described in Section 2.6.6) may occur. While the Project Area is defined as an overall area that encompasses such activities for the duration of the Project, different components and activities may occupy smaller areas within this overall area, as described in Chapter 2. The Core BdN Development Area is located entirely within the Project Area. The Project Area is approximately 4,900 km². The footprint of the Core BdN Development subsea infrastructure is approximately 0.1 percent of the Project Area. If Project Area Tiebacks were to be undertaken, using the illustration presented in Figure 10-1 the footprint of potential new tiebacks represents approximately 15 km², less than 0.5 percent of the Project Area.

Local Study Area (LSA): The LSA encompasses the overall geographic area over which all planned and routine Project-related environmental interactions may occur. It represents the predicted environmental zone of influence of the Project's planned components and activities, within which Project-related environmental changes to Marine and Migratory Birds may occur and can be assessed and evaluated. Nocturnally active marine and migratory birds are susceptible to attraction to artificial lighting. Very few estimates have been attempted to determine the distance at which nocturnally active birds are attracted to artificial lighting. However, large numbers of young short-tailed shearwaters fledging from a nesting colony on a headland in Australia were attracted to intense, temporary electrical lighting at a coastal construction site separated from the colony by 15 km of sea rather than to lower intensity electrical lighting across only 2.5 km of sea (Rodríguez et al. 2014). Therefore, the LSA is defined as a 15 km area around the offshore Project Area and the vessel traffic route between the Project Area and St. John's, NL.

Regional Study Area (RSA): The environmental effects assessment also recognizes and considers the characteristics, distributions, and movements associated with the individual VCs under consideration from an ecological perspective. The RSA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). The RSA is defined based on the predicted zone of influence of a potential oil spill event, as summarized in Section 16.4, specifically, the area of maximum cumulative surface oil thickness for the 95th percentile surface oil exposure case at the ecological threshold of 10 g/m² (0.01 mm). The RSA captures the marine waters offshore eastern NL including all or part of NAFO Divisions 2J, 3K, 3L, 3M, 3N and 3O.

10.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the frequency and duration of routine Project-related activities, as well as the likely timing of resulting environmental effects. The overall schedule for the Project is provided in Section 2.1.1, and the temporal boundaries of each Project phase are provided in Table 10.1.

Table 10.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Core BdN Development Phases	
Offshore Construction and Installation, and Hook-up and Commissioning (HUC)	• Site surveys commencing as early as 2021 • Offshore construction as early as 2023, but may occur later • Approximately 5 years; as early as 2021 • Seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of year
Production and Maintenance Operations	• Commencement as early as 2026 • 12 to 20 years; year-round
Drilling Activities	• Commencement as early as 2024 • On average, drilling time is approximately 45-85 days per development well (timeframe for pilot wells and sidetracks will be shorter) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2022 • Ongoing throughout life of Project; year-round
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed. • Approximately 2 to 4 years; seasonal or year-round
Project Area Tiebacks	*Extension of Project life to maximum 30 years*
Offshore Construction and Installation, and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to four tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but activities could occur year-round • May occur at any time over life of Project
Production and Maintenance Operations	• Continuation of activities from existing FPSO out to end of Project life • Year-round

Table 10.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Drilling Activities	• Total timeframe for drilling depends on number of wells required; • On average, drilling time is approximately 45-85 days per well • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Year-round, when drilling occurs
Supply and Servicing	• Continuation of activities to end of Project life • Year-round
Supporting Surveys	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

10.1.3 Approach and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on the EA methodology detailed in Chapter 4 of this EIS and include the nature, scale and timing of the Project's planned components and activities (see Chapter 2), and the existing environment for this VC (see Section 6.2). This analysis has focused on identifying key potential Project-VC interactions and, in particular, anticipated changes to the existing biophysical environment resulting from planned Project activities that may, through one or more associated pathways, lead either directly or indirectly to overall effects on the presence, abundance, diversity, health or other aspects of Marine and Migratory Birds at the individual and/or population levels.

The assessment considers what is known and can reasonably be deduced about the presence, abundance and distribution of marine and migratory bird species within the LSA and the RSA, with a focus on important or sensitive species and components, and those with the potential to be affected by the Project. The assessment and description of environmental effects and the identification of mitigation has been informed by a review of the existing and available literature, including scientific studies and monitoring initiatives.

Modelling was undertaken to provide additional Project-specific information and analysis of specific discharges (drill cuttings (Appendix I) and produced water (Appendix J) and air emissions (Appendix K) to evaluate the potential dispersion and predicted "footprint" of these discharges and the possible ecological implications of these interactions. Section 9.1.3 provides an overview of the modelling undertaken.

10.1.4 Environmental Effect Significance Definitions

The definitions used to characterize environmental effects are provided for in Chapter 4 and are provided below (Table 10.2) specific to Marine and Migratory Birds. These characterizations will be used throughout this VC assessment in describing residual environmental effects on Marine and Migratory Birds from routine Project Activities.

Table 10.2 Characterization of Residual Effects on Marine and Migratory Birds

Characterization	Description	Definition of Categories
Nature/Direction of effect	The long-term trend of the residual environmental effect relative to baseline conditions	• **Positive** – a residual environmental effect on habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health in a direction that is considered beneficial to Marine and Migratory birds relative to baseline conditions • **Adverse** - a residual environmental effect on habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health in a direction that is considered harmful to Marine and Migratory birds relative to baseline conditions • **Neutral** – no change in habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health of Marine and Migratory birds relative to baseline conditions
Magnitude of effect	The degree of change in habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions	• **Negligible** – although there is a potential for a Project-VC interaction, there would be no change in habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions • **Low** – a change in habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions, that is considered within the range of natural variability, but with no associated adverse effect on the viability of the affected population • **Medium** - a change in habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions that is considered beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population • **High** - a change in habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions that is considered beyond the range of natural variability, but with an adverse effect on the viability of the affected population

Table 10.2 Characterization of Residual Effects on Marine and Migratory Birds

Characterization	Description	Definition of Categories
Geographic Extent of effect	The spatial area within which the residual environmental effect will likely occur	• Less than 1 km^2 • Between 1 km^2 and 10 km^2 • Between 10 km^2 and 100 km^2 • Between 100 km^2 and 1,000 km^2 • Between 1,000 km^2 and 10,000 km^2 • Greater than 10,000 km^2
Duration of effect	The period of time required until the habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health of marine and migratory birds returns to its baseline condition, or the residual effect can no longer be measured or otherwise perceived	• Short Term - less than 12 months (1 year) • Medium Term - 1 to 5 years • Long Term - more than 5 years • Permanent - recovery to baseline conditions unlikely
Frequency of effect	Identifies how often a residual effect will likely occur	• Not likely to occur • Occurs once – effect occurs one time • Occurs sporadically – effect occurs episodically, no set schedule • Occurs regularly – effect occurs at regular intervals • Occurs continuously – effect occurs continuously
Reversibility of effect	Pertains to whether habitat quality/availability, food quality/availability, behaviour, mortality, injury and/or health of marine and migratory birds can return to baseline conditions after the Project/activity stops	• **Reversible**: Will eventually recover to baseline conditions • **Irreversible**: Permanent

Significant residual environmental effects are considered to be those that could cause a change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. In consideration of the descriptors listed in Table 10.2, as well as a consideration of regulatory requirements, and SARA recovery plans, a significant residual adverse environmental effect on Marine and Migratory Birds resulting from the Project is defined as one that would cause one or more of the following:

- A detectable decline in bird abundance or change in the spatial and temporal distributions of bird populations within the RSA over multiple generations. Generation time varies from species to species (i.e., 2-3 years in dovekie and 8-12 years in northern fulmar)
- Effects on a designated (protected) SAR or its designated critical habitat under SAR such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected

Summary effects assessment statements for each phase/activity (e.g., Offshore Construction and Installation and HUC; Production and Maintenance, etc.).

The potential environmental effects of accidental events on Marine and Migratory Birds are evaluated and assessed in Chapter 16 (Accidental Events).

10.1.5 Potential Environmental Changes, Effects, and Mitigation Measures

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine and Migratory Birds. Mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable.

10.1.5.1 Potential Project-related Environmental Changes and Effects

Potential environmental interactions between Project activities and Marine and Migratory Birds have been identified through review of the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014), the Flemish Pass Exploration Drilling EIS (herein referred to as the Drilling EIS) (Statoil 2017) and the information required by the Canadian Environmental Assessment Agency (the CEA Agency) arising from its technical review of the Drilling EIS (the "IRs"). In addition, the EIS Guidelines issued by the CEA Agency in September 2018 identify and specify a number of issues and potential effects on this VC that are also considered in the EIS (refer to Section 7.1.4 in Appendix A). Based on review of these resources, it has been determined that the potential direct and indirect adverse effects on Marine and Migratory Birds, including population level effects that could be caused by Project activities, include but are not limited to:

- Change in habitat availability and/or quality
- Change in food availability and/or quality
- Change in avifauna presence and abundance (behavioural effects)
- Change in mortality / Injury levels and/or health of individuals or populations

Equinor Canada completed an environmental assessment process per the *Canadian Environmental Assessment Act*, 2012 (CEAA 2012) process for its Drilling EIS. Marine and Migratory Birds associated comments from the Drilling EIS EA process, as well as those received during ongoing engagement with Indigenous groups and stakeholders in regards to the BdN Development (as identified in Sections 3.3.1.2 and 3.4 of this EIS) are as follows and are addressed, as applicable to the scope of the assessment, herein.

Government Departments and Agencies

- Potential attraction of marine and migratory birds to lighting / flaring, and cumulative effects
- Protocols for seabird monitoring and observation
- Potential for mortality of marine and migratory birds during flaring events
- Potential effects of the Project on Leach's storm-petrels, which are known to have a declining population

Indigenous Groups

- Potential for marine and migratory birds to be attracted to lights
- Potential for mortality of marine and migratory birds during flaring events
- Potential effects of sound, including continuous sounds, on marine and migratory birds
- Potential effects of increased traffic (e.g., sound, light and emissions) on marine and migratory birds
- Protocols for seabird monitoring and observation

Stakeholder Organizations

- Protocols for seabird monitoring and observation
- Potential effects of the Project on Leach's storm-petrel, which is known to have a declining population

The environmental effects assessment for this VC considers and focuses on the issues and questions identified through these issues scoping exercises, and as identified in Sections 7.1.4 of the EIS Guidelines (Appendix A), including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from them. These are summarized in Table 10.3.

Table 10.3 Potential Project-Related Environmental Changes and Potential Effects: Marine and Migratory Birds

Potential Environmental Effect	Potential Environmental Change
Change in Habitat Availability and/or Quality	• Project-related components, activities and associated emissions or disturbances may change the physical characteristics of habitats used by marine birds • Resulting environmental changes in the availability, extent, and quality of habitats for birds have the potential to affect the presence and abundance of birds in the affected areas
Change in Food Availability and/or Quality	• Changes to the availability, quantity, and quality of food sources (e.g., marine fish and invertebrates, other birds, waste generated from Project site) have the potential to affect the presence and abundance of birds
Change in Avifauna Presence and Abundance (Behavioural Effects)	• Light emissions associated with the FPSO, drilling installations and vessels may create associated environmental changes such as food availability or by disorientation due to increased lighting levels • Conversely, others may avoid the area because of the associated sensory disturbance in the marine environment • These potential behavioural changes may influence the spatial and temporal presence and abundance or birds in the area, as well as possibly affecting individuals or populations of birds if risk of injury / mortality, loss of access to key habitats for extended periods occurs, and/or affects key and sensitive life history stages

Table 10.3 Potential Project-Related Environmental Changes and Potential Effects: Marine and Migratory Birds

Potential Environmental Effect	Potential Environmental Change
Change in Mortality / Injury Levels and/or Health of Individuals or Populations	• Potential mortality, injury of health effects may occur because of oil and gas related activities • These could include potential direct Project induced environmental changes on birds (e.g., increased lighting levels or flaring) or possible indirect outcomes (e.g., artificial lighting and organic waste leading to increased rates of predation).

An overview of the potential interactions between each of the Project's planned components and activities and Marine and Migratory Birds, and specifically, the potential for these to result in environmental changes to the various aspects of this VC, are presented in Table 10.4.

In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of project activities is based on those discharges/activities "with the greatest potential to have environmental effects." This is based on scientific literature, research studies, Indigenous knowledge, input from Indigenous groups and stakeholders, and professional experience of the EIS team. The primary interaction with Marine and Migratory Birds is vessel presence, light emissions from vessels and installations, flaring from the FPSO, underwater sound emissions from geophysical surveys. Underwater sound emissions from vessels is not considered an interaction that has "the greatest potential to have environmental effects."

There is no interaction of Marine and Migratory Birds associated with the installation of subsea infrastructure. For marine discharges, the focus is on produced water from the FPSO. Other marine discharges from vessels and installations, such bilge and ballast water are treated in accordance with regulatory requirements and therefore are not predicted to have an interaction. In addition, food and sewage waste (organic waste) discharged overboard are expected to be degraded after release (BP 2016) however there is potential for interaction with Marine and Migratory Birds, especially for the longer-term presence of the FPSO. As a result, the interaction of the discharge of organic waste is considered an interaction and is assessed below.

Interactions associated with underwater sound are limited to underwater sound emissions from geophysical activities. Birds demonstrate avoidance behaviour from helicopters at greater distances than fixed wing aircraft suggesting sound is a more important stimulus than presence, therefore the interaction from helicopters focuses on its presence and movement.

There is no interaction with air emissions from the Project.

With regards to drilling activities, especially the discharge of water-based muds and cuttings, no interaction with Marine and Migratory Birds is anticipated. Water-based muds and cuttings are discharged untreated at the seabed in accordance with the OWTG (NEB et al. 2010), at depths far below the maximum diving range of most seabirds. Water depths in the Core BdN Development Area range from approximately 1,000 m to 1,200 m, while water depths in the Project Area ranges from approximately 340 m to 1,200 m. Thick-billed murre, the deepest-diving seabird species found in the

Project Area, rarely reaches depths of 200 m (Gaston and Hipfner 2000). SBM has a synthetic base fluid as a component. SBM cuttings are treated prior to discharge and have a small (and permitted) fraction of residual SBM when discharged. Periodically, the discharge of SBM have caused surface sheening (Morandin and O'Hara 2016) and the effect is addressed below. With appropriate screening and selection of chemicals (including use of non-toxic drilling fluids), and proper disposal of drill muds and cuttings, effects on birds due to disposal of drill muds and cuttings are considered unlikely.

Table 10.4 Potential Project-VC Interactions and Associated Effects: Marine and Migratory Birds

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 10.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Avifauna Presence and Abundance (Behavioural Effects)	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	
CORE BdN DEVELOPMENT					
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING					
Vessels					
• Presence	•		•		
• Light Emissions		•	•	•	B, C, D
• Underwater Sound Emissions	No interaction				
• Marine Discharges		•	•	•	L, M, N
Installation of Subsea Infrastructure	No interaction				
Hook-up and Commissioning					
• HUC discharges		•			O
PRODUCTION AND MAINTENANCE OPERATIONS					
• Presence of FPSO	•		•		
• Light Emissions from FPSO		•	•	•	A, B, C, D, E, F, G, J
• Underwater Sound Emissions from FPSO	No interaction				
Waste Discharges during Production and Maintenance					
• Produced Water				•	K, O
• Marine Discharges		•	•	•	K, L, M, N
• Non-routine Flaring		•	•	•	B, C, D, G, I, J

Table 10.4 Potential Project-VC Interactions and Associated Effects: Marine and Migratory Birds

Project Component / Activity	Potential Environmental Effects: Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Avifauna Presence and Abundance (Behavioural Effects)	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	Mitigation (see Section 10.1.5.2)
DRILLING ACTIVITIES					
• Presence of Drilling Installation	•		•		
• Light Emissions from Drilling Installation		•	•	•	B, C, D
• Underwater Sound Emissions	No Interaction				
Waste Discharges from Drilling Installation					
• Drill Cuttings				•	K, O
• Marine Waste Discharges		•	•	•	K, L, M, N
• Flaring during formation flow testing		•	•	•	B, C, D, H, I
SUPPLY AND SERVICING					
Marine Vessels					
• Presence	•		•		P, R
• Light Emissions		•	•	•	B, C, D (SBVs only)
• Underwater Sound Emissions	No Interaction				
• Marine Waste Discharges		•	•	•	L, M, N
Aircraft (helicopters)					
• Movement/Sound	•		•		P, Q, R
SUPPORTING SURVEYS					
• Presence of Vessels (and Towed Equipment for geophysical surveys)	•		•		
• Light Emissions from Vessels		•	•	•	B, C, D

Table 10.4 Potential Project-VC Interactions and Associated Effects: Marine and Migratory Birds

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 10.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Avifauna Presence and Abundance (Behavioural Effects)	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	
• Underwater Sound emissions from Vessels	No Interaction				
• Marine Discharges		•	•	•	L, M, N
• Underwater Sound Emissions from Geophysical Survey Equipment		•		•	
DECOMMISSIONING					
Decommissioning of the FPSO	•	•	•	•	
Decommissioning of the Subsea Infrastructure	No interaction				
Decommissioning of wellheads	No Interaction				
PROJECT AREA TIEBACKS					
OFFSHORE CONSTRUCTION, INSTALLATION AND HUC					
Vessels					
• Presence	•		•		
• Light Emissions		•	•	•	B, C, D
• Marine Discharges		•	•	•	L, M, N
Hook-up and Commissioning					
• HUC discharges		•			O
PRODUCTION AND MAINTENANCE OPERATIONS					
• Presence of FPSO	•		•		
• Light Emissions from FPSO		•	•	•	A, B, C, D, E, F, G, J
Waste Discharges during Production and Maintenance					
• Produced Water				•	K, O
• Marine Discharges		•	•	•	K, L, M, N
• Non-routine Flaring		•	•	•	B, C, D, G, I, J

Table 10.4 Potential Project-VC Interactions and Associated Effects: Marine and Migratory Birds

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 10.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Avifauna Presence and Abundance (Behavioural Effects)	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	
DRILLING ACTIVITIES					
• Presence of Drilling Installation	•		•		
• Light Emissions from Drilling Installation		•	•	•	B, C, D
Waste Discharges from Drilling Installation					
• Drill Cuttings				•	K, O
• Marine Waste Discharges		•	•	•	K, L, M, N
• Flaring during formation flow testing		•	•	•	B, C, D, H, I
SUPPLY AND SERVICING					
Marine Vessels					
• Presence	•		•		P, R
• Light Emissions		•	•	•	B, C, D (SBVs only)
• Marine Waste Discharges		•	•	•	L, M, N
Aircraft (helicopters)					
• Movement/Sound	•		•		P, Q, R
SUPPORTING SURVEYS					
• Presence of Vessels (and Towed Equipment for geophysical surveys)	•		•		
• Light Emissions from Vessels		•	•	•	B, C, D
• Marine Discharges		•	•	•	L, M, N

Table 10.4 Potential Project-VC Interactions and Associated Effects: Marine and Migratory Birds

Project Component / Activity	Potential Environmental Effects				Mitigation (see Section 10.1.5.2)
	Change in Habitat Availability and/or Quality	Change in Food Availability and/or Quality	Change in Avifauna Presence and Abundance (Behavioural Effects)	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	
• Underwater Sound Emissions from Geophysical Survey Equipment		•		•	
DECOMMISSIONING					
Decommissioning of FPSO	•	•	•	•	
Decommissioning of Subsea Infrastructure	No Interaction				
Decommissioning of wells	No Interaction				

10.1.5.2 Summary of Mitigation Measures

Mitigation measures to prevent or reduce adverse effects upon Marine and Migratory Birds, as listed below, are identified and considered in an integrated manner within and throughout the environmental effects analysis that follows, where applicable. Mitigations for the associated interactions are identified in Table 10.4.

A. Lighting on the FPSO will be reduced (reduces attraction of birds) to the extent that worker safety and safe operations, per regulatory requirements, are not compromised. Lighting reduction options will be evaluated during detail design, and economically and technically feasible options, which do not compromise worker safety and safe operations, will be implemented. This may include, but not limited to shading, avoiding use of unnecessary lighting, and directional lighting (i.e., towards the deck and not out to sea). Equinor Canada will engage with ECCC on the results of the lighting engineering study(s) undertaken in the front-end engineering and design phase before proceeding to detailed design. The selection of technical and economic feasible lighting options will be undertaken at detail design, whereby Equinor Canada will again engage with ECCC on the selection of lighting options.

B. With regards to stranded seabirds the following will be undertaken:

    i. Routine systematic searches for stranded seabirds will be conducted on vessels engaged in construction and installation activities and HUC, the FPSO, drilling installation(s), stand-by vessels (SBVs), and during supporting surveys. Searches will be undertaken by vessel/installation crew, who have been trained in bird identification and handling.
    ii. Equinor Canada will work with ECCC to develop installation/vessel-specific protocols applicable to the Project with respect to the systematic searches for, and documentation of, stranded birds.
    iii. Appropriate programs and protocols for the collection and release of stranded seabirds will be implemented and will be developed in consideration of ECCCs “Procedures for handling and documenting stranded birds encountered on infrastructure offshore Atlantic Canada” (ECCC 2017).
    iv. If a Species at Risk is found alive (stranded) or dead on the installation/vessel a report will be sent to ECCC for identification.

C. A Seabird Handling Permit will be obtained from ECCC annually.
D. In accordance with ECCC requirements, an annual report, including all occurrence data, will be submitted to ECCC that summarizes stranded and/or seabird handling occurrences.
E. Flaring on the FPSO will not occur during routine operations and excess gas will be reinjected into the reservoir, reducing air and light emissions.
F. Low pressure flare gas (e.g., produced water degassing, cargo tank blanket gas) will be recovered, therefore no continuous flaring, which reduces air and light emissions.
G. High efficiency burners (flare tip) will be used when flaring is required to reduce air emissions
H. The preferred option is for well clean-up to be done through the FPSO, thereby reducing need to flare from the drilling installation. However, if required, the option is available to flare from the drilling installation during well clean-up and/or well testing.
I. The duration of non-routine flaring will typically be of short duration and will be governed by Equinor best practices to reduce overall flaring duration, thereby reducing light emissions from flaring
J. A flaring and venting plan will be submitted to the C-NLOPB for review and acceptance in in support of the application for Operations Authorization, which will outline planned non-routine flaring events. It is the understanding of Equinor Canada that a flaring and venting plan is required to be submitted annually for approval.
K. In consideration of the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010) and regulatory discharge limits, for discharges associated with the Project, the use of best treatment practices that are commercially available and technically feasible will be implemented.
L. Appropriate procedures will be implemented for the handling, storage, transportation, and onshore disposal of solid and hazardous waste
M. Sewage and grey water will be treated in consideration of the OWTG and in accordance with Canadian and international regulatory requirements (e.g., IMO).

N. Marine discharges (e.g., bilge water) are treated in accordance with MARPOL and Canadian requirements prior to discharge
O. The selection and screening of chemicals to be discharged, will be undertaken in consideration of the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG) (NEB et al. 2009) and Equinor Canada's chemical selection and screening processes.
P. Use of common traffic routes for vessels and helicopters will be used where possible and practicable.
Q. Low-level aircraft operations will be avoided where it is not required per Transport Canada protocols.
R. Helicopter flight paths and offshore supply vessel (OSV) transit routes will adhere to the periods of avoidance and specific set back distances, associated with specific, established migratory bird nesting colonies outlined in the NL *Seabird Ecological Reserve Regulations, 2015*, and in consideration of federal guidelines in order to reduce disturbance to seabird colonies.
S. In consideration of the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2018), mitigation measures applied during the Project's geophysical surveys where air source arrays are used will be consistent with those outlined in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) (DFO 2007).
T. A decommissioning plan will be developed and submitted to the C-NLOPB for review and acceptance. The plan will be developed in consideration of regulatory requirements in place at the time of decommissioning, engagement with Indigenous groups, commercial fisheries and other stakeholders and likely effects on the environment.
U. At the time of decommissioning, surface-related infrastructure (e.g., FPSO, turret, anchor lines) will be removed.
V. At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements

10.2 Overview of Marine and Migratory Birds in the Project Area

The following is a summary of the information presented in Section 6.2 regarding marine and migratory birds common in the Project Area. The coastline of eastern NL and the waters offshore provide important habitat for various species of marine-associated birds. The nutrient-rich Grand Banks and Flemish Cap regions are important feeding areas for dozens of marine bird species (Barrett et al. 2006; Fort et al. 2012, 2013). Coastal islands and mainland cliffs provide nesting grounds for tens of millions of seabirds representing some 20 species, including some of the largest seabird colonies in eastern North America south of the Hudson Strait (Lock et al. 1994). Marine-associated birds in the Project Area can be roughly divided into 1) seabirds (petrels and relatives, gannets, cormorants, phalaropes, skuas and jaegers, auks and relatives, gulls, and terns), 2) waterfowl (ducks, geese, and swans) and divers (loons and grebes), and 3) shorebirds (plovers and sandpipers). These groups are regarded as the most vulnerable to perturbation because they spend much of their life in the marine environment.

Among the fulmarine petrels, shearwaters and storm-petrels, northern fulmar forages in the Project Area year-round, using foraging strategies such as dipping, surface-seizing, surface-plunging, pursuit-diving (to 3 m), and scavenging (Mallory et al. 2020). It feeds primarily on Atlantic cod, capelin, herring, sand lance, rockfishes, lanternfishes, various squid species, cuttlefish, octopus, amphipods, copepods, mysids, decapods, krill, isopods, cumaceans, polychaetes, sea butterflies, and cnidarians (Mallory et al. 2020). Great shearwater occupies the Grand Banks and shelf slope waters, including the Project Area, during summer, utilizing plunge-diving and pursuit-diving to 2 m depth, as well as surface-seizing (Ronconi et al. 2010). This species feeds on fish including capelin and mackerel, squid (especially northern shortfin squid), and crustaceans (Brooke 2004), This species and sooty shearwater are the primary avian fish consumers in the northwest Atlantic during the northern hemisphere summer (Barrett et al. 2006). Sooty shearwaters forage in large numbers on the Grand Banks in small numbers in the Project Area during the summer, using pursuit-diving and plunge-diving to depths of 30-40 m, surface-seizing, and hydroplaning (low flight over the water while filtering surface layer) (Carboneras et al. 2020, Weimerskirch and Sagar 1996). This species feeds on schooling fish such as spawning capelin and herring, northern shortfin squid, and crustaceans such as krill (Brown et al. 1981, Brooke 2004, Ronconi et al. 2010). Northern fulmar and these two species of shearwaters are not regularly preyed upon at sea but may occasionally be taken by large fish, seals, or bald eagle (coastal areas only), and are subject to kleptoparasitism by skuas and jaegers. Most of the world's population of great shearwater spends the northern summer on the Grand Banks, its slopes and the Project Area. Millions of Leach's storm-petrels nesting in Newfoundland commute to the continental shelf slope, including the Project Area, from late May to mid-November to feed at night on mesopelagic prey that undertake diel vertical migrations. This species forages while hovering low over the water and picking up prey from the surface, occasionally while pattering its feet on the surface (Pollet et al. 2019). It feeds mainly on vertically migrating lanternfish, mysids, and decapods, and, to a lesser extent, sand lance and amphipods (Steele and Montevecchi 1994; Hedd et al. 2006, 2009; Pollet et al. 2019). After the young Leach's storm-petrels fledge from their nests and the adults abandon the nesting colonies (peaking mid-September to mid-October), fledglings and adults may also pass through the NL Offshore area on their way to the continental shelf slope, including the Project Area to begin their migration. Great black-backed and herring gull are responsible for most predation of Leach's storm-petrels, primarily at the nesting colonies, but may take smaller numbers at sea (Pollet et al. 2019). Wilson's storm-petrel is in the Project Area during summer and has a foraging strategy similar to Leach's storm-petrel, also occasionally shallow-diving (Drucker et al. 2020). Its prey species are primarily planktonic crustaceans, especially krill, as well as small fish, squid, polychaetes, gastropods, and carrion (Drucker et al. 2020).

Red-necked and red phalaropes migrate through the PA in spring and fall. They feed at ocean fronts by surface-seizing copepods, krill, other crustaceans, mollusks, polychaetes, gastropods, and fish eggs (Rubega et al. 2020, Tracy et al. 2020). They sometimes feed in association with marine mammals. Predation on phalaropes at sea is poorly known.

Great skua is present in the RSA well offshore, including the Project Area, from late summer and fall to early spring and south polar skua is present in summer and early fall. Their diet at this time of year is largely unstudied but probably includes fish such as sand lance caught via surface-plunging, kleptoparasitism on other seabird species, and scavenging (Furness et al. 2020a,b). They also prey on other seabird species such as black-legged kittiwake, Atlantic puffin, and Leach's storm-petrel. The skuas' relatives, the three jaeger species, migrate through the Project Area during spring and fall. In marine waters they feed on fish captured by surface-seizing, dipping (in flight to peck at surface items), kleptoparasitism, scavenging, and, in pomarine jaeger, by surface-plunging and plunge-diving (Haven Wiley and Lee 2020a,b,c). However, pomarine jaeger is rarely observed feeding during migration. Long-tail jaeger also feeds on invertebrates. There are no known predators of skuas or jaegers at sea.

The alcids forage by surface-diving. Dovekie is present in very large numbers in offshore waters, including the Project Area, in fall and winter, feeding to depths of 30 m on copepods, krill, amphipods, and young capelin (Montevecchi and Stenhouse 2020). Common murre is present in the RSA in very large numbers from spring to fall primarily close to the nesting colonies, but only in relatively small numbers in the PA from fall to early spring. Whereas thick-billed murre is present in very large numbers, especially on the continental shelf slope, including the Project Area, primarily from fall to early spring. Common murre usually dives to 20-50 m but occasionally up to 180 m (Ainley et al. 2020). It feeds on capelin, Atlantic cod, rockfish, herring, sprat, sand lance, krill, large copepods, and squid. Thick-billed murre dives primarily to 7-31 m but occasionally as deep as 210 m (Gaston and Hipfner 2020). Off Newfoundland it feeds on capelin, arctic cod, squid, krill, and amphipods.

Predators of alcids at sea include large gull species, skuas, peregrine falcon and bald eagle (coastal areas), and, in pack ice, (which may include the Project Area) gyrfalcon and snowy owl. Because alcids use their wings for underwater propulsion, their wing structure has evolved as a compromise between aerial and underwater flight. As a result, their wing area is small in relation to body mass and flight is energetically expensive. In contrast to most seabird species that search for food while in flight, alcids make foraging bouts (dives) from a resting position on the sea surface.

In spring and summer, large numbers of gulls are present in the coastal waters of RSA near breeding colonies. In fall and winter, they are concentrated on the continental shelf slope, including the Project Area. Black-legged kittiwake is the only gull in regionally significant densities offshore, including the Project Area, in winter, foraging by surface-plunging, surface-seizing, and surface-dipping (Hatch et al. 2020b). This species feeds primarily inshore on capelin during the breeding season, and offshore at other times of the year on sand lance, lanternfish, krill, amphipods, polychaetes, and squid. Great black-backed, herring, and ring-billed gulls are primarily coastal species, with the exception of some great black-backed gulls which are found offshore, including the Project Area, during fall migration. These species feed by surface-seizing, surface-dipping, surface-diving, shallow plunge-diving, scavenging, and kleptoparasitism in pelagic, shallow subtidal, and intertidal zones (Good 2020, Nisbet et al. 2020a, Pollet et al. 2020). They are generalist predators and scavengers, feeding on capelin, Atlantic cod, Atlantic tomcod, alewife, mackerel, herring, Leach's storm-petrel, Atlantic puffin, seabird nestlings and eggs, northern shortfin squid, crabs, shrimps, lobster larvae, bivalves, whelks, fishery waste, sewage, and garbage. During the fall migration large numbers of great black-backed gulls have been observed to gather at production platforms on the Grand Banks Offshore NL to forage nocturnally on fish attracted to the surface by platform lighting (Montevecchi et al. 1999; LGL 2017). The primary predator of gulls in marine waters is bald eagle (coastal areas only).

Common and Arctic terns are present in the coastal of the RSA during the breeding season. Arctic terns are present offshore, including the Project Area, during spring and fall migration. They feed by plunge-diving, diving-to-surface, and surface-dipping to capture primarily small, schooling fish species such as herring, gadids, land lance, capelin, as well as smaller quantities of amphipods and other crustaceans (Hatch et al. 2020c, Nisbet et al. 2020b). The dive to depths of < 1 m. Predators of these tern species at sea is unknown but they are subject to kleptoparasitism by gulls, skuas, and jaegers.

As discussed above, Leach's storm-petrel is the most common species to interact with offshore exploration and production installations in the NL offshore area. As identified in Section 10.1.5.1, regulatory agencies and stakeholders identified Leach's storm-petrel as a species meriting heightened focus regarding attraction interactions. This species feeds nocturnally primarily in the deep waters off the continental shelf (see Section 6.2.2.2). As a result, individuals nesting in Newfoundland colonies travel to the waters beyond the Grand Banks to forage, then return to the colonies to provision their nestlings. Large numbers nest at Baccalieu Island and the Witless Bay Islands Ecological Reserve. Tracking of storm-petrels nesting at seven colonies in Atlantic Canada during incubation shows that adults nesting at Baccalieu Island and Witless Bay colonies forage in the LSA\, including the Core and Project areas, and adjacent areas, averaging 4 days per foraging trip (Hedd et al. 2018). When the colonies are abandoned at the end of the nesting season both fledglings and adults may also stage in these waters before beginning their southward migration. It is acknowledged that populations of Leach's storm-petrel have declined substantially in the past two decades, which has resulted in a recent International Union for Conservation of Nature (IUCN) designation of "Vulnerable". The decline has been attributed to a number of factors including predation, ingestion of marine contaminants (e.g., mercury), collisions and strandings due to attraction to lighted structures, contact with hydrocarbons, and shifts in pelagic food webs (BirdLife International 2018). Foraging ranges during the breeding season for four of the seven major colonies in the western Atlantic colonies mentioned above overlapped with offshore oil and gas operations, and numbers have declined at three of these colonies in recent decades (Pollet et al. 2014).

10.3 Core BdN Development

The Core BdN Development includes six broad phases / categories of activities as described in Chapter 2:

- Offshore construction and installation, and HUC
- Production and maintenance operations
- Drilling activities
- Supply and servicing
- Supporting surveys
- Decommissioning

The assessment in the following sections is based on these activities and associated potential interactions as identified in Section 10.1.5.1.

Some or all of these activities may also be part of Project Area Tiebacks in the larger Project Area; their interactions and potential environmental effects are discussed in Section 10.4.

10.3.1 Offshore Construction and Installation, Hook-up and Commissioning

Activities associated with offshore construction and installation and HUC, as described in Section 2.6.1, are those activities that are undertaken before and during the arrival of the FPSO at the Core BdN Development Area.

Offshore Construction and installation activities include site preparation for, and the installation of subsea infrastructure (i.e., well templates, flowlines, risers, riser base, umbilicals, fibre optic cable). As noted in Section 2.6.1.2, options for installation of flowlines, umbilicals, and/or cables include placement on seafloor, or laid via trenching. In certain cases, there may be a requirement for protection of the flowlines / cables / umbilicals. Options for protection include rock placement, concrete mattresses or trenching. These protection measures would be undertaken during the offshore construction and installation phase.

All of these activities will likely be executed seasonally, when offshore weather conditions are favourable, and could extend seasonally over a five-year period. For the purpose of this EA, seasonal offshore activities are generally assumed to occur between the spring and fall months when weather conditions are more favorable for offshore marine activity. Specialized vessels, as listed in Section 2.6.4.2, will be engaged as required to carry out these activities; the number of vessels offshore at any one time will depend on the activities ongoing at that time. Vessels would be engaged in activities at set locations within the footprint of the subsurface installations. For instance, for well template installations, it is likely that a single vessel would be engaged for installation, therefore the zone of influence during well template installation would be limited to a specific well template location and when installation is complete at one location, the vessel would move to the next well template location. Similarly, for flowline installation, the vessel engaged would be situated at one location only. While two different activities may occur at the same time (i.e., well template installation and flowline installation by two different vessels), it is not anticipated that there would be more than one vessel engaged in the same activity. The approximate sequence of SURF installation would be to install well templates and related components, install the FPSO mooring system, install the flowlines, risers and umbilicals, install the turret buoy, pull-in the risers, hook up the FPSO, and install infrastructure protection, as needed.

HUC activities may occur at any time of the year and are estimated to last approximately four months, depending on operational and/or technical issues. Vessels on site during HUC activities, in addition to the FPSO, may include, but not limited to, vessels engaged to attach flowlines, moorings, risers, etc., to the FPSO and/or well templates. Activities also include the leak testing production lines on the FPSO and flowlines on the seafloor.

As indicated in Section 10.1.5.1, the effects assessment for offshore construction and installation and HUC is focused on those interactions and activities “with the greatest potential to have environmental effects” (Part 2, Section 3.2 of the EIS Guidelines) and therefore includes interactions associated with marine vessels, including presence, light emissions and marine waste discharges.

10.3.1.1 Presence of Vessels

The primary effects on Marine and Migratory Birds associated with the presence of vessels during offshore construction and installation and HUC are:

- Change in Habitat Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)

Based on the environmental effects analysis on Marine Fish and Fish Habitat in Chapter 9, which concluded that effects on fish and prey species would be negligible, there is no predicted Change in Food Availability and/or Quality for Marine and Migratory Birds from the presence of vessels during Offshore Construction and installation and HUC activities. A Change in Mortality / Injury Levels and/or Health of Individuals or Populations is primarily associated with vessel lighting, which results in attraction and stranding of birds and is assessed under “Lighting from Vessels”.

Changes in Habitat Availability and/or Quality is a potential effect associated with presence of vessels involved in offshore construction and installation and HUC activities.

Structures may be used as roosting and resting sites by gulls (Burke et al. 2012), as stopover locations for migrating shorebirds and landbirds (April-May, August to October) who may forage around the vessels (Russell 2005 and Bruinzeel and van Belle 2010), or even potentially as hunting grounds for predatory species such as large gull species and vagrant, passage migrant peregrine falcons (September to October), which take advantage of concentrations of birds around the vessels (Russell 2005). In the Core BdN Development Area, the species of birds likely to be present during the offshore construction/installation season include northern fulmar, great shearwater, black-legged kittiwake, great black-backed gull, both murres and dovekie. Since HUC activities could be carried out at any time of the year, outside the offshore construction season, birds likely be present include northern fulmar, great shearwater, Leach’s storm-petrel, black-legged kittiwake, great black-backed gull, both murres and dovekie. The number of birds present is likely lower during offshore construction and installation, and higher if HUC were to occur outside this timeframe. The large gull species and landbird may use the vessels as resting locations but the vessels may cause temporary a loss of habitat for fulmar, shearwater, murres and dovekie. Therefore, these birds are likely to be affected by the presence of vessels in the Core BdN Development Area.

The change in habitat availability and/or quality due to the presence of vessels would be positive and adverse, as described above, but short-term during the construction and installation season or during HUC activities. The geographic extent of the change in habitat would be less than 1 km^2 of the location of the vessel within the Core BdN Development Area. The change in habitat would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. As the vessel footprint would occupy a very small area of the existing baseline habitat available within the entire 470 km^2 Core BdN Development Area (including if more than one vessel were on site at the same time), the magnitude of change in habitat availability would be considered within the range of natural variability and is therefore low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat availability are not proposed.

In summary, the residual environmental effects of a Change in Habitat Availability and/or Quality from the presence of vessels during Construction and Installation and HUC are predicted to be positive and adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with presence of vessels involved in offshore construction and installation and HUC activities. Like ocean-going vessels, there is potential for the temporary presence of vessels engaged in construction and installation and HUC activities to lead to the temporary disturbance and possible displacement of seabirds from foraging and resting areas within the Core BdN Development Area. Disturbance of birds due to increased vessel presence can cause increased flushing or disturbance during foraging, which may lead to reductions in foraging efficiency, greater energy expenditures and elevated stress levels. Foraging activities are typically most common in the Core BdN Development Area from September to April, when Leach's storm-petrel (September and October), murre, and dovekie species are numerous offshore, and overlaps with the construction and installation and HUC seasons. Therefore, should construction and installation or HUC occur during this time period, effects on foraging behaviour are anticipated. However, in the other months when HUC may be undertaken and when foraging is not common in the Core BdN Development Area, no effects are anticipated during HUC activities. There is potential for interaction given that there is likely to be high number of foraging seabirds in the Core BdN Development Area during the latter part of the construction season. For murre species and dovekies that are offshore during this time, behavioural effects are likely (Lieske et al. 2019).

The change in avifauna presence and abundance due to the presence of vessels would be adverse, as described above, but short-term during the construction season or during HUC activities. The geographic extent of the change in habitat would be localized to the location of the vessel(s) within the Core BdN Development Area (i.e., less than 1 km²). The change in avifauna presence and abundance would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. As the vessel footprint would occupy a very small area of the existing baseline habitat available within the entire 470km² Core BdN Development area (including if more than one vessel were on site at the same time), the magnitude of the change in avifauna presence and abundance is considered within the range of natural variability and is therefore low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in avifauna presence and abundance are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from the presence of vessels during Construction and Installation and HUC are predicted to be adverse, low in magnitude, with a geographic extent of less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with vessel presence during Offshore Construction and Installation and HUC are not proposed.

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with vessel presence during Offshore Construction and Installation and HUC in consideration of residual effects predictions.

10.3.1.2 Light Emissions from Vessels

The primary effects on Marine and Migratory Birds, due to the presence of vessels during offshore construction and installation and HUC are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Changes in Habitat Availability and/or Quality are primarily associated with vessel presence and are addressed in Section 10.3.1.1.

Vessels would likely occupy a single location at any one time, as described in Section 10.3.1. Vessels are on-site for four to six months in the Core BdN Area, an area which is typically occupied by transient ocean-going vessels and has only natural lighting sources (sunlight, moonlight). The presence of the vessels for a four- to six-month period during Offshore Construction and Installation or HUC activities would be a new source of artificial lighting in a region that is relatively free of nocturnal artificial lighting, as indicated in a world atlas of computed artificial night sky brightness (Falchi et al. 2016). Studies and literature on effects of lighting on marine and migratory birds tends to be focused on lighting from production and drilling installations. The results and data from studies using oil industry vessels (mentioned above in section 10.3.1.1, LGL 2017) can be used to predict potential effects of vessel lighting on marine and migratory birds.

Changes in Food Availability and/or Quality is a potential effect associated with vessels involved in offshore construction and installation and HUC activities. The change in food availability is likely more pronounced at night and in periods of low visibility, where vessel lighting may attract prey species to the surface of the water (as described in Section 9.3.2.2), that typically would not have been attracted except under clear moonlight conditions. As stated in Section 9.3.2.2, effects of fish attraction due to installation lighting has a zone of influence less than 1.5 km from the installation. While there is no literature to provide data on the intensity and illumination from vessels, based on professional experience the number of lights and the resulting total intensity and overall spread from vessel lighting would be lower than that from a production installation, and therefore the zone of influence regarding prey attraction would be less than the 15 km zone from offshore installation. As noted above in Section 10.2, prey species such as Atlantic saury and sand lance, which are present in the Core BdN Development Area, may be attracted to lighting from vessels, and could result in a larger number of night feeding birds (such as great black-backed gull) to the area than would typically be there under baseline conditions (Burke et al. 2005, Hope Jones 1980, Montevecchi 2006\, Tasker et al., 1986). These effects would be more pronounced in August to November months, when there is a higher concentration of great black-backed gulls in the area because of their migration, and therefore would be expected during offshore construction and installation and HUC activities. There is no anticipated change in food quality due to vessel lighting.

The change in food availability due to the vessel lighting would be positive due to predicted increase in prey species at night, as described above, but short-term in duration. The geographic extent of the change in food availability would be less than 1 km² around the location of the vessel within the Core BdN Development Area. The change in food availability would be regular at night while vessels were on-site, and reversible once the vessel(s) leaves the area. While light emissions may change food availability within a localized area of the vessel, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the change is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from vessel lighting during Construction and Installation and HUC are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km², of short-term in duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with lighting from vessels involved in offshore construction and installation and HUC activities. Attraction to lighting may result in mortality or injury due to stranding, collisions, and predation, which is discussed below under “Change in Mortality / Injury Levels and/or Health of Individuals or Populations”.

As described in Section 10.3.2.2, nocturnally active species may be attracted to artificial lighting from the FPSO and similar effects are expected from vessels during construction and installation and HUC activities. Section 10.3.2.2 explains that the marine birds commonly attracted to offshore artificial lighting include several members of the petrels and allied families, of which Leach’s storm-petrel commonly strands at artificial lighting in the Core BdN Development Area. This suggests that some aspect of the orientation system common to petrels and allies may be disoriented by artificial light. Nocturnally foraging seabirds such as shearwaters and Leach’s storm-petrel, which are present in the Core BdN Development Area, may mistake the lighting for bioluminescent prey (Wiese et al. 2001). Since many nocturnally active bird species navigate using visual cues, authors suggest that artificial lights are being mistaken for celestial cues by species in passage migration (Wiese et al. 2001, Gauthreaux and Belser 2006 and Poot et al. 2008). It is not known whether Leach’s storm-petrels use celestial cues to navigate between their active nests and the continental shelf slope during their foraging trips, or they are searching for their bioluminescent lanternfish prey.

As noted in Section 10.3.2.2, the distance at which lighting attracts birds is not well understood and is assumed to be within 15 km of the light source. Information is limited regarding the distance from which birds may be attracted to lighted structures in the offshore environment, and the zone of influence varies with factors such as weather, intensity and position (height) of the light source, and ambient light conditions (Montevecchi 2006). Migratory bird stranding due to artificial lighting appears to be associated with certain environmental conditions. Greater numbers of birds strand around artificial lighting when there is a low cloud ceiling, particularly when accompanied by fog or rain (Telfer et al. 1987; Black 2005; Poot et al. 2008; LGL 2017). Low visibility is common offshore during

June, July, and September (Section 5.3.4) overlapping with the Offshore Construction and Installation season.

In the Core BdN Development Area, species common offshore during the construction and installation season, and in particular nocturnal species, which may be affected by vessel lighting are Leach's storm-petrel. This species is the most commonly attracted species in September and October. The change in avifauna presence and abundance due to vessel lighting would be adverse, as described above, but short-term during the construction season or HUC activities. The geographic extent of the behaviour change would within a 15 km radius of a vessel, during period of low visibility or at night. The change in avifauna presence and abundance would occur regularly at night, and reversible once the vessel(s) leaves the area. The change in behaviour would be of low magnitude. The short term and seasonal nature of the activity, and the likely zone of influence of the change at any one time or location represents a small proportion of overall area, the change in behaviour is considered within the range of natural variability, without affecting the viability of the affected populations in the region. With the exception of geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with vessel lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence. Mitigations to reduce the change in avifauna presence and abundance are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from vessel lighting during Construction and Installation and HUC during Offshore Construction and Installation and HUC activities are predicted to be adverse, low in magnitude, with a geographic extent less than 1000 km² (15 km radius around vessels) of short-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with lighting from vessels involved in offshore construction and installation and HUC activities. Species of marine and migratory birds likely to be present in the Core BdN Development Area during the offshore construction and installation season that are attracted to vessels include black-legged kittiwake, large gull species, northern fulmar, shearwaters, and storm-petrels (see Section 6.2). Of these, the nocturnally active species attracted to the artificial light is Leach's storm-petrel, which is most likely to be present in the Core BdN Development Area from May to early November. In months outside the offshore construction season when HUC activities may occur, black-legged kittiwake, large gull species, northern fulmar, and storm-petrels are likely to be present.

As stated above, and further described in Section 10.3.2.2, attraction-related effects appear to be common among petrels and allied families, i.e., the fulmarine- and gadfly-petrels, shearwaters, and prions family, the northern and southern storm-petrel families, and the diving-petrel family (except for the albatross family). Marine and migratory bird attraction to light emissions from artificial lighting offshore platforms and vessels is well documented, but the causes are poorly understood (Rodríguez et al. 2015, Ronconi et al. 2015). There are no published studies that systematically quantify seabird mortality on offshore platforms (Ellis et al. 2013; Ronconi et al. 2015). However, mortality of nocturnally active landbirds has been reported on offshore platforms and at lighthouses, and the underlying mechanisms and the causes of mortality are thought to be same as for marine birds (Bruinzeel and van Belle, 2010). This mortality arises from stranding, collision, exhaustion of disoriented birds flying continuously around lights, delayed foraging or migration due to diversion toward the lights, and predation (Bourne 1979, Sage 1979, Wiese and Montevecchi 1999, Wiese et al. 2001, Jones and Francis 2003, and Bruinzeel and van Belle 2010, Ronconi et al. 2015).

A change in mortality, injury and/or health of birds may occur due to collision with the vessels and/or strandings of birds on the vessels. It is difficult to quantify the mortality rate of birds attracted to artificial lighting because the available estimates rely on recovery of birds on platforms and vessels, and it is not known how many birds are killed but not recovered due to scavenging or falling into the sea (Bruinzeel et al. 2009 and Ellis et al. 2013). Depending on where birds strand, they may become oiled from oily locations on vessel decks. As summarized in Section 10.3.2.2, Baillie et al. (2005) reported 469 stranded birds (mostly Leach's storm-petrels) at offshore installations and vessels off NL between 1998 and 2002, of which 3 percent were reported to have died and 74 percent were released. The fate of the remaining 23 percent of birds was not noted in the study and cannot be speculated. As discussed in detail in Section 10.3.2.2, bird strandings are most common in the fall months (September to October) but have occurred during summer months as well. Leach's Storm Petrels were the most commonly found species stranded on vessels of various types, including fishing vessels as well as oil and gas-related vessels, with highest strandings occurring in September and October months (refer to Section 10.3.2.2), in which 97 percent of strandings were Leach's Storm Petrels. Based on the seabird stranding data presented in Section 10.3.2.2 and considering construction season offshore will occur in the September and October time period, it is likely that seabird strandings on vessels will occur during construction and installation activities, and the most likely species to strand will be Leach's Storm Petrels. Similarly, if HUC activities were carried out during these months, strandings of Leach's Storm Petrels are likely. At other times of the year, strandings are less frequent. Recoveries of stranded birds are often conducted on an incidental basis, which provides limited spatial and temporal coverage compared to a systematic observer-based monitoring system (Ronconi et al. 2015). Nonetheless, even incidental information from industry-based observation programs is useful to determine seasonal and weather-related patterns in strandings, and to determine which species are likely more susceptible to this phenomenon. Of those marine birds that are recovered from installations and vessels, most are not injured during the stranding. Of the 994 storm-petrels that stranded on oil industry vessels, 15.7 percent were found dead or died during rehabilitation (LGL 2017). Most of that mortality was due to the birds' plumage being fouled by hydraulic fluid upon landing on the deck or in drip-trays, then succumbing to hypothermia as a result. However, since most of the birds that were uninjured and unoiled were unable to escape the vessels, they would also have died were they not recovered and returned to the sea. While Leach's storm-petrel population sizes are in decline, based on the information presented in Section 10.3.2.2, mortality from strandings is low if stranded birds are recovered and released. There is uncertainty in the exact numbers of mortality due to strandings as deck searches, releases and documentation have not been consistent.

The change in mortality / injury / health of marine and migratory birds due to the vessel lighting will be adverse, as described above and short-term. While attraction effects may be evident out to 15 km from the vessel, the geographic extent of the change in mortality / injury / health would be localized to the location of the vessel(s) (i.e., less than 1 km^2) within the Core BdN Development Area where birds strand and may be injured or die. The mortality / injury / health from strandings would be sporadic, as strandings tend to occur at different times under varying conditions, and reversible once the vessel(s) leaves the area. As discussed in Section 10.3.2.2 while Leach's storm-petrels are the most common bird species to strand offshore, the change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted above, there are uncertainties associated with extent of injury/mortality with bird strandings, therefore the predicted magnitude of change is made with a moderate level of confidence.

Mitigations on vessels to reduce the strandings of birds are not available. However, during Offshore construction and Installation and HUC activities, while vessels are on-site in the Core BdN Development Area, routine systematic searches for stranded seabirds will be conducted on these vessels. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. These protocols will be developed by Equinor Canada working with ECCC and will include the systematic documentation of stranded seabirds and releases.

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from vessel lighting during Construction and Installation and HUC are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km^2, short-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with vessel lighting during Offshore Construction and Installation and HUC are not proposed, however systematic and routine searches for stranded birds will be undertaken while vessels are on location in the Core BdN Development Area (B, C, D).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with vessel lighting during Offshore Construction and Installation and HUC in consideration of residual effects predictions.

10.3.1.3 Marine Waste Discharges from Vessels

The discharge of organic (grey water and sewage) waste is an interaction for marine and migratory birds. Vessel discharges (e.g., bilge and ballast water) are treated in accordance with regulatory requirements and would not have an effect. The primary effects on Marine and Migratory Birds, due to the discharge of sewage waste during offshore construction and installation and HUC are:

- Change in Food Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

There is no predicted Change in Habitat Availability or Quality due to these discharges due to the discharge location, sinking, and degradation of organic waste at depths below which most seabirds dive, and to the treatment of other discharges in accordance with regulatory requirements (BP 2016).

Change in Food Availability and/or Quality is a potential effect associated with the discharge of organic wastes from vessels involved in offshore construction and installation activities.

The discharge of organic wastes may result in enrichment of the baseline food supply for northern fulmar and shearwaters. However, food and sewage waste discharged overboard are expected to be degraded after release (BP 2016). Grey and black water discharged into the environment may lead to organic enrichment of areas that have either positive or negative effects on local fish and invertebrates (Peterson et al. 1996) and may result in little localized organic enrichment supporting local productivity for seabirds (Ortego 1978). Effects to fish species upon which avifauna depend may also indirectly affect birds, but such effects are predicted to be negligible (Section 9.3.1.3). The change in food availability and/or quality due to the discharge of organic wastes from vessels would be positive, as described above, but short-term. The geographic extent of the change in food availability would be within less than 1 km² from the discharge location of the vessel within the Core BdN Development Area. The change in food availability and/or quality would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. As the change is food availability is localized to area of the vessel, the overall food availability in the Core BdN Development Area is not affected (including if more than one vessel were on site at the same time) and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality from waste discharges (i.e., organic wastes and HUC discharges) during Construction and Installation and HUC are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Changes) is a potential effect associated with the discharge of organic wastes from vessels involved in offshore construction and installation and HUC activities. The discharge of organic wastes may result in enrichment of the baseline food supply (Peterson et al. 1996) which may lead to an attraction of foraging marine and migratory birds (Ortego 1978) to the vessels, such as fulmars and shearwaters, which are common in the Core BdN Development Area toward the end of the offshore construction and installation season. There are no behaviour changes predicted from HUC discharges.

The Change in Avifauna Presence and Abundance of Marine and Migratory Birds due to organic waste discharges from vessels would be adverse, as described above, but short-term during the construction season. The geographic extent of the change in would be less than 1 km² of the location of the vessel within the Core BdN Development Area (Burke et al., 2012). The change in presence and abundance would be regular while vessels were on-site, and reversible once the vessel(s) leaves the area. The change in presence and abundance would be negligible in magnitude, as birds would be in the area foraging, but temporarily attracted to vessel location due to the organic waste discharge; there would be no change relative to baseline conditions. These predictions are made with a high level of confidence based on the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Change) from the discharge of organic wastes from vessels during Construction and Installation and HUC are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2 , of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with the discharge of organic wastes from vessels involved in Offshore Construction and Installation and HUC activities. There are no changes in mortality / injury or heath predicted from HUC discharges.

As noted above, there may be an increase in the presence of foraging marine birds due to the discharge of organic wastes from vessels and fish attraction to lighting on vessels. This potentially positive effect may be offset by increased exposure to risk of collision / strandings (see section 10.3.1.1 Lighting from Vessels) or predation on Leach's storm-petrels by bird species (large gull species) attracted by organic wastes as well as energetic costs due to deviation from normal movement/migration patterns. The increase in gulls to the area may lead to increase predation on Leach's storm-petrels, especially during September and October months when they most abundant offshore. As noted in Chapter 6 and throughout this chapter, the population of Leach's storm petrel is in decline, however the increase in mortality of individuals by their predators would not likely have an adverse effect on the population.

The change in mortality / injury / health of marine and migratory birds, particularly Leach's storm-petrels, due to organic waste discharges from vessels would be adverse, as described above, but short-term. The geographic extent would be localized to the vessel (less than 1 km^2) (Burke et al. 2012). The mortality / injury / health would be sporadic, and reversible once the vessel(s) leaves the area. The change in mortality / injury / health to Leach's storm-petrel and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. These predictions are made with a high level of confidence based on the scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with discharges of organic waste from vessels during Construction and Installation and HUC are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km^2 , short-term in duration, occurring sporadically and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from vessels engaged in Offshore Construction and Installation and HUC include management and treatment of marine wastes and discharges from vessels (L, M, N).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with marine discharges from vessels during Offshore Construction and Installation and HUC in consideration of residual effects predictions.

10.3.1.4 Hook-up and Commissioning: HUC Discharges

The primary effects on Marine and Migratory Birds associated with discharges during HUC activities is:

- Change in Food Availability and/or Quality

Change in Food Availability and/or Quality is a potential effect associated with the HUC discharges. When flowlines are hooked up either to the FPSO, well templates or risers, they are pressure and/or leak tested and there is a discharge of fluid from the flowlines which may contain chemicals.

As indicated in Section 2.7.5, Per Equinor's chemical management system, and in accordance with the OCSG (NEB et al. 2009), the chemical selection and management process enables the selection of chemicals that, once discharged at sea, would have the least effect on the receiving environment. At the seabed, when flowlines are flushed, there is no anticipated interaction with Marine and Migratory birds, as the water depth is beyond the range of diving seabirds. For surface discharges, these may affect the quality of prey species if they come in contact with the liquid discharge, but as indicated in Section 9.3.1.5, the magnitude of the effect on fish species is low, less than 1 km² of the vessel and short term. While there is an interaction in food availability in a localized area of the Core BdN Development Area associated with HUC discharges, the overall food quality and availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability/quality relative to baseline conditions, therefore, the magnitude of the change is negligible. The change in food availability/quality due to HUC discharges would be adverse and short-term. The geographic extent of the change in habitat is estimated to be less than 1 km² from the discharge location (e.g., Burke et al. 2012) within the Core BdN Development Area. The change in food quality would be sporadic, occurring when flowlines are flushed, and reversible once HUC activities are complete. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As stated, all chemicals that would be discharged to the marine environment would be screened in accordance with the OCSG (NEB et al 2009).

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality associated with discharges during HUC are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km² of the vessel, of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from HUC activities include screening of chemicals that may be discharged to the marine environment (O).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with associated with HUC activities in consideration of residual effects predictions.

10.3.2 Production and Maintenance Operations

Activities associated with Production and Maintenance Operations, as described in Section 2.6.2, are those activities that are undertaken once HUC activities are complete when production operations commence on the FPSO. All activities are from the FPSO and therefore in a fixed location within the Core BdN Development Area. The FPSO will be onsite for approximately 12 to 20 years at its location within the Core BdN Development Area, an area typically occupied by transient ocean-going vessels.

Production and maintenance activities involve the various discharges and emissions which may interact with Marine and Migratory Birds, including the presence of the FPSO, produced water discharges, discharges from drains, artificial light emissions, flaring of natural gas, and vessel discharges include bilge and ballast water. The presence of subsea infrastructure will not interact with Marine and Migratory Birds as the water depth in the Core BdN Development area is beyond the depth of diving birds. There will be no flaring of gas during routine production and maintenance operations. However, during start-up, regularly scheduled major shutdowns / turnarounds, well clean-up activities, and upset process conditions, depressurization of process segments may be required for safety reasons, and gas will be sent to the flare. Production and maintenance operations for the Core BdN Development is expected to between 12 to 20 years.

10.3.2.1 Presence of FPSO

The primary effects on Marine and Migratory Birds due to the presence of the FPSO are:

- Change in Habitat Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)

Based on the environmental effects analysis on Marine Fish and Fish Habitat in Chapter 9, which concluded that Operations and Maintenance activities did not have a significant effect on prey species, there is no predicted Change in Food Availability and/or Quality for Marine and Migratory Birds from the presence of FPSO. A Change in Mortality / Injury Levels and/or Health of Individuals or Populations is primarily associated with lighting, which results in attraction and stranding of birds and is assessed in section 10.3.2.2.

Changes in Habitat Availability and/or Quality is a potential effect associated with presence of the FPSO during production and maintenance operations.

Daytime densities of northern fulmar, shearwaters, black-legged kittiwake, and large gulls within 500 m of offshore platforms are often many times higher than before the installation of the platforms or some distance farther away from platforms, suggesting that the birds are attracted to foraging opportunities or to the shelter found downwind of platforms (Tasker et al. 1986, Baird 1990, and Wiese and Montevecchi 1999). Structures may be used as roosting and resting sites by gulls (Burke et al. 2012), as stopover locations for migrating shorebirds and landbirds (April-May, August to October) which may forage around the platforms (Russell 2005 and Bruinzeel and van Belle 2010), or even potentially as hunting grounds for predatory species such as large gull species and vagrant, passage migrant peregrine falcons, which take advantage of concentrations of birds around the structures (Russell 2005). In the Core BdN Development Area, common species likely to be found, depending on the time of year include northern fulmar, great shearwater, Leach's storm-petrel, black-legged kittiwake, great black-backed gull, both murres and dovekie. The large gull species are more likely to be affected by the presence of the FPSO because of its potential as a resting location and the shelter it provides from wind. The FPSO may represent a loss of habitat for fulmar, shearwaters, the two murre species and dovekie.

The change in habitat availability and/or quality due to the presence of the FPSO would be positive and adverse, depending on species present, as described above and long-term. The geographic extent of the change in habitat would be less than 1 km² of the FPSO at its location in the Core BdN Development Area. The change in habitat would be continuous, and reversible once the FPSO leaves the area at end of Project. As the FPSO footprint would occupy a very small area within the entire 470 km² Core BdN Development area (including if other vessels or drilling installation(s)were on-site at the same time), the magnitude of the change in habitat would be considered within the range of natural variability and therefore would be low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat due to the presence of the FPSO are not proposed.

In summary, the residual environmental effects of a Change in Habitat Availability and/or Quality from the presence of the FPSO during Production and Operations are predicted to positive and adverse, low in magnitude, with a geographic extent less than 1 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with presence of the FPSO during production and maintenance operations. There is potential for the presence of the FPSO to lead to the disturbance and possible displacement of seabirds from foraging and resting areas within the Core BdN Development Area. Disturbance of birds due to the FPSO presence can cause increased flushing or disturbance during foraging, which may lead to reductions in foraging efficiency, greater energy expenditures and elevated stress levels. However, seabird densities have not been calculated at a geographic scale fine enough to determine whether persistent seabird foraging, and resting areas are present within the Core BdN Development Area. In addition, the number of surveys conducted may be insufficient at that geographic scale to confidently calculate densities. Also, foraging and resting areas probably vary in location with varying current and wind direction. Foraging activities are typically most common in the Core BdN Development Area during September to April, when Leach's Storm Petrel, the two murre species noted in Section 10.2, and dovekies are at peak densities offshore and therefore may be affected by the FPSO presence.

The presence of offshore installations elicits varying responses among species of marine and migratory birds. Some researchers have documented displacement of birds due to offshore platforms (Bramford et al. 1990). Alcids, for example, are prone to disturbance from vessel traffic which may at least partially explain observed avoidance behaviour around platforms (Ronconi and St. Clair 2002 and Bellefleur et al. 2009). Alcid distribution along survey transects to platforms on the Grand Banks are more strongly related to ocean temperature than with proximity to platforms (Burke et al. 2005), although these attraction effects differed among species and seasons (Burke et al. 2012). Similarly, Baird (1990) found that puffins, unlike most seabird species, occurred at lower densities within 10 km of the platform than farther away. Observed densities of dovekie, northern fulmar, shearwater, and storm-petrel species on the Scotian Shelf were lower within 10 km of platforms compared to regions further away, suggesting some avoidance of platforms by certain species, although the effects of habitat preferences were not assessed (Amec 2011).

The effect of habitat displacement on marine-associated birds is considered low, except potentially in areas such as the North Sea where platforms occur in high concentrations, or where they are situated on or near productive sites associated with discrete physiographic features such as continental shelf edges and slopes (Hedd et al. 2011; Ronconi et al. 2015). As suggested above, it is not certain whether the seabird densities published for the areas overlapping the Core BdN Development Area are representative of the latter. However, in the Canada-NL Offshore Area there are currently four production installations (with distances between the installations ranging from 10 to 75 km), and one to two drilling installations operating at any one time. For Core BdN Development Area, which is in the Flemish Pass and east of the shelf edge, the FPSO will be approximately 180 km from the nearest production installation.

The change in avifauna presence and abundance due to the presence of the FPSO would be adverse, as described above, and long-term. The geographic extent of the change in habitat would be localized to the FPSO at its fixed location within the Core BdN Development Area (i.e., less than 1 km^2). The change in habitat would be continuous, and reversible once the FPSO leaves the area at end of Project. As the FPSO footprint would occupy a very small area within the entire 470 km^2 Core BdN Development Area (including if other vessels were on-site at the same time), the magnitude of the change in avifauna presence and abundance would be considered within the range of natural variability and is therefore low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in avifauna presence and abundance are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from the presence of FPSO are predicted to be adverse, low in magnitude, with a geographic extent of less than 1 km^2, of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with the presence of the FPSO are not proposed.

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with the presence of the FPSO in consideration of residual effects predictions.

10.3.2.2 Light emissions from FPSO

The primary effects on Marine and Migratory Birds due to light emissions from the FPSO are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Changes in Habitat Availability and/or Quality are primarily associated with FPSO presence and are addressed above.

The presence of the FPSO during Production and Maintenance at the Core BdN Development Area would be a new source of artificial lighting in a region that is relatively free of nocturnal artificial lighting, as indicated in a world atlas of computed artificial night sky brightness (Falchi et al. 2016). The overall light emissions from the FPSO assessed here includes emissions from the pilot flare, because the latter's light emissions will be similar to that of a small subset of the FPSO's electrical lighting (e.g., pilot flare and electrical lighting on the Hebron production platform, A. Lang, pers. obs.). Therefore, this assessment of light emissions from the FPSO will consider the intensity of light emitted during routine operations. The absence of routine flaring will mitigate overall light emissions. Equinor Canada is investigating the use of a pilotless flare versus a continuous pilot flare. However, the assessment of the effects of the flare in this EIS assumes a continuous pilot flare.

Species of marine and migratory birds in the Core BdN Development Area that are attracted to offshore installations, include northern fulmar, shearwaters, storm-petrels, black-legged kittiwake, and large gulls. Of these species, some are nocturnally active species (i.e., Leach's storm-petrels and great black-backed gull) that are attracted by the light emitted by artificial lighting and flares on the installation at night. Artificial lighting may lead to changes to food availability, changes in behaviour and/or mortality and injury to marine and migratory birds. Consequently, this interaction has the greatest potential for the Project to effect marine and migratory bird species. As indicated in Section 10.2, the species of birds most likely to be affected by lighting from the FPSO include Leach's storm-petrels and great black-backed gull and will form the basis for the following assessment of effects from lighting.

Changes in Food Availability and/or Quality is a potential effect associated with lighting from the FPSO during production and maintenance operations. The change in food availability is likely more pronounced at night and in periods of low visibility, where FPSO lighting may attract prey species to the surface of the water (as described in Section 9.3.2.2), that typically would not have been attracted except under clear moonlight conditions. As stated in Section 9.3.2.2 and noted in Section 10.3.1.2, effects of fish attraction due to installation lighting has a zone of influence less than 1.5 km from the installation. Prey species such as Atlantic saury and sand lance, which are present in the Core BdN Development Area, may be attracted to lighting from the FPSO, and could result in a larger number of night feeding birds (such as great black-backed gull) to the area than would typically be there under baseline conditions. These effects would be more pronounced from September to November, when there is a higher concentration of great black-backed gulls in the area due to their stopover during migration. There is no anticipated change in food quality due to lighting from the FPSO.

Foraging opportunities may also be enhanced around platforms because they themselves may become artificial reefs around which new invertebrate and fish assemblages are established (Fabi et al. 2002, 2004). Great black-backed gulls congregate in large flocks at drilling and production platforms offshore NL in late summer post-breeding dispersal and fall migration and have been observed to capture fish species, such as Atlantic saury (Montevecchi et al. 1999; LGL 2017). Diving thick-billed murres are attracted to underwater lights during the Arctic polar night, but dovekies are not, suggesting that some diving marine bird species could potentially be attracted to the FPSO at night for foraging opportunities (Ostaszewska et al. 2017).

The change in food availability due to the lighting from the FPSO would be positive due to predicted increase in prey species at night, as described above and long-term, occurring at night or in periods of low visibility. The geographic extent of the change in food availability would be less 10 km² round the location of the FPSO. The change in food availability would be regular at night while the FPSO was on-site, and reversible once the FPSO leaves the area. As noted in Section 9.3.2.2, changes to prey (i.e., lanternfish) availability associated with FPSO lighting is predicted to be negligible in magnitude, therefore the magnitude of change on food availability for marine birds would be negligible.While light emissions may change food availability for marine birds within a localized area of the FPSO, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the change is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

Mitigations such as reduced lighting on the FPSO, where worker and navigational safety are not compromised, and no routine flaring would reduce overall light emissions and therefore may reduce the overall change in prey species availability at night. With mitigations, is it anticipated that the magnitude of effect may be reduced, but the change would be within the range of natural variability, and therefore would of low magnitude.

In summary, with the application of mitigations, the residual environmental effects of a Change in Food Availability and/or Quality from light emissions from the FPSO are predicted to be positive and long-term in duration, with a geographic extent less than 10 km², negligible in magnitude, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with lighting from the FPSO during production and maintenance operations. Marine and migratory bird attraction to light emissions from artificial lighting and flaring on offshore installations and vessels is well documented, but the causes are poorly understood (Rodríguez et al. 2015, Ronconi et al. 2015). Among marine birds, attraction to offshore and coastal artificial lighting and related grounding appears to be widespread among petrels and allied families, including, Leach's storm-petrels. This behaviour has been observed in more than 40 species of petrels and allies (Imber 1975; Reed et al. 1985; Telfer et al. 1987; Le Corre et al. 2002; Black 2005; Montevecchi 2006; Rodríguez and Rodríguez 2009; Miles et al. 2010; Rodríguez et al. 2015). This suggests that some aspect of the orientation system common to petrels and allies may be disoriented by artificial light. Light attraction to offshore installations has also been reported in the Atlantic puffin in coastal areas near nesting colonies in both Scotland and Newfoundland (Miles et al. 2010; Wilhelm et al. 2013), albeit an infrequent visitor in the Core BdN Development Area.

Information is limited regarding the distance from which birds may be attracted to lighted structures in the offshore environment, and the zone of influence varies with factors such as weather, intensity and position (height) of the light source, and ambient light conditions (Montevecchi 2006). Migratory bird stranding due to artificial lighting appears to be associated with certain environmental conditions. Greater numbers of birds strand around artificial lighting when there is a low cloud ceiling, particularly when accompanied by fog or rain (Telfer et al. 1987; Black 2005; Poot et al. 2008; LGL 2017). In fog or drizzle, the moisture droplets in the air refract the light and greatly increase the illuminated area, thereby extending the distance to which artificial light interacts with birds (Wiese et al. 2001). Conversely, Bruinzeel and van Belle (2010) found that the distance at which birds become disoriented ranges from 200 m in dense fog to 1 km to 1.4 km in lighter fog to light rain, to up to 4.5 km in overcast skies with no celestial cues and otherwise good visibility. Low visibility is most common offshore during June, July and September (Section 5.3.4).

The distance at which birds can be affected by lighting from a production, drilling installations and/or vessels is uncertain. In unpublished study, Marquenie and van de Laar (2004, cited in Poot et al. 2008) found that the response to 30 kW of light on a platform 70 km offshore affected migrating landbirds out to at least 5 km, but greater distances cannot be ruled out (Marquenie and van de Laar 2004, cited in Poot et al. 2008; Ronconi et al. 2015). It is not known whether seabirds react similarly. Many fledgling short-tailed shearwaters abandoning a nesting colony on a headland were attracted to intense artificial lighting on the coastline 15 km from the colony rather than dimmer coastal lighting only 2.5 km away (Rodríguez et al. 2014). Attraction of marine and migratory birds from distances greater than the 15 km zone of influence could result in a greater number of birds potentially affected by artificial lighting associated with the Project; however, to date, there are no studies demonstrating attraction from such large distances.

The wavelength and intensity of lighting have been shown to influence the degree of attraction, with white and red-coloured lights associated with the highest levels of mortality, while blue and green lights appear to result in considerably less attraction (Gauthreaux and Belser 2006, Poot et al. 2008, and Marquenie et al. 2013). Experimentation showed that high pressure sodium lights (colour temperature 2000 K, i.e., warm) attracted fewer short-tailed shearwaters than metal halide (4500 K, cool) or light emitting diode lights (4536 K, cool) (Rodríguez et al. 2017). High pressure sodium lights emitted much less energy below 575 nm (yellow, orange and red) than the other two types. Bird attraction has been found to be highly correlated with lighting intensity, and when platform lighting is reduced from full illumination to only beacon and navigation lights the number of birds observed circling the platform has been greatly reduced (Marquenie and van de Laar 2004, cited in Marquenie et al. 2013). Shielding lights downward has also been shown to reduce attraction (Reed et al. 1985).

Marine bird strandings appear to peak when moonlight levels are lowest (i.e., around the time of the new moon) (Telfer et al. 1987; Rodríguez and Rodríguez 2009; Miles et al. 2010; Wilhelm et al. 2013). This may be related to greater activity on darker nights by species prone to stranding. For example, the arrival and departure of small storm-petrels and related species at active nests occurs primarily at night, presumably to reduce predation on the eggs, nestlings and adults. This activity is lowest around the time of the full moon (Imber 1975; Bretagnolle 1990), so a preference among seabirds to be active on darker nights may be a mechanism for avoiding nocturnal predators (Watanuki 1986; Mougeot and Bretagnolle 2000; Oro et al. 2005).

Since many nocturnally active bird species navigate using visual cues, some authors suggest that artificial lights are being mistaken for celestial cues by birds in passage migration (Wiese et al. 2001, Gauthreaux and Belser 2006 and Poot et al. 2008). Coastal lighting may have more of an influence on landbirds than marine birds, since most migrating landbirds tend to fly closer to land (Weir 1976 and Blomqvist and Peterz 1984). Alternatively, nocturnally foraging seabirds such as storm-petrels, which are common in the Core BdN Development Area, may mistake the lighting for bioluminescent prey (Imber 1975, Wiese et al. 2001, Gauthreaux and Belser 2006 and Poot et al. 2008).

In the Core Bay du Nord Development Area, species common offshore, and in particular nocturnal species, which may be affected by lighting from the FPSO are Leach's Storm Petrel. The change in avifauna presence and abundance due to lighting from the FPSO would be adverse, as described above, and long-term. The geographic extent of the behavioural change would within a 15 km radius of the FPSO, especially during periods of low visibility or at night. The change in avifauna presence and abundance would occur regularly at night throughout the production life of the Project and reversible once the FPSO leaves the area. The change in behaviour would be of medium magnitude, as the change in behaviour is likely beyond the range of natural variability for these species, but with no associated adverse effect on the viability of the affected population. With the exception geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with FPSO lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence.

Mitigations to reduce bird attraction and other behavioural effects would include reducing overall light emissions from the FPSO. As listed in Section 10.1.5, economically and technically feasible mitigations will be implemented to reduce light emissions on the FPSO to the extent that worker safety and safe operations, per regulatory requirements, are not compromised. Lighting options will be evaluated during project design phases, and Equinor Canada will engage with ECCC regarding lighting options. Systematic searches for and recovery of stranded, live birds on the FPSO be undertaken and birds found will be documented following protocols that will be developed in consultation with ECCC. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. The development and implementation of such systematic protocols for the search, recovery, documentation, and release of stranded birds will provide the necessary spatial and temporal coverage to mitigate strandings (Ronconi et al. 2015). With the application of these mitigation measures, as indicated above, a reduction in light emissions should reduce attraction of marine and migratory birds to the FPSO.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from light emissions from the FPSO are predicted to be adverse, medium in magnitude, with a geographic extent less than 1,000 km^2 (i.e., 15 km radius of the FPSO), of long-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with lighting from the FPSO during Production and Maintenance operations. Species of marine and migratory birds likely to be present in the Core BdN Development Area that are attracted to light emissions, especially nocturnally active species such as Leach's storm-petrel.

Attraction of nocturnally active birds may result in direct mortality or injury through collisions with facility infrastructure, predation, or stranding on the offshore (i.e., birds are unable to return to the sea) (Baird 1990, Montevecchi et al. 1999, and Wiese et al. 2000; LGL 2017). There are no published studies that systematically quantify seabird mortality on offshore platforms (Ellis et al. 2013; Ronconi et al. 2015). However, mortality of nocturnally active landbirds has been reported on offshore platforms and at lighthouses, and the underlying mechanisms and the causes of mortality are thought to be same as for marine birds (Bruinzeel and van Belle, 2010). This mortality arises from stranding, collision, exhaustion of disoriented birds flying continuously around lights, delayed foraging or migration due to diversion toward the lights, and predation (Bourne 1979, Sage 1979, Wiese and Montevecchi 1999, Wiese et al. 2001, Jones and Francis 2003, and Bruinzeel and van Belle 2010, Ronconi et al. 2015).

Based on data collected in the Canada-NL Offshore Area, marine birds strand on drilling and production installations, offshore oil and gas support and survey vessels and fishing vessels (Baillie et al. 2005, Ellis et al. 2013). Baillie et al. (2005) reported 469 stranded birds (mostly Leach's storm-petrels) at offshore oil installations and their associated support vessels off NL between 1998 and 2002, of which 16 (3 percent) were reported to have died and 344 (74 percent) were released; the fate of the remaining birds was not reported. The strandings were most common in September and October, and 97 percent of the birds were Leach's storm-petrels, which was also the most commonly seen species during seabird surveys conducted from the vessels. The fate of the remaining 23 percent of birds was not noted in the study and cannot be speculated. Other species that were sighted on board included Atlantic puffin, common murre, ruddy turnstone and glaucous gull. Atlantic puffin, ruddy turnstone, and glaucous gull are uncommon away from coastal waters, but occur regularly and small numbers can be expected annually. Also, data from support vessels in that study likely include birds that landed on vessels in transit while close to the coast. In both Ellis et al. (2013) and Environment Canada (2015), LGL (2017) analysed more recent stranding data. From 2003 to 2014, over the course of 14,136 days, 541 stranding events consisting of 2,048 birds of 31 species were recorded in the bird salvage logs of five drilling installations and three offshore production facilities on the Jeanne d'Arc Basin, Orphan Basin, and Flemish Pass (LGL 2017). The distance between these facilities and shore ranged from 325 km for Hibernia to 480 km for a drilling installation in the Project Area (Mizzen O-16 well). Of the 2,048 birds recorded, 1,986 were marine birds consisting of 11 species and the remainder were landbirds or shorebirds (20 species). Of the marine birds, 86 percent (1,706 individuals) were identified as Leach's storm-petrels or unknown storm-petrel. The remainder of the marine birds consisted of species that strand on offshore facilities only when their plumage is oiled or when they collide with the structures in poor visibility (46 individuals of Atlantic puffin, murre species, dovekie, and shearwater species), or due to illness (208 individuals of various gull species were associated with an avian cholera outbreak in 2007). Multi-individual stranding events appear to be episodic, with the number of strandings per day on a given platform ranging from 0 to 122 individuals. The latter occurred on 2 October 2006 on the SeaRose FPSO. In addition, 60 percent of storm-petrels stranded during 2003 to 2014 were recorded during 2006.

The stranding of seabirds due to artificial lighting from offshore installations occurs year-round but tends to be more common at the end of the nesting season (late July to early October depending on the species) (Telfer et al. 1987; Le Corre et al. 2002; Miles et al. 2010). Based on studies conducted in the in the Canada-NL Offshore Area for all offshore oil and gas activity, strandings of Leach's storm-petrels on offshore installations (drilling and production platforms) and geophysical vessels peaks sharply when fledglings and adults abandon nesting colonies from mid-September to mid-October (LGL 2017). In studies in which the ages of the grounded seabirds have been determined, the majority of individuals have been newly fledged young, particularly in strandings near seabird nesting colonies, suggesting that juvenile inexperience is a factor (Imber 1975; Telfer et al. 1987; Wiese et al. 2001; Gauthreaux and Belser 2006; Poot et al. 2008; Rodríguez and Rodríguez 2009; Miles et al. 2010; Rodríguez et al. 2015).

Strandings are highly seasonal. The vast majority (95 percent) of strandings occurred during September and October, peaking from 10 September to 13 October. The beginning of this peak period corresponds to the earliest published date of Leach's storm-petrel fledging at the nesting colony on Great Island in Witless Bay, NL (Pollet et al., 2019). Most fledging takes place from mid-September to late October. After fledglings and adults abandon the colonies, they begin their southward migration, the last birds leaving during November (Huntington et al. 1996). Strandings also appear to be episodic, introducing additional uncertainty about the effect of offshore oil and gas operations on the Leach's storm-petrel population in NL. There is some potential for the attraction of landbirds in passage migration, particularly during the fall. However, most landbird migration involving water crossings in Atlantic Canada is thought to take place south of and west of NL (Williams and Williams 1978; Richardson 1978). Some fall shorebird migration departs from the south coast of Newfoundland (experience of recreational birdwatchers). They may head on a southeasterly course like those departing from Nova Scotia (Richardson 1978). It is therefore likely that most of this migration passes to the west of the Project Area, including the Core BdN Development Area, and that a small amount traverses the southwest corner of the RSA, so it is unlikely that large numbers of shorebirds and other landbirds will interact with the Project.

It is difficult to quantify the mortality rate of birds attracted to artificial lighting because the available estimates rely on recovery of birds on platforms and vessels, and it is not known how many birds are killed but not recovered due to scavenging or falling into the sea (Bruinzeel et al. 2009 and Ellis et al. 2013). These recoveries are often conducted on an incidental basis, which provides limited spatial and temporal coverage compared to a systematic observer-based monitoring system (Ronconi et al. 2015). Nonetheless, even incidental information from industry-based observation programs is helpful to determine seasonal and weather-related patterns in strandings, whether it is on a vessel or installation, and to determine which species are likely more susceptible to this phenomenon. Of those marine birds that are recovered from platforms and vessels, most are not injured during the stranding. As stated in Section 10.3.1.2, data from Leach's storm petrels stranding on industry vessels indicate that there was approximately 16 percent mortality (either found dead or died during rehabilitation) (LGL 2017). While this data is from industry vessels, the data illustrate that mortalities from strandings occur. However, since most of the birds that were uninjured and unoiled were unable to escape the vessels, they would also have died had they not been recovered and returned to the sea. Data also indicates that Leach's storm-petrels attracted to drilling and production platforms in the Canada-NL offshore area also suffer predation in late summer and fall from great black-backed gulls attracted by the fish drawn to the surface at night by the artificial lighting (Montevecchi et al. 1999; LGL 2017). However, the success rate of the gulls in capturing storm-petrels is unknown.

An unknown proportion of storm-petrels are killed or injured from collisions with vessels and fall into the water, fall prey to gulls, or are not encountered during routine searches. Of those birds found on offshore platforms a large proportion are found alive and those found dead appear to have died of hypothermia or dehydration. This fact, and the slow speed at which attracted birds approach platforms, suggests that few birds die in collisions and fall into the sea undetected. The natural variability in mortality and population size in Leach's storm-petrel is poorly understood (Wilhelm et al. 2019). For example, the number of storm-petrels nesting at Baccalieu Island, the world's largest colony, has been surveyed only three times (1983, 1984, and 2013) (Wilhelm et al. 2019). The cause of the large declines that have been observed in the numbers of storm-petrels nesting at some colonies in the northwest Atlantic are unclear (Wilhelm et al. 2019). Adult survival rates at three colonies are low (Wilhelm et al. 2019). High levels of mercury born by these birds (Bond and Diamond 2009; Burgess et al. 2016 in Pollet et al. 2019; Pollet et al. 2016), and interactions with oil/gas platforms have been proposed as contributing factors (Wilhem et al. 2019). It has also been speculated that recruitment of young birds into breeding populations is low, potentially caused by important shifts in demersal and pelagic food webs in the northwest Atlantic as a result of ocean warming (Head and Pepin 2010; Buren et al. 2014; Mauck et al. 2018) have also been identified as potentially important factors (Wilhelm et al. 2019). The proportion of total mortality arising from stranding at artificial lighting in Leach's Storm Petrel is not known. However, storm-petrels commonly strand on fishing and other vessels on which there is no regulatory requirement to recover and release stranded birds, therefore the actual extent of strandings offshore and its associated effects are unknown.

The change in mortality / injury / health of marine and migratory birds due to lighting from the FPSO would be adverse, as described above. While attraction effects may be evident out to 15 km from the FPSO, the geographic extent of the change in mortality / injury / health would be localized to the location of the FPSO (i.e., less than 1 km^2) at its fixed location within the Core BdN Development Area. The mortality / injury / health from strandings would be sporadic, as strandings tend to occur at different times under varying conditions, and reversible once the FPSO leaves the area. As discussed above, while Leach's storm-petrel is the most common bird species to strand offshore, the change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be considered low in magnitude. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted above, there are uncertainties associated with extent of injury/mortality with bird strandings, therefore the predicted magnitude of change is made with a moderate level of confidence.

As stated above, mitigations to reduce bird attraction and other behavioural effects would include reducing overall light emissions from the FPSO and would also reduce mortality and injury effects. Mitigations to reduce lighting on the FPSO will be examined, and those options which do not compromise the worker safety and safe operations, per regulatory requirements, will be implemented. Furthermore, as stated above, systematic searches for and documentation of stranded birds will be undertaken on the FPSO. With the application of these mitigation measures, as indicated above, a reduction in light emissions should greatly reduce attraction and stranding of marine and migratory birds to the FPSO, and therefore mortality and injury effects.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from light emissions from the FPSO are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², long-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with the light emissions from the FPSO include lighting reduction options where worker safety and safe operations are not compromised (A), no routine flaring (E, F, G, J), and systematic searches for, documentation of, and release of stranded seabirds (B, C, D).

Follow-up Monitoring: In consideration of the residual effects predictions, and the uncertainty in potential attraction and strandings of Leach's storm petrels, and associated injury and/or mortality from FPSO lighting, observational-based follow-up monitoring is proposed. See Section 10.7 for additional information.

10.3.2.3 Waste Discharges during Production and Maintenance

As stated in Section 10.1.5, the discharge of produced water is an interaction for marine and migratory birds. The discharge of organic waste is also an interaction which may affect marine and migratory birds. Other marine discharges (e.g., bilge and ballast water) are treated in accordance with regulatory requirements and would not have an effect.

As stated in Section 2.5.3.1, there will be no routine flaring associated with production and maintenance operations. Non-routine and/or safety flaring will occur during turnarounds / shut-down for maintenance and depressurization of process segments for safety reasons. The effects of non-routine flaring on marine and migratory birds is addressed below.

Produced Water

The primary effects on Marine and Migratory Birds associated with the discharge of produced water are:

- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Produced water is the largest volume of waste discharged from the FPSO. Produced water will be treated using best treatment practices that are commercially available and economically feasible and discharged to the marine environment. Produced water is predicted to be 40°C at the discharge source and discharge volumes are estimated to range between 30,000 m³/d and 50,000 m³/d.

The primary effect associated with produced water discharge is the potential for surface sheening which may lead to oiling of birds and result in injury or mortality. As noted in Section 10.1.5.1, the effects assessment focuses on those interactions with the greatest potential to have environmental effects. Behavioural effects are a secondary effect of oiling are addressed below. There is no predicted Change in Habitat Availability or Quality associated with produced water discharge. The change in water temperature at point-source discharge is negligible in relation to the overall water quality in the area.

Produced Water Plume Dispersion Modelling

Based on modelling of produced water discharge scenarios undertaken for the Project (see summary in Section 9.3.2.4 and detailed report in Appendix J, DeBlois 2019), the produced water plume was predicted to be of highest concentration within 100 m of the discharge source and within the upper 10 m of the water column, with changes in water quality and oil-in-water concentrations predicated with less frequency out to 1 km from discharge. Oil at or near the surface has the greatest potential to affect the plumage of marine birds. Dose-Related Risk and Effects Assessment Model (DREAM) concentrates on underwater releases, so that surface processes are of secondary importance (EIS Appendix J, DeBlois 2019). Oil-in-water (OIW) concentrations can change due to oil droplets rising to the surface to form a slick, so DREAM incorporates this phenomenon. Although the areal distributions of OIW concentrations are modelled and presented (Appendix D in DeBlois 2019), the distributions of slicks are not modelled. The modelling simulated six produced water discharge scenarios with assumed concentrations of 15 ppm or 30 ppm dispersed oil and no dilution or dilution with cooling water. Oil at or near the surface has the greatest potential to affect the plumage of marine birds. For the worst-case scenario of 50,000 m^3/d release with an OIW concentration of 30 ppm, the modelling predicts decreasing OIW concentrations with increasing distance from the release site and decreasing concentrations with increasing depth.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with the discharge of produced water from Production and Maintenance Operations.

Despite the practice of removing free oil from produced water before discharge, oil sheens are sometimes associated with produced water discharges (e.g., ERIN Consulting Ltd. and OCL Services Ltd. 2003; Morandin and O'Hara 2016). The potential for sheen formation is reduced with standard treatment and management of operational discharges in accordance with the OWTG (NEB et al. 2010); however, the discharge of treated operational wastes (e.g., produced water and/or synthetic-based mud (SBM) drilling cuttings) have caused isolated events of surface sheening, typically under calm conditions (Morandin and O'Hara 2016). In calm conditions, discharges at allowable OIW concentrations may result in formation of hydrocarbon sheens of up to 3 μm thickness. As reported in Morandin and O’Hara (2016), from 2003 to 2014, the C-NLOPB received 290 reports of surface sheens from offshore oil and gas operations. Many of these sightings were associated with reported discharges that had oil-in-water (OIW) concentrations permitted by the OWTG (NEB et al. 2010) for produced water, whereas others had higher concentrations (Morandin and O'Hara 2016). However, this number may underestimate the actual number of sheens since 50 percent of the reported sheens were sighted during the four months of the year when conditions are best for sighting sheens (i.e., May to August) when daylight hours are longest and sea states are lowest (Morandin and O'Hara 2016).

Small amounts of oil from sheens has been shown to affect the structure and function of seabird feathers (O'Hara and Morandin 2010), which has the potential to result in water penetrating plumage and displacing the layer of insulating air, resulting in loss of buoyancy and hypothermia. This can in turn cause a heightened metabolic rate (increased energy expenditure), as well as behavioural changes such as increased time spent preening at the expense of foraging and breeding, and potentially death, especially in the winter months when conditions are colder, and thermoregulation is most difficult (Morandin and O’Hara 2016). A tracking study showed that nesting Leach’s storm-petrels commute between their active nests on Baccalieu Island and in Witless Bay and the Project Area on four-day foraging trips (Hedd et al. 2018). Chicks and eggs are most susceptible to negative effects of exposure to oil (even at low levels) (Morandin and O’Hara 2016). When oiled adults return to the nest to incubate eggs or to feed and brood nestlings, oil is transferred from the breast plumage of adults to nestlings and eggs. Butler et al. (1986; 1988) and Trivelpiece et al. (1984), for example, have found effects from relatively low levels of oil on Leach’s storm-petrel metabolic rate and chick growth, so this species may be vulnerable to potential effects of hydrocarbon exposure. Incubating adults of this species undertake round trips from nesting colonies on Baccalieu and Great Islands to the LSA, including the Project Area, to forage (Hedd et al. 2018).

Fraser et al. (2006) modelled the potential worst-case scenario effect of produced water on the Grand Banks on alcids present within 1 km² of a release resulting in a sheen. The following assumptions were used. The authors used published estimates of alcid density and determined that alcids could be present within 1 km² of the platform 210 days annually; assumed 1) a daily occurrence of sheens (all 210 days); 2) contact between birds and sheens causes mortality; and, 3) a geographic extent of produced water of 1 km² or less. It must be noted that these three scenarios are not typical of offshore operations in the Canada-NL Offshore Area. As discussed above, C-NLOPB received a total of 290 reports of sheen sightings in a 12-year period from a varying number of production and drilling installations, so the number of days with sheens assumed by Fraser et al. (2006) represents a highly unlikely scenario. Based on Fraser et al. (2006) modelling of this worst-case scenario, it suggests a potential effect on the alcids present within 1 km² of the release, ranging in magnitude from low to high, depending on the highly variable number of alcids within that area. Although this suggests that sheens have the potential to cause mortality, Morandin and O’Hara (2016) could not conclude whether the effects of sheens on individuals have had long-term population effects through small reductions in adult fecundity or survivorship. First, there is a lack of data on the occurrence of oiling of seabirds around platforms (Morandin and O'Hara 2016). Second, data are lacking on the frequency, likelihood, persistence, fate, and thickness of sheens resulting from discharges of SBM drill cuttings and produced water. Third, there is a lack of quantitative studies on the direct effects of sheens on seabirds. Last, there is also a lack of studies on the effects of sheens on the abundance of pelagic seabirds in Atlantic Canada. Calculating the probability of marine birds encountering sheens from produced water with confidence is also difficult because of the patchy and ephemeral nature of their distributions at small geographic scales. Their distributions are dependent on the influences of weather and prey distribution, which are themselves poorly known. Although the results of recent surveys of seabirds at-sea have been published, geographic coverage and effort were low during the winter months, reducing confidence in the use of these data for predicting species- and site-specific distribution and abundance (Fifield et al. 2009; Bolduc et al. 2018).

Produced water sheens reported in the Newfoundland offshore were associated with OIW concentrations of 4 to 137 mg/L (~ppm) (Morandin and O'hara 2016). The results of the produced water plume dispersion modelling suggest that the highest OIW concentrations would be in close proximity of the FPSO, it is therefore assumed that the likelihood of enough oil rising to the surface to form a sheen could be higher near the FPSO. However, because sheen formation and distribution were not modelled, a prediction of the probability of exposure of marine and migratory birds to such sheens is not possible, beyond predicting that the probability of exposure to sheens will increase with decreasing distance from the platform.

As indicated above, for those seabirds attracted to the FPSO, great black-backed gulls and Leach's storm-petrels are most abundant in the Core BdN Development Area and are most numerous after fledglings and adults abandon the nesting colony at the end of the breeding season. Unlike Leach's storm-petrel, gulls regularly come in contact with the water around the FPSO whether resting on the surface or foraging for fish. Although storm-petrels' bills and feet make contact with the surface during feeding, this species rarely rests on the water's surface while at sea. Therefor, gulls and storm-petrels would be at greatest risk of encountering a sheen from produced water during fall because their abundance around production and drilling platforms peaks at this time. The risk would be lower during winter and lowest during spring and summer when gulls are rarely seen offshore. Produced water will be treated using best treatment practices that are commercially available and economically feasible before discharge to the marine environment.

The change in change in mortality / injury levels and/or health of individuals or populations due to the sporadic and unlikely surface sheening events associated with the discharge of produced water would be adverse, as described above, and long-term, should it occur. The geographic extent of the change in mortality would be less than 1 km² of the FPSO at its fixed location in the Core BdN Development Area, as supported by produced water modelling and scientific literature noted above. The change in mortality / injury / health is not likely to occur to sporadically occurring as sheening is not a common occurrence and birds would have to be in the area if sheening occurs. Should an effect occur, it would be reversible. As discussed above, the change in mortality / injury / health to Leach's Storm Petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of geographic extent and duration of effect, these predications are made high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on produced water modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge or emissions modelled, therefore there is some uncertainty regarding the zone of influence of produced water and water quality predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Based on the uncertainties noted above regarding the duration of effects from sheening (i.e., long-term) the prediction of long-term effect duration is made with a moderate level of confidence.

Mitigations include the treatment of produced water using best treatment practices that are commercially available and technically feasible, in consideration of the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010), prior to discharge.

In summary, with the application of mitigations measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with unlikely sheening events from produced water discharge are predicted to be adverse, low in magnitude, within a geographic extent less than 1 km², of long-term duration, not likely to occur to occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

Marine Waste Discharges

As noted above, the discharge of organic (grey water and sewage) waste is an interaction for marine and migratory birds. Other marine discharges (e.g., bilge and ballast water) are treated in accordance with regulatory requirements and would not have an effect. The primary effects on Marine and Migratory Birds, due to the discharge of organic waste from the FPSO during production and maintenance activities are:

- Change in Food Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

The effects associated with the discharge of organic waste from vessels, as assessed in Section 10.3.1.4 would be the same for the FPSO, with the exception of some of the characterizations of residual effects. The assessment of effects from organic waste discharges during production and operations will focus on any differences in these characterizations of residual effects associated with long term production operations.

Change in Food Availability and/or Quality is a potential effect associated with the discharge of organic wastes from the FPSO during production and maintenance operations. As noted in Section 10.3.1.4, the discharge of organic wastes may result in enrichment of the baseline food supply (Peterson et al. 1996) for marine and migratory birds; however, food and sewage waste discharged overboard are expected to be degraded after release (BP 2016). For year-round production and maintenance operations, marine and migratory birds most likely to interact with and be affected by the discharge of organic wastes includes gulls and fulmars. The change in food availability and/or quality due to the discharge of organic wastes from the FPSO would be positive and long-term. The geographic extent of the change in food would be within less than 1 km² from the discharge location of the FPSO at its fixed location within the Core BdN Development Area. The change in food availability and/or quality would be continuous during production and maintenance operations and reversible once the FPSO leaves the area. While marine discharges may change food availability within a localized area of the FPSO, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There would be no change in food availability relative to baseline conditions and the magnitude of the change is, therefore, negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per regulatory requirements, the FPSO is required to treat wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality associated with organic waste discharges during Production and Operations are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km² of the vessel, of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Changes) is a potential effect associated with the discharge of organic wastes from the FPSO during production and maintenance operations. As discussed in Section 10.3.1.4, the discharge of organic wastes may result in enrichment of the baseline food supply (Peterson et al. 1996) which may lead to an attraction of foraging marine and migratory birds to the FPSO location, such as black-legged kittiwake, large gull species and northern fulmar (Ortego 1978).

The Change in Avifauna Presence and Abundance of Marine and Migratory Birds due to organic waste discharges during production and operations would be adverse, as described above and long-term. The geographic extent of the change in would be less than 1 km² of the location of the FPSO at its fixed location within the Core BdN Development Area (Burke et al. 2012). The change in presence and abundance would be regular while the FPSO is on-site, and reversible once it leaves the area. The change in presence and abundance would be negligible in magnitude, as the birds would be in the area foraging, but temporarily attracted to FPSO location due to the organic waste discharge. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per regulatory requirements, the FPSO is required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Change) from the discharge of organic wastes from the FPSO during production and maintenance operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km² of the FPSO, of long-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with the discharge of organic wastes from the FPSO during production and maintenance operations. The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels.

As noted above, there may be an increase in the presence of foraging marine birds due to the discharge of organic wastes from the FPSO. This potentially positive effect may be offset by increased exposure to risk of collision / strandings (see Section 10.3.2.2) or predation by bird species (large gull species, falcons) attracted by organic wastes (Montevecchi et al. 1999, Ronconi et al. 2015) as well as energetic costs due to deviation from normal movement/migration patterns. The increase in gulls to the area may lead to increase to predation on Leach's storm petrels. This would likely occur during September and October months when numbers of Leach's storm-petrels and great black-backed gulls peak offshore because of the exodus of fledglings and adults from nesting colonies. As noted in Chapter 6 and throughout this chapter, the population of Leach's storm petrel is in decline, however the increase in mortality of individuals by their predators around the FPSO would not likely have an adverse effect on the population. Per regulatory requirements, the FPSO is required to treat organic wastes prior to discharge.

The change in mortality / injury / health of marine and migratory birds, particularly Leach's storm petrels, due to organic waste discharges from the FPSO would be adverse, as described above and long-term. The geographic extent would be localized to fixed location of the FPSO (less than 1 km²). The mortality / injury / health would be sporadic, and reversible once the FPSO leaves the area. The change in mortality / injury / health to Leach's storm petrels and other marine birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, the FPSO is required to treat organic wastes prior to discharge

In summary, with the application of mitigations, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from discharges of organic waste from the FPSO during Production and Maintenance operations are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km² from the FPSO, long-term in duration, occurring sporadically and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges during Production and Maintenance Operations include treatment of wastes in consideration of OWTG discharge limits with the use of best treatment practices that are commercially available and economically feasible treatment of produced water prior to discharge (K), selection and screening of chemicals in accordance with guidelines (O), and the treatment and management of marine wastes prior to discharge (L, M, N).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with waste discharges during Production and Maintenance Operations in consideration of residual effects predictions.

10.3.2.4 Non-routine Flaring

The primary effects on Marine and Migratory Birds due to non-routine flaring during operations and maintenance are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

As mentioned in Section 2.5.3.1, there will be no routine flaring associated with production and maintenance operations. Non-routine and/or safety flaring will be sporadic, occurring during turnarounds / shutdown for maintenance and depressurization of process segments for safety reasons. Section 2.7.1.4 provides information on non-routine flaring operations. Scheduled maintenance turnarounds are typically carried out every three to five years. Non-routine flaring during these events would be short-term and are governed by Equinor's global best practices to reduce overall flaring durations during these activities.

The interactions leading to effects on food availability and behaviour would the same as those assessed under lighting (see Section 10.3.2.2) from the FPSO. Residual effects ratings may differ and are noted below as applicable. The primary effect from flaring would be a change in mortality / injury / health of marine and migratory birds and is the focus of this section.

There will likely be a continuously lit pilot flare for the purposes of this assessment. The effects of the pilot flare are assessed as part of the overall light emissions from the FPSO in section 10.3.2.2.

Changes in Food Availability and/or Quality is a potential effect associated with non-routine flaring during Production and Maintenance Operations.

In contrast to a continuously lit pilot flare which is part of the overall light emissions from the FPSO, when non-routine flaring occurs, it will add to the overall light emissions from the FPSO. As a result, the flare, acting as a light source, may contribute to the attraction of prey, as assessed above in Sections 10.3.2.2 if the flaring event occurs at night and its duration occurs for longer than a few minutes. The change in food availability due to non-routine flaring during production and maintenance activities would be positive due to predicted increase in the availability of prey species at night, as described above, and short-term. The geographic extent of the change in food availability would be less than 1km^2 from the location of the FPSO. The change in food availability would be sporadic, and reversible once non-routine flaring stops. While non-routine flaring events may change food availability within a localized area of the FPSO, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There would be no change in food availability relative to baseline conditions and the magnitude of the change is, therefore, negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

The duration of non-routine flaring will typically be of short duration and will be governed by Equinor best practices to reduce overall flaring duration, thereby reducing light emissions from flaring.

In summary, with the application of mitigation measures the residual environmental effects of a Change in Food Availability and/or Quality from non-routine flaring during Production and Operations are predicted to be positive, negligible in magnitude, with a geographic extent less than 10 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with non-routine flaring during production and maintenance operations. As noted in Section 10.3.2.2, marine and migratory bird attraction to light emissions from artificial lighting and flaring on offshore installations and vessels is well documented, but the causes are poorly understood (Rodríguez et al. 2015, Ronconi et al. 2015).

As noted above, species common in the Core BdN Development Area, in particular nocturnal species likely affected by light emissions from non-routine flaring are Leach's storm-petrel. They are common from May to early November, but especially September and October. The change in avifauna presence and abundance due to non-routine flaring would be the same as the effects from lighting from the FPSO (see Section 10.3.2.2) and would be adverse but short-term. The geographic extent of the behavioural change associated with non-routine flaring would be the same as light emission, which would be within a 15 km radius of the FPSO, especially at night or during periods of low visibility (common in June, July, and September). The change in avifauna presence and abundance would be sporadic, occurring only when non-routine flaring is carried out and reversible once flaring stops. The change in behaviour would be medium magnitude; it is beyond the range of natural variability but does not affect the viability of population. With the exception geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with FPSO lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence.

Mitigations to reduce bird attraction and other behavioural effects would include reducing overall light emissions from the FPSO, including non routine flaring, as listed in Section 10.1.5. Flaring during safety events or turnaround/maintenance activities cannot be limited to daytime hours and periods of good visibility, due to safety constraints. The duration of non-routine flaring will typically be of short duration and will be governed by Equinor best practices to reduce overall flaring duration. Systematic searches for- and recovery of stranded, live birds on the FPSO will be undertaken and birds found will be documented following protocols that will be developed in consultation with ECCC. When stranded birds are discovered, pursuant to a standard protocol as noted in Section 10.3.2.2, the birds will be collected and released. The development and implementation of such systematic protocols for the search, recovery, documentation, and release of stranded birds will provide the necessary spatial and temporal coverage to mitigate strandings (Ronconi et al. 2015).

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from non-routine flaring during Production and Maintenance Operations are predicted to be adverse, medium in magnitude, with a geographic extent less than 1,000 km² (i.e., 15 km radius of the FPSO), of short-term duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with non-routine flaring during production and maintenance operations.

In Atlantic Canada, nocturnal passage migrants, and nocturnally active, locally-resident nesting seabirds (e.g., primarily Leach's storm-petrel) are the marine and migratory birds most at risk of attraction to flares. A tracking study showed Leach's storm-petrels incubating at nests on Baccalieu Island and in the Witless Bay Islands Ecological Reserve commute between their colonies and the LSA on foraging trips lasting four days (Hedd et al. 2018). However, the potential mortality resulting from attraction to flares is poorly understood. Available estimates often rely on recovery of birds on platforms, and it is not known how many birds are killed but not recovered due to scavenging or landing in the ocean (Bruinzeel et al. 2009 and Ellis et al. 2013).

Some authors suggest that some of the birds attracted by artificial lighting on drilling and production installations that flare at night may be incinerated (Russell 2005; Montevecchi 2006). Systematic visual monitoring of North Sea gas flares has detected no incineration (Hope Jones 1980; Wallis 1981). Such monitoring has not been conducted in the Gulf of Mexico, but only two burned songbirds out of almost 120,000 birds of 279 species were found in a multi-year study of the use of offshore oil platforms as habitat by landbird passage migrants (Russell 2005). However, mortality at flares appears to be episodic, so may not have been detected in past, short-term studies. Bird mortality at an onshore flare stack in Alberta has been documented (Bjorge 1987). However, necropsies of 56 of the birds revealed equivocal evidence of collisions and no evidence of burning. The injuries observed were instead consistent with hydrogen sulfide poisoning. Although little studied, avian mass mortality incidents related to flaring at facilities such as the one at the Canaport liquid natural gas facility in Saint John, New Brunswick (NB) that killed approximately 7,500 birds in September 2013 (CBC News 2013), appear to be extremely rare. Atmospheric conditions included fog and overcast sky. Many of the birds were burned, but many showed no external injuries. There have been isolated accounts of mass mortality events (>100 birds in a night) from Canada and United States associated with oil and gas activities with fewer than five documented occurrences (Bjorge 1987; CWHC 2009), but because these events are so rare, no comprehensive analysis has been published. At least one similar incident has been reported with offshore flares in the North Sea, where a large number ("hundreds to thousands") of passerines were observed to have been killed in a night by flares (although not by incineration) (Sage 1979); however, research by Bourne (1979) and Hope Jones (1980) suggests a much lower mortality rate in the North Sea of approximately a few hundred birds per year per platform. These studies demonstrate interaction of flaring with birds and can be used to estimate potential effects offshore NL. The relative commonness of reports of nocturnal circulation of birds around flares and electric lighting in contrast with the rarity of reports of direct mortality from flares (Bourne 1979; Russell 2005) suggesting that the magnitude of the effects of attraction to a platform, i.e., energy consumption diverted from foraging and migration and of potential for mortality from stranding and collisions, is many times greater than the potential mortality from the heat of the flare. While accurate assessment of mortality at offshore facilities may be difficult, no mass mortality events have ever been reported at offshore oil and gas operations in offshore NL. In order to provide information regarding bird attraction to offshore installations, Equinor Canada is investigating means by which to monitor for attraction of marine and migratory birds to the FPSO. Options being investigated include technology (e.g., bird radar) that can be incorporated into the design of the FPSO, or vessel-based observation programs similar to those undertaken for the Hebron Platform (LGL 2017). Equinor Canada is working with experts in bird attraction to develop such an observational program and will engage with the CWS as planning progresses.

As with offshore lighting, a number of factors influence the potential severity of marine bird interactions with flares including the time of year, location (i.e., whether concentrations of birds are present near the flare for reasons other than attraction to the flare), height, and weather conditions (Weir 1976; Wiese et al. 2001). Mortality can also increase during migration, particularly when poor weather conditions force birds to fly at relatively low altitudes (Wiese et al. 2001). Risk of mortality due to artificial light sources such as flares may also be higher in the latter part of the night because most nocturnal migrants climb to their migrating height soon after takeoff and then undertake a gradual descent shortly after midnight (Weir 1976).

The change in mortality / injury / health of marine and migratory birds due to non-routine flaring would be adverse, as described above, and short-term. While attraction effects may be evident out to 15 km from the FPSO, the geographic extent of the change in mortality / injury / health would be localized to the location of the FPSO (i.e., less than 1 km^2) at its fixed location within the Core BdN

Development Area. The change in mortality / injury / health would be sporadic and reversible once the FPSO leaves the area. As discussed above, while Leach's storm-petrel is the most common bird species to strand offshore, the change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted above, there are uncertainties associated with extent of injury/mortality associated with bird strandings and flaring, therefore the predicted magnitude of change is made with a moderate level of confidence.

Mitigations to reduce bird attraction and potential mortality / injury / health effects associated with non-routine flaring would include limiting duration of non-routine flaring in accordance with Equinor's global best practices to reduce overall flaring duration. Flaring during safety events or turnaround/maintenance activities cannot be limited to daytime hours and periods of good visibility, due to safety constraints. Systematic searches for and recovery of stranded, live birds on the FPSO be undertaken and birds found will be documented following protocols that will be developed in consultation with ECCC. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. The development and implementation of such systematic protocols for the search, recovery, documentation, and release of stranded birds will provide the necessary spatial and temporal coverage to mitigate strandings (Ronconi et al. 2015).

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with non-routine flaring during Production and Maintenance Operations are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², short-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with non-routine flaring include systematic searches for, documentation of, and release of stranded seabirds (B, C, D); duration of flaring in keeping with Equinor's global best practices (I), use of high efficiency burners (G), and submission of a flaring and venting plan to the C-NLOPB (J).

Follow-up Monitoring: In consideration of the residual effects predictions, and the uncertainty in potential attraction and strandings of Leach's storm petrels, and associated injury and/or mortality associated with non-routine flaring, observational-based follow-up monitoring is proposed. See Section 10.8 for additional information.

10.3.3 Drilling Activities

Drilling activities to be undertaken for the Core BdN Development are described in Section 2.6.3. Drilling will occur at set locations in the Core BdN Development Area, as illustrated in Figure 2-12. These set locations are illustrated on the figure as "well templates." Depending on final project design, wells will either be drilled using templates (multiple wells drilled in one location) or at individual well locations (satellite wells). Drilling will likely commence before the FPSO arrives on site and will overlap periodically during production operations.

The effects assessment, as stated in Section 10.1.5.1 is focused on those activities "with the greatest potential to have environmental effects." (EIS Guidelines, 2018). Therefore, the effects assessment will assume that multiple wells are to be drilled at set well template locations, which provides a more conservative estimate of effects than if a single well were drilled at these well template locations. Based on current Project design, well templates may be 4-, 6- or 8-slot templates, which means that either 4, 6 or 8 wells could be drilled at a single location, from the same well template. As noted in Table 10-1, it is estimated that 45-85 days are required to drill each well. Therefore, assuming eight wells are drilled consecutively, the drilling installation could be on a well template location between approximately one to two years, respectively, therefore source of light and attraction for marine and migratory birds for this time period. If number of wells per well template is less than eight, the time on location would be reduced accordingly. Drilling will not be carried continuously over the life of the project, but will occur in phases, with a set number of wells drilled per drilling campaign. The drilling installation may be on-site before the FPSO arrives on site. There may be periods of time, throughout the life of the project where the drilling installation and FPSO are in the Core BdN Development Area at the same time

As identified in Section 10.1.5, potential interactions from drilling activities on Marine and Migratory Birds includes presence of the drilling installation, light emissions and waste discharges from the drilling installation. Flaring may be an interaction, if a formation flow test is carried out.

10.3.3.1 Presence of Drilling Installation

The primary effects on Marine and Migratory Birds due to the presence of the drilling installation are:

- Change in Habitat Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)

Based on the environmental effects analysis on Marine Fish and Fish Habitat in Chapter 9, which concluded that the effects from drilling activities did not have a significant effect on prey species, there is no predicted Change in Food Availability and/or Quality for Marine and Migratory Birds from the presence of the drilling installation. A Change in Mortality / Injury Levels and/or Health of Individuals or Populations is primarily associated with lighting, which results in attraction and stranding of birds and is assessed under "Lighting from Drilling Installation".

Changes in Habitat Availability and/or Quality is a potential effect associated with presence of the drilling installation.

The changes in habitat availability due to the presence of the drilling installation would be the same as those assessed for the presence of the FPSO (Section 10.3.2.1), except for duration. The change in habitat availability and/or quality due to the presence of the drilling installation would be positive and adverse, depending on species, as described above and short-term. The geographic extent of the change in habitat would be less than 1 km² of the drilling installation at the wellsite location in the Core BdN Development Area. The change in habitat would be continuous, and reversible once the drilling installation leaves the area. As the drilling installation footprint would occupy a very small area within the entire 470 km² Core BdN Development Area (including if the FPSO and/or other vessels were on-site at the same time), the magnitude of the change in habitat availability would be considered within the range of natural variability and therefore would be low. Should the drilling installation and FPSO be onsite concurrently, the geographic extent may be additive but would still represent a very small area within the entire of the Core BdN Development Area. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat due to the presence of the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Habitat Availability and/or Quality from the presence of the drilling installation are predicted to be positive and adverse, low in magnitude, with a geographic extent less than 1 km², of medium-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with presence of the drilling installation.

As with the presence of the FPSO (see Section 10.3.2.1), there is potential for the presence of the drilling installation to lead to the disturbance and possible displacement of seabirds from foraging and resting areas within the Core BdN Development Area. Foraging activities are typically most common in the Core BdN Development Area during September to April, when Leach's storm-petrel, the murre two murre species, and dovekie are at their highest densities offshore and therefore may be affected by the presence of the drilling installation, if drilling activities occur during this timeframe.

The change in avifauna presence and abundance due to the presence of the drilling installation would be adverse, as described in Section 10.3.2.1, and medium-term. The geographic extent of the change in habitat would be localized to the location of the drilling installation at its well template location within the Core BdN Development Area (i.e., less than 1 km²). The change in habitat would be continuous, and reversible once the drilling installation leaves the area. As the drilling installation footprint would occupy a very small area within the entire 470 km² Core BdN Development area, the magnitude of the change in avifauna presence and abundance is considered within the range of natural variability and would be low. Should the drilling installation and FPSO be onsite concurrently, the geographic extent may be additive but would still represent a very small area within the entire of the Core BdN Development Area. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in avifauna presence and abundance are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from the presence of drilling installation are predicted to be adverse, low in magnitude, with a geographic extent of less than 1 km², of medium-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with the presence of the drilling installation are not proposed.

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with the presence of the drilling installation in consideration of residual effects predictions.

10.3.3.2 Light Emissions from Drilling Installation

The primary effects on Marine and Migratory Birds due to light emissions from the drilling installation are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Changes in Habitat Availability and/or Quality are primarily associated with the presence of the drilling installation and are addressed above.

Light emissions from the drilling installation would have the same effects, but shorter duration, on Marine and Migratory Birds as the light emissions from the FPSO, which are assessed above in Section 10.3.2.2. If the drilling installation arrives onsite prior to the FPSO, its presence would be a new source of artificial lighting in a region that is relatively free of nocturnal artificial lighting, as indicated in a world atlas of computed artificial night sky brightness (Falchi et al. 2016). The drilling installation may be on-site before the FPSO arrives on site. There may be periods of time, throughout the life of the project where the drilling installation and FPSO are in the Core BdN Development Area at the same time. As indicated in Section 10.3.2.2, Leach's storm-petrel is the species of marine and migratory bird present in the Core BdN Development area that is likely to be attracted to offshore installations.

Changes in Food Availability and/or Quality is a potential effect associated with light emissions from the drilling installation.

As discussed in Section 10.3.2.2, the change in food availability is likely more pronounced at night and in periods of low visibility. Prey species in the Core BdN Development Area, may be attracted to lighting from the drilling installation, and could result in a larger number of night feeding birds (such as great black-backed gull) to the area than would typically be there under baseline conditions. These effects would be more pronounced from September to November, when there is a higher concentration of great black-backed gulls in the area due to their stopover during migration. Foraging opportunities may also be enhanced around platforms because they themselves may become artificial reefs where species such as great black-backed gulls congregate and feed on prey, such as Atlantic saury and sand lance, which are attracted to the surface by artificial lighting from installations. There is no anticipated change in food quality due to lighting from the drilling installation.

The change in food availability due to the lighting from the drilling installation would be positive due to predicted increase in prey species at night, as described above and medium-term, occurring at night or in periods of low visibility. The geographic extent of the change in food availability would be less than 10 km² around the location of the drilling installation. The change in food availability would occur regularly at night while the drilling installation was on-site, and reversible once the drilling installation leaves. As noted in Section 9.3.3, the magnitude of changes to fish (presence/abundance, including effects on prey) associated with drilling activities are predicted to be negligible, therefore the magnitude of change in food availability for marine and migratory birds would be negligible. While light emissions may change food availability near the drilling installation, food availability is not affected within the Core BdN Development Area relative to baseline conditions. As stated in Section 2.7.4.6, there are no mitigations proposed to reduce light emissions from drilling installations. Should the drilling occur concurrently with production operations, there would be an increase in overall light emissions in the Core BdN Development Area from than if a single installation were onsite. However, the overall magnitude of change in food availability would not change. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability due to the light emissions from the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from light emissions from the drilling installation are predicted to be positive, negligible in magnitude, with a geographic extent less than 10 km^2, of medium-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with light emissions from the drilling installation.

Behavioural effects of light emissions from the drilling installation would be the same as those described and assessed in Section 10.3.2.2, except for the duration of effect. As stated above, in the Core Bay du Nord Development Area, species common offshore, and in particular nocturnal species, which may be affected by lighting from the drilling installation include Leach's storm-petrel. The change in avifauna presence and abundance due to lighting from the drilling installation would be adverse, as described above, and medium-term while the drilling installation is on the well template location. The geographic extent of the behavioural change would within a 15 km radius of the drilling installation, especially during periods of low visibility or at night. The change in avifauna presence and abundance would occur regularly at night or in periods of low visibility while the drilling installation is onsite and reversible once it leaves the area. The change in behaviour would be of medium magnitude, as the change in behaviour is likely beyond the range of natural variability for the species likely affected, but with no associated adverse effect on the viability of the affected population. If drilling and production operations are simultaneous, the geographic extent over which birds may be affected by light emissions may be greater, however the overall magnitude of the effect would be medium. Well templates, and hence the location of the drilling installation is estimated to be less than 15 km from the FPSO. With the exception geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with FPSO lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence.

As stated in Section 2.7.4.6, mitigations to reduce light emissions from drilling installation are not feasible. Systematic searches for and recovery of stranded, live birds on the drilling installation will be undertaken and birds found will be documented following protocols that will be developed in consultation with ECCC. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. The development and implementation of such systematic protocols for the search, recovery, documentation, and release of stranded birds will provide the necessary spatial and temporal coverage to mitigate strandings (Ronconi et al. 2015).

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from light emissions from the drilling installation are predicted to be adverse, medium in magnitude, with a geographic extent less than 1,000 km² (15 km radius of the installation), of medium-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with light emissions from the drilling installation.

Changes in mortality / injury / health of Marine and Migratory Birds due to light emissions from the drilling installation would be the same as those described and assessed in Section 10.3.2.2 for the FPSO, except for the duration of effect. As stated in Section 10.3.2.2, attraction of nocturnally active birds, such as Leach's storm-petrels, may result in direct mortality or injury through collisions with facility infrastructure, predation, or stranding on the installation (Baird 1990, Montevecchi et al. 1999, and Wiese et al. 2000; LGL 2017). Stranding data from Equinor Canada exploration activities in the Flemish Pass, including the Project Area, were collected over 1,755 days from 2008 to 2016 in programs conducted during every month of the calendar year. A total of 282 birds were recovered, of which 252 were released alive. Leach's storm-petrels comprised 81 percent of the stranded birds and another 5 percent were great shearwaters. Other species found were great black-backed gull, thick-billed murre, northern fulmar, sooty shearwater, south polar skua, and Lincoln's sparrow. Most of these strandings occurred from June through August. Data presented in Section 10.3.2.2 regarding marine bird strandings and release would be relevant to drilling activities, which indicate that the most common species to strand offshore by far is the Leach's storm-petrel. Strandings tend to be episodic and most common in September and October. Of the strandings, the data also indicates that the majority of birds are released, and small percentage are injured and die. It is also indicated in Section 10.3.2.2, Leach's storm-petrels attracted to drilling and production platforms in the Canada-NL offshore area also suffer predation in late summer and fall from great black-backed gulls attracted by the fish drawn to the surface at night by the artificial lighting (Montevecchi et al. 1999; LGL 2017).

The change in mortality / injury / health of marine and migratory birds due to light emissions from the drilling installation would be adverse, as described above, and medium-term. While attraction effects of lighting may be evident out to 15 km from the drilling installation, the geographic extent of the change in mortality / injury / health would be localized to the location of the installation (i.e., less than 1 km²) at its well template location within the Core BdN Development Area. The mortality / injury / health from strandings would be sporadic, as strandings tend to occur at different times under varying conditions, and reversible once the drilling installation leaves the area. As discussed above, while Leach's storm-petrel are the most common bird to strand offshore, the change in mortality / injury / health to Leach's Storm Petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. Attraction and stranding effects on marine and migratory birds may be greater with simultaneous operations, the change in mortality / injury health would be limited to the location of either installation and the overall magnitude of effect would be low, as there would be no change from natural variability in the population. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted above, there are uncertainties associated with extent of injury/mortality with bird strandings, therefore the predicted magnitude of change is made with a moderate level of confidence.

As stated above, mitigations to reduce light emissions from drilling installation are not feasible. Systematic searches for, recovery and release of stranded, live birds on the drilling installation will be undertaken and birds found will be documented following protocols that will be developed in consultation with ECCC. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. The development and implementation of such systematic protocols for the search, recovery, documentation, and release of stranded birds will provide the necessary spatial and temporal coverage to mitigate strandings (Ronconi et al. 2015).

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from light emissions from the drilling installation are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², medium-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with the light emissions include systematic searches for, documentation of, and release of stranded seabirds (B, C, D).

Follow-up Monitoring: In consideration of the residual effects predictions, the uncertainty in potential attraction and strandings of Leach's storm petrels and associated injury and/or mortality associated with light emissions from the drilling installation, and potential intra-project effects when the drilling installation and FPSO are operating concurrently, observational-based follow-up monitoring is proposed when the drilling installation and FPSO are operating concurrently within the Core BdN Development Area. See Section 10.7 for additional information.

10.3.3.3 Waste Discharges during Drilling

As stated in Section 10.1.5, the discharge of organic waste and the discharge of SBM cuttings are interactions that may affect Marine and Migratory Birds.

As indicated in Section 2.6.2, formation flow testing is not typically carried out for development drilling. Should a formation flow test be required, it is Equinor Canada's preferred option to carry out a formation flow test without flaring. If a formation flow test is required, it is likely that the test flow will be routed to the FPSO, however, the drilling installation would have the capacity to carry out flaring associated with a well test.

SBM Cuttings Discharges

SBM cuttings are treated prior to discharge and have a small (and permitted) fraction of residual SBM when discharged. Periodically, the discharge of SBM have caused surface sheening. As noted in Section 10.3.2.4, surface sheening can cause the following affect:

- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with surface sheening from the discharge of SBM cuttings during Drilling Activities.

Surface sheening, while unlikely to occur, associated with the discharge of SBM cuttings would have similar effects on Marine and Migratory Birds as discussed in Section 10.3.2.3. Should surface sheening occur, the change in mortality / injury levels and/or health of individuals or populations would be adverse as described above, and likely long-term. The geographic extent of the change in mortality would be less than 1 km² from the drilling installation at its well template location in the Core BdN Development Area. The change in mortality / injury / health would not likely to occur as sheening is not a common occurrence associated with the discharge of SBM treated cuttings, and birds would have to be in the area if sheening event occurred. Should an effect occur, it would be reversible. As discussed above, the change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of duration of effect, these predications are made high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Based on the uncertainties noted in Section 10.3.2.3 above regarding the duration of effect from sheening (i.e., long-term) the prediction of long-term effect duration is made with a moderate level of confidence.

SBM cuttings will be treated prior to discharge using best treatment practices that are commercially available and economically feasible, and chemicals will be screened in accordance with guidelines and Equinor's best practices.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with the discharge of treated SBM cuttings are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², of long-term in duration, not likely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with SBM drill cuttings discharge include the treatment of drill cuttings prior to discharge (K), selection and screening of chemicals in accordance with guidelines (O).

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with discharge of drill cuttings during Drilling Activities.

Marine Waste Discharges

The primary effects on Marine and Migratory Birds, due to the discharge of organic waste from the drilling installation during drilling activities are:

- Change in Food Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

There is no predicted Change in Habitat Availability or Quality due to these discharges as a result of the discharge location, sinking, and degradation of organic waste at depths below which most seabirds dive, and to the treatment of other discharges in accordance with regulatory requirements (BP 2016).

The effects associated with the discharge of organic waste from vessels, as assessed in Section 10.3.1.4 would be the same for the drilling installation, except for certain characterizations of residual effects.

Change in Food Availability and/or Quality is a potential effect associated with the discharge of organic wastes from the drilling installation.

As noted in Section 10.3.1.4, the discharge of organic wastes may result in enrichment of the baseline food supply (Peterson et al. 1996) for marine and migratory birds (Ortego 1978); however, food and sewage waste discharged overboard are expected to be degraded after release (BP 2016). During drilling activities, marine and migratory birds most likely to interact with and be affected by the discharge of organic wastes includes gulls (September to November) and fulmar (year-round). The change in food availability and/or quality due to the discharge of organic wastes from the drilling installation would be positive, as described in Section 10.3.1.4, and medium-term. The geographic extent of the change in food would be within less than 1 km^2 from the discharge location of the drilling installation at the well template location within the Core BdN Development Area. The change in food availability and/or quality would be continuous during drilling and reversible once the drilling installation leave the area. While marine discharges may change food availability within a localized area of the drilling installation, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There would be no change in food availability relative to baseline conditions and the magnitude of the change is, therefore, negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per regulatory requirements, the drilling installation is required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality from organic waste discharges during Drilling Activities are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km^2 of the drilling installation, of medium-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Changes) is a potential effect associated with the discharge of organic wastes during drilling activities.

As discussed in Section 10.3.1.4, the discharge of organic wastes may result in enrichment of the food supply (Peterson et al. 1996) which may lead to an attraction of foraging marine and migratory birds, such as gulls and northern fulmar to the drilling installation location (Ortego, 1978).

The Change in Avifauna Presence and Abundance of Marine and Migratory Birds due to organic waste discharges during Drilling Activities would be adverse, as described in Section 10.3.1.3, and medium-term. The geographic extent of the change in would be less than 1 km² of the location of the drilling installation (Burke et al. 2012) at the well template location within the Core BdN Development Area. The change in presence and abundance would be regular while the drilling installation is on-site, and reversible once it leaves the area. The change in presence and abundance would be negligible in magnitude, as the birds would be in the area foraging, but temporarily attracted to drilling installation location due to the organic waste discharge, and therefore no change relative to baseline conditions. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per regulatory requirements, the drilling installation is required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Change) from the discharge of organic wastes during Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of medium-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with the discharge of organic wastes during drilling activities.

As noted in Section 10.3.1.4, there may be an increase in the presence of foraging marine birds due to the discharge of organic wastes from the drilling installation. This potentially positive effect may be offset by increased exposure to risk of collision / strandings, as noted in previous sections, or predation by bird species (e.g., large gull species) attracted by organic wastes (Ortego 1978) as well as energetic costs due to deviation from normal movement/migration patterns. The increase in gulls to the area may lead to increase to predation on Leach's storm-petrels and may be greater during September and October months when Leach's storm-petrel numbers are greatest offshore. As noted in Chapter 6 and throughout this chapter, the population of Leach's storm-petrel is in decline, however the increase in mortality of individuals by their predators would not likely have an adverse effect on the population.

The change in mortality / injury / health of marine and migratory birds, particularly Leach's storm petrels, due to organic waste discharges from the drilling installation would be adverse, as described above in Section 10.3.1.4 and medium-term. The geographic extent would be localized to fixed location of the drilling installation (less than 1 km²) (Burke et al. 2012). The mortality / injury / health would be sporadic, and reversible once the drilling installation leaves the area. The change in mortality / injury / health to Leach's storm-petrels and other marine birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the

EIS Team. Per regulatory requirements, the drilling installation is required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from discharges of organic waste during Drilling Activities are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², medium-term in duration, occurring sporadically and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from drilling installations during Drilling Activities include treatment and management of marine discharges and wastes from the installation (K, L, M, N).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with marine discharges during Drilling Activities in consideration of residual effects predictions.

Flaring during Formation Flow Testing

The primary effects on Marine and Migratory Birds due to flaring during operations and maintenance are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

As indicated in Section 2.6.2, formation flow testing is not typically carried out for development drilling. However, if formation flow testing is required, it is Equinor Canada's preferred option to carry out a formation flow test without flaring. If a formation flow test is required, it is likely that the test flow will be routed to the FPSO, however, the drilling installation would have the capacity to carry out flaring associated with a well test. Flaring during a formation flow text, if required, is expected to last two to three days or up to five days for an extended flow test. As noted in Section 2.7.1.2, only one formation flow test may be required. The effects of flaring are discussed in Section 10.3.2.4 and would be similar should flaring occur during drilling activities.

Changes in Food Availability and/or Quality is a potential effect associated with flaring during a formation flow test.

If flaring is required during a formation flow test, it will contribute to the overall light emissions from the drilling installation. As a result, similar to the effects from lighting (including pilot flare) or non-routine flaring on the FPSO, the flare acting as a light source may contribute to the attraction of prey, as assessed above in Section 10.3.2.2 and 10.3.2.4. The change in food availability due to a single flaring event during a formation flow test would be positive due to predicted increase in prey species at night, as assessed in Sections 10.3.3.2 and 10.3.2.4 and short-term. The geographic extent of the change in food availability would be less than 10 km² from the location of the drilling installation. The change in food availability would be a single event and reversible once flaring ceases. While flaring during a formation flow test may change food availability around the drilling installation, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There would be no change in food availability relative to baseline conditions and the magnitude of the change is, therefore, negligible. Should a formation flow test while drilling occur concurrently with production operations, including non-routine flaring events, there would be an increase in overall light emissions in the Core BdN Development Area than if a single installation were onsite. However, the overall magnitude of change in food availability would not change. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the effects on food availability during flaring from a formation flow test are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from flaring during a formation flow test are predicted to be positive, negligible in magnitude, with a geographic extent less than 10 km^2, and short-term in duration, occurring once, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with flaring during a formation flow test.

The change in avifauna presence and abundance due to a flaring during a formation flow test would be similar as the effects from lighting from the FPSO (see Section 10.3.2.2). The change would be adverse but short-term. The geographic extent of the behavioural change associated with flaring during a formation flow test would be the same as light emission, which would be within a 15 km radius of the drilling installation, especially at night or during periods of low visibility (common in June, July and September). The change in avifauna presence and abundance would occur once and would be reversible once flaring stops. The change in avifauna behaviour from a single event would be low in magnitude compared to the short-term, medium magnitude changes associated with continuous light emissions on the drilling installation (see Section 10.3.3.2). The change in behaviour would be considered within the range of natural variability without affecting the viability of the affected populations, and therefore low. Should a formation flow test while drilling occur concurrently with production operations, including non-routine flaring events, there would be an increase in overall light emissions in the Core BdN Development Area than if a single installation were onsite. However, the overall magnitude of change in behaviour would not change. With the exception geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence.

Mitigations to reduce behavioural effects should a formation flow test with flaring be required, are not proposed. Systematic searches for and recovery of stranded, live birds on the drilling installation will be undertaken and birds found will be documented following protocols that will be developed in consultation with ECCC. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. The development and implementation of such systematic protocols for the search, recovery, documentation, and release of stranded birds will provide the necessary spatial and temporal coverage to mitigate strandings (Ronconi et al. 2015).

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from flaring during a formation flow test are predicted to be adverse, low in magnitude, with a geographic extent less than 1,000 km² (15 km radius of the drilling installation), of short-term duration, occurring once and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with flaring during a formation flow test.

The change in mortality / injury / health of marine and migratory birds should flaring during formation flow test be carried out would be similar to those described in Section 10.3.2.4. Effects would be adverse and short-term, as the duration of flaring would be less than five days. While attraction effects may be evident out to 15 km from the drilling installation, the geographic extent of the change in mortality / injury / health would be localized to the location of the drilling installation (i.e., less than 1 km²) at its location on a well template location within the Core BdN Development Area. The change in mortality / injury / health would occur once and reversible once flaring is stopped. As discussed above, while Leach's storm-petrel are the most common bird species to strand offshore, the change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted in Section 10.3.2.4, there are uncertainties associated with extent of injury/mortality associated with bird strandings and flaring, therefore the predicted magnitude of change is made with a moderate level of confidence.

Mitigations to reduce change in mortality / injury / health of marine and migratory birds should a formation flow test with flaring be required, are not proposed. Systematic searches for and recovery of stranded, live birds on the drilling installation will be undertaken and birds found will be documented following protocols that will be developed in consultation with ECCC. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. The development and implementation of such systematic protocols for the search, recovery, documentation, and release of stranded birds will provide the necessary spatial and temporal coverage to mitigate strandings (Ronconi et al. 2015).

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from flaring during a formation flow test are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², short-term in duration, occurring once and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with the flaring during formation flow testing include systematic searches for, documentation of, and release of stranded seabirds (B, C, D), preference for well clean-up to be done through the FPSO (H) and duration of flaring in keeping with Equinor's global best practices (I).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with the flaring during formation flow testing in consideration of the residual effects predictions.

10.3.4 Supply and Servicing

Activities associated with Supply and Servicing are described in Section 2.6.4. Supply and servicing to support the Project will involve marine vessels and aircraft transiting to, from and within the Core BdN Development Area and Project Area at all times of the year throughout the Project duration.

As described in Section 2.6.4.2, the volume of vessel traffic associated with Core BdN Development activities represents a small increase to the overall vessel traffic off eastern Newfoundland. At a maximum, when Project phases overlap, albeit for a short duration, it is estimated that up to six support vessels could supporting project activities and up to 16 vessels transits per month could occur. Of the total annual transits recorded servicing offshore oil and gas activities, these 16 transits per month (or 192 per year) represents and estimated 20 percent increase to offshore oil and gas related traffic or 12 percent of all traffic in the port of St. John's. During normal operational timeframe, when only one Project activity is occurring at any one time, for instance Production and Maintenance, up to three support vessels would be supporting the Project, representing eight transits per month. This typical level of supply and servicing traffic represents an estimated 10 percent increase in offshore oil and gas related traffic and 10 percent increase in all vessel traffic in the port of St. John's. Supply and support vessels supporting the Project will transit in a straight-line approach to and from port to the Project location, a common industry practice for energy efficiency employed for over 30 years by operators with facilities offshore NL.

With regards to helicopter support traffic, helicopters will be used for the transport of crew and supplies to and from the Project. As described in Section 2.6.4.3 up to 15 trips per week are estimated at a maximum when multiple activities are occurring such as HUC and drilling. When only production activities are ongoing, up to five helicopter transits per week are estimated. Of the total annual transits for helicopter flights servicing NL offshore oil and gas activities, at a maximum15 helicopter trips per week would represent an estimated 27 percent of annual helicopter traffic when activities are simultaneous and 11 percent of annual helicopter traffic during normal production timeframe. Note that the maximum helicopter flights would only occur for a short period of time while HUC and drilling carried out simultaneously.

10.3.4.1 Marine Vessels

Presence of Vessel

The primary effects on Marine and Migratory Birds, due to the presence of vessels engaged in supply and servicing activities for the Project are:

- Change in Habitat Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)

There is no predicted Change in Food Availability and/or Quality for Marine and Migratory Birds associated with supply and support vessel activities, as indicated in Section 10.3.1.1, and supported by effects assessment conclusions in Chapter 9.

Changes in Habitat Availability and/or Quality is a potential effect associated with vessels in transit or while on-site at the Core BdN Development Area supporting Project activities. The change to habitat Availability due the presence of the supply vessels on site would be similar to effects assessed in Section 10.3.1.1 with the expectation of the stand-by vessel (SBV) which must remain on-site within a set distance of the FPSO and/or drilling installation. Offshore supply vessels would only be onsite while carrying out their duties (cargo transport, crew change, etc.). While onsite, vessels may act as structures where, as stated in Section 10.3.1.1, they act as roosting and resting sites, and stopover locations.

As noted in Section 10.3.1.1, species of birds likely to be affected by vessel presence include northern fulmar, great and sooty shearwaters, northern gannet, black-legged kittiwake, great black-backed and herring gulls, both murres, Atlantic puffin, razorbill, and dovekie. During transit, along the vessel transit route, these species are more likely to be encountered along the shelf edge and closer to shore. Although the presence of these vessels may result in a change in habitat availability, overall the VC is unlikely to be affected by Project-related vessel activity due to its transitory nature and thus its short-term presence at any one location. The SBV on site would provide another structure in the Core BdN Development Area. Project-related supply vessel traffic will use common routes wherever possible. Vessels will avoid coastal seabird colonies during the nesting season as per the *Seabird Ecological Reserve Regulations, 2015.*

The change in Habitat Availability and/or Quality due to the presence of vessels engaged in supply and servicing would be positive and adverse, as described above and short-term for vessels in transit to long-term for to presence of the SBV at the Core BdN Development Area. The geographic extent of the change in habitat would be less than 1 km² of the location of the vessel at site and along its transit route. In transit the change in habitat would be sporadic, but once onsite, the change in habitat would be continuous due to the presence of the SBV, and reversible once the vessel(s) leaves the area. As the vessel footprint would occupy a very small area of the existing baseline habitat available within the entire Core BdN Development area (including if more than one vessel were on site at the same time) and/or vessel traffic route, the magnitude of change in habitat availability would be low, as it is considered within the range of natural variability. For vessels in transit, the magnitude of change would be negligible, as there would be no change in habitat relative to baseline conditions as transiting vessels are common offshore NL. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat availability are not proposed.

In summary, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with the presence of vessels engaged in Supply and Servicing are predicted to be positive and adverse, negligible to low in magnitude, with a geographic extent less than 1 km², of short- to long-term duration, occurring sporadically to continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with supply and support vessels in transit or while on-site at the Core BdN Development Area supporting Project activities. Behavioural changes due the presence of the supply and support vessels would be similar to those effects assessed in Section 10.3.1.1. With the expectation of the stand-by vessel (SBV) which must remain on-site continuously within a set distance of the FPSO and/or drilling installation, supply and support vessels would only be onsite while carrying out their duties (cargo transport, crew change, etc.,). As assessed in Section 10.3.1.1, there is potential for the presence of vessels to lead to the temporary disturbance and possible displacement of northern fulmar, great and sooty shearwaters, black-legged kittiwake, great black-backed gulls, both murres, and dovekie from foraging and resting areas within the Core BdN Development Area.

The change in avifauna presence and abundance due to the presence of vessels would be adverse, as described in Section 10.3.1.1, and short term while in transit and long-term due to presence of the SBV at the Core BdN Development Area. The geographic extent of the change in behaviour would be less than 1 km² of the location of the vessel at site and along its transit route. The change in avifauna presence and abundance would be sporadic for vessels in transit, continuous for the SBV at site, and reversible once the vessel(s) leaves the area. As the vessel footprint would occupy a very small area of the existing baseline habitat available within the entire Core BdN Development area (including if more than one vessel were on site at the same time) and/or vessel traffic route, the magnitude of the change in avifauna presence and abundance would be low as it is considered within the range of natural variability. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce changes in behaviour associated with Supply and Servicing include adherence to regulations regarding avoidance of nesting colonies and use of common vessel traffic routes.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from the presence of vessels engaged in Supply and Servicing are predicted to be adverse, low in magnitude, with a geographic extent of less than 1 km², of short- to long-term duration, occurring sporadically to continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with vessel presence during Supply and Servicing include use of common traffic routes (P) and adherence to regulatory requirements regarding set-back distances for helicopters and vessels from nesting colonies (R).

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with vessel presence during Supply and Servicing in consideration of residual effects predictions.

Light Emissions from Vessels

The primary effects on Marine and Migratory Birds, due to the vessels engaged in supply and servicing activities for the Project are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Changes in Habitat Availability and/or Quality are primarily associated with vessel presence and are addressed above.

Changes in Food Availability and/or Quality is a potential effect associated with light emissions from supply and support vessels while on-site at the Core BdN Development Area supporting Project activities. Light emissions from vessels transiting to/from port would not contribute to a change in food availability as the vessels are in transit and not stationary and not likely to attract prey species and therefore there is no interaction while transiting. The change to food availability due the light emissions would be while SBV was on site and would be similar to effects assessed in Section 10.3.1.2 and 10.3.2.2 for vessels on-site within the Core BdN Development Area.

SBVs maintain position around the FPSO and/or drilling location by transiting at slow speeds around the installations. Other support vessels may be onsite carrying out specific activities from time to time (i.e., well intervention). As discussed in Sections 10.3.1.2 and 10.3.2.2, light emissions may attract fish, which in turn may attract great black-backed gull and other gull species (LGL 2017). The change in food availability due to the vessel lighting would be positive due to predicted increase in prey species at night, as described above in Sections 10.3.1.2 and 10.3.2.2. As vessel lighting is much less intense than that from the FPSO and/or drilling installation, the increase in food availability from the SBV would be lower in comparison to the installations, however, the additional light source could provide an overall additive effect to food availability. The effect would be long-term due to presence of the SBV at the FPSO location. The geographic extent of the change in food availability would be less than 1 km² within the location of the SBV within the Core BdN Development Area. The change in food availability would occur regularly at night while vessels were on-site, and reversible once the vessel(s) leaves the area. While light emissions may change food availability within a localized area of the vessel, including with the FPSO and drilling installation on site, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the change is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from the presence of vessels on-site at the Core BdN Development Area engaged in Supply and Servicing are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km², of long-term in duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with vessels in transit or while on-site at the Core BdN Development Area supporting Project activities. The change in avifauna presence and abundance due to light emissions from vessels engaged in supply and support would be similar to effects assessed in Section 10.3.1.2 and 10.3.2.2 for vessels on-site within the Core BdN Development Area, which is part of a foraging area for Leach's storm-petrels as noted in Section 10.3.2.2. At typical transiting speeds between the Project Area and shore, Leach's storm-petrels are unlikely to overtake the vessels and become stranded.

As described in Sections 10.3.1.2 and 10.3.2.2, nocturnally active species may be attracted to artificial lighting from vessels. SBVs, while maintaining position on-site, are either stationary or travelling slowly around the FPSO and/or drilling installation such that birds, especially Leach's storm-petrels may be attracted and become stranded. Likewise, OSVs and other support vessels in the Core BdN Development area, may attract birds and lead to their stranding. However, as discussed in Section 10.3.2.2, SBVs and OSVs typically have only a small fraction of the storm-petrel strandings compared to seismic survey vessels. Based on the information presented in previous sections above, it is assumed, with some uncertainty that the distance at which lighting attracts birds is approximately 15 km. As noted above, migratory bird stranding due to artificial lighting appears to be associated with certain environmental conditions. Greater numbers of birds strand around artificial lighting when there is a low cloud ceiling, particularly when accompanied by fog or rain (Telfer et al. 1987; Black 2005; Poot et al. 2008; LGL 2017). Low visibility is common offshore during June, July and September (Section 5.3.4) and therefore behaviour changes associated with vessel lighting on-site are predicted.

The change in avifauna presence and abundance due to vessel lighting would be adverse, as described in above and in Section 10.3.1.2, and but long-term for the SBV at site. The geographic extent of the behaviour change would within a 15 km radius of a vessel, during period of low visibility or at night. The change in avifauna presence and abundance would occur regularly at night, and reversible once the vessel(s) leaves the area. The change in behaviour would be of low magnitude, in consideration of the lighting effects from the FPSO and/or drilling installation, which is predicted to be of medium magnitude. With the exception geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with FPSO lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence. Mitigations to reduce the change in avifauna presence and abundance for the supply and servicing vessels are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) associated with light emissions from vessels engaged in Supply and Servicing on-site at the Core BdN Development Area, but not along the vessel traffic route, are predicted to be adverse, low in magnitude, with a geographic extent less than 1,000 km² (i.e., 15 km radius around vessels), of long-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with vessels in transit or while on-site at the Core BdN Development Area supporting Project activities. Changes in mortality / injury / health due the light emissions from supply and support vessels would be similar to those effects assessed in Sections 10.3.1.2 and 10.3.2.2. As assessed above, there is potential for birds to stand on vessels, which may lead to their injury or mortality. Lighting from vessels while in transit would not elicit attraction effects, as noted above, therefore stranding and related mortality / injury / health effects are not predicted for vessels in transit.

As stated above, and further described in Section 10.3.1.2 and 10.3.2.2, attraction related effects appear to be common among petrels and allied families. Mortality arises from stranding, collision, exhaustion of disoriented birds flying continuously around lights, delayed foraging or migration due to diversion toward the lights, and predation (Bourne 1979, Sage 1979, Wiese and Montevecchi 1999, Wiese et al. 2001, Jones and Francis 2003, and Bruinzeel and van Belle 2010, Ronconi et al. 2015). Depending on where birds strand, they may become oiled from oily locations on vessel decks. As discussed in detail in Section 10.3.2.1, bird strandings are most common in the fall months (September to October) but have occurred during summer months as well. Leach's Storm Petrels were the most common bird that was stranded, with highest strandings occurring in September and October months (refer to Section 10.3.2.2).

As noted in Sections 10.3.1.2 and 10.3.2.2, it is difficult to quantify the mortality rate of birds attracted to artificial lighting. Incidental information from industry-based observation programs is useful to determine seasonal and weather-related patterns in strandings, and to determine which species are likely more susceptible to this phenomenon. Of those marine birds that are recovered from installations and vessels, most are not injured during the stranding. Of the 994 storm-petrels that stranded on oil industry vessels, 15.7 percent were found dead or died during rehabilitation (LGL 2017). While Leach's storm-petrel populations are in decline, based on the information presented in Section 10.3.2.2, mortality from strandings is low. There is uncertainty in the exact numbers of mortality due to strandings as deck searches, releases and documentation have not been consistent.

The change in mortality / injury / health of marine and migratory birds due to the lighting supply and support vessels on-site would be adverse, as described above, and long-term for the SBVs. While attraction effects may be evident out to 15 km from the vessel, the geographic extent of the change in mortality / injury / health would be localized to the location of the vessel(s) (i.e., less than 1 km²) within the Core BdN Development Area where birds strand and may be injured or die. The mortality / injury / health from strandings would be sporadic, as strandings tend to occur at different times under varying conditions, and reversible once the vessel(s) leaves the area. As discussed in Section 10.3.2.2, while Leach's storm-petrel is the most common bird species to strand offshore, the change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted above, there are uncertainties associated with extent of injury/mortality with bird strandings, therefore the predicted magnitude of change is made with a moderate level of confidence.

Mitigations to reduce the strandings of birds on vessels are not available. For the SBVs onsite at the Core BdN Development Area, systematic routine searches for stranded seabirds will be conducted on these vessels. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. These protocols will be developed by Equinor Canada working with ECCC and will include the systematic documentation of stranded seabirds and releases.

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with light emissions from vessels engaged in Supply and Servicing activities are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², long-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with vessel lighting from vessels engaged in Supply and Servicing, however systematic and routine searches for stranded birds will be undertaken while the SBV is on location in the Core BdN Development Area (B, C, D).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with light emissions from vessels engaged in Supply and Servicing in consideration of residual effects predictions.

Marine Waste Discharges from Vessels

As noted above, the discharge of organic (grey water and sewage) waste is an interaction for marine and migratory birds. Other marine discharges (e.g., bilge and ballast water) are treated in accordance with regulatory requirements and would not have an effect. The primary effects on Marine and Migratory Birds, due to the discharge of organic waste from supply and servicing vessels are:

- Change in Food Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Change in Food Availability and/or Quality is a potential effect associated with the discharge of organic wastes from vessels engaged in supply and servicing. Vessels transiting to/from port would not contribute to a change in food availability due to the speed of transit.

The change to food availability due the discharge of organic wastes would be similar to effects assessed in Section 10.3.1.4 and 10.3.2.4 for vessels on-site within the Core BdN Development Area. The change in food availability and/or quality due to the discharge of organic wastes from vessels would be positive, as described in Sections 10.3.1.4 and 10.3.2.4, and long-term due to the presence of the SBV. The geographic extent of the change in food availability would be within less than 1 km² from the discharge location of the vessel (Burke et al. 2012) within the Core BdN Development Area. The change in food availability and/or quality would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. As the change is food availability is localized to area of the vessel, the overall food availability in the Core BdN Development Area is not affected (including if more than one vessel and/or installation were on site at the same time) and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality from marine discharges (i.e., organic wastes) from supply and support vessels are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km² of the vessel, of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Changes) is a potential effect associated with the discharge of organic wastes from vessels engaged in supply and servicing. The behavioural changes associated with the discharge of organic wastes would be similar to effects assessed in Section 10.3.1.4 and 10.3.2.4 for vessels on-site within the Core BdN Development Area.

The Change in Avifauna Presence and Abundance of Marine and Migratory Birds due to organic waste discharges from vessels would be adverse, as described above, and long-term due to the presence of the SBV. The geographic extent of the change in would be less than 1 km² of the location of the vessel (Burke et al. 2012) either in the Core BdN Development Area or along the vessel traffic route. The change in presence and abundance would occur sporadically along the vessel transit route. It may be continuous while the SBV is on-site. The change in behaviour would be reversible once the vessel(s) leaves the area. The change in presence and abundance would be negligible in magnitude, as the birds would be in the area foraging, but temporarily attracted to vessel location due to the organic waste discharge. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Change) from the discharge of organic wastes from vessels are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km² of the vessel, of long-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with the discharge of organic wastes from supply and support vessels. The changes in mortality / injury / health associated with the discharge of organic wastes would be similar to effects assessed in Section 10.3.1.4 and 10.3.2.4 for vessels on-site within the Core BdN Development Area. As vessels in transit do not have the same attraction effects as stationary vessels (see above), changes in mortality / injury / health are not predicted for vessels transiting to/from the Project.

The change in mortality / injury / health of marine and migratory birds, particularly Leach's storm petrels, due to organic waste discharges from vessels would be adverse, as described above and long-term due to the presence of the SBV. The geographic extent would be localized to the vessel (less than 1 km². The mortality / injury / health would be sporadic, and reversible once the vessel(s) leaves the area. The change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. These predictions are made with a high level of confidence based on the scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, the residual environmental effects of a Change in Mortality / injury Levels and/or Health of Individuals or Populations from discharges of organic waste from vessels engaged in supply and servicing are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², long-term in duration, occurring sporadically and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from vessels engaged in Supply and Servicing include treatment and management of marine wastes and discharges from vessels (L, M, N).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with marine discharges from vessels engaged in Supply and Servicing in consideration of residual effects predictions.

10.3.4.2 Aircraft (Helicopters)

The primary effects on Marine and Migratory Birds, associated with helicopters (movement and sound) are:

- Change in Habitat Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)

There is no predicted Change in Habitat Availability or Quality or Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with the presence of helicopters.

Helicopters will operate out of the St. John's International Airport and will be used for crew transfers and other purposes as required. As noted in Section 10.3.4, there could be up to 15 flights per week when HUC activities and drilling occur simultaneously and approximately 5 flights per week during normal production. Flights will use existing and common routes wherever possible. Per regulatory requirements, standard altitude profiles are between approximately 610 metres (m) (or 2,000 feet) and 2,743 m (or 9,000 feet), with an odd number altitude being flown on the eastbound flight, and an even number altitude being flown on the westbound flight for separation purposes. During the approach phase to an offshore installation, the helicopter is typically only below 152 m (or 500 feet) for three to six minutes, or approximately 2 percent of a total round-trip flight, assuming the flight is 4.5 hours. Onshore approaches to the St. John's International Airport are flown at the same approach points and altitudes as commercial air traffic.

Change in Habitat Availability and/or Quality is a potential effect associated with the presence of helicopters supporting the Core BdN Development.

An interaction associated with presence of helicopters is the possible disturbance effects of aircraft overflights on birds. The disturbance effects can lead to a temporary loss of useable habitat. Helicopter presence (due to movement and sound) can disturb nesting seabirds at colonies, although seabird response to helicopters and other aircraft depends on a number of factors including species, previous exposure levels, and the location, altitude, and number of flights (Hoang 2013). As noted above, with the application of mitigations and the distance of the airport from coastal nesting seabird colonies, interaction with coastal colonies are not anticipated. Helicopter sound may also deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure (Larkin 1996 and Beale 2007). Offshore, the presence of helicopters may cause a change in habitat availability for birds along the helicopter flight path (same as vessel traffic route) and on approach to the FPSO. As discussed above, helicopters in transit will be at altitudes for most of their route that are above those of birds, except long-distance migrant shorebirds and landbirds. Consequently, the majority of marine and migratory birds in the Project Area and along the vessel traffic route will not be affected by helicopter presence. As a result, there will be no adverse effects on marine bird habitat use within or beyond natural variability.

The change in habitat availability and/or quality for marine and migratory birds due to the presence of helicopters would be adverse, as described above and short-term while the helicopter is in the area. The geographic extent would be less than 1 km^2 from the helicopter along its flight path and on approach and takeoff, as noted below. The change in habitat availability and/or quality would be sporadic as helicopter traffic would be intermittent and reversible once the helicopter leaves the area. While there may be an interaction from helicopters, there would be no change in habitat availability and/or quality relative to baseline conditions, and therefore the magnitude of the change is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce effects are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Availability and/or Quality associated with helicopters are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Changes) is a potential effect associated with the presence of helicopters supporting the Core BdN Development.

One of the primary interactions associated with presence of helicopters is the increased energy expenditure of birds due to escape reactions, increased heart rate, and lower food intake due to interruptions (Ellis et al. 1991; Trimper et al. 2003; and Komenda-Zehnder et al. 2003). Helicopter sound may also deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure (Larkin 1996 and Beale 2007). In terms of behavioural effects of helicopter presence on birds, flushing of breeding birds from the nest in response to helicopter presence is perhaps the most obvious and can have immediate negative consequences including predation of eggs and chicks and decreased incubation and brooding (Burger 1981; Brown 1990; Bolduc and Guillemette 2003; Beale 2007; and Burger et al. 2010). Nestlings may also be vulnerable to exposure, and adults may inadvertently knock eggs and flightless young from the nest, which is of concern for cliff-nesting species (Burger 1981; Carney and Sydeman 1999). Other behavioural effects may include reduced foraging and provisioning rates (Davis and Wiseley 1974; Lynch and Speake 1978; Belanger and Bedard 1990; Delaney et al. 2002; Goudie 2006). Research has shown that overt behavioural responses to aircraft traffic, such as flushing, may occur at a distance of 366 m for common murres (Rojek et al. 2007), although there is inherent variability in behavioural responses between and even within species (Blumstein et al. 2005 and Hoang 2013).

Interactions with and effects on coastal breeding colonies and IBAs are unlikely. Figure 6-50 identifies the locations of bird colonies within the RSA and along the coast of Newfoundland. These areas are not within the typical flight path of aircraft from the St. John's International Airport to the Project Area. The nearest seabird nesting colony, a black-legged kittiwake colony on Freshwater Bay, is over 5 km south of existing helicopter routes. The nearest IBA with nesting seabirds, Witless Bay Islands Ecological Reserve, is 40 km south of the St. John's International Airport and is outside the LSA. Low-level aircraft operations will be avoided, as appropriate. In keeping with *Seabird*

Ecological Reserve Regulations, 2015, helicopters will avoid seabird breeding colonies during the times outlined in the regulations. This use of existing helicopter routes and operating altitudes, regulatory requirement to avoid seabirds breeding colonies and avoidance of low-level operations will avoid marine bird concentrations and consequently will reduce interactions with marine and migratory birds.

Behavioural changes for marine and migratory birds due to the presence of helicopters would be adverse, as described above and short-term due while the helicopter is in the area. The geographic extent would be less than 1 km² from the helicopter along its flight path and on approach and takeoff (Nettleship 1980, Rojek et al. 2007). In consideration of the flight path of helicopters relative to existing bird colonies as discussed above, the change in behaviour would be considered within the range of natural variability without affecting the viability of affected bird populations and is therefore of low magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce effects are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Changes) associated with helicopters are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with helicopters engaged in Supply and Servicing include use of common traffic routes (P), avoidance of low-level aircraft operations as applicable (Q), and adherence to regulatory requirements regarding set-back distances for nesting colonies (R).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with helicopters engaged in Supply and Servicing in consideration of residual effects predictions.

10.3.5 Supporting Surveys

As described in Section 2.6.5, throughout the Project, surveys may be required to support all Project activities. These surveys include geophysical surveys (e.g., 2D/3D/4D seismic, VSP, wellsite geohazard), geotechnical and/or geological surveys, environmental surveys, and ROV/AUV/video surveys.

Geohazard/wellsite surveys are used to identify anomalies beneath the seafloor and hazards to support well location and design. These surveys typically take between five and 21 days to complete, but the overall duration can be shorter or longer depending on the data requirements and weather /operational delays. They may involve the use of seismic sound sources, multibeam echosounder (MBES), sidescan sonar (SSS), synthetic aperture sonar (SAS) subbottom profiler (SBP), video and other non-invasive equipment. The equipment is deployed either as hull-mounted equipment, on a towfish or on ROV / AUVs. Equipment may be autonomous, towed by the vessel or hull-mounted. These surveys may occur at any time of the year over the temporal scope of the Project.

Geophysical surveys that may occur over the life of the Project and include 2D/3D/4D seismic surveys or VSP surveys. Any required will take place within the Project Area. As noted in Section 2.6.5, 2D seismic surveys are not anticipated. 3D surveys are typically focussed to a specific area. 4D surveys, also known as 'time lapse seismic', simply means that successive 3D survey data sets for the same area are interpreted to define changes in the reservoir over time. These surveys are undertaken to access and revalidate previous seismic data. For 3D/4D surveys, multiple sound source arrays can be used, and the vessel could tow between eight and 16 streamers containing hydrophones, also called conventional seismic surveys. Another option for 4D surveys is to place the hydrophones on the seabed, in either nodes or cables. If nodes/cables are used and installed on the seafloor it is called 'permanent reservoir monitoring'; the nodes/cables are removed at the end of the Project. The Project is considering permanent reservoir monitoring or conventional seismic. Permanent reservoir monitoring are estimated to take approximately two weeks to complete and could be carried out twice per year. Conventional seismic surveys could be between two and four weeks and occur as frequently as once per year in early Project life, with reduced frequency in later years. If permanent reservoir monitoring is chosen, the area occupied on the seabed by the installed OBC/OBN could be approximately 135 km². Timing and duration of these seismic surveys are estimated and will be finalized during Project design. If permanent reservoir monitoring is chosen, the area occupied on the seabed by the installed OBC/OBN could be approximately 135 km². The coordinates will be provided to Canadian Hydrographic Services, NAFO, and One Ocean.

VSP is a tool used to further define the depth of geological features and potential petroleum reserves by obtaining high resolution images of the target. As stated in Section 2.6.5, it is estimated that one to two VSP surveys could be carried out for the Core BdN Development Area. VSP differs from surface geophysical surveys in that it is conducted in a vertical wellbore using hydrophones inside the wellbore and a sound source near the surface at or near the well; a VSP is quieter and more localized than a surface geophysical survey, being smaller in size and volume. A VSP usually taking less than 48 hours per well to complete. VSP surveys may be carried out at any time of the year.

Environmental surveys are conducted to collect samples to analyze the physical, chemical, and biological aspects of an area. Sampling is typically carried out from a support / supply vessel or a dedicated vessel suitable to the survey. It can also include biota, water, and sediment sample collection, and ROV-video or drop camera surveys. Environmental surveys may occur throughout Project life at any time of the year using vessels of opportunity associated with the Project, typically taking between five to 21 days to complete.

Geotechnical or geotechnical surveys measure the physical properties of the seabed and subsoil through the collection of sediment samples and in-situ testing. Methods to collect the samples typically include drilled boreholes or gravity coring. In-situ testing is done through cone penetration testing and pore pressure measurements. Installation of piezometers in boreholes to measure soil properties may also be carried out. Piezometers could be left in place to collect data for up to 12 months or longer. Geotechnical surveys may occur throughout the Project life at any time of the year, using dedicated vessels provided by marine geotechnical specialist suppliers.

ROV or AUV surveys are used to conduct visual inspections (camera equipped) of facilities and/or carry out repairs of subsea equipment. ROV / AUV surveys may also be used during pre-drill surveys and before marine installations to determine presence / absence of physical objects on the seafloor.

They may also be used during any or all of the surveys described above. They will be conducted throughout the Project-life at any time of the year using vessels of opportunity associated with the Project.

As noted in Table 10-3, the primary interactions associated with Supporting Surveys are for the most part vessel related and include vessel presence, light emissions from vessels and marine discharges from vessels. These interactions and effects would the same as those assessed in Sections 10.3.1 and 10.3.4. All supporting surveys are short duration, and the vessel-related interactions would be the same as those assessed for vessel engaged in construction and installation and supply and servicing activities, Sections 10.3.1 and 10.3.4, respectively. The assessment of these interactions is not repeated below. Where there may be differences in the characterization of effects (i.e., magnitude, duration, etc.) it will be noted and explained. The only interactions associated with supporting surveys, which is not a vessel-related interaction are the presence of towed equipment and underwater sound emissions associated with geophysical equipment. The presence of towed equipment in the water column will not interact with marine diving birds such as the two murre species and dovekie. These species typically move away from approaching vessels and would therefore avoid the survey vessel before coming into close proximity to the towed equipment. The effects assessment associated underwater sound emissions from geophysical equipment is provided below.

10.3.5.1 Presence of Vessels

The primary effects on Marine and Migratory Birds, due to the presence of vessels and towed equipment during supporting surveys are:

- Change in Habitat Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)

As noted above, these effects are the same as those assessed in Section 10.3.1. Similar to construction and installation activities, vessels will be on site for a short period of time in the Core BdN Development Area while carrying out the survey and the effects would be the same as those described in Section 10.3.1. If Supporting surveys were carried out at the same time as other Project activities, the geographic extent of these vessel-related effects could be additive during the activities' overall duration but, overall, would occupy a very small area compared to the of the Core BdN Development Area.

The residual environmental effects of a **Change in Habitat Availability and/or Quality** from the presence of vessels engaged in Supporting Surveys are predicted to be positive and adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

The residual environmental effects of a **Change in Avifauna Presence and Abundance (Behavioural effects)** from the presence of vessels engaged in Supporting Surveys are predicted to be adverse, low in magnitude, with a geographic extent of less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with vessel presence during Supporting Surveys are not proposed.

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with vessel presence during Supporting Surveys in consideration of residual effects predictions.

10.3.5.2 Light Emissions from Vessels Engaged in Supporting Surveys

The primary effects on Marine and Migratory Birds, due to the light emissions from vessels engaged in Supporting Surveys are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Changes in Habitat Availability and/or Quality are primarily associated with vessel presence and are addressed above.

Mitigations to reduce these effects include the execution of routine searches for stranded seabirds on vessels engaged in these supporting surveys in the Core BdN Development Area. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. These protocols will be developed by Equinor Canada working with ECCC and will include the systematic documentation of stranded seabirds and releases.

The residual environmental effects of a **Change in Food Availability and/or Quality** associated with light emissions from vessels engaged in Supporting Surveys are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km², of short-term in duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural effects) is a potential effect associated with light emissions from vessels engaged in supporting surveys. The characterization of the change in behaviour would be the same as predicted for Supply and Servicing (see Section 10.3.4.1).

In summary, the residual environmental effects of a **Change in Avifauna Presence and Abundance (Behavioural effects)** associated with light emissions from vessels engaged in Supporting Surveys are predicted to be adverse, low in magnitude, with a geographic extent less than 1,000 km² (15 km radius around vessels),_of short-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with light emissions from vessels engaged in Supporting Surveys. Further to the discussion in Sections 10.3.1, 10.3.2 and 10.3.3 regarding strandings of birds on vessels and installations, data in bird salvage logs from oil industry geophysical exploration vessels and OSVs from 2003 to 2014 have also been summarized (LGL 2017). Biologists were on board primarily to serve as Marine Mammal Observers (MMOs), but their duties also included searching the vessel for stranded birds and were trained to recover and document stranded birds. The vessels were engaged in the Canada-NL Offshore Area in exploration programs initiated as early as 7 May and terminated as late as 26 November; however, most were conducted during some portion of the months of June through September. In total, seabird stranding monitoring spanned 2,197 days over 38 voyages.

Detailed weather observations throughout the night were not recorded. Storm-petrel strandings on these vessels showed similar numbers and seasonality of strandings. Over this 11-year period 291 stranding events occurred consisting of 1,029 birds, of which 1,012 were marine birds, 17 were landbirds of six species, and 994 individuals were Leach's storm-petrels. The number of storm-petrels stranding totalled among vessels peaked sharply from 21 in September to 10 in October despite few vessels conducting programs after September. Almost all the storm-petrels stranded on the streamer and air source array decks of geophysical vessels, which are open only at the stern, or in similar partially enclosed spaces. Very few stranded on open decks of geophysical vessels or on supply vessels even though storm-petrels are frequently seen approaching the lights on the open afterdecks of those vessels. This data, along with the effects assessment in the above sections, supports the effects assessment noted attraction-related effects from light emissions on vessels engaged in supporting surveys.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with light emissions from vessels engaged in Supporting Surveys are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², short-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with light emissions from vessels engaged in Supporting Surveys in the Core BdN Development Area include systematic searches for, documentation of, and release of stranded seabirds (B, C, D).

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with light emissions from vessels engaged in Supporting Surveys in consideration of residual effects predictions.

10.3.5.3 Marine Discharges

The primary effects on Marine and Migratory Birds of organic waste discharges from vessels engaged in Support Surveys are:

- Change in Food Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

There is no predicted Change in Habitat Availability or Quality associated with these discharges. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

With the application of mitigation measures, the residual environmental effects of a **Change in Food Availability and/or Quality** associated with the discharge of organic waste from vessels engaged in Supporting Surveys are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

With the application of mitigation measures, the residual environmental effects of a **Change in Avifauna Presence and Abundance (Behavioural Change)** associated with the discharge of organic wastes from vessels engaged in Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km² of the vessel, of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

With the application of mitigation measures, the residual environmental effects of a **Change in Mortality / Injury Levels and/or Health of Individuals or Populations** from discharges of organic waste from vessels engaged in Supporting Surveys are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², short-term in duration, occurring sporadically and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from vessels engaged in Supporting Surveys include treatment and management of marine wastes and discharges from vessels (L, M, N).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with marine discharges from vessels engaged in Supporting Surveys in consideration of residual effects predictions.

10.3.5.4 Underwater Sound Emissions from Geophysical equipment

The primary effects on Marine and Migratory Birds, due to the underwater sound emissions from geophysical equipment used in Supporting Surveys are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

There are no Changes in Habitat Availability and/or Quality predicted because avoidance of the survey vessel would prevent close approach between the equipment and the birds.

Geophysical activities for the Project will be planned and conducted in consideration of the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP, DFO 2007; and appended to the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2018b)). As Project design is ongoing, the timing of surveys is unknown; sound sources used for either the 4D seismic or VSP surveys will be determined at time of planning the surveys. If a VSP is required, specific details of the VSP operations for the Project will depend on the geological target and the objectives of the VSP in question.

The focus of the following effects assessment of Supporting Surveys on Marine and Migratory Birds is focused on the potential effects of underwater sound from geophysical activities on diving birds, such as the two murre species and dovekie, which are known to be present in the Core BdN Development Area from September to April.

Changes in Food Availability and/or Quality for Marine and Migratory Birds is a potential effect associated with the underwater sound emissions from geophysical equipment used in Supporting Surveys.

As noted in Section 9.3.5.4, underwater sound emissions from geophysical equipment may alter the presence and abundance of prey species (e.g., small fish, squid, copepods, krill, and other small crustaceans) in the Core BdN Development Area, but significant effects are not predicted. Changes in food availability and or quality within the Core BdN Development Area are not anticipated. The change in food availability would be considered adverse. The surveys are short-term, ranging from two to four weeks in duration, and would be reversible once the sound source is turned off. The geographic extent of the change in food availablity, based on sound modelling (see Section 9.3.5.4) would be within 50 km from the sound source or between a 1,000 km² to 10,000 km² areas within the Core BdN Development Area. Based on the effects assessment of a change in behaviour to fish from geophysical activities, which predicts that the change would be low magnitude, the change in magnitude for food availablity for marine bird species would also be of low magnitude. Surveys, as noted above could be carried out once or twice a year, depending on method chosen. Effects would be reversible once geophysical survey is completed. With the exception of geographic extent, these predictions are made with high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Geographic extent is based on underwater sound modelling. Modelling is a predictive tool providing an estimate of the zone of influence for the discharge/emissions modelled, therefore there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling. Based on this uncertainty there is a moderate level of confidence in the prediction of geographic extent. Mitigations as listed in the SOCP (DFO 2007) should reduce overall effects on fish behaviour and therefore the effects on food availability.

In summary, with the application of mitigation measures, the residual environmental effects of a Food Availability and/or Quality from underwater sound emissions from geophysical equipment used in Supporting Surveys are predicted to be adverse, low in magnitude, with a geographic extent less between 1,000 km² and 10,000 (50 km radius), short-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Avifauna Presence and Abundance (Behavioural Effect) for Marine and Migratory Birds is a potential effect associated with the underwater sound emissions from geophysical equipment used in Supporting Surveys.

Hearing sensitivity has only recently been measured in seabirds. Crowell (2016) measured in-air auditory brainstem response in seabird species that included long-tailed duck, lesser scaup, red-throated loon, and northern gannet. This study found that hearing sensitivity of these species is greatest between 1,500 and 3,000 Hz. Underwater hearing thresholds in great cormorant are similar to seals and toothed whales in the 1 to 4 kHz frequency range (Anderson Hansen et al. 2016; Johansen et al. 2016). Great cormorants also respond to underwater sounds and may have special adaptations for hearing underwater (Anderson Hansen et al. 2017; Johansen et al. 2016).

Early research suggested that there are no substantial behavioural effects of underwater sound on birds (LGL 1998 and Minerals Management Service 2004). A study of moulting long-tailed ducks in the Beaufort Sea found no changes in movements or diving behaviour during geophysical surveys, although the authors noted that smaller-scale behavioural changes could not be ruled out based on the study design (Flint et al. 2003 and Lacroix et al. 2003). In the Davis Strait, Stemp (1985) studied three species that are also found in the Core BdN Area and larger LSA (thick-billed murre, northern fulmar, and black-legged kittiwake) and found no evidence of effects of geophysical surveys on marine bird mortality or distributions in the offshore. Stemp (1985) also notes that shearwaters have been observed close to a geophysical sound array with their heads underwater, but no behavioural response was observed. Research in the Irish Sea also indicated no evidence that marine birds are attracted to or repelled by offshore seismic survey activity (Evans et al. 1993). However, a recent, multi-year study using GPS tracking of African penguins found strong avoidance of seismic surveys when initially foraging less than 100 km from the surveys (Pichegru et al. 2017). The seismic source was four sub-arrays of air source arrays with a total volume of 4,230 in^3 at 2,000 psi ±10 percent. The air source arrays were discharged at 25 m point intervals, 169 discharges per hour, 24 hours per day (2D survey).

Behavioural effects due to geophysical surveys have not been detected in diving species, such as thick-billed murre or dovekie, occurring in the Core BdN Development Area, although as noted above, a recent study has found avoidance behaviour by African penguins. Above the water, air source array sound is reduced to a muffled shot that should have little or no-effect on birds that have their heads above water or are in flight. Effects of sound disturbance on the nesting or foraging behaviour of surface-feeding marine birds (such as northern fulmar, shearwaters, storm-petrels, kittiwake, and the large gulls found in the Core BdN Development Area) are also unlikely, given that the above-water sound levels of geophysical sound arrays are very low. Because these survey activities will be offshore, underwater sound from geophysical equipment will not interact with birds at coastal locations, including nesting sites and IBAs and adult attendance at nests.

The change in avifauna presence and abundance due to underwater sound from geophysical survey equipment is not likely to occur, based on the information presented above. Since there would be no predicted change in behaviour relative to baseline conditions the effect would be neutral and negligible in magnitude. Negligible effects would be short-term as surveys would be between two to four weeks. The geographic extent of the change in behaviour would be less than 100 km^2. The change in behaviour is not likely to occur. and reversible once the survey is completed. With the exception of magnitude of effects, these predictions are made with a high level of confidence based the experience and professional judgement of the EIS Team. As noted above, there is a relatively limited body of research on behavioural effects of underwater sound on diving birds and therefore the prediction of magnitude of effect is made with a moderate level of confidence.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) associated with underwater sound from geophysical surveys are predicted to be neutral, negligible in magnitude, with a geographic extent of less than 100 km^2,of short-term duration, not likely to occur , and reversible. These predictions are made with a moderate to high level of confidence

Change in Mortality / Injury Levels and/or Health of Individuals or Populations) for Marine and Migratory Birds is a potential effect associated with the underwater sound emissions from geophysical equipment used in Supporting Surveys. As noted below, injury is the most likely effect.

Mortality is not anticipated as diving bird species avoidance of the survey vessel will likely remove birds from close enough proximity to sound-emitting geophysical equipment to receive damaging sound pressure levels and there have been no documented cases of underwater sound from geophysical surveys causing mortality in marine and migratory birds.

Studies have not tested the levels of sound (and especially, underwater sound) that cause injury to marine birds, although temporary hearing impairment can occur in avifauna that are exposed to sound in air (Saunders and Dooling 1974). However, studies have found that avian species vary in their susceptibility to hearing damage resulting from sound exposure (Ryals et al. 1999), although they are generally more resistant to damage than mammals (Dooling and Popper 2007). In addition, birds (unlike mammals) can regenerate sensory hair cells in the ear (Dooling and Popper 2007). The available evidence suggests that the underwater hearing of birds is poorer than in air, given that the middle ear constricts under the increased pressure associated with diving (Dooling and Therrien 2012).

Unlike some other marine animals, seabirds are not known to communicate vocally underwater, and a heightened auditory sensitivity in water is thus unlikely to have developed. Permanent physiological damage, namely hearing loss (permanent acoustic threshold shift), is unlikely to result from geophysical arrays, because although low-frequency sound waves propagate further than higher frequencies, they are less damaging. Temporary auditory damage from exposure to loud impulse sound may last days (Hashino et al. 1988), which may impede a bird’s ability to find their kin at nest sites, for example.

Deep-diving birds such as alcids (including murres, dovekies and puffins), as well as other bird species that forage underwater at shallower depths, such as northern fulmar, sooty shearwater, Wilson’s storm-petrel, skuas, jaegers, gulls, and terns, which are present in the Core BdN Development Area, may be at somewhat higher risk of injury or disruption due to exposure to underwater sound such as that generated by geophysical sound sources. Alcids dive from a resting position on the water in search of small fish and invertebrates and are capable of reaching depths between 20 m to 60 m and spending up to 40 seconds underwater at a time (Gaston and Jones 1998). Unlike fish or marine mammals, diving birds typically place their heads under the water suddenly in pursuit of prey and could therefore be exposed to higher sound levels without the benefit of a steady gradient or associated ramp up procedures. Consequently, they would find it difficult to predict or avoid excessively high sound levels in the water column. This interaction may be further accentuated by the attraction of many bird species to offshore vessels and drilling installations (as discussed above).

Estimated sound levels from the representative air source array (5085 in^3) modelled for the Project were above SPL_{peak} injury thresholds (PTS onset) for impulsive sounds for most marine mammal groups within 40 m of the array (see Table 7 in Zykov 2018 in Appendix D). As discussed in Chapter 11, it is estimated that most marine mammals would have to occur within approximately 40 m to 160 m of the air source array for 24 hours to incur auditory injury. Assuming similar or less acute hearing sensitivity in birds, the risk of auditory injury in diving birds exposed to air source pulses is considered low and would likely be limited to a small area around the air source array.

The change in injury/health associated with underwater sound from geophysical equipment would be adverse, as noted above but short-term. The geographic extent of the change in injury/health would be less than 1 km² of the air source array, as described above. As noted above, marine birds would likely have to remain in the area of underwater sound emissions for extended periods of time for injury effects to occur, therefore effects are unlikely. If injury effects were to occur, as the change in injury is beyond the range of natural variability in diving seabirds, but without affecting the viability of the population, the magnitude of change is medium. Effects would be reversible. These predictions are made with a moderate level of confidence based the limited body of research on physiological effects of underwater sound on diving birds and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat availability are not proposed.

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with underwater sound from geophysical surveys are predicted to be adverse, medium in magnitude, with a geographic less than 1 km², of short-term duration, not likely to occur and reversible. These predictions are made with a moderate level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with underwater sound emissions from geophysical surveys are not proposed.

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with underwater sound emissions from geophysical surveys in consideration of residual effects predictions.

10.3.6 Decommissioning

As described in Section 2.6.7, at end of field-life the Project will be decommissioning in accordance with regulatory requirements in place at the time of decommissioning. Depending on the activity undertaken, decommissioning may occur seasonally or at any time of the year. It is anticipated that decommissioning will be carried out over multiple seasons, similar to Offshore Construction and Installation (Section 10.3.1) and be completed within a two to four-year timeframe. Decommissioning of the FPSO may occur at any time of the year.

As a base case, the FPSO will be decommissioned and removed from the Project location. It is likely that the FPSO will be decommissioned and removed from site in the initial phases of decommissioning. As noted above, vessels will be engaged to support decommissioning of the FPSO. All floating equipment (turret, mooring lines) will be removed. Subsea infrastructure, including flowlines and well templates may be removed or left in place. As noted in Section 2.6.7, these options will be further examined at the time of decommissioning.

Wells will be abandoned in accordance with regulatory requirements and as described in Section 2.6.7.2. Depending on water depth, the wellhead will either be removed during decommissioning or left in place. Well decommissioning may be carried out with a drilling installation (internal cutting of the well casing) or vessel and ROV-equipped with a mechanical cutter (external cutting of wellhead). Explosives will not be used to remove wellheads.

Activities associated with decommissioning are the same as described and the above sections, including vessels engaged in decommissioning activities, supply and servicing, helicopter supply and servicing, ROV / AUV surveys. Environmental, geotechnical, and/or geological surveys may be required during decommissioning. Well decommissioning may be carried out with a drilling installation (internal cutting of the well casing) or vessel and ROV-equipped with a mechanical cutter (external cutting of wellhead). As noted in Table 10-3 the primary interactions during these activities are vessel-related and include vessel presence, light emissions from vessels and marine discharges from vessels. These vessel-related interactions would be the same as those assessed for vessel engaged in construction and installation and supply and servicing activities and the effects assessment would be the same as presented in Sections 10.3.1, and 10.3.4 and 10.3.5. It is anticipated that the number of vessels on site during decommissioning would be the same as during offshore construction and installation. The assessment of these interactions is not repeated below.

In consideration of the interaction and associated effects of vessel-based interactions, as noted above, the effects assessment of decommissioning will focus on removal of the FPSO, which will remove a source of artificial lighting that will have been an attraction and potential source of mortality and injury for Marine and Migratory Birds for the 12- to 20-year life of Project.

10.3.6.1 Decommissioning of FPSO

The FPSO, once the moorings and turret are disconnected is a marine vessel and will transit under its own power to its next destination. As the FPSO at this stage a vessel in transit, the interaction would be similar to a vessel in transit as assessed in Section 10.3.4 and would not be considered an interaction with Marine and Migratory Birds. Discharges, up to the point of the FPSO transit, will be similar to those under Production and Maintenance, with the same mitigations and treatment in place. Therefore, the interactions with Marine and Migratory Birds would be the same as Production and Maintenance and are not considered an interaction under Decommissioning.

While the FPSO will remain on site for a period of time to complete decommissioning of the process system, the vessel-based interactions (presence, lighting, marine waste discharges) as assessed in Section 10.3.2, would continue during decommissioning until the FPSO is removed from site. Therefore, these interactions are not considered in the effects of decommissioning as the effects conclusions would be the same as provided in Sections 10.3.2.1, 10.3.2.2 and 10.3.2.4. The primary interaction associated with the decommissioning of the FPSO is its removal from site. The FPSO, after a period of 12 to 20 years on its location at the Core BdN Development Area, has been a constant source of interaction (presence, light emissions, organic discharges, pilot flare) for Marine and Migratory Birds. The effects discussion below, considers the overall effect of removal of the FPSO on Marine and Migratory Birds. Effects are not addressed individually, but as one overall effect on Marine and Migratory Birds.

The primary effects on Marine and Migratory Birds, associated with the decommissioning of the FPSO are:

- Change in Habitat Availability and/or Quality
- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Changes in Habitat Availability and/or Quality for Marine and Migratory Birds is a potential effect associated with decommissioning of the FPSO. Removal of the FPSO will remove a physical structure that was present in the offshore for 12-20 years. The removal of the FPSO would result in a return to baseline habitat conditions, an overall neutral effect for Marine and Migratory Birds. A small area of sea surface that was unavailable to murres, dovekie, and storm-petrels when the FPSO was present, will be made available. However, given the ephemeral nature of sources of food for seabirds due to shifting current direction, it is unlikely that a reliable patch of habitat was lost when the FPSO was installed, and it is equally unlikely that a reliable patch will develop with the removal of the FPSO. In contrast, a source of shelter downwind of the FPSO for kittiwakes and large gull species (especially great black-backed gull during fall migration), and a dry loafing/roosting area for large gulls will be lost. However, the number of murres and dovekies benefited by the FPSO removal would be insignificant in its contribution to populations of these species in the North Atlantic. Although the numbers of kittiwakes and large gulls affected may number in the hundreds of each species, these numbers are also likely insignificant components of North Atlantic populations. This effect would be short-term and occur once, as time to return to baseline conditions would occur as soon as the FPSO leaves location. These predictions are made with a high level of confidence based on the experience and professional judgement of the EIS Team. The geographic extent would be less than 1 km². The magnitude of effect will be negligible as there would be no change from baseline conditions.

In summary, the Change in Habitat Availablity and/or Quality associated with the decommissioning on the FPSO would be neutral to adverse, negligible in magnitude, with a geographic less than 1 km², of short-term duration, occurring once. These predictions are made with a high level of confidence.

Changes in Food Availability and/or Quality for Marine and Migratory Birds are potential effects associated with decommissioning of the FPSO. Removal of the FPSO will remove the light source attracting vertically migrating prey and also remove a source of organic waste that may have been exploited by fish, which in turn may have been exploited by gulls and fulmars in the area. The effect would be neutral, as there would be no change from baseline conditions. The effect would occur once and be short-term as the time to return to baseline conditions would be within a two- to four-year timeframe. The geographic extent would be less than 1 km² from the original location of the FPSO, as that area no longer has a source of attraction. The magnitude of effect will be negligible as there would be no change from baseline conditions. These predictions are made with a high level of confidence based on the experience and professional judgement of the EIS Team.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality associated with the Decommissioning of the FPSO are predicted to be neutral, negligible in magnitude, with a geographic extent less than 1 km² of the vessel, of short-term duration, and occurring once. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) and **Change in Mortality / Injury Levels and/or Health of Individuals or Populations** for Marine and Migratory Birds are potential effects associated with decommissioning of the FPSO. The removal of the FPSO will remove a source of disturbance that deterred murres and dovekies from being present in the immediate vicinity. The removal of the FPSO as a light source would remove the potential light attraction interactions such as attraction of prey species that in turn attracted gulls to the FPSO and the attraction of Leach's storm-petrels to the FPSO. Associated effects from strandings, mortality, injury to Leach's storm-petrels as assessed in Section 10.3.2 would be eliminated as the light source is no longer present and light emissions return to baseline conditions, an overall neutral effect. This effect would be short-term and occur once, as time to return to baseline conditions would occur as soon as the FPSO leaves location. The geographic of would be 15 km from the original location of the FPSO. The magnitude of effect will be negligible as there would be no change from baseline conditions.

The removal of the light source will also eliminate the source of light attracting vertically migrating fish, which are fed on by large gull species and which, due to their attraction to the FPSO, opportunistically preyed on Leach's storm-petrels. The removal of the FPSO would thereby reduce or remove food sources that gulls had likely not exploited to the same degree. The effect would be neutral, as no change from baseline conditions. The effect would be continuous and short-term as the time to return to baseline conditions would be within a two- to four-year timeframe. The geographic extent would be less than 1 km² from the original location of the FPSO, as that area no longer has a source of attraction. The magnitude of effect will be negligible as there would be no change from baseline conditions. These predictions are made with a high level of confidence based on the experience and professional judgement of the EIS Team.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Change) associated with the Decommissioning of the FPSO are predicted to be neutral, negligible in magnitude, with a geographic extent less than 1 km² of the vessel, of short-term duration and occurring once. These predictions are made with a high level of confidence.

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with the Decommissioning of the FPSO are predicted to be neutral, negligible in magnitude, with a geographic extent less than 1 km², short-term in duration and occurring once. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with Decommissioning are not proposed.

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with Decommissioning in consideration of residual effects predictions.

10.4 Project Area Tiebacks

Over the life of the Project, Equinor Canada may choose to undertake additional exploration activities (e.g., exploration, appraisal, delineation drilling, 2D, 3D / 4D seismic) to search for and possibly develop economically recoverable reserves. Should additional economically and technically recoverable reserves be discovered within the Project Area, they could be processed on the BdN FPSO through the installation of additional subsea templates and flowlines ("subsea tiebacks") as described in Section 2.6.6. Between one and five well templates could be tied-back to the FPSO and/or existing well templates via flowlines, and may include the drilling of up to 20 additional wells within the additional well templates Activities associated with Project Area Tiebacks would be the same as those described in Section 2.6.6, and summarized below.

- Installation of subsea tie-back(s) (well templates and flowlines)
- Continuation of production and maintenance operations from the existing FPSO
- Drilling activities associated with the drilling of up to 20 additional wells (total) in well templates
- Continuation of supply and servicing
- Additional supporting surveys, if required
- Decommissioning

The Core BdN Development has a field life of 12 to 20 years. Should Project Area Tiebacks occur, the field life of the Project may be extended while maximum daily potential production rates would remain the same. Tiebacks may be feasible up to a distance of approximately 40 km from the FPSO and/or template location. Figure 10-2 illustrates Project Area Tiebacks, providing examples of tiebacks to the FPSO and existing well templates.

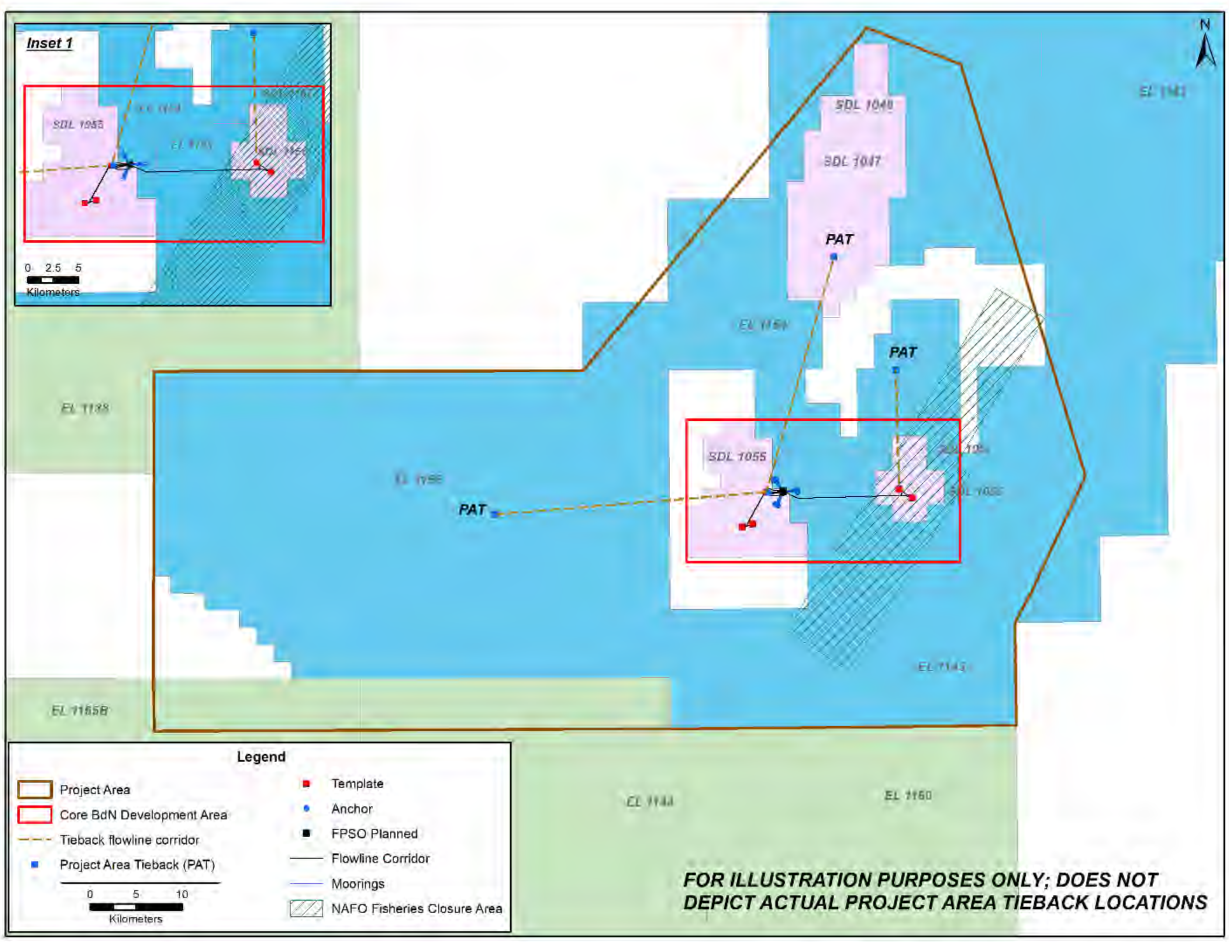

Figure 10-2 Illustration of Examples of Project Area Tiebacks

For the purposes of environmental effects assessment, it is assumed that the timeframe for Project Area Tiebacks would the same as those listed for the Core BdN Development. For instance, it is assumed that offshore construction and installation of well templates and flowlines, and HUC activities of the new subsea infrastructure could occur over several seasons; production and maintenance operations, supply and servicing and supporting surveys occurring during the Core BdN Development would continue until 30-year end of Project life (an additional 10 to 18 years). Mitigation measures, as described in Section 10.1.5.2 and Table 10-3, implemented for the Core BdN Development would be applied to activities undertaken in Project Area Tiebacks.

As noted in Section 10.2 and illustrated in Figures 6-51 through 6-59 (Section 6.22), the range of seabird densities in the Project Area where potential tiebacks could be developed is same as within the Core BdN Development Area. Therefore, the interaction and associated effects from Project Area Tieback activities within the Project area will be the same as those assessed for the Core BdN Development Area.

10.4.1 Offshore Construction and Installation, and Hook-up and Commissioning

Project Area Tiebacks of up to five additional subsea tiebacks (flowlines, well templates) may involve seabed surveys and site preparation, installation of subsea infrastructure, and eventual HUC of newly installed well templates and flowlines, similar to those described in Section 10.3.1. Activities would occur at locations within the Project Area but would likely be seasonal and may occur over multiple years as with similar activities for the Core BdN Development. Offshore construction and installation and HUC of tiebacks may occur at the same time as ongoing production and/or drilling operations for the Core BdN Development.

As discussed in Section 10.3.1, the primary interactions with Marine and Migratory Birds during this phase are associated with vessels (presence, lighting, and discharges). There is no interaction associate with the installation of subsea equipment. The potential interactions and effects of offshore construction and installation, and HUC for Project Area Tiebacks would be the same as those assessed in Section 10.3.1 for the Core BdN Development. Marine and Migratory Birds presence as noted in Section 10.3.1, for the Core BdN Development would be the same over the entire Project Area, where Project Area Tiebacks may occur.

10.4.1.1 Presence of Vessels

As noted, and assessed in Section 10.3.1.1, the primary effects on Marine and Migratory Birds, due to the presence of vessels during Offshore Construction and Installation and HUC activities are:

- Change in Habitat Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)

These effects would be the same during Offshore Construction and Installation and HUC for Project Area Tiebacks as assessed for the Core BdN Development area as species densities are similar in the Project Area. Similar to the interactions described in Section 10.3.1, vessels occupy a single location at any one time in the broader Project Area.

Changes in Habitat Availability and/or Quality is a potential effect associated with presence of vessels involved in offshore construction and installation and HUC activities of Project Area Tiebacks. Vessels in these locations, as a physical structure may be used as roosting and resting sites by gulls (Burke et al. 2012), as stopover locations for migrating shorebirds and landbirds that may rest or forage around the platforms (Russell 2005 and Bruinzeel and van Belle 2010), or even potentially as hunting grounds for predatory species such as large gull species which take advantage of concentrations of birds around the structures (Russell 2005). The presence of birds noted in Section 10.3.1.1 for the Core BdN Development Area would be the same for the Project Area (i.e., northern fulmar, great and sooty shearwaters, Leach's storm-petrels, two murre species, dovekie, black-legged kittiwake, and great skua, etc.). The species present in spring and fall migration and summer would also be present in the greater Project Area during the offshore construction/installation season. As noted in 10.3.1.1, since HUC activities could be carried out at any time of the year, species present at other times of the year in the Project area are the same as those identified for the Core BdN Development Area (Section 10.3.1.1). The number of birds present is likely lower during offshore construction and installation, and higher if HUC were to occur outside this timeframe. Therefore, the migrating and summering birds are likely to be affected by the presence of vessels in the Core BdN Development Area.

The change in habitat availability and/or quality due to the presence of vessels would be adverse, as described in Section 10.3.1, but short-term during construction and installation season or during HUC activities. The geographic extent of the change in habitat would be less than 1 km² of the location of the vessel within the Project Area. The change in habitat would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. As the vessel footprint would occupy a very small area of the existing baseline habitat available within the entire 4900 km² Project Area (including if more than one vessel/installation were in the Project/Core BdN Development area at the same time), the magnitude of change in habitat availability would be considered within the range of natural variability and is therefore low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat availability are not proposed.

In summary, the residual environmental effects of a Change in Habitat Availability and/or Quality from the presence of vessels during Construction and Installation and HUC activities, should Project Area Tiebacks be undertaken, are predicted to be positive and adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with presence of vessels, as noted in Section 10.3.1.1. Similar to interactions described in Section 10.3.1, vessels occupy a single location at any one time in the broader Project Area and there is a potential for the temporary presence of vessels to lead to the temporary disturbance and possible displacement of seabirds from foraging and resting areas within the Project Area. As noted in Section 10.3.1, disturbance of birds due to increased vessel presence can cause increased flushing or disturbance during foraging, which may lead to reductions in foraging efficiency, greater energy expenditures and elevated stress levels. Foraging activities are typically most common in the Project Area year-round. Leach's storm-petrels nesting at Baccalieu Island and Witless Bay commute between their active nests and Flemish Pass / Sackville Spur, and non-breeding fulmars, shearwaters, and Wilson's storm-petrel forage there for the summer. Densities of foraging seabirds may be higher at other times of the year especially during the fall when the young-of-the-year greatly increase numbers. During spring and fall migration fulmar, shearwaters, storm-petrels, phalaropes, murres, dovekie, skuas, jaegers, kittiwake, large gulls, and tern may all forage in the Project Area to some degree, During winter the two murre species, dovekie, black-legged kittiwake, and great skua forage in the Project Area.

The change in avifauna presence and abundance due to the presence of vessels would be adverse, as described above, but short-term during the construction season or during HUC activities. The geographic extent of the change in habitat would be localized to the location of the vessel(s) within the Project Area (i.e., less than 1 km²). The change in avifauna presence and abundance would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. As the vessel footprint would occupy a very small area of the existing baseline habitat available within the entire 4900 km² Project area (including if more than one vessel/installation were in Project/Core BdN Development Area at the same time), the magnitude of the change in avifauna presence and abundance is considered within the range of natural variability and therefore would be low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in avifauna presence and abundance are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from the presence of vessels during Construction and Installation and HUC activities, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent of less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with vessel presence during Offshore Construction and Installation and HUC are not proposed.

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with vessel presence during Offshore Construction and Installation and HUC in consideration of residual effects predictions.

10.4.1.2 Light Emissions from Vessels

As noted and assessed in Section 10.3.1.2, the primary effects on Marine and Migratory Birds, due to the presence of vessels during offshore construction and installation and HUC are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

These effects would be the same during Offshore Construction and Installation and HUC for Project Area Tiebacks as assessed for the Core BdN Development area as species densities are similar in the Project Area.

Changes in Food Availability and/or Quality is a potential effect associated with light emissions from vessels. Similar to interactions described in Section 10.3.1.2, vessels would occupy a single location at any one time in the broader Project Area, an area which is typically occupied by transient ocean-going vessels and has only natural lighting sources (sunlight, moonlight). As noted in Section 10.3.1.2, the change in food availability is likely more pronounced at night and in periods of low visibility, where vessel lighting may attract prey species to the surface of the water. As noted in Section 10.3.2.1, the zone of influence less regarding prey attraction would be less than 1.5 km from the vessel. As noted in Section 10.2, prey species such as Atlantic saury and sand lance present in the Project Area may be attracted to lighting from vessels and could result in a larger number of night feeding birds (such as great black-backed gull in fall) to the area than would typically be there under baseline conditions. These effects would be more pronounced September to November, when there is a higher concentration of great black-backed gull in fall migration in the area, and therefore would be expected during construction/installation and HUC if carried out during this time. There is no anticipated change in food quality due to vessel lighting.

The change in food availability due to the vessel lighting would be positive due to predicted increase in prey species at night, as described above, but short-term. The geographic extent of the change in food availability would be less than 1 km² within the location of the vessel within the Project Area. The change in food availability would be regular at night while vessels were on-site, and reversible once the vessel(s) leaves the area. While light emissions may change food availability within a localized area of the vessel, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availablity relative to baseline conditions, therefore, the magnitude of the change is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from vessel lighting during Construction and Installation and HUC, should Project Area Tiebacks be undertaken, are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km², of short-term in duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with lighting from vessels. Similar to interactions described in Section 10.3.1.2, vessels would occupy a single location at any one time in the broader Project Area, an area which is typically occupied by transient ocean-going vessels and has only natural lighting sources (sunlight, moonlight). Attraction to lighting may result in mortality or injury due to stranding, collisions, and predation, which is discussed below under "Change in Mortality / Injury Levels and/or Health of Individuals or Populations".

As described in Section 10.3.1.2, nocturnally active species may be attracted to artificial lighting from the vessels. Marine birds commonly attracted to offshore artificial lighting include several members of the petrels and allied families, which are present in the Project Area. As noted above, Leach's storm-petrel is the most common species to strand on vessels and installations. Nocturnally-foraging seabirds such as shearwaters and storm-petrels, which are present in the Project Area, may mistake the lighting for bioluminescent prey (Imber 1975, Wiese et al. 2001, Gauthreaux and Belser 2006 and Poot et al. 2008). Since many nocturnally active bird species navigate using visual cues, authors suggest that artificial lights are being mistaken for celestial cues by birds in passage migration (Wiese et al. 2001, Gauthreaux and Belser 2006 and Poot et al. 2008). As noted in Section 10.3.1.2, it is not known whether Leach's storm-petrels use celestial cues to navigate between their active nests and the continental shelf slope during their foraging trips, or they are searching for their bioluminescent lanternfish prey. As noted in Section 10.3.1.2, the zone of influence at which lighting attracts birds is assumed to be 15 km from the light source.

Migratory bird stranding due to artificial lighting appears to be associated with certain environmental conditions, such as fog or rain. Low visibility is common offshore during June, July and September (Section 5.3.4) overlapping with the Offshore Construction and Installation season. In the Project Area, species likely to be affected by vessel lighting and common offshore during the construction and installation season consists of Leach's storm-petrel, stranding most commonly during September and October. At other times of the year none of the species present strand due to attraction to artificial lighting. The change in avifauna presence and abundance due to vessel lighting would be adverse, as described above, but short-term during the construction season or HUC activities. The geographic extent of the behaviour change would within a 15 km radius of a vessel, during period of low visibility or at night. The change in avifauna presence and abundance would occur regularly at night or in periods of low visibility, and reversible once the vessel(s) leaves the area. The change in behaviour would be of low magnitude. The short term and seasonal nature of the activity, and the likely zone of influence of the change at any one time or location represents a small portion overall area within the Project Area that the change in behaviour would be considered within the range of natural variability without affecting the viability of the affected populations in the region. With the exception of geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with vessel lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence. Mitigations to reduce the change in avifauna presence and abundance are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from vessel lighting during Construction and Installation and HUC, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1,000 km² (15 km radius around vessels), of short-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with lighting from vessels. Similar to interactions described in Section 10.3.1.2, vessels would occupy a single location at any one time in the broader Project Area, an area which is typically occupied by transient ocean-going vessels and has only natural lighting sources (sunlight, moonlight). As stated above, attraction related effects appear to be common among petrels and allied families, of which Leach's storm-petrel commonly strand due to attraction to artificial lighting. This species is most likely to be present in the Project Area from May to early November.

Mortality arises from stranding, collision, exhaustion of disoriented birds flying continuously around lights, delayed foraging or migration due to diversion toward the lights, and predation (Bourne 1979, Sage 1979, Wiese and Montevecchi 1999, Wiese et al. 2001, Jones and Francis 2003, and Bruinzeel and van Belle 2010, Ronconi et al. 2015). A change in mortality, injury or health of birds may occur due to collision with the vessels and strandings of birds on the vessels. Depending on where birds strand, they may become oiled from oily locations on vessel decks. As discussed in detail in Section 10.3.2.1, bird strandings are most common in the fall months (September to October) but have occurred during summer months as well. Leach's Storm Petrels were the most common bird that was stranded, with highest strandings occurring in September and October months (refer to Section 10.3.2.1 – FPSO - Lighting). Based on the seabird stranding data presented in Section 10.3.2.2 and considering construction season offshore will occur in the September and October time period, it is likely that seabird strandings on vessels will occur during construction and installation activities, and the most likely species to strand will be Leach's Storm Petrels. Leach's storm-petrels were the most commonly found species stranded on vessels of various types, including fishing vessels as well as oil and gas-related vessels Similarly, if HUC activities were carried out during these months, strandings of Leach's Storm Petrels are likely. At other times of the year, strandings are less frequent.

These strandings may result in bird injury or mortality. As summarized in Section 10.3.2.2 Lighting from the FPSO, Baillie et al. (2005) reported 469 stranded birds (mostly Leach's storm-petrels) at offshore installations and vessels off NL between 1998 and 2002, of which 3 percent were reported to have died 74 percent were released. The fate of the remaining 23 percent of birds was not noted in the study and cannot be speculated. Strandings were most common in September and October, in which 97 percent of strandings were Leach's storm petrels. As noted above, based on bird stranding data, the level of mortality in Leach's storm-petrels stranded appears to be less than 20 percent (LGL 2017). While Leach's storm-petrel populations are in decline, based on the information presented in Section 10.3.2.1, mortality from strandings is low if stranded birds are recovered and released. There is uncertainty in the exact numbers of mortality due to strandings as deck searches, releases and documentation have not been consistent.

The change in mortality / injury / health of marine and migratory birds associated with light emissions from vessels will be adverse, as described above, but short-term. While attraction effects may be evident out to 15 km from the vessel, the geographic extent of the change in mortality / injury / health would be localized to the location of the vessel(s) (i.e., less than 1 km²) within the Project Area where birds strand and may be injured or die. The mortality / injury / health from strandings would be sporadic, as strandings tend to occur at different times under varying conditions, and reversible once the vessel(s) leaves the area. As discussed in Section 10.3.2.1, while Leach's storm-petrel is the most common bird species to strand offshore, the change in mortality / injury / health to Leach's storm-petrel and other bird species, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted above, there are uncertainties associated with extent of injury/mortality with bird strandings, therefore the predicted magnitude of change is made with a moderate level of confidence.

As noted in Section 10.3.1.2, while mitigations to reduce the strandings of birds are not available, during offshore construction and installation and HUC activities for Project Area Tiebacks activities, while vessels engaged in construction and installation and HUC activities are on-site in the Project Area, routine searches for stranded seabirds will be conducted on these vessels. When stranded birds are discovered, pursuant to a standard protocol, the birds will be collected and released. These protocols will be developed by Equinor Canada working with ECCC and will include the systematic documentation of stranded seabirds and releases.

In summary, the residual environmental effects of a Change in Mortality / injury Levels and/or Health of Individuals or Populations from vessel lighting during Construction and Installation and HUC, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km^2, short-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with vessel lighting during Offshore Construction and Installation and HUC are not proposed, however systematic and routine searches for stranded birds will be undertaken while vessels are on location in the Core BdN Development Area (B, C, D).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with vessel lighting during Offshore Construction and Installation and HUC in consideration of residual effects predictions.

10.4.1.3 Marine Waste Discharges from Vessels

As noted and assessed in Section 10.3.1.4, the discharge of organic (grey water and sewage) waste is an interaction for marine and migratory birds. During HUC activities, discharges from the flushing of lines may also be an interaction. Other vessel discharges (e.g., bilge and ballast water) are treated in accordance with regulatory requirements and would not have an effect. The primary effects on Marine and Migratory Birds, due to the discharge of sewage waste and HUC discharges during offshore construction and installation and HUC are:

- Change in Food Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)
- Change in Mortality / injury Levels and/or Health of Individuals or Populations.

As noted above, seabird densities in the Project Area outside the Core BdN Development Area are the same as those within. Therefore, these effects would be the same as assessed in Section 10.3.1.4, should Project Area Tiebacks be undertaken, and would continue until end of Project life

Change in Food Availability and/or Quality is a potential effect associated with the discharge of organic wastes from vessels.

As noted in Section 10.3.1.4, the discharge of organic wastes may result in enrichment of the baseline food supply for northern fulmar and shearwaters; however, food and sewage waste discharged overboard are expected to be degraded after release (BP 2016). Grey and black water discharged into the environment may lead to organic enrichment of areas that have either positive or negative effects on local fish and invertebrates (Peterson et al. 1996) and may result in little localized organic enrichment supporting local productivity for seabirds (Ortego 1978). The change in food availability and/or quality due to the discharge of organic wastes from vessels would be positive, as described above, but short-term. The geographic extent of the change in food availability would be within less than 1 km² from the discharge location of the vessel within the Project Area. The change in food availability and/or quality would be continuous while vessels were on-site, and reversible once the vessel(s) leaves the area. As the change is food availability is localized to area of the vessel, the overall food availability in the Project Area is not affected (including if more than one vessel were on site at the same time) and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality from waste discharges (i.e., organic wastes and HUC discharges) during Construction and Installation and HUC, should Project Area Tiebacks be undertaken, are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km² , of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Changes) is a potential effect associated with the discharge of organic wastes from vessels.

The discharge of organic wastes may result in enrichment of the baseline food supply (Peterson et al. 1996) which may lead to an attraction of foraging marine and migratory birds to the vessels (Ortego 1978), such as northern fulmar and shearwaters, which is common in the Project Area during the offshore construction and installation season. Fulmar is common in the Project Area year-round whereas great black-backed gull is common during fall migration and black-legged kittiwake is common during winter and during spring and fall migration.

The Change in Avifauna Presence and Abundance of Marine and Migratory Birds due to organic waste discharges from vessels would be adverse, as described above, but short-term during the offshore construction season. The geographic extent of the change in would be less than 1 km² of the location of the vessel (Burke et al. 2012) within the Project Area. The change in presence and abundance would be regular while vessels were on-site, and reversible once the vessel(s) leaves the area. The change in presence and abundance would be negligible in magnitude, as the birds would be in the area foraging, but temporarily attracted to vessel location due to the organic waste discharge. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Change) from the discharge of organic wastes from vessels during Construction and Installation and HUC, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than

1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Mortality / injury Levels and/or Health of Individuals or Populations is a potential effect associated with the discharge of organic wastes from vessels. There are no changes in mortality / injury or heath predicted from HUC discharges.

As noted above, there may be an increase in the presence of foraging marine birds due to the discharge of organic wastes from vessels. This potentially positive effect may be offset by increased exposure to risk of collision / strandings (as discussed in Section 10.3.1.2) or predation by bird species (large gull species) attracted by organic wastes as well as energetic costs due to deviation from normal movement/migration patterns. The increase in gulls to the area may lead to increase to predation on Leach's storm petrels, likely occurring during September and October months when Leach's storm-petrel is most abundant offshore. As noted in Chapter 6 and throughout this chapter, the population of Leach's storm petrel is in decline, however the increase in mortality of individuals by their predators would not likely have an adverse effect on the population.

The change in mortality / injury / health of marine and migratory birds, particularly Leach's storm petrels, due to organic waste discharges from vessels would be adverse, as described above, but short-term. The geographic extent would be localized to the vessel (less than 1 km²) (Burke et al. 2012). The mortality / injury / health would be sporadic, and reversible once the vessel(s) leaves the area. The change in mortality / injury / health to Leach's storm-petrel and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per Canadian and international requirements, vessels are required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / injury Levels and/or Health of Individuals or Populations from discharges of organic waste from vessels during Construction and Installation and HUC, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km² , short-term in duration, occurring sporadically and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from vessels engaged in Offshore Construction and Installation and HUC include management and treatment of marine wastes and discharges from vessels (L, M, N).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with marine discharges from vessels during Offshore Construction and Installation and HUC in consideration of residual effects predictions.

10.4.1.4 HUC Discharges

The primary effects on Marine and Migratory Birds associated with discharges during HUC activities is:

- Change in Food Availability and/or Quality

Change in Food Availability and/or Quality is a potential effect associated with the HUC discharges. When flowlines are hooked up either to the FPSO, well templates or risers, they are pressure and/or leak tested and there is a discharge of fluid from the flowlines which may contain chemicals.

As noted above, seabird densities in the Project Area outside the Core BdN Development Area are the same as those within. Therefore the effects associated with discharges from the flowlines when flushed and hooked up to the template/riser or FPSO are the same as those discussed and assessed in Section 10.3.1.4. At the seabed, when flowlines are flushed, there are no anticipated interactions with Marine and Migratory birds, as the water depth is beyond the range of diving seabirds. For surface discharges, these may affect the quality of prey species if they come in contact with the liquid discharge. The change in food quality due to HUC discharges would be negative, and short-term as discussed in Section 10.3.1.4. The geographic extent of the change in habitat is estimated to be less than 1 km^2 from the discharge location, either within the Core BdN Development Area or in the Project Area, depending on where leak testing is being carried out. The change in food quality would be continuous while vessels were on-site, and reversible once HUC activities are complete. The magnitude of the change is food quality is predicated to be negligible, as noted in Section 10.3.1.4. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As stated, all chemicals that would be discharged to the marine environment would be screened in accordance with the OCSG (NEB et al 2009).

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Food Availability and/or Quality associated with discharges during HUC are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from HUC activities include screening of chemicals that may be discharged to the marine environment (O).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with associated with HUC activities in consideration of residual effects predictions.

10.4.2 Production and Maintenance Operations

The addition of subsea development tiebacks would may the life of the Project (12 to 20 years) to 30 years. The potential effects of production and maintenance operations are detailed in Section 10.3.2. The FPSO would remain on its location in the Core BdN Development Area. As there would be no changes to the lighting, marine discharges, or flaring, the potential effects would be the same as described and assessed for the Core BdN Development. The longer life would increase the timeframe for the interactions to occur.

The interactions and effects assessment for Marine and Migratory Birds for Production and Maintenance Operations, as assessed in Section 10.3.2, would be the same for Project Area Tiebacks as the FPSO would remain in its position in the Core BdN Development Area. The only change is that the FPSO could be on-station until end of Project at 30 year, verses the estimated 12- to 20-year timeframe for the Core BdN Development. While the timeframe is extended, the duration of effects would remain as long term. As the production life may extend an additional 10 to 18 years, as noted in Section 10.3.2.4 scheduled maintenance operations will continue to be carried out.

Over this 10- to 18-year timeframe, as scheduled maintenance turnarounds are typically carried out every three to five years, it is anticipated that two to three turnarounds may occur. Non-routine flaring during these events would be short-term and are governed by Equinor best practices to reduce overall flaring durations during these activities. Therefore, the effects on Marine and Migratory Birds associated with non-routine flaring events would be the same as those assessed under the Core BdN Development Area.

In summary, the interactions and effects associated with Production and Maintenance Operations on Marine and Migratory Birds would be the same as the Core BdN Development Area should Project Area Tiebacks be undertaken. The effects assessment for these interactions are provided in Section 10.3.2. Mitigation measures, as applicable, employed for the Core BdN Development would continue for Project Area Tiebacks.

10.4.3 Drilling Activities

As stated in Section 2.6.6, up to 20 additional wells may be drilled at either individual well locations or in well templates (4-, 6- or 8-slot) at tieback well template locations in the Project Area. Drilling activities could occur at any time of the year, and as noted in Section 10.3.3, the drilling installation could be site at a well template location up to two years if eight wells were drilled consecutively. is occurring. Drilling will not be carried continuously over the life of the project, but will occur in phases, with a set number of wells drilled per drilling campaign. Drilling at potential well templates in the Project Area may be carried out while ongoing production at the FPSO is occurring.

As identified in Section 10.1.5 and assesses in Section 10.3.3, potential interactions from drilling activities on Marine and Migratory Birds includes presence of the drilling installation, light emissions, and waste discharges from the drilling installation. Flaring may be an interaction, if a formation flow test is carried out. Bird species present in the Project Area would be the same as those present in the Core BdN Development Area, as noted in Section 10.3.3. Therefore, these interactions would be the same with Marine and Migratory Birds at these well template locations should Project Area Tiebacks be undertaken.

10.4.3.1 Presence of Drilling Installation

As noted in Section 10.3.3.1, the primary effects on Marine and Migratory Birds due to the presence of the drilling installation are:

- Change in Habitat Availability and/or Quality
- Change in Avifauna Presence and/or Abundance (Behavioural Effects)

As noted above, seabird densities in the Project Area outside the Core BdN Development Area are the same as those within. Therefore, the effects would be the same as assessed in Section 10.3.3.1, should Project Area Tiebacks be undertaken, and would continue until end of Project life.

Changes in Habitat Availability and/or Quality is a potential effect associated with presence of the drilling installation. Bird species present in the Project Area would be the same as those present in the Core BdN Development Area.

The changes in habitat availability due to the presence of the drilling installation at well template locations in the Project Area would be positive and adverse, as described in Section 10.3.3.1, and short-term. The geographic extent of the change in habitat would be less than 1 km² of the drilling installation at the well template location in the Project Area. The change in habitat would be continuous, and reversible once the drilling installation leaves the area. As the drilling installation footprint would occupy a very small area within the entire 4,900 km² Project Area, including the presence of the FPSO, the magnitude of the change in avifauna presence and abundance would be considered within the range of natural variability and therefore would be low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat due to the presence of the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Habitat Availability and/or Quality from the presence of the drilling installation in the Project Area, should Project Area Tiebacks be undertaken, are predicted to be positive and adverse, low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with presence of the drilling installation. Bird species present in the Project Area would be the same as those present in the Core BdN Development Area.

As indicated in Section 10.3.3.1, there is potential for the presence of the drilling installation to lead to the disturbance and possible displacement of seabirds from foraging and resting areas within the Project Area. Foraging activities may throughout the year but are typically most common in the Project Area during September to April, when Leach’s storm-petrel, the two murre species, and dovekie are at their highest densities offshore and therefore may be affected by the presence of the drilling installation if drilling occurs during this timeframe. The change in avifauna presence and abundance due to the presence of the drilling installation at potential well template locations in the Project Area would be adverse, as described in Section 10.3.3.1, and short-term. The geographic extent of the change in habitat would be localized to the location of the drilling installation at its well template location within the Project Area (i.e., less than 1 km²). The change in habitat would be continuous, and reversible once the drilling installation leaves the area. As the drilling installation footprint would occupy a very small area within the entire 4900 km² Project Area, including the presence of the FPSO, the magnitude of the change in avifauna presence and abundance is considered within the range of natural variability and is therefore low. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in avifauna presence and abundance are not proposed.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from the presence of drilling installation, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent of less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

10.4.3.2 Light emissions from Drilling Installation

As noted in Section 10.3.3.2, the primary effects on Marine and Migratory Birds due to the presence of the drilling installation are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / injury Levels and/or Health of Individuals or Populations.

As noted above, seabird densities in the Project Area outside the Core BdN Development Area are the same as those within. Therefore, the interactions associated with light emissions from the drilling installation at potential well template locations in the Project Area would have the same effects on Marine and Migratory Birds as the light emissions as assessed for the Core BdN Development (Section 10.3.3.2). The drilling installation would be a new source of artificial lighting in broader Project Area, a region that is relatively free of nocturnal artificial lighting. The drilling installation could be at a well template location for up to 2 years, should the maximum eight wells be drilled.

Changes in Food Availability and/or Quality is a potential effect associated with presence of the drilling installation in the Project Area.

As discussed in Section 10.3.3.2, the change in food availability is likely more pronounced at night and in periods of low visibility. Prey species in the Project Area would be the same as those in the Core BdN Development Area and may be attracted to lighting from the drilling installation and could result in a larger number of night feeding birds (such as great black-backed gull) to the area than would typically be there under baseline conditions. These effects would be more pronounced from September to November months, when there is a higher concentration of great black-backed gulls in the area because of fall migration. Foraging opportunities may also be enhanced around platforms because they themselves may become artificial reefs, as noted in Section 10.3.3.2.

The change in food availability due to the lighting from the drilling installation in the Project Area would be positive due to predicted increase in prey species at night, as described above and short-term, occurring at night or in periods of low visibility. The geographic extent of the change in food availability would be less than 10 km² around the location of the drilling installation. The change in food availability would occur regularly at night while the drilling installation was on-site, and reversible once the drilling installation leaves. As indicated in Section 10.3.3.2, the magnitude of change in food availablity for marine and migratory birds would be negligible. While light emissions may change food availablity near the drilling installation, food availability is not affected within the Core BdN Development Area relative to baseline conditions. Should drilling occur concurrently with production operations, there would be an increase in overall light emissions in the Project Area from than if a single installation were onsite. However, the overall magnitude of change in food availability would not change. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in food availability due to the light emissions from the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from light emissions from the drilling installation, should Project Area Tiebacks be undertaken, are predicted to be positive, negligible in magnitude, with a geographic extent less than 10 km², short-term in duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with light emissions from the drilling installation in the Project Area.

Behavioural effects of light emissions from the drilling installation in the Project Area would be the same as those described and assessed in Section 10.3.3.2. As in the Core BdN Project Area, nocturnal species that may be affected by lighting from the drilling installation is Leach's storm-petrel. The change in avifauna presence and abundance due to light emissions would be adverse, as described in Section 10.3.3.2, and short-term while the drilling installation is on site at the well template location. The geographic extent of the behavioural change would within a 15 km radius of the drilling installation, especially during periods of low visibility or at night. The change in avifauna presence and abundance would be occur regularly at night while the drilling installation is onsite and reversible once it leaves the area. The change in behaviour would be of medium magnitude, as the change in behaviour is likely beyond the range of natural variability for the species likely affected, but with no associated adverse effect on the viability of the affected population. If drilling and production operations are simultaneous, the geographic extent over which birds may be affected by light emissions may be greater, depending where drilling occurs within the Project Area. If drilling occurs within 15 km of the FPSO, the geographic extent would likely be greater, however it if occurs at distances greater there 15 km, there would likely be two sources of light in the Project Area which do not overlap. However, given the size of the Project Area relative to the potential zone of influence from light emissions offshore, the overall magnitude of effect would be medium. With the exception geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with FPSO lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence.

As stated in Section 2.7.4.6, mitigations to reduce light emissions from drilling installation are not feasible. Systematic searches for, and documentation of stranded birds, as described in Section 10.3.1.2, will be undertaken.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from light emissions from the drilling installation, should Project Area Tiebacks be undertaken, are predicted to be adverse, medium in magnitude, with a geographic extent less than 1,000 km² (15 km radius of the installation), of short-term duration, occurring regularly, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / injury Levels and/or Health of Individuals or Populations is a potential effect associated with light emissions from the drilling installation in the Project Area.

Changes in mortality / injury / health of Marine and Migratory Birds due to light emissions from the drilling installation in the Project Area would be the same as those described and assessed in Section 10.3.3.2. As noted above, Leach's storm-petrel is the primary species in the Project Area that could be attracted to the drilling installation which may result in direct mortality or injury. As indicated in Section 10.3.3.2, Leach's Leach's storm-petrels, which are common in the Project area from May to early November, are the most common bird to strand.

The change in mortality / injury / health of marine and migratory birds due to light emissions from the drilling installation would be adverse, as described above, and short-term. While attraction effects of lighting may be evident out to 15 km from the drilling installation, the geographic extent of the change in mortality / injury / health would be less than 1 km² centered on its well template location within the Project Area. The mortality / injury / health from strandings would be sporadic, as strandings tend to occur at different times under varying conditions, and reversible once the drilling installation leaves the area. As discussed above, while Leach's storm-petrel is the most common bird species to strand offshore, the change in mortality / injury / health to Leach's Leach's storm-petreland other bird species, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. If drilling and production operations are simultaneous, the geographic extent of attraction may vary. As noted above, depending on the location of the drilling installation in relation of the FPSO, the zone of influence of light attraction could be greater than 15 km if the distance between both installation were less than 15 km (i.e., the zones of influence could overlap). Attraction and stranding effects on marine and migratory birds may be enhanced with simultaneous operations, the change in mortality / injury health would be limited to the location of either installation and the overall magnitude of effect would be low, as there would be no change from natural variability in the population. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted above, there are uncertainties associated with extent of injury/mortality with bird strandings, therefore the predicted magnitude of change is made with a moderate level of confidence.

As noted in Section 10.3.3, mitigations to reduce light emissions from drilling installation are not feasible. Systematic searches for, recovery, release, and documentation of stranded birds, as described in Section 10.3.1, will be undertaken.

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with light emissions from the drilling installation, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², short-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

10.4.3.3 Waste Discharges during Drilling

As discussed in Section 10.3.3.4, the discharge of organic waste may and the discharge of SBM are interactions that may affect Marine and Migratory Birds. As noted above, seabird densities in the Core BdN Development Area are the same as those in the Project Area. Therefore, effects from these interactions would be the same in the Project Area, should Project Area Tiebacks be undertaken.

As indicated in Section 2.6.2, formation flow testing is not typically carried out for development drilling. Should a formation flow test be required for additional wells drilled should Project Area Tiebacks occur, it is Equinor Canada's preferred option to carry out a formation flow test without flaring. If a formation flow test is required, it is likely that the test flow will be routed to the FPSO, however, the drilling installation would have the capacity to carry out flaring associated with a well test.

SBM Cuttings Discharges

As noted, and assessed in Section 10.3.2.4, surface sheening has periodically occurred with the discharge of SBM cuttings and may cause the following affect:

- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Change in Mortality / injury Levels and/or Health of Individuals or Populations is a potential effect associated with surface sheening, should it occur, from the discharge of SBM cuttings during Drilling Activities.

The potential effects associated with surface sheening events from the discharge of SBM cuttings, should they occur, are assessed in Section 10.3.3.4 for the Core BdN Development and would be the same should Project Area Tiebacks occur. The change in mortality / injury levels should surface sheening occur would be adverse as described above, and likely long-term. The geographic extent of the change in mortality would be less than 1 km² from the drilling installation at its well template location in the Project Area. The change in mortality / injury / health would not likely to occur as sheening is not a common occurrence associated with the discharge of SBM treated cuttings, and birds would have to be in the area if sheening event occurred. Should an effect occur, it would be reversible. As discussed in Section 10.3.3.3, the change in mortality / injury / health to Leach's Storm Petrels and other birds is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of duration of effect, these predication are made high level of confidence based on scientific literature and the experience and professional judgement of the EIS

Team. Based on the uncertainties noted in Section 10.3.2.3 above regarding the duration of effect from sheening (i.e., long-term) the prediction of long-term effect duration is made with a moderate level of confidence. SBM cuttings will be treated prior to discharge using best treatment practices that are commercially available and economically feasible.

In summary, with the application of mitigations, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with the discharge of treated SBM cuttings, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², of long-term in duration, unlikely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Marine Waste Discharges

As noted and assessed in Section 10.3.3.4, the primary effects on Marine and Migratory Birds, due to the discharge of organic waste from the drilling installation during drilling activities are:

- Change in Food Availability and/or Quality
- Change in the Avifauna Presence and Abundance (Behavioural Changes)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Change in Food Availability and/or Quality is a potential effect associated with the discharge of organic wastes from the drilling installation. Bird species present in the Project Area would be the same as those present in the Core BdN Development Area.

During drilling activities in the Project Area, marine and migratory birds most likely to interact with and be affected by the discharge of organic wastes includes gulls (September to November) and fulmar (year-round). The change in food availability and/or quality due to the discharge of organic wastes from the drilling installation would be positive, as described in Section 10.3.3.4, and short-term. The geographic extent of the change in food would be within less than 1 km² from the discharge location of the drilling installation at the well template location within the Project Area. The change in food availability and/or quality would be continuous during drilling and reversible once the drilling installation leave the area. While marine discharges may change food availability within a localized area of the drilling installation, the overall food availability in the Project Area is not affected and is available for predator species. There would be no change in food availability relative to baseline conditions and the magnitude of the change is, therefore, negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per regulatory requirements, the drilling installation is required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures,the residual environmental effects of a Change in Food Availability and/or Quality from organic waste discharges, should Project Area Tiebacks be undertaken¸ are predicted to be positive, negligible in magnitude, with a geographic extent less than 1 km² of the drilling installation, of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Changes) is a potential effect associated with the discharge of organic wastes during drilling activities. Bird species present in the Project Area would be the same as those present in the Core BdN Development Area.

As discussed in Section 10.3.3.4, the discharge of organic wastes may result in enrichment of the baseline food supply (Peterson et al. 1996) which may lead to an attraction of foraging marine and migratory birds, such as gulls and northern fulmar to the drilling installation location (Ortego, 1978) in the Project Area. Fulmar is common in the Project Area year-round whereas great black-backed gull is common during September to November and black-legged kittiwake is common from September to March. The change in behaviour associated with organic waste discharges during drilling activities would be adverse, as described in Section 10.3.3.4, and short-term. The geographic extent of the change in would be less than 1 km² of the location of the drilling installation (Burke et al. 2012) at the well template location within the Project Area. The change in presence and abundance would be regular while the drilling installation is on-site, and reversible once it leaves the area. The change in presence and abundance would be negligible in magnitude, as the birds would be in the area foraging, but temporarily attracted to drilling installation location due to the organic waste discharge, and therefore no change relative to baseline conditions. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per regulatory requirements, the drilling installation is required to treat organic wastes prior to discharge.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural Change) from the discharge of organic wastes during Drilling, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring regularly, and reversible. These predictions are made with a high level of confidence.

Change in Mortality / injury Levels and/or Health of Individuals or Populations is a potential effect associated with the discharge of organic wastes during drilling activities. Bird species present in the Project Area would be the same as those present in the Core BdN Development Area.

As noted in Section 10.3.3.4, there may be an increase in the presence of foraging marine birds due to the discharge of organic wastes from the drilling installation. This potentially positive effect may be offset by increased exposure to risk of collision / strandings or predation by bird species attracted by organic wastes (Ortego 1978) as well as energetic costs due to deviation from normal movement/migration patterns. The increase in gulls to the area may lead to increase to predation on Leach's storm petrels. The increased predation would likely occur during September and October months when Leach's storm petrel numbers are greatest offshore due to fledging of young and colony abandonment by the adults.

The change in mortality / injury / health of marine and migratory birds, particularly Leach's storm petrels, due to organic waste discharges from vessels would be adverse, as described in Section 10.3.3.4 and short-term. The geographic extent would be localized to fixed location of the drilling installation (less than 1 km²) (Burke et al. 2012) at its location in the Project Area. The mortality / injury / health would be sporadic, and reversible once the drilling installation leaves the area. The change in mortality / injury / health to Leach's storm-petrels and other marine birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Per regulatory requirements, the drilling installation is required to treat organic wastes prior to discharge

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from discharges of organic waste, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², short-term in duration, occurring sporadically and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with marine discharges from drilling installations during Drilling Activities include treatment and management of marine discharges and wastes from the installation (K, L, M, N).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with marine discharges during Drilling Activities in consideration of residual effects predictions.

Flaring during Formation Flow Testing

As noted and assessed in Section 10.3.3.4, the primary effects on Marine and Migratory Birds, due to the discharge of organic waste from the drilling installation during drilling activities are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

As indicated in Section 2.6.2, formation flow testing is not typically carried out for development drilling. However, if formation flow testing is required, it is Equinor Canada's preferred option to carry out a formation flow test without flaring. The effects of flaring during drill stem test should Project Area Tiebacks be undertaken, would be the same as those assessed in Section 10.3.3.4.

Changes in Food Availability and/or Quality is a potential effect associated with flaring during a formation flow test. Flaring during a formation flow text, if required, is expected to last two to three days or up to five days for an extended flow test. There may be periods of time, throughout the life of the project where the drilling installation and FPSO are in the Project Area at the same time.

If flaring is required during a formation flow test, it will contribute to the overall light emissions from the drilling installation. As a result, the flare, acting as a light source, may contribute to the attraction of prey, as assessed above in Sections 10.3.3.2. The change in food availability due to a single flaring event during a formation flow test would be positive due to predicted increase in prey species at night, as described in Section 10.3.3.2 and short-term. The geographic extent of the change in food availability would be less than 10 km² from the location of the drilling installation. The change in food availability would be a single event and reversible once flaring ceases. While flaring during a formation flow test may change food availability around the drilling installation, the overall food availability in the Core BdN Development Area is not affected and is available for predator species. There would be no change in food availability relative to baseline conditions and the magnitude of the change is, therefore, negligible. Should a formation flow test while drilling occur concurrently with production operations, including non-routine flaring events, there would be an increase in overall light emissions in the Project Area than if a single installation were onsite. However, the overall magnitude of change in food availability would not change. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the effects on food availability during flaring from a formation flow test are not proposed.

In summary, the residual environmental effects of a Change in Food Availability and/or Quality from flaring during a formation flow test are predicted to be positive, negligible in magnitude, with a geographic extent less than 10 km², short-term in duration, occurring once, and reversible. These predictions are made with a high level of confidence.

Change in Avifauna Presence and Abundance (Behavioural Effect) is a potential effect associated with flaring during a formation flow test. Flaring during a formation flow text, if required, is expected to last two to three days or up to five days for an extended flow test. There may be periods of time, throughout the life of the project where the drilling installation and FPSO are in the Project Area at the same time.

The change in avifauna presence and abundance in the Project Area due to a flaring during a formation flow test would the same as discussed for the Core BdN Development in Section 10.3.3.4. The change would be adverse but short-term. The geographic extent of the behavioural change associated with flaring during a formation flow test would be within a 15 km radius of the drilling installation, especially at night or during periods of low visibility (common in June, July and September). The change in avifauna presence and abundance would occur once and would be reversible once flaring stops. The change in avifauna behaviour from a single event would be low in magnitude compared to the short-term, medium magnitude changes associated with continuous light emissions on the drilling installation (see Section 10.3.3.2). The change in behaviour would be considered within the range of natural variability without affecting the viability of the affected populations. Should a formation flow test while drilling occur concurrently with production operations, including non-routine flaring events, there would be an increase in overall light emissions in the Project Area than if a single installation were onsite. However, the overall magnitude of change in behaviour would not change. With the exception geographic extent, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As discussed above, the zone of influence for attraction of birds associated with lighting is not well understood, therefore the geographic extent is made with a moderate level of confidence.

Mitigations to reduce behavioural effects should a formation flow test with flaring be required, are not proposed. Systematic searches for, and documentation of stranded birds, as described in Section 10.3.1, will be undertaken.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) from flaring during a formation flow test, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent less than 1,000 km² (i.e., 15 km radius of the drilling installation), of short-term duration, occurring once and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations is a potential effect associated with flaring during a formation flow test. Flaring during a formation flow text, if required, is expected to last two to three days or up to five days for an extended flow test.

The change in mortality / injury / health of marine and migratory birds should flaring during formation flow test be carried out would be the same as those assessed for the Core BdN Development in Section 10.3.3.4. Effects would be adverse and short-term, as the duration of flaring would be less than five days. While attraction effects may be evident out to 15 km from the drilling installation, the geographic extent of the change in mortality / injury / health would be localized to the location of the drilling installation (i.e., less than 1 km²) at its location on a well template location within the Project Area. The change mortality / injury / health would occur once and would be reversible once flaring stops. As discussed above, while Leach's storm-petrels are the most common bird species to strand offshore, the change in mortality / injury / health to Leach's storm-petrels and other birds, is low in comparison with the variation in population size arising from other known sources of mortality (predation at nesting colonies, high levels of mercury, and shifts in demersal and pelagic food webs); therefore, the change in mortality / injury / health would be low in magnitude. With the exception of magnitude of change, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS team. As noted in Section 10.3.2.4, there are uncertainties associated with extent of injury/mortality associated with bird strandings and flaring, therefore the predicted magnitude of change is made with a moderate level of confidence.

Mitigations to reduce change in mortality / injury / health of marine and migratory birds should a formation flow test with flaring be required, are not proposed. Systematic searches for, and documentation of stranded birds, as described in Section 10.3.1, will be undertaken.

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations from flaring during a formation flow test are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², short-term in duration, occurring once and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with the flaring during formation flow testing include systematic searches for, documentation of, and release of stranded seabirds (B, C, D), preference for well clean-up to be done through the FPSO (H) and duration of flaring in keeping with Equinor's global best practices (I).

Follow-up Monitoring is not proposed for effects on Marine and Migratory Birds associated with the flaring during formation flow testing in consideration of the residual effects predictions.

10.4.4 Supply and Servicing

The addition of subsea tiebacks would extend the life of the Project (12 to 20 years) to 30 years. Supply and servicing operations, as described in Section 2.6.4 and as assessed for the Core BdN Development in Section 10.3.4 would be the same should Project Area Tiebacks be undertaken but be carried out for an additional 10 to 18 years. The vessel and aircraft traffic route to the Project Area would be same as for Core BdN Development. Vessel traffic in the Project Area would be the same as vessel traffic in the Core BdN Development Area. Depending on the distance between the drilling installation in the Project Area and the FPSO at its fixed location, a second SBV may be required, which would be short-term while the drilling installation was on location.

In summary, the interactions and effects associated with Supply and Servicing on Marine and Migratory Birds would be the same as the Core BdN Development Area should Project Area Tiebacks be undertaken. The effects assessment for these interactions are provided in Section 10.3.4 Mitigation measures, as applicable, employed for the Core BdN Development would continue for Project Area Tiebacks.

10.4.5 Supporting Surveys

As with the Core BdN Development, supporting surveys, including geophysical activities, environmental, geotechnical, geological and ROV / AUV surveys may be required should Project Area Tiebacks be undertaken. Should supporting surveys be required, the interactions and associated effects due to vessel presence, light emissions, and marine discharges would be the same as discussed in Section 10.3.5. As noted above, seabird densities in the Project Area are the same as those within the Core BdN Development Area. Therefore, the characterization of effects discussed in Section 10.3.5 for the Core BdN Development and the effects assessment summaries would be the same for the Project Area should Project Area Tiebacks occur and are not repeated here.

Should 4D seismic surveys be required to assess changes in reservoir properties from potential new reservoirs being exploited at the tieback locations, it is anticipated that the type and frequency of surveys would be the same as described in Section 10.3.5. While the locations of these surveys would be within the broader Project Area, the interaction with marine and migratory birds would be the same as discussed and assessed in Section 10.3.5.1. In the event that 4D seismic surveys are required at the tieback locations, it is likely that all locations would be surveyed within the same survey season. The overall duration of seismic activity may be longer to include multiple locations, the time at each location would likely be within the two- to four-week timeframe noted in Section 2.6.5.

10.4.5.1 Underwater Sound Emissions from Geophysical equipment

As noted and assessed in Section 10.3.5.1, the primary effects on Marine and Migratory Birds, due to the underwater sound emissions from geophysical equipment used in Supporting Surveys are:

- Change in Food Availability and/or Quality
- Change in Avifauna Presence and Abundance (Behavioural Effects)
- Change in Mortality / Injury Levels and/or Health of Individuals or Populations.

Geophysical activities for the Project will be planned and conducted in consideration of the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP, DFO 2007; and appended to the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2018b)). As Project design is ongoing, the timing of surveys is unknown; sound sources used for either the 4D seismic or VSP surveys will be determined at time of planning the surveys. If a VSP is required, specific details of the VSP operations for the Project will depend on the geological target and the objectives of the VSP in question.

The focus of the following effects assessment of Supporting Surveys on Marine and Migratory Birds is focused on the potential effects of underwater sound from equipment used in geophysical surveys on diving birds, such as the two murre species and dovekie, which are known to be present in the Project and Core BdN Development Areas from September to April.

Changes in Food Availability and/or Quality for Marine and Migratory Birds is a potential effect associated with the underwater sound emissions from geophysical equipment used in Supporting Surveys.

As noted in Section 9.3.5.4, underwater sound emissions from geophysical equipment may alter the presence and abundance of prey species (e.g., small fish, squid, copepods, krill, and other small crustaceans) in the Project Area, but significant effects are not predicted. While there may be localized scaring effects on fish due to underwater sound, changes in food (fish species) availability within the larger Project Area would be of low magnitude as predicted in Section 9.4.5.1. The change in food availability would be considered adverse. The surveys are short-term, ranging from two to four weeks per location, and at defined 4D survey areas within the Project Area. Effects would be reversible once geophysical survey is completed. Mitigations to reduce the change in food availability associated with underwater sound emissions from geophysical equipment are not proposed.

In summary, residual environmental effects of a **Change in Food Availability and/or Quality** associated with underwater sound from geophysical surveys, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent between 1,000 km² and 10,000 (i.e., 50 km zone of influence), short-term in duration, occurring sporadically and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Avifauna Presence and Abundance (Behavioural Effect) for Marine and Migratory Birds is a potential effect associated with the underwater sound emissions from geophysical equipment used in Supporting Surveys in the Project Area. The effects assessment for the Core BdN Development predicted that effects would be neutral and of negligible magnitude. These effects predications would apply to supporting activities.

In summary, the residual environmental effects of a Change in Avifauna Presence and Abundance (Behavioural effects) associated with underwater sound from geophysical surveys are predicted to be neutral, negligible in magnitude, with a geographic extent of less than 100 km² of short-term duration, not likely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Change in Mortality / Injury Levels and/or Health of Individuals or Populations) for Marine and Migratory Birds is a potential effect associated with the underwater sound emissions from geophysical equipment used in Supporting Surveys in the Project Area.

As noted and assessed in Section 10.3.5.1, injury is the most likely effect. Mortality is not anticipated as diving bird species avoidance of the survey vessel will likely remove birds from close enough proximity to sound-emitting geophysical equipment to receive damaging sound pressure levels and there have been no documented cases of underwater sound from geophysical surveys causing mortality in marine and migratory birds. Deep-diving birds such as alcids, including the murre species, and dovekies, as well as other bird species that forage underwater at shallower depths, such as northern fulmar, sooty shearwater, Wilson's storm-petrel, skuas, jaegers, gulls, and terns, which are all present in the Project area, may be at somewhat higher risk of injury or disruption due to exposure to underwater sound such as that generated by geophysical sound sources. Alcids dive from a resting position on the water in search of small fish and invertebrates and are capable of reaching depths between 20 m to 60 m and spending up to 40 seconds underwater at a time (Gaston and Jones 1998). Unlike fish or marine mammals, diving birds typically place their heads under the water suddenly in pursuit of prey and could therefore be exposed to higher sound levels without the benefit of a steady gradient or associated ramp up procedures. Consequently, they would find it difficult to predict or avoid excessively high sound levels in the water column. This interaction may be further accentuated by the attraction of many bird species to offshore vessels and drilling installations (as discussed above).

Estimated sound levels from the representative air source array (5085 in^3) modelled for the Project were above SPL_{peak} injury thresholds (PTS onset) for impulsive sounds for most marine mammal groups within 40 m of the array (see Table 7 in Zykov 2018 in Appendix D). As discussed in Chapter 11, it is estimated that most marine mammals would have to occur within approximately 40 m to 160 m of the air source array for 24 hours to incur auditory injury. Assuming similar or less acute hearing sensitivity in birds, the risk of auditory injury in diving birds exposed to air source pulses is considered low and would likely be limited to a small area around the air source array.

The change in injury/health associated with underwater sound from geophysical equipment would be adverse, as noted above but short-term. The geographic extent of the change in injury/health would be less than 1 km^2 of the air source array, as described above. As noted above, marine birds would likely have to remain in the area of underwater sound emissions for extended periods of time for injury effects to occur, therefore effects are unlikely. If injury effects were to occur, as the change in injury is beyond the range of natural variability in diving seabirds, but without affecting the viability of the population, the magnitude of change is medium. These predictions are made with a moderate level of confidence based the limited body of research on physiological effects of underwater sound on diving birds and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat availability are not proposed.

In summary, the residual environmental effects of a Change in Mortality / Injury Levels and/or Health of Individuals or Populations associated with underwater sound from geophysical surveys, should Project Area Tiebacks be undertaken, are predicted to be adverse, medium in magnitude, with a geographic less than 1 km^2, of short-term duration, not likely to occur, and reversible. These predictions are made with a moderate level of confidence.

Mitigations to reduce potential effects to Marine and Migratory Birds associated with underwater sound emissions from geophysical surveys are not proposed.

Follow-up Monitoring is not proposed for the effects Marine and Migratory Birds associated with underwater sound emissions from geophysical surveys in consideration of residual effects predictions.

10.4.6 Decommissioning

At end of field-life, which will either be at the end of the Core BdN Development or at the end of Project life, should Project Area Tiebacks be undertaken, the Project will be decommissioned in accordance with regulatory requirements in place at the time of decommissioning. Section 10.3.6 provides an effects assessment of decommissioning activities on Marine and Migratory Birds. The timeframe for decommissioning, whether at the end of the Core BdN Development or at the end of Project life is anticipated to be the same. The interactions and associated effects, due to the removal of the FPSO would be the same as the Core BdN Development Area should Project Area Tiebacks be undertaken. The effects assessment for these interactions are provided in Section 10.3.6. Mitigation measures, as applicable, employed for the Core BdN Development would continue for Project Area Tiebacks.

10.5 Species at Risk: Overview of Potential Effects and Mitigation

The potential environmental interactions between the Project and bird SAR are the same as those for the Marine and Migratory Bird VC as a whole, as are the planned mitigation measures to avoid or reduce such changes assessed above.

Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these SAR designated by provincial or federal legislation is provided in Table 10.5.

Table 10.5 Marine and Migratory Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Barrow's Goldeneye (eastern population)	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Moults and winters in small numbers along coast of eastern Canada • Known to congregate in relatively small geographic areas in important shipping corridors, therefore considered to be particularly vulnerable to being affected by accidental spills (Schmelzer 2006) • Unlikely to be present in Project Area / LSA due to its preference for coastal habitats, therefore no interaction is predicted and no effects on this species are predicted

Table 10.5 Marine and Migratory Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Ivory Gull	Endangered	Endangered (Schedule 1)	Endangered	• It breeds in far north and winters offshore in pack ice • Globally important wintering area from Northeast Newfoundland Shelf to Baffin Bay (Gilg et al. 2010; Spencer et al. 2016) • No critical habitat has been designated in the Project Area • May potentially be present in the Project Area if pack ice reaches the area. Refer to Figure 5-60 in Section 5.5.1 for pack ice extents in the Project Area • Reported on two occasions in bird surveys conducted at Bay de Verde Well Site, which is in the Core BdN Development Area, in winter of 2014-2015 (PAL 2015) • Interaction with the Project is possible in late winter but no adverse effects from routine activities on this species have been described, so none are predicted
Harlequin Duck (eastern population)	Vulnerable	Special Concern (Schedule 1)	Special Concern	• This population breeds inland but occurs in coastal marine environment throughout fall and winter months • The sub-population that breeds northern Labrador, northern Quebec and Nunavut winters in coastal southwest Greenland; the southern sub-population winters in coastal Atlantic Canada and coastal northeastern U.S. • Some non-breeding individuals may be found year-round at Cape St. Mary's. • Sighted on rare occasions in the / LSA (Lang 2016). • The LSA is not located on a migratory route between nesting grounds and wintering areas, so this species not expected to occur in the LSA except accidentally, so is not expected to interact with the Project and no effects on this species are predicted

Table 10.5 Marine and Migratory Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Ross's Gull	None	Threatened (Schedule 1)	Threatened	• Breeds in small numbers in Canadian Arctic Archipelago • Wintering range includes Labrador Sea to Orphan Basin known from tracking of few individuals (Maftei et al. 2015) • Interaction with the Project is possible during winter but no adverse effects from routine activities on this species have been described, so none are predicted
Red-necked Phalarope	None	None	Special Concern	• Come onshore only to breed and occur in the coastal marine environment the rest of the year • Surface feeders, often congregating in areas such as upwellings which are associated with higher prey densities • Sighted in during Equinor Canada's 2018 Seabed Survey in September in the BdN Core Development Area (Mactavish 2018) • Expected to occur in the LSA as a passage migrant, but not attracted to Project infrastructure or routine activities so no effects on this species are predicted
Piping Plover (*melodus* subspecies)	Endangered	Endangered (Schedule 1)	Endangered	• During the nesting season, Piping Plovers are found on sandy beaches along the coast • Breeding occasionally has been reported in the RSA at Deadman's Bay near Cape Freels Coastline IBA in northeastern Newfoundland • Unlikely to interact with routine Project activities due to its strictly coastal habitat
Common Nighthawk	Threatened	Threatened (Schedule 1)	Threatened	• Does not breed in insular Newfoundland • Unlikely to occur regularly in the Project Area / LSA; however, a vagrant was observed offshore in November 2014 (PAL 2015a)

Table 10.5 Marine and Migratory Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Red Knot (*rufa* subspecies)	Endangered	Endangered (Schedule 1)	Endangered	• Arctic breeder. Newfoundland is not considered to be major migratory stopover location • Fall sightings of small numbers are reported around much of coastal Newfoundland and occasionally offshore • Rarely present in Project Area / LSA (Jones and Lang 2013) due to most migrants crossing the Gulf of St. Lawrence to Nova Scotia • May interact with the Project by using installations and vessels as platforms for rest but no adverse effects of routine operations are predicted
Buff-breasted Sandpiper	None	Special Concern (Schedule 1)	Special Concern	• Arctic breeder. Newfoundland is not considered to be a major migratory stopover location • Nonetheless, fall sightings have been reported in parts of the coast and offshore Newfoundland (Abgrall et al. 2008; Jones and Lang 2013) • Rarely occurs in the Project Area / LSA due to most fall migrants passing to the west • May interact with the Project by using installations and vessels as platforms for rest but no adverse effects from routine operations are predicted
Peregrine Falcon	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Migrates along coast of Newfoundland during fall (particularly the west coast), preying on concentrations of migrating seabirds and shorebirds • Some evidence suggests this species may be attracted to platforms due to the abundance of prey species • Regularly occurs in the Project Area / LSA in small numbers during migration where it feeds on seabirds (Moulton et al. 2006; Lang et al. 2008; PAL 2015a). • One was photographed on the survey vessel during the Equinor Canada 2018 Seabed Survey • Small numbers of individuals likely to interact with the project, using installations and vessels to rest

Table 10.5 Marine and Migratory Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	NL ESA	SARA	COSEWIC	Summary of Presence and Potential Interactions
Gray-cheeked Thrush (*minimus* subspecies)	Threatened	none	Candidate Species (low priority)	• An inland species, therefore unlikely to be affected by offshore activities at most times of year • Unlikely to be found in the Project Area / LSA except accidentally; however, during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment
Olive-sided Flycatcher	Threatened	Threatened (Schedule 1)	Threatened	• An inland species, therefore unlikely to be affected by offshore activities at most times of year • Unlikely to be found in the Project Area / LSA except accidentally; however, during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment
Bobolink	Vulnerable	None	Threatened	• Uncommon in eastern Newfoundland. • An inland species, therefore unlikely to be affected by offshore activities at most times of year • Unlikely to be found in the Project Area / LSA except accidentally; however, during fall migration, like other nocturnal migrants, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment
Short-eared Owl	Vulnerable	Special Concern (Schedule 1)	Special Concern	• Typically nests in coastal barrens and grasslands, and suitable habitat occurs in much of coastal Newfoundland • Unlikely to occur regularly in the Project Area / LSA; however, a vagrant was observed near an offshore production installation in October 2015 (McTavish and Lang 2015)

As discussed in Section 6.2.4 and Table 10.5 above, there is low potential for SAR (listed in Table 10.4) to interact with the Project because of these species' low densities in the Core BdN Development Area, Project Area, LSA and overall RSA and because there are no critical habitats or nesting sites of SAR or SOCC in the RSA. The presence of the FPSO, drilling installation(s) and Project support vessels may potentially provide a temporary rest platform benefitting red knot, buff-breasted sandpiper, and peregrine falcon in passage migration. Ivory gull and Ross's gull are associated with pack ice. The frequency of presence of sea ice is greater than zero only from early

February to mid-April and falls in the range of (1 to 15 percent) (see Section 5.5.1, Table 5-58). This suggests that these two gull species are likely to occur in the LSA or along the Project supply vessel route. Ivory gull and red-necked phalarope may be attracted by increased food availability in the form of prey attracted by organic wastes generated by the drilling installation and support vessels; however, these species are not known to be susceptible to disorientation by artificial light sources, and no strandings of ivory gull were reported in the survey reports provided by Equinor Canada.

The Project Area and LSA are outside the current range of piping plover. Harlequin duck and Barrow's goldeneye are very rare in the LSA, but if individuals occur during moult migration or seasonal migration they may benefit from wind and waves by sheltering downwind of the production and/or drilling installations or Project supply vessels. Red-necked phalarope is not known to be attracted to offshore vessels or platforms. Nocturnally migrating landbird species at risk may be attracted by the Project lighting; however, because it is situated hundreds of kilometres east of landbird migratory routes, these landbird species are unlikely to occur with regularity or in significant numbers in the Project Area / LSA.

As a result of the above analysis, and with the implementation of the various mitigation measures outlined above the effects of the Project on marine and migratory bird SAR are predicted to be neutral, negligible in magnitude, extend to the LSA, long-term in duration, and reversible, with a high level of confidence. Routine activities associated with the Project will not affect critical habitat for these species, nor is it likely to result in disturbance of coastal breeding colonies, moulting or wintering areas of SAR given its offshore location.

10.6 Significance of Residual Environmental Effects

This section summarizes the residual effects of the Project on Marine and Migratory Birds and presents a determination of significance for the environmental effects assessment for this VC.

10.6.1 Ecosystem Component Linkages

The interconnections between the physical, biological and human environment have been considered in the EIS and are summarized in Table 10.6. Overall, the EIS is based on the interactions between project activities and select VC's using source-pathway-receptor relationships. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not impact significance determinations, as the potential effects (via direct and indirect pathways) on Marine and Migratory Birds have been assessed.

Table 10.6 Ecosystem Linkages – Marine and Migratory Birds

Component/Activity	Interaction	Pathway	Ecosystem Linkages
Offshore Construction and Installation, Hook-Up and Commissioning (in Core BdN and Project Area Tiebacks)			
Presence of Vessels	• Presence of vessels • Light emissions • Marine Discharges	**Core BdN and Project Area Tiebacks – PA** • Attraction of nocturnally active birds may result in direct mortality or injury through collisions with vessels, predation, or stranding. • Disorientation due to attraction may also increase energy expenditure which can have negative impacts on survival rates, particularly for migrating birds. • The discharge of organic wastes may attract birds.	Avoidance/attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.
HUC Activities	• Presence of vessels • Light emissions • Marine Discharges	**Core BdN and Project Area Tiebacks – PA** • Attraction of nocturnally active birds may result in direct mortality or injury through collisions with vessels, predation, or stranding. • Disorientation due to attraction may also increase energy expenditure which can have negative impacts on survival rates, particularly for migrating birds. • The discharge of organic wastes may attract birds.	Avoidance/attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.
Production and Maintenance Operations (in Core BdN and Project Area Tiebacks)			
Presence of FPSO	• Presence • Light emissions	**Core BdN and Project Area Tiebacks – PA** • Attraction of nocturnally active birds may result in direct mortality or injury through collisions with facility infrastructure including pilot flare, if applicable, predation or stranding on the platforms. Disorientation due to attraction may also increase energy expenditure which can have negative impacts on survival rates, particularly for migrating birds. • Minor displacement of birds from foraging areas may occur due to presence of FPSO.	Avoidance/attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.

Table 10.6 Ecosystem Linkages – Marine and Migratory Birds

Component/Activity	Interaction	Pathway	Ecosystem Linkages
Waste Management	• Produced water • Marine discharges • Non-routine Flaring	**Core BdN and Project Area Tiebacks – PA** • Contact with sheens occurring due to produced water may result in mortality and sublethal effects on seabirds, due to toxicity and/or disruption of the waterproofing and insulating properties of feathers. • Organic waste discharges (food and sewage waste) may result in attraction of birds to vessels and platforms. • Flares may attract or disorient nighttime-flying birds, which may result in mortality or injury to marine and migratory birds.	Avoidance/attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.
Drilling Activities (in Core BdN and Project Area Tiebacks)			
Drilling Installation	• Presence • Light	**Core BdN and Project Area Tiebacks – PA** • Attraction of nocturnally active birds may result in direct mortality or injury through collisions with facility infrastructure, predation, or stranding on the platforms. Disorientation due to attraction may also increase energy expenditure which can have negative impacts on survival rates, particularly for migrating birds.	Avoidance/attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.
Waste Management	• Drill cuttings • Marine discharges • Flaring during Formation Flow Testing	**Core BdN and Project Area Tiebacks – PA** • With appropriate selection of chemicals (including use of non-toxic drilling fluids), and proper disposal, effects on birds due to disposal of drill muds and cuttings and associated waste materials are considered unlikely. • Organic waste discharges (food and sewage waste) may result in attraction of birds to vessels and platforms. • If flaring occurs, flares may attract or disorient nighttime-flying birds, which may result in mortality or injury to marine and migratory birds.	Avoidance/attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.

Table 10.6 Ecosystem Linkages – Marine and Migratory Birds

Component/Activity	Interaction	Pathway	Ecosystem Linkages
Supply and Servicing (in Core BdN and Project Area Tiebacks)			
Marine Vessels	• Presence of vessels • Light emissions • Marine Discharges	**Core BdN and Project Area Tiebacks – PA** • Attraction of nocturnally active birds may result in direct mortality or injury through collisions with vessels, predation, or stranding. Disorientation due to attraction may also increase energy expenditure which can have negative impacts on survival rates, particularly for migrating birds. • The discharge of organic wastes may attract birds.	Avoidance/attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.
Aircraft (helicopters)	• Presence	**Core BdN and Project Area Tiebacks – PA** • At low altitudes (during takeoff and landing), presence of helicopters may result in disruptions to marine and migratory birds from sound or overflight effects. Disruptions may result in temporary loss of useable habitat, increased energy expenditure due to escape reactions and lower food intake due to interrupted foraging or disruption of migratory activities. • Avoidance of seabird breeding colonies during critical times (as outlined in *Seabird Ecological Reserve Regulations*, 2015) will ensure no disturbance of nesting seabirds.	Avoidance behaviours could result in temporary change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles during takeoff and landing.

Table 10.6 Ecosystem Linkages – Marine and Migratory Birds

Component/Activity	Interaction	Pathway	Ecosystem Linkages
Supporting Surveys (in Core BdN and Project Area Tiebacks)			
Supporting Surveys	• Presence of vessels • Lighting • Marine Discharges • Underwater sound emissions from geophysical survey equipment	**Core BdN and Project Area Tiebacks – PA** • Attraction of nocturnally active birds may result in direct mortality or injury through collisions with vessels, predation, or stranding. Disorientation due to attraction may also increase energy expenditure which can have negative impacts on survival rates, particularly for migrating birds. • Underwater sound emissions from equipment may cause sensory disturbance which may be responsible for the avoidance response in the immediate vicinity of vessels. Physical effects (i.e., auditory injury) on diving birds from seismic surveys are unlikely and limited to a small area around the air source array. • The discharge of organic wastes may attract birds.	Avoidance / attraction behaviours could result in change in food availability and/or quality for marine and migratory birds, larger marine fish and marine mammals and sea turtles.
Decommissioning (in Core BdN and Project Area Tiebacks)			
Decommissioning	• Decommissioning of FPSO	**Core BdN and Project Area Tiebacks – PA** • Removal of the FPSO would likely result in the interactions and effects returning to baseline conditions • Removal of FPSO will restore habitat for foraging seabirds.	Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and/or quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.

10.6.2 Residual Environmental Effects Summary

Project activities for the Core BdN Development Area and Project Area Tiebacks have the potential to adversely affect Marine and Migratory Birds. Many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized at a specific location, or transient, though of a long-term nature. The implementation of the mitigation measures outlined throughout this EIS will reduce direct or indirect potential effects on the existing species, and environmental characteristics and conditions of these areas.

Artificial lighting from Project installations and vessels has the potential to attract Marine and Migratory Birds, including the nocturnally active Leach's storm-petrel, which may result in mortality from collisions, stranding and predation. Nesting Leach's storm-petrels undertake long foraging trips between globally important nesting colonies in and near the RSA and feeding areas in the deep waters off the continental shelf, including the Project and Core BdN Development Areas. These nesting colonies have been declining in size in recent decades. The potential for this mortality will be mitigated through investigating lighting reduction options and avoiding flaring during routine operations. In addition, a systematic protocol for searches of stranded seabirds will be developed and implemented.

Some Marine and Migratory Bird species may respond to the presence of the FPSO, drilling installation, vessels and aircraft by localized avoidance, particularly alcids at sea, and individuals of species at nesting colonies. Marine vessel and helicopter traffic servicing the FPSO and drilling installation will be inherently transient in nature, reducing the potential environmental effects associated with discharges, light and sound to any one location. As further mitigation, OSV traffic routes and helicopter flight paths will reduce disturbance to nesting colonies via the use of existing and common vessel and aircraft routes, and by adhering to periods of avoidance and setback distances prescribed in provincial *Seabird Ecological Reserve Regulations* and federal guidelines.

Potential adverse effects from marine discharges would be highly localized. Effects associated with produced water and SBM drill cuttings discharges from Project activities will be mitigated through the use of best treatment practices commercially available and economically feasible, in consideration of the OWTG and regulatory discharge limits. Treatment of organic waste will reduce attraction of birds, with its potential for collision and exposure to contaminants. It will also reduce the attraction of large gull species, which are predators of Leach's storm-petrel. Treatment of produced water and SBM drill cuttings will reduce the potential for Marine and Migratory Birds to be exposed to hydrocarbon sheens. SBM cuttings will be discharged below the water's surface to further mitigate the potential for contact with marine birds.

Tables 10.7 and 10.8 provide individual environmental effects assessment summaries for Project activities for the Core BdN Development and Project Area Tiebacks that comprise the Project being assessed under CEAA 2012.

10.6.3 Determination of Significance

It is predicted that the Project will not result in significant adverse effects on Marine and Migratory Birds. Although Project-related components, activities and emissions may result in some localized, short- to long-term interactions with Marine and Migratory birds in parts of the LSA, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects and will not result in detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within the RSA. This conclusion has been reached with a moderate to high level of confidence based on the nature and scope of the Project, knowledge about the existing environment within the LSA and RSA, and current understanding of the effects of similar projects on the VC and relevant, planned mitigation measures. Given the uncertainties associated with the number of storm-petrels and other marine and migratory birds stranding on installations and vessels in offshore Newfoundland due to the lack of systematic protocols to search for and document bird strandings, a moderate level of confidence was prescribed to the effects determinations for light emissions associated with various phases of the Project.

The primary mechanisms of interaction that may have effects on this VC include attraction associated with Project light emissions, increased foraging opportunities, potential for predation on seabirds attracted to project lighting, and potential hydrocarbon sheening which are likely episodic and not continuous. While these interactions may lead to increased potential for mortality or injury of individuals, the magnitude of these changes are anticipated to be low, spatially limited and long-term during production operations. For SAR, the potential for interactions between individuals and the Project is limited, and no identified critical habitat is present in the LSA. The Project will therefore not have implications for the overall abundance, distribution, or health of these species nor its eventual recovery. With the application of mitigation measures, the residual environmental effects on Marine and Migratory Birds are predicted to be not significant.

Table 10.7 Environmental Effects Assessment Summary: Marine and Migratory Birds (including SAR) - Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY											
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Marine Vessels										
Presence of Vessels	Change in Habitat Availability and/or Quality	P - A	L	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S	C	Y	H		
Light Emissions	Change in Food Availability and/or Quality	P	N	<1 km²	S	R	Y	H	B, C, D	Not Proposed
	Change in Avifauna Presence and/or Abundance (Behavioural Effects)	A	L	<1,000 km²	S	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	M - H		
Marine Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	S	C	Y	H	L, M, N	Not Proposed
	Change in Avifauna Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	H		
Hook up and Commissioning										
HUC Discharges	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H	O	Not Proposed
PRODUCTION AND MAINTENANCE OPERATIONS										
FPSO and Subsea Infrastructure										
Presence	Change in Habitat Availability and/or Quality	P - A	L	<1 km²	L	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	L	C	Y	H		
Light Emissions	Change in Food Availability and/or Quality	P	N	<10 km²	L	R	Y	H	A, B, C, D, E, F, G, J	Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	M	<1,000 km²	L	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	M - H		
Waste Discharges from FPSO										
Produced Water	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	N - S	Y	M - H	K, O	Not Proposed
Marine Waste Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	L	C	Y	H	K, L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km²	L	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	H		
Non-Routine Flaring										
Non-Routine Flaring	Change in Food Availability and/or Quality	P	N	<10 km²	S	S	Y	H	B, C, D, E, G, I, J	Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	M	<1,000 km²	S	S	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	M - H		

Table 10.7 Environmental Effects Assessment Summary: Marine and Migratory Birds (including SAR) - Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
DRILLING ACTIVITIES										
Drilling Installation										
Presence	Change in Habitat Availability and/or Quality	P -A	L	<1 km²	M	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	M	C	Y	H		
Light Emissions	Change in Food Availability and/or Quality	P	N	<10 km²	M	R	Y	H	B, C, D	Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	M	<1,000 km²	M	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	M	S	Y	M - H		
Waste Discharges from Drilling Installation										
Drill Cuttings	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	M	N	Y	M - H	K, O	Not Proposed
Marine Waste Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	M	C	Y	H	K, L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km²	M	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	M	S	Y	H		
Flaring during Formation Flow Test	Change in Food Availability and/or Quality	P	N	<10 km²	S	O	Y	H	B, C, D, H, I	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1,000 km²	S	O	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	O	Y	M - H		
SUPPLY AND SERVICING										
Marine Vessels										
Presence	Change in Habitat Availability and/or Quality	P - A	N - L	<1 km²	S - L	S - C	Y	H	P, R	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S - L	S - C	Y	H		
Light Emissions from Vessels	Change in Food Availability and/or Quality	P	N	<1 km²	L	R	Y	H	B, C, D (SBVs only)	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1,000 km²	L	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	M - H		
Marine Waste Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	L	C	Y	H	L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km²	L	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	H		
Aircraft (Helicopters)										
Movement / Sound	Change in Habitat Availability and/or Quality	A	N	<1 km²	S	S	Y	H	P, Q, R	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S	S	Y	H		
SUPPORTING SURVEYS										
Marine Vessels										
Presence of Vessels and Towed Equipment	Change in Habitat Availability and/or Quality	P - A	L	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S	C	Y	H		

Table 10.7 Environmental Effects Assessment Summary: Marine and Migratory Birds (including SAR) - Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
Light Emissions from Vessels	Change in Food Availability and/or Quality	P	N	<1 km²	S	R	Y	H	B, C, D	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1,000 km²	S	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	M - H		
Marine Discharges from Vessels	Change in Food Availability and/or Quality	P	N	<1 km²	S	C	Y	H	L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	H		
Geophysical Equipment										
Underwater Sound Emissions	Change in Food Availability and/or Quality	A	L	<1,000 km² - <10,000 km²	S	S	Y	M - H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	N	N	<100 km²	S	N	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	M	<1 km²	S	N	Y	M		
DECOMMISSIONING										
Decommissioning of FPSO	Change in Habitat Availability and/or Quality	N - A	N	<1 km²	S	O	N/A	H	Not Proposed	Not Proposed
	Change in Food Availability and/or Quality	N	N	<1 km²	S	O	N/A	H		
	Change in Avifauna Presence and Abundance (Behavioural Effects)	N	N	<1 km²	S	O	N/A	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	N	N	<1 km²	S	O	N/A	H		

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Core BdN Development is not likely to result in significant residual adverse effects on Marine and Migratory Birds.
- Although Project-related components, activities and emissions may result in some localized, short- to long-term interactions with marine-associated avifauna in parts of the Core BdN Development Area / LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area
- With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant residual adverse effects on avian species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Table 10.8 Environmental Effects Assessment Summary: Marine and Migratory Birds (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Marine Vessels										
Presence of Vessels	Change in Habitat Availability and/or Quality	P - A	L	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S	C	Y	H		
Light Emissions	Change in Food Availability and/or Quality	P	N	<1 km²	S	R	Y	H	B, C, D	Not Proposed
	Change in Avifauna Presence and/or Abundance (Behavioural Effects)	A	L	<1000 km²	S	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	M - H		
Marine Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	S	C	Y	H	L, M, N	Not Proposed
	Change in Avifauna Presence and/or Abundance (Behavioural Effects)	A	N	<1 km²	S	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	H		
Hook up and Commissioning										
HUC Discharges	Change in Food Availability and/or Quality	A	N	<1 km²	S	C	Y	H	O	Not Proposed
PRODUCTION AND MAINTENANCE OPERATIONS										
FPSO - No Change from Core BdN Development										
Presence	Change in Habitat Availability and/or Quality	P - A	L	<1 km²	L	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	L	C	Y	H		
Light Emissions	Change in Food Availability and/or Quality	P	N	<10 km²	L	R	Y	H	A, B, C, D, E, F, G, J	Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	M	<1,000 km²	L	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	M - H		
Waste Discharges from FPSO – No Change from Core BdN Development										
Produced Water	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	N - S	Y	M - H	K, O	Not Proposed
Marine Waste Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	L	C	Y	H	K, L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km²	L	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	H		
Non-Routine Flaring – No Change from Core BdN Development										
Non-Routine Flaring	Change in Food Availability and/or Quality	P	N	<10 km²	S	S	Y	H	B, C, D, G, I, J	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	M	<1,000 km²	S	S	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	S	Y	M - H		

Table 10.8 Environmental Effects Assessment Summary: Marine and Migratory Birds (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY											
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
DRILLING ACTIVITIES										
Drilling Installation										
Presence	Change in Habitat Availability and/or Quality	P - A	L	<1 km²	M	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	M	C	Y	H		
Light Emissions	Change in Food Availability and/or Quality	P	N	<10 km²	M	R	Y	H	B, C, D	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	M	<1,000 km²	M	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	M	S	Y	M - H		
Waste Discharges from Drilling Installation										
SBM Cuttings	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	M	N	Y	M - H	K, O	Not Proposed
Marine Waste Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	M	C	Y	H	K, L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km²	M	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	M	S	Y	H		
Flaring during Formation Flow Test	Change in Food Availability and/or Quality	P	N	<10 km²	S	O	Y	H	B, C, D, H, I	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1,000 km²	S	O	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	S	O	Y	M - H		
SUPPLY AND SERVICING										
Marine Vessels – No Change from Core BdN Development										
Presence	Change in Habitat Availability and/or Quality	P - A	N - L	<1 km²	S - L	S - C	Y	H	P, R	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S - L	S - C	Y	H		
Light Emissions from Vessels	Change in Food Availability and/or Quality	P	N	<1 km²	L	R	Y	H	B, C, D (SBVs only)	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1,000 km²	L	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	M - H		
Marine Waste Discharges	Change in Food Availability and/or Quality	P	N	<1 km²	L	C	Y	H	L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km²	L	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km²	L	S	Y	H		
Aircraft (Helicopters)										
Movement/Sound	Change in Habitat Availability and/or Quality	A	N	<1 km²	S	S	Y	H	P, Q, R	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S	R	Y	H		
SUPPORTING SURVEYS										
Marine Vessels										
Presence of Vessels and Towed Equipment	Change in Habitat Availability and/or Quality	P - A	L	<1 km²	S	C	Y	H	Not Proposed	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1 km²	S	C	Y	H		

Table 10.8 Environmental Effects Assessment Summary: Marine and Migratory Birds (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		
Light Emissions from Vessels	Change in Food Availability and/or Quality	P	N	<1 km^2	S	R	Y	H	B, C, D	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	L	<1,000 km^2	S	R	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km^2	S	S	Y	M - H		
Marine Discharges from Vessels	Change in Food Availability and/or Quality	P	N	<1 km^2	S	C	Y	H	L, M, N	Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	A	N	<1 km^2	S	R	Y	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	L	<1 km^2	S	S	Y	H		
Geophysical Equipment										
Underwater Sound Emissions	Change in Food Availability and/or Quality	A	L	<1,000 km^2 - <10,000 km^2	S	S	Y	M - H		Not Proposed
	Change in Avifauna Presence and Abundance (Behavioural Effects)	N	N	<100 km^2	S	N	Y	M - H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	A	M	<1 km^2	S	N	Y	M		
DECOMMISSIONING										
Decommissioning of FPSO	Change in Habitat Availability and/or Quality	N - A	N	<1 km^2	S	O	N/A	H		Not Proposed
	Change in Food Availability and/or Quality	N	N	<1 km^2	S	O	N/A	H		
	Change in Avifauna Presence and Abundance (Behavioural Effects)	N	N	<1 km^2	S	O	N/A	H		
	Change in Mortality / Injury Levels and/or Health of Individuals or Populations	N	N	<1 km^2	S	O	N/A	H		

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine and Migratory Birds.
- Although Project-related components, activities and emissions may result in some localized, short- to long-term interactions with marine-associated avifauna in parts of the Project Area / LSA, including bird attraction to offshore lighting and other components, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area
- With regard to avifauna species at risk, ivory gull and red-necked phalarope are the only such species that are likely to be found in the Project Area. During fall migration, there is some potential for Peregrine Falcons and nocturnally migrating landbird species at risk to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species at risk nor its eventual recovery. The Project is therefore not likely to result in significant residual adverse effects on avian species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km^2
Less than 10 km^2
Less than 100 km^2
Less than 1,000 km^2
Less than 10,000 km^2
Greater than 10,000 km^2

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

10.7 Environmental Monitoring and Follow-up

Equinor Canada will obtain the required authorizations for the Project, and comply with applicable regulations, guidelines, and mitigation measures as identified and committed to in the preceding sections, the implementation of which will be planned, managed, and monitored in accordance with existing operational procedures and policies. Section 18.4.2 provides an overview of the objectives of a follow-up monitoring program.

Equinor Canada will conduct a seabird observation program focussed on the attraction of birds to the FPSO and will work with ECCC in the development of this program. The options for this program include technology-based observations though the use of equipment such as bird radar, or through dedicated seabird observation programs from supply vessels similar to those undertaken by ExxonMobil at the Hebron production platform (LGL 2017). Other operators have investigated the use of technology-based observations (i.e., bird radar) and it is understood that there may be some technical limitations to the use of the equipment in an offshore environment. Equinor Canada will further investigate the use of equipment such as bird radar to determine if it can be incorporated into the design of the FPSO. Equinor Canada will work with ECCC-CWS to develop an observation program that meets the needs of the Project.

In consideration of the residual effects predictions, the uncertainty in potential attraction and strandings of Leach’s storm petrels, and associated injury and/or mortality associated with light emissions from the drilling installation, and potential intra-project effects when the drilling installation and FPSO are operating concurrently, the observational-based follow-up monitoring program will include a short-term component to monitor attraction effects during the initial overlap of production and drilling activities for Core BdN Development. The data will be reviewed to determine if additional observational programs are required when drilling and production activities are occurring concurrently.

Routine systematic searches for stranded seabirds will be conducted on Project vessels and/or installations (construction and installation activities and HUC vessels, the FPSO, drilling installation(s), stand-by vessels (SBVs)), and during supporting surveys. Searches will be undertaken by vessel/installation crew, who have been trained in bird identification and handling. Equinor Canada will work with ECCC to develop installation/vessel-specific protocols applicable to the Project with respect to the systematic searches for, and documentation of, stranded birds. If a SAR is found alive (stranded) or dead on the FPSO, drilling installation and/or SBVs, a report will be sent to ECCC-CWS for identification. If a Leach’s storm-petrel is found deceased on the FPSO, drilling installation or SBVs, the carcass will be sent to ECCC for further evaluation as detailed in Section 10.1.5.2.

In accordance with ECCC requirements, an annual report, including all occurrence data, will be submitted to ECCC which summarizes stranded and/or seabird handling occurrences.

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11.0 MARINE MAMMALS AND SEA TURTLES: ENVIRONMENTAL EFFECTS ASSESSMENT

Marine Mammals and Sea Turtles were selected as a VC because of the potential for these species to interact with Project components and activities, and because of their ecological, economic, and cultural importance, as identified by government departments and agencies, Indigenous and stakeholder groups. Additionally, many species of marine mammals and sea turtles that occur offshore Newfoundland and Labrador (NL) are considered at risk. The assessment of potential Project effects on Marine Mammals and Sea Turtles is also required in the Environmental Impact Statement (EIS) Guidelines (Appendix A).

Marine mammals and sea turtles and their habitat are protected under the federal *Fisheries Act* and *Species at Risk Act* (SARA). The *Fisheries Act* includes provisions that prohibit serious harm to fish (i.e., the death of fish or permanent alteration to, or destruction of, fish habitat) that are part of a commercial, recreational, or Aboriginal fishery. Marine mammals and sea turtles as “marine animals” are considered “fish” for the purposes of the Act. SARA includes provisions to protect species listed on Schedule 1 of the Act as well as their critical habitat, which is defined 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)). The Marine Mammal and Sea Turtle VC considers species that are secure as well as those listed under SARA or identified by the Committee of the Status of Endangered Wildlife in Canada (COSEWIC) as species at risk (SAR). However, species of conservation concern (SOCC) are given special attention and emphasis in the identification, analysis and evaluation of potential Project effects and required mitigation measures. Due to similarities in habitat use and the nature of potential interactions with Project components and activities, sea turtles are assessed together with marine mammals, with key differences noted where applicable.

Offshore waters of eastern NL are known to support many species of marine mammals and sea turtles, including species designated as SAR or SOCC (see Section 6.3.7). Several Ecologically and Biologically Significant Areas (EBSAs), representing important foraging habitat and migratory routes for marine mammals and sea turtles (Templeman 2007), are also present in the region. An overview of EBSAs is presented in Section 6.4.2 of this EIS. Critical habitat for marine mammals and sea turtles has not been designated in or near the Project Area.

11.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

The following sections define the spatial and temporal context within which potential environmental effects on Marine Mammals and Sea Turtles are assessed. These have been established to direct and focus the environmental effects assessment for the VC.

11.1.1 Spatial Boundaries

Four spatial assessment boundaries (i.e., assessment areas) have been defined for the environmental effects assessment of this VC. They reflect the Core Bay du Nord (BdN) Development, the Project Area Tiebacks, and the varying ways in which the Project and VC may interact. The boundaries were established in consideration of the nature, scale, timing, and other characteristics of the Project and the existing environmental setting, and potential environmental interactions. These assessment areas are defined as follows and are illustrated in Figure 11-1.

Core BdN Development Area: The Core BdN Development Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbance to the marine environment may occur. It occupies an offshore area of approximately 470 km^2, encompassing the potential location of the floating production, storage and offloading (FPSO) and supporting subsea infrastructure and activities. The actual seabed footprint of Project facilities within the Core BdN Development Area is approximately 7 km^2, representing approximately 1.5 percent of the entire Core BdN Development Area.

Project Area: The broader Project Area is where Project Area Tiebacks (as described in Section 2.6.6) may occur. While the Project Area is defined as an overall area that encompasses such activities for the duration of the Project, different components and activities may occupy smaller areas within this overall area, as described in Chapter 2. The Core BdN Development Area is located entirely within the Project Area. The Project Area is approximately 4,900 km^2. The footprint of the Core BdN Development subsea infrastructure is approximately 0.1 percent of the Project Area. If Project Area Tiebacks occur, using the illustration presented in Figure 11-2, the footprint of the subsea infrastructure for potential new tiebacks, including Core BdN Development, is estimated to be approximately 15 km^2, which represents less than 0.5 percent of the Project Area.

Local Study Area (LSA): The LSA encompasses the overall geographic area over which planned and routine Project-related environmental interactions may occur. It represents the predicted environmental zone of influence of the Project's planned components and activities, within which Project-related environmental changes to Marine Mammals and Sea Turtles may occur and can be assessed and evaluated. The LSA is therefore (conservatively) defined as a 50 km area around the offshore Project Area, as well as an approximately 10 km area around the associated vessel and aircraft traffic route to the Project Area. The 50 km buffer distance is based on acoustic modelling results (Zykov 2018 in Appendix D) and established behavioural thresholds for non-impulsive sound (120 dB re 1 µPa (rms)) as described in Section 11.2.5. The 10 km buffer around the transit route to the Project Area is based on consideration of the scientific literature on marine mammal response to vessels (see Section 11.3.5 for a review).

Regional Study Area (RSA): The environmental effects assessment also recognizes and considers the characteristics, distributions, and movements associated with the individual VCs under consideration from an ecological perspective. The RSA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). The RSA is defined based on the predicted zone of influence of a potential oil spill event, as summarized in Section 16.4, specifically, the area of maximum cumulative surface oil thickness for the 95th percentile surface oil exposure case at the ecological threshold of 10 g/m^2 (0.01 mm). The RSA captures the marine waters offshore eastern NL including all or part of NAFO Divisions 2J, 3K, 3L, 3M, 3N and 3O.

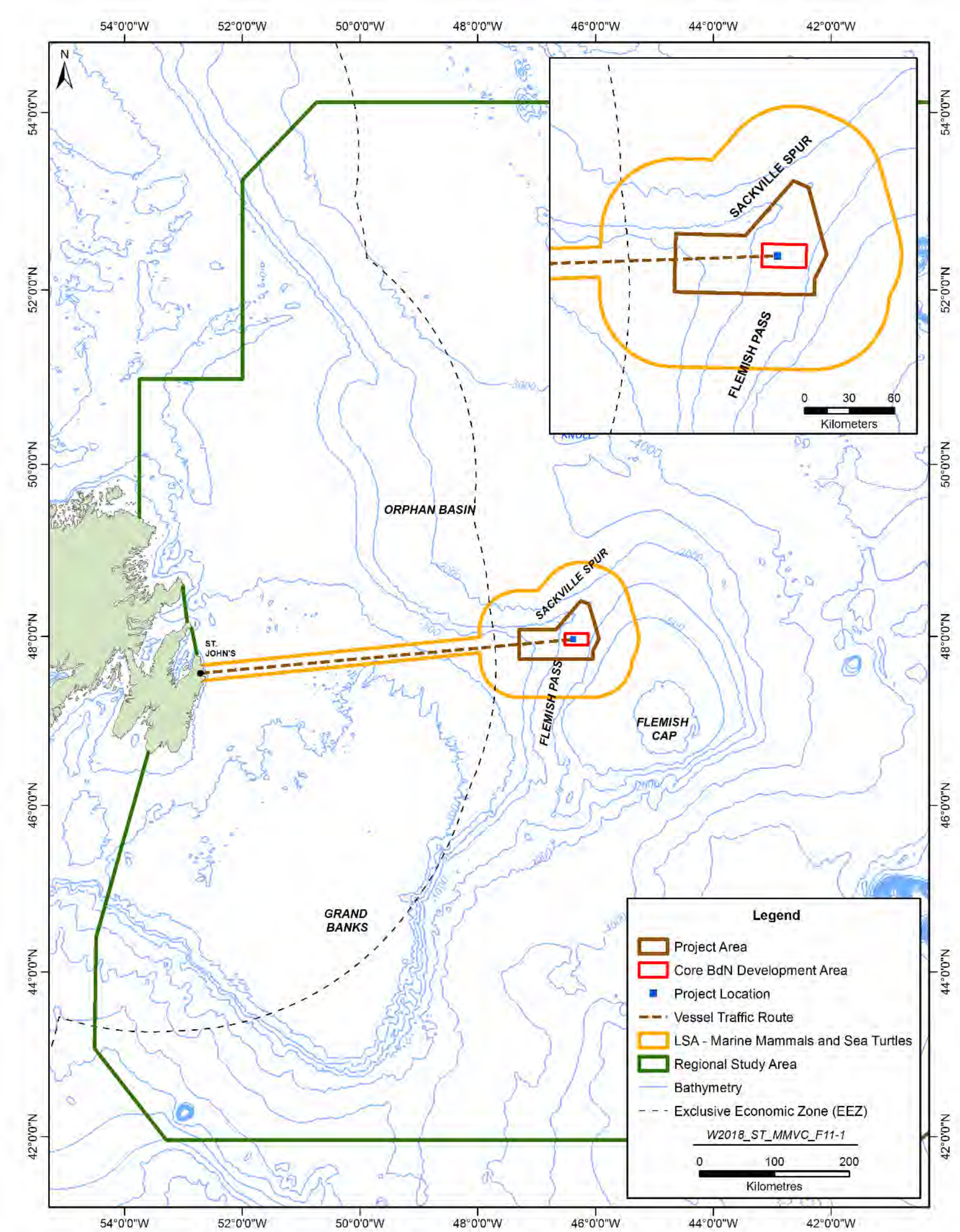

Figure 11-1 Environmental Assessment Study Areas: Marine Mammals and Sea Turtles

11.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the frequency and duration of routine Project-related activities, as well as the likely timing of resulting environmental effects. The overall schedule for the Project is provided in Section 2.1.1, and the temporal boundaries of each Project Phase are provided in Table 11.1.

Table 11.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Core BdN Development Phases	
Offshore Construction and Installation, and Hook-up and Commissioning (HUC)	• Site surveys commencing as early as 2021 • Offshore construction as early as 2023, but may occur later • Approximately 5 years; as early as 2021 • Seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of year
Production and Maintenance Operations	• Commencement as early as 2026 • 12 to 20 years; year-round
Drilling Activities	• Commencement as early as 2024 • On average, drilling time is approximately 45-85 days per development well (timeframe for pilot wells and sidetracks will be shorter) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2022 • Ongoing throughout life of Project; year-round
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed. • Approximately 2 to 4 years; seasonal or year-round
Project Area Tiebacks	*Extension of Project life to a maximum of 30 years*
Offshore Construction and Installation, and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to five tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but activities could occur year-round • May occur at any time over life of Project

Table 11.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Production and Maintenance Operations	• Continuation of activities from existing FPSO out to end of Project life • Year-round
Drilling Activities	• Total timeframe for drilling depends on number of wells required; • On average, drilling time is approximately 45-85 days per well • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Year-round, when drilling occurs
Supply and Servicing	• Continuation of activities to end of Project life • Year-round
Supporting Surveys and Activities	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

11.1.3 Approach and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on EA methodology detailed in Chapter 4 of this EIS and include the nature, scale and timing of the Project’s planned components and activities (see Chapter 2), and the existing environment for this VC (see Section 6.3). This analysis has focused on identifying key potential Project-VC interactions and anticipated changes to key species (see Section 11.2) in the LSA resulting from Project activities that may, through one or more associated pathways, lead either directly or indirectly to overall effects on the presence, abundance, health or other aspects of Marine Mammals and Sea Turtles at the individual and/or population levels.

The assessment considers what is known and can reasonably be deduced about the presence, abundance and distribution of marine mammal and sea turtle species within the LSA and the RSA, with a focus on important or sensitive species and components, and those with the potential to be affected by the Project. The assessment and description of environmental effects and the identification of mitigation has been informed by a review of the existing and available literature, including scientific studies and monitoring initiatives.

Modelling was undertaken to provide additional Project-specific information and analysis of specific discharges and emissions (drill cuttings (Appendix I) and produced water (Appendix J), air emissions (Appendix K), and sound emissions (Appendix D)) to evaluate the potential “footprint” of these discharges and emissions and the possible ecological implications of these interactions. An overview of the results of drill cuttings and produced water modelling is provided in Section 9.1.3. An overview of underwater sound modelling is presented in Section 11.3.5 below. Chapter 8 provides the results of the air emissions modelling.

11.1.4 Environmental Effects Significance Definitions

The definitions used to characterize environmental effects are provided for in Chapter 4 (Table 4.5) and are provided below specific to Marine Mammals and Sea Turtles. These characterizations will be used throughout this VC assessment in describing residual environmental effects on Marine Mammals and Sea Turtles from routine Project Activities.

Table 11.2 Characterization of Residual Effects on Marine Mammals and Sea Turtles

Characterization	Description	Definition of Categories
Nature/Direction of effect	The long-term trend of the residual environmental effect relative to baseline conditions	• **Positive** – a residual environmental effect on habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health that is considered beneficial to Marine Mammals and Sea Turtles relative to baseline conditions • **Adverse** - a residual environmental effect on habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health that is considered harmful to Marine Mammals and Sea Turtles relative to baseline conditions • **Neutral** – no change in habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health of Marine Mammals and Sea Turtles relative to baseline conditions
Magnitude of effect	The degree of change in habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions	• **Negligible** – although there is a potential for a Project-VC interaction, there would be no change in habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions • **Low** – a change in habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions, that is considered within the range of natural variability, but with no associated adverse effect on the viability of the affected population • **Medium** - a change in habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions that is considered beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population • **High** - a change in habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health relative to baseline conditions that is considered beyond the range of natural variability, but with an adverse effect on the viability of the affected population

Table 11.2 Characterization of Residual Effects on Marine Mammals and Sea Turtles

Characterization	Description	Definition of Categories
Geographic Extent of effect	The spatial area within which the residual environmental effect will likely occur	• Less than 1 km^2 • Less than 10 km^2 • Less than 100 km^2 • Less than 1,000 km^2 • Less than 10,000 km^2 • Greater than 10,000 km^2
Duration of effect	The period of time required until the habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health of marine mammals and sea turtles returns to its baseline condition, or the residual effect can no longer be measured or otherwise perceived	• Short Term - less than 12 months (1 year) • Medium Term - 1 to 5 years • Long Term - more than 5 years • Permanent - recovery to baseline conditions unlikely
Frequency of effect	Identifies how often a residual effect will likely occur	• Not likely to occur - • Occurs once – effect occurs one time • Occurs sporadically – effect occurs episodically, a no set schedule • Occurs regularly – effect occurs at regular intervals • Occurs continuously – effect occurs continuously
Reversibility of effect	Pertains to whether habitat quality/availability, prey quality/availability, behaviour, mortality, injury and/or health of marine mammals and sea turtles can return to baseline conditions after the Project/activity stops	• **Reversible**: Will eventually recover to baseline conditions • **Irreversible:** Permanent

Significant residual environmental effects are considered those that could cause a change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. In consideration of the descriptors listed in Table 11.2 as well as a consideration of regulatory requirements, SARA recovery plans, a significant residual environmental effect on Marine Mammals and Sea Turtles is defined as one that would cause one or more of the following:

- A detectable decline in overall marine mammal or sea turtle abundance or change in the spatial and temporal distributions of population(s) within the overall RSA over multiple generations
- Effects on a designated (protected) SAR or its designated critical habitat such that the overall abundance, distribution and health of that species and its eventual recovery within the RSA is adversely affected

Summary effects assessment statements are provided for each potential effects for each phase/activity (e.g., Offshore Construction and Installation and HUC; Production and Maintenance).

The potential environmental effects of accidental events on Marine Mammals and Sea Turtles are assessed in Chapter 16 (Accidental Events).

11.1.5 Potential Environmental Changes, Effects, and Mitigation Measures

The following sections provide an assessment and evaluation of the potential effects of Project activities on Marine Mammals and Sea Turtles. Mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable.

11.1.5.1 Potential Project-related Environmental Changes and Effects

Potential environmental interactions between Project activities and Marine Mammals and Sea Turtles were identified through review of several environmental assessment (EA) documents (EMCP 2011; Amec 2014; Statoil 2017), consideration of the EIS Guidelines (i.e., Sections 7.3.3 and 7.3.4 of the guidelines; Appendix A), Indigenous and stakeholder feedback, professional judgement, and the information required by the Canadian Environmental Assessment Agency (the CEA Agency) arising from its technical review of the Drilling EIS (the “IRs”). As described in Section 2.7 of this EIS, given the current stage of planning and design for the various aspects of the Project, the EIS assesses the various alternatives still under consideration in planning and design, as applicable to the VC. It also considers potential variation in the possibility, nature and degree of environmental interactions and resulting effects between species and species groups and/or in different parts of the LSA or at different times of the year, as applicable. Marine Mammal and Sea Turtle SAR are considered integrally within the environmental effects assessment for this VC, although these species are given attention and emphasis in the identification, analysis and evaluation of potential environmental effects and required mitigation measures herein.

Based on review of these resources, it has been determined that direct and indirect adverse effects on Marine Mammals and Sea Turtles that could be caused by Project activities, include but are not limited to:

- Change in injury levels (underwater sound)
- Change in mortality and/or injury levels (ship strikes)
- Change in habitat quality and/or use (behavioural effects)
- Change in prey availability and/or quality
- Change in health (contaminants)

Equinor Canada completed an environmental assessment process per the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) process for its Drilling EIS and has received comments related to Marine Mammals and Sea Turtles. Marine Mammals and Sea Turtles associated comments from the Drilling EIS process, as well as those received during ongoing engagement with Indigenous groups and stakeholders in regards to the BdN Development (as identified in Sections 3.3.1.2 and

3.4 of this EIS) are summarized below and are addressed, as applicable to the scope of the assessment, herein.

Government Departments and Agencies

- Potential effects of sound from supply vessels, drilling installations, vertical seismic profiling (VSP) surveys and geophysical surveys
- Potential for Project vessels to strike marine mammals and sea turtles, and notification procedures

Indigenous Groups

- Potential for Project vessels to strike marine mammals and sea turtles resulting in increased mortality
- Potential effects of air emissions on marine mammals
- Potential effects of underwater sound on marine mammals
- Potential effects on marine mammals (i.e., right whales and seals)
- Potential effects of increased traffic, sound, infrastructure, emissions and discharges on whales, dolphins and seals

Stakeholder Organizations

No comments were received regarding potential effects on Marine Mammals and Sea Turtles.

The environmental effects assessment for this VC considers and focuses on the issues and questions identified through these issues scoping exercises, and as identified in Sections 7.3.1 and 7.3.4 of the EIS Guidelines (Appendix A), including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from them. These are summarized in Table 11.3.

Table 11.3 Potential Project-Related Environmental Changes and Resulting Effects: Marine Mammals and Sea Turtles

Potential Environmental Effect	Potential Environmental Change
Change in Injury Levels (Underwater Sound)	• Project-related activities (e.g., installations at site, geophysical surveys, vessel transits) will introduce underwater sound to the marine environment and result in changes to the acoustic environment • Exposure to underwater sound levels at or above established acoustic thresholds has the potential to result in hearing impairment and/or injury to marine mammals and sea turtles
Change in Mortality / Injury Levels (Ship Strikes)	• Project-related activities will require the use of marine vessels throughout the Project • Marine vessel traffic has the potential to result in ship strikes with marine mammals and sea turtles

Table 11.3 Potential Project-Related Environmental Changes and Resulting Effects: Marine Mammals and Sea Turtles

Potential Environmental Effect	Potential Environmental Change
Change in Habitat Quality and/or Use (Behavioural Effects)	• Project-related activities (e.g., installations at site, geophysical surveys, vessel transits) will introduce underwater sound to the marine environment and result in changes to the acoustic environment • Exposure to underwater sound levels at or above published and/or industry standard thresholds has the potential to result in behavioural changes (e.g., changes in activity, movement) in marine mammals and sea turtles • Communication masking and increased stress levels may also occur at sound levels potentially below those for which overt behavioural responses may occur
Change in Prey Availability and/or Quality	• Project components and activities have the potential to change the availability and/or quality of marine mammal and sea turtle prey • This may have secondary effects on marine mammal foraging options and success
Change in Health (Contaminants)	• Discharge of produced water, drill cuttings, and/or marine discharges have the potential to introduce contaminants to the marine environment and result in changes to water quality in the affected areas • Introduction of contaminants has potential to adversely affect marine mammal and sea turtle short- or long-term health

An overview of the potential interactions between each of the Project's planned components and activities and Marine Mammals and Sea Turtles, and specifically, the potential for these to result in environmental changes to the various aspects of this VC, are presented in Table 11.4. In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of project activities is based on those discharges/activities "with the greatest potential to have environmental effects." This is based on scientific literature, research studies, Indigenous knowledge, input from Indigenous groups and stakeholders, and professional experience of the EIS team. Marine Mammals and Sea Turtles have the potential to interact with many aspects of the Project. However, key issues are generally related to the effects of underwater sound (i.e., hearing impairment, injury, behavioural changes, and masking) from vessels/installations and geophysical surveys and to a lesser extent the potential for transient Project vessels to strike a marine mammal and/or sea turtle resulting in injury or mortality.

Light emitted (including flaring) from Project vessels/installations will be mostly above the water's surface and as such is not anticipated to interact directly with marine mammals and sea turtles; furthermore, sea turtles are considered rare in the Project Area. Similarly, air emissions from vessels/installations will not interact with marine mammals they spend minimal time at surface in proximity to emission sources.

Project activities and components may result in the small-scale and localized releases of marine discharges such as organic waste, bilge water, etc., during routine operations. Increased exposure to contaminants and/or decreases in water quality may subsequently lead to negative effects on marine mammal and sea turtle health and possible effects on their prey. However, treatment of these routine wastes (with the possible exception of long-term discharge of produced water) will result in negligible effects on marine mammals and sea turtles. As such, these activities are not considered further in the detailed effects assessment. Effects associated with the discharge of produced water is assessed below.

WBM mud and cuttings are discharged to the seabed and typically accumulate in the vicinity of the wellhead and are unlikely to interact with marine mammals and sea turtles. Water depths in the Project Area range from approximately 300 m to approximately 1,200 m. Deposition of discharged WBM and cuttings to the seafloor is expected to result in some mortality of sedentary and slow-moving benthic species; however, these do not represent primary prey for any marine mammal and sea turtle species in the Project Area, including SAR. In addition, none of the marine mammals that regularly occur in the Project Area or LSA are known to feed on benthos in the area. The bearded seal, which is considered a benthic feeder, typically occurs much farther north near ice and forages at shallower water depths. Therefore, there is no interaction associated with the discharge of WBM and cuttings.

For the purposes of this assessment, potential effects resulting from the introduction of underwater sound have been assessed and described based on two overall categories of associated environmental change and resulting effects: 1) potential injury, and 2) changes in habitat quality and use. Available sound threshold levels are considered as a guide for the assessment of potential effects of sound, rather than an absolute measure of such effects (see Section 11.3.1 for further details on assessment approach).

The assessment of the potential for injury focuses on the possibility of permanent auditory injury (permanent threshold shift, or PTS). There are no documented cases of marine mammal and sea turtle mortalities causally linked to sound generated during oil and gas exploration and production activities. The concept of change in habitat quality and use is used here in a relatively broad context to reflect adverse alterations in the acoustic quality of marine mammal and sea turtle habitat and associated (non-injurious) results. It therefore includes subtle behavioural effects (e.g., changes in diving / breathing rate), overt behavioural responses (e.g., avoidance and changes in migration or movement patterns or activity state), communication masking (interference) and impaired detection of conspecifics and/or prey. The assessment also considers stress responses to Marine Mammals and Sea Turtles as part of the change in habitat quality.

Project vessels, such as supply and support vessels in transit to and from the Project Area have the potential to strike a marine mammal or sea turtle, resulting in injury or mortality. The pathway of effect for injury in the case of a ship strike is a result of physical contact with the vessel. Vessels engaged in construction and installation and HUC activities are either stationary or moving at slower speeds and therefore would result in vessel strikes, therefore there is no interaction.

Table 11.4 Potential Project-VC Interactions and Associated Effects: Marine Mammals and Sea Turtles

Project Component / Activity	Potential Environmental Effects				Mitigations (see Section 11.1.5.2)
	Change in Injury and/or Mortality Levels	Change in Habitat Quality and/or Use (Behavioural effects)	Change in Prey Availability and/or Quality	Change in Health	
CORE BdN DEVELOPMENT					
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING (HUC)					
Marine Vessels					
• Presence of vessels	No interaction				
• Light Emissions from Vessels	No Interaction				
• Underwater Sound Emissions from vessels		•	•		
• Marine Discharges	No Interaction				C, D, E
HUC Activities					
• Marine Discharges	No Interaction				A, B, C, D, E
PRODUCTION AND MAINTENANCE OPERATIONS					
Presence of FPSO and Subsea Installation					
• Presence of FPSO and Subsea Installation	No Interaction				
• Light Emissions	No Interaction				
• Underwater Sound Emissions from FPSO	•	•	•		
Waste Management - Marine Discharges and Emissions					
• Produced Water			•	•	A, B, C, D, E
• Marine Discharges	No Interaction				C, D, E
• Non-routine Flaring	No Interaction				
DRILLING ACTIVITIES					
• Presence of Drilling Installation	No interaction				
• Light emissions	No interaction				
• Underwater Sound emissions from Drilling Installation	•	•	•		
Waste discharges from Drilling Installation					
• Drill Cuttings	No interaction				A, B, C, D
• Marine Waste Discharges	No interaction				C, D, E

Table 11.4 Potential Project-VC Interactions and Associated Effects: Marine Mammals and Sea Turtles

Project Component / Activity	Potential Environmental Effects				Mitigations (see Section 11.1.5.2)
	Change in Injury and/or Mortality Levels	Change in Habitat Quality and/or Use (Behavioural effects)	Change in Prey Availability and/or Quality	Change in Health	
• Flaring during formation flow testing	No Interaction				
SUPPLY AND SERVICING					
Marine Vessels					
• Presence of Vessels	•				F, J, M
• Sound emissions		•	•		
• Light emissions	No Interaction				
Aircraft (helicopters)					
• Underwater sound emissions		•			F, G
SUPPORTING SURVEYS					
• Presence of Vessels (and Towed Equipment for geophysical surveys	•				
• Light Emissions from Vessels	No Interaction				
• Underwater Sound Emissions from vessels		•	•		M
• Underwater sound emissions from survey equipment	•	•	•		H, I, K, L
• Marine Discharges	No Interaction				
DECOMMISSIONING					
• Decommissioning of FPSO	•	•	•		A, B, C, D, E, F, G, M, N
• Decommissioning of Subsea Infrastructure	•	•	•		A, B, C, D, E, F, G, M, N
• Well Decommissioning	•	•	•		N, O
PROJECT AREA TIEBACKS					
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HUC					
Marine Vessels					
• Underwater Sound Emissions from vessels		•	•		

Table 11.4 Potential Project-VC Interactions and Associated Effects: Marine Mammals and Sea Turtles

Project Component / Activity	Potential Environmental Effects				Mitigations (see Section 11.1.5.2)
	Change in Injury and/or Mortality Levels	Change in Habitat Quality and/or Use (Behavioural effects)	Change in Prey Availability and/or Quality	Change in Health	
PRODUCTION AND MAINTENANCE OPERATIONS – same as Core BdN Development					
Presence of FPSO and Subsea Installation					
• Underwater Sound Emissions from FPSO	•	•	•		
Waste Management - Marine Discharges and Emissions					
• Produced Water			•	•	A, B, C, D, E
DRILLING ACTIVITIES					
• Underwater Sound emissions from Drilling Installation	•	•	•		
SUPPLY AND SERVICING – Same as Core BdN Development					
Marine Vessels					
• Presence of Vessels	•				F, J, M
• Sound emissions		•	•		
Aircraft (helicopters)					
• Underwater sound emissions		•			F, G
SUPPORTING SURVEYS					
• Presence of Vessels (and Towed Equipment for geophysical surveys	•				
• Underwater Sound Emissions from vessels		•	•		M
• Underwater sound emissions from survey equipment	•	•	•		H, I, K, L
DECOMMISSIONING					
• Decommissioning of FPSO	•	•			A, B, C, D, E, F, G, M, N
• Decommissioning of Subsea Infrastructure	•	•			A, B, C, D, E, F, G, M, N
• Well Decommissioning	•	•			N, O

Underwater Sound

Marine mammals require a functional underwater acoustic environment, as they use and produce sounds both passively and actively to communicate, navigate, locate prey and predators, and gather information about their surroundings (Richardson et al. 1995; Nowacek et al. 2007; Tyack 2008; Shannon et al. 2015). The importance of underwater sound to sea turtles is not well known but is thought to be less important than marine mammals.

Marine mammals are known or thought to hear sounds produced by offshore oil and gas activities and are generally divided into the functional hearing groups based upon the frequencies they can hear (see Appendix 4 in LGL 2015a for a review). Baleen whales are considered low-frequency cetaceans with an estimated auditory bandwidth of 7 Hz to 35 kHz. Mid-frequency cetaceans include dolphins, long-finned pilot whales, sperm whales, and beaked whale species that occur off NL and which can hear frequencies ranging from 150 Hz to 160 kHz. Harbour porpoises are considered high-frequency cetaceans with a hearing range of 275 Hz to 160 kHz. To put this in context, baleen whales are likely to hear sound sources with most energy at low-frequencies (e.g., air source pulses) farther away than can small toothed whales and, at closer distances, air source sounds may seem more prominent to baleen than to toothed whales. The functional hearing range for seals in water is generally considered to extend from 50 Hz to 86 kHz (Southall et al. 2007; NMFS 2018).

Limited available data indicate that the frequency range of best hearing sensitivity of sea turtles extends from approximately 100 Hz to 700 Hz (see Appendix 5 in LGL 2015a for a review). Sensitivity deteriorates outside of this range, that is, at either lower or higher frequencies. However, there is some sensitivity to frequencies as low as 60 Hz, and probably as low as 30 Hz (Ridgway et al. 1969). Thus, there is substantial overlap in the frequencies that sea turtles detect, and the dominant frequencies produced by air source pulses as well as the frequencies produced by ships and drilling activities.

Types of Effects Related to Sound Considered in the Assessment

The introduction of anthropogenic sound, including that from offshore production and drilling activities and vessel traffic has the potential to result in adverse effects on Marine Mammals and Sea Turtles. There are generally three primary types of potential effects of sounds on marine mammals generated by Project activities considered in this assessment. These include:

- Hearing impairment with emphasis placed on permanent hearing impairment, evident as Permanent Threshold Shift (PTS) and considered an injury. Also, considered is a temporary reduction in hearing sensitivity, evident as Temporary Threshold Shift (TTS)
- Changes in behaviour and distribution of the animals (i.e., “disturbance”) that are of sufficient magnitude to be “biologically important”
- Masked communication

The assessment of hearing impairment (i.e., “Change in Injury Level”; see Section 11.1.5.1) is typically based on whether sound levels reach or exceed established thresholds. Behavioural reactions of marine mammals to sound are difficult to predict in the absence of site and context-specific data. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007; Ellison et al. 2012). If a marine mammal reacts to an underwater sound by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be biologically important to the individual, let alone the stock or population (e.g., New et al. 2013a). However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be serious (Lusseau and Bejder 2007; Weilgart 2007; New et al. 2013b; Nowacek et al. 2015; Forney et al. 2017). Masking is the obscuring of sounds of interest by interfering sounds, generally at similar frequencies. Introduced underwater sound will, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014; Erbe et al. 2016; Tenessen and Parks 2016).

Relative to marine mammals, there is limited information on the effects of underwater sound on sea turtles. The sea turtle assessment focuses on the potential behavioural effects and hearing impairment. Sea turtles are not known to vocalize when at sea.

Acoustic Thresholds and Modelling for Assessing Effects

Canada has not developed or formally adopted guidelines regarding acoustic thresholds for hearing impairment or behavioural responses by marine mammals and sea turtles. In short, there is no single standard for defining which sound levels or criteria are appropriate for assessing effects on marine mammals and sea turtles. This assessment considers the most relevant and available scientific information. Furthermore, quite often species-specific information is lacking and information from similar species is used as a proxy. A summary of the criteria used in this assessment and the rationale for the selection is provided below for marine mammals and sea turtles.

The United States National Marine Fisheries Service (NMFS) guidelines provide the most current guidance on threshold levels of underwater sound for the onset of PTS (and TTS) in marine mammals (NMFS 2016, 2018). Much of the basis for these guidelines comes from recommendations by Southall et al. (2007) as well as those presented by Finneran (2016). Dual metrics for threshold values (i.e., recommend consideration of both peak sound pressure levels (SPL_{peak}) and cumulative (over 24 hours) sound exposure levels (SEL_{cum}) are provided and indicate that conclusions should be based on whichever metric is first exceeded. In other words, onset of PTS (i.e., injury) is assumed to occur if a received sound exposure exceeds the peak SPL criterion, or the SEL criterion, or both criteria. Acoustic threshold levels for the onset of PTS proposed by NMFS (2016, 2018) are summarized in Table 11.5. As with any acoustic threshold, it should be noted that these values serve as a guide only and in many cases are based on limited data.

To account for key acoustic features of sound that may affect marine mammals, acoustic thresholds are typically examined using the two different metrics of sound pressure level (SPL) and sound exposure level (SEL; a measure of received sound energy). When determining injury threshold distances based on SEL, frequency-weighting is used, which accounts for the animal's hearing relative to the sound frequency of interest (e.g., seismic pulse). The low-frequency cetaceans have the greatest SEL threshold distances as their hearing is most sensitive at low frequencies that overlap with those of industrial sounds (e.g., airsource array pulses).

Injury threshold distances based on SPL are not frequency-weighted so the hearing frequency band of specific marine mammals is not taken into account; rather, the threshold level accounts for the instantaneous peak SPL that could affect the marine mammal. Auditory weighting is not considered appropriate with peak SPL, as potential injury associated with sounds having high peak sound pressures does not necessarily reflect the frequencies at which an individual species hears best. The SPL threshold distances are highest for high-frequency cetaceans as this group has been assigned the lowest threshold level for peak SPL, as these cetaceans appear to be sensitive to a wide range of sounds at low exposure levels (reviewed by Southall et al. 2007). The acoustic threshold levels for all other groups are higher.

Table 11.5 Acoustic Threshold Levels for Permanent Threshold Shift Onset

Hearing Group	PTS Onset Threshold Levels			
	NMFS Acoustic Guidelines (2016, 2018[a])			
	Impulsive Sound		Non-impulsive Sound	
	dB SPL_{peak}	dB SEL_{cum}	dB SPL_{peak}	dB SEL_{cum}
Low-frequency Cetaceans	219	183	230	199
Mid-frequency Cetaceans	230	185	230	198
High-frequency Cetaceans	202	155	202	173
Pinnipeds (in water)	218-232	185-203	230	201-219

Notes:
dB (decibel) SPL_{peak} has a reference value of 1 µPa
dB SEL_{cum} has a reference value of 1 $\mu Pa^2 s$
[a] Final guidelines released by NMFS in July 2016 (with minor changes in NMFS 2018) update their draft thresholds (NOAA 2015, 2016) and replace their previous interim dB SPL_{rms} criteria for injury (i.e., 180 dB SPL_{rms} for cetaceans and 190 dB SPL_{rms} for pinnipeds (NOAA n.d.))

National Oceanic and Atmospheric Administration's (NOAA's) previous interim guidelines for injury (NOAA n.d.) also provided threshold root-mean-square (rms) SPLs for broadband underwater sound levels for behavioural disruption in marine mammals. Thresholds for behavioural disturbance were not updated in the more recent NMFS (2016, 2018) guidelines. Applied to both cetaceans and pinnipeds, these generic threshold levels are 120 dB re 1 µPa (rms) for non-impulsive sounds (e.g., vessels, drilling, FPSO) and 160 dB re 1 µPa (rms) for impulsive sounds (e.g., geophysical surveys, vertical seismic profiling (VSP)) (NOAA n.d.). These behavioural disturbance thresholds have commonly been used in marine mammal effects assessments of offshore geophysical programs in Atlantic Canada, as well as Pacific Canada, Arctic Canada, and the US (e.g., Stantec 2012, 2014a, 2014b; LGL 2014, BP 2016). In this assessment, available sound threshold levels are considered as a guide for the assessment of potential effects of sound on behavioural responses of marine mammals, rather than an absolute measure of such effects. Additionally, where species-specific information on received sound levels (and/or related response distances) is available, this information is considered as recommended in Southall et al. (2007).

Threshold criteria provided by NMFS (2016, 2018) were developed specifically for marine mammals. As soon as adequate data are available, NMFS intends to establish similar acoustic thresholds for onset of PTS in other species, such as sea turtles and marine fish (NOAA 2015). Under the American National Standards Institute-Accredited Committee S3, Subcommittee 1, an Animal Bioacoustics Working Group has established sound exposure guidelines for sea turtles that adopt some of Southall et al.'s (2007) approaches for marine mammals. Because little is known about hearing and the effects of underwater sound in sea turtles, the Animal Bioacoustics Working Group has thus far only developed numeric thresholds for potential sea turtle mortality in relation to explosions, air sources, and pile driving (Popper et al. 2014).

As referenced in Section 2.8.3 and 4.3.4.3 and presented in detail in Appendix D (Zykov 2018), acoustic modelling was undertaken to provide estimates of distances where received sound levels from Project activities reach or exceed acoustic thresholds. The acoustic modelling, as well as the Environmental Studies Research Fund (ESRF) acoustic soundscape report (Delarue et al. 2018), also provide context relative to ambient sound levels in the LSA and RSA.

Assessing Other Effects

With respect to assessing increased potential for vessel strikes, the change in risk is assessed by describing the estimated change in the (qualitative) likelihood of mortality or injury to marine mammals resulting from Project-related increases in marine traffic (i.e., increased potential for vessel strike; see Section 11.2.4). This is based primarily on an understanding of marine mammal and sea turtle strike risk as reported in scientific literature and other EAs, and from offshore experience with similar projects and activities off eastern NL and elsewhere.

The potential for Project-related effects on the prey of Marine Mammals and Sea Turtles is addressed briefly below but is characterized and described in detail within the Marine Fish and Fish Habitat assessment (Chapter 9). The scope of this assessment captured a range of species, including (but not limited to) benthic, demersal, and pelagic species (including zooplankton), as well as short- and long-lived species, migratory and non-migratory species, and invertebrate and fish taxa. This broad range includes many Marine Mammal and Sea Turtle prey species. However, there is limited information on marine mammal prey offshore Newfoundland and Labrador (Lawson, J., DFO Research Scientist, pers. comm., 12 May 2020).

The assessment of change in health considers the (qualitative) likelihood that routine Project activities and components result in the release of marine contaminants such that Marine Mammals and Sea Turtles experience a change in short-term or long-term health. The potential environmental effects of accidental events on Marine Mammals and Sea Turtles are evaluated and assessed in Chapter 16.

11.1.5.2 Summary of Mitigation Measures

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine Mammals and Sea Turtles. Mitigation measures to prevent or reduce adverse upon this VC, as listed below, are identified and considered in an integrated manner within and throughout the environmental effects analysis that follows, as applicable. The environmental effects assessment for accidental events for VCs is presented separately in Chapter 16.

A. In consideration of the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010) and regulatory discharge limits, for discharges associated with the Project, the use of best treatment practices that are commercially available and economically feasible will be implemented.
B. The selection and screening of chemicals to be discharged, will be undertaken in consideration of the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG) (NEB et al. 2009) and Equinor Canada's chemical selection and screening processes.
C. Sewage and grey water will be treated in consideration of the OWTG (NEB et al. 2010) and in accordance with Canadian and international regulatory requirements (e.g., IMO).
D. Marine discharges (e.g., bilge water) will be treated in accordance with MARPOL and Canadian requirements prior to discharge.
E. Appropriate procedures will be implemented for the handling, storage, transportation, and onshore disposal of solid and hazardous waste.
F. Use of common traffic routes for vessels and helicopters will be used where possible and practicable.
G. Low-level aircraft operations will be limited or avoided where it is not required per Transport Canada protocols.
H. In consideration of the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2017), mitigation measures applied during the Project's geophysical surveys where air source arrays are used will be consistent with those outlined in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) (DFO 2007). This includes implementing shut downs of the air source array(s) when SAR listed as Endangered or Threatened on Schedule 1 of SARA (as well as all beaked whale species) are detected within the safety zone during anytime air sources are active, including ramp up.
I. Shut-down of air source arrays for all beaked whales when observed within safety zone.
J. Consistent with International Regulations for Preventing Collisions at Sea, 1972 with Canadian Modifications, Rule 5, every vessel shall maintain a proper lookout at all times. Project vessels will alter course and/or reduce speed if a marine mammal(s) (or sea turtle) is detected ahead of the vessel.
K. Equinor Canada will communicate seismic survey plans to C-NLOPB and geophysical operators as early as possible to reduce concurrent seismic surveys and/or to maximize the separation distance between surveys to the extent possible.
L. Equinor Canada will develop a marine mammal and sea turtle monitoring plan for 4D seismic surveys which will be provided to Fisheries and Oceans Canada (DFO) for review and input.
M. If Equinor Canada is aware of a Project vessel striking a marine mammal or sea turtle, the Equinor Canada will inform DFO through their 24-hour emergency contact number (1-888-895-3003)

N. A decommissioning plan will be developed and submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) for review and acceptance. The plan will be made in consideration of regulatory requirements, engagement with Indigenous groups, commercial fisheries and other stakeholders and likely effects on the environment.
O. Use of explosives will not be employed for removal of wellheads.
P. At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements.

11.2 Overview of Marine Mammals and Sea Turtles

The existing biological environment for Marine Mammals and Sea Turtles is described in Section 6.3 and key species and their prey are summarized below as context for the overall effects assessment. Information on marine mammals and sea turtles within the Project Area was based primarily on regional government datasets, ESRF acoustic study, observations made during Equinor seabed surveys, and inferences from the scientific literature. The life history characteristics, foraging strategies, and prey of marine mammals in the Project Area are poorly understood.

The Project Area incorporates areas of the Flemish Pass and slopes of the Grand Bank and Flemish Cap in water depths ranging from 340 m to 1,200 m. The Core BdN area is located in the northern part of the Flemish Pass and overlaps part of the Sackville Spur. These slope and canyon waters provide important habitat for several species of marine mammals including baleen whales, larger toothed whales, dolphins, and to a lesser extent seals. Sea turtles are considered rare in the Project Area. As reviewed in Section 6.3, fin whales, humpback whales, northern bottlenose whales, sperm whales, and delphinids including long-finned pilot whales, Atlantic white-sided dolphin, short-beaked common dolphin, and white-beaked dolphin are considered common in the Project Area and have been detected there year-round. Fin whales are listed as Special Concern under Schedule 1 of SARA and it is uncertain which population of northern bottlenose whales occurs in the Project Area. Based on acoustic recordings, the Flemish Pass/Sackville Spur area is considered important year-round habitat for dolphins, sperm whales, and northern bottlenose whales (Delarue et al. 2018). There are no direct studies of marine mammal prey preferences and foraging strategies in the Project Area or LSA. Information for the RSA is dated and limited to a few species. Capelin and herring are considered large components for most marine mammal diets during the summer, with mackerel serving as an important prey species in the fall on the west coast of Newfoundland and southern Labrador (Lawson, J., DFO Research Scientist, pers. comm., 12 May 2020). Short-finned squid where at one time an important prey item for long-finned pilot whales in nearshore waters of Newfoundland (Mercer 1975) but it is uncertain if that is still the case. Likewise, sperm whales consume squid (Lien 1985) as do northern bottlenose whales (DFO 2016a). In addition to capelin, sand lance and euphausiids are considered important prey for most baleen whales (Mitchell 1973, 1974, 1975), which may occur in the Project Area including the more prevalent fin whale and humpback whale. The potential relationships amongst marine mammal prey and their place in the larger context of a marine food web is discussed briefly in Section 9.2.

11.3 Core BdN Development

The Core BdN Development includes six broad phases / categories of activities as described in Chapter 2:

- Offshore construction and installation, and HUC
- Production and maintenance operations
- Drilling activities
- Supply and servicing
- Supporting surveys
- Decommissioning

The assessment in the following sections is based on these activities and associated potential interactions with Marine Mammals and Sea Turtles.

Some or all of these activities may also be part of Project Area Tiebacks in the larger Project Area; these interactions and potential environmental effects are discussed in Section 11.4.

11.3.1 Offshore Construction and Installation, Hook-up and Commissioning

Offshore construction and installation and HUC refers to activities that are undertaken before and during the arrival of the FPSO at the Core BdN Development Area; these activities are described in Section 2.6.1 and summarized below.

Offshore Construction and installation activities include site preparation for, and the installation of subsea infrastructure (i.e., well templates, flowlines, risers, riser base, umbilicals, fibre optic cable). As noted in Section 2.6.1.2, options for installation of flowlines, umbilicals, and/or cables include placement on seafloor, or laid via trenching. In certain cases, there may be a requirement for protection of the flowlines/cables/umbilicals. Options for protection include rock placement, concrete mattresses or trenching. These protection measures would be undertaken during the offshore construction and installation phase.

Construction and installation activities will likely be carried out seasonally, when offshore weather conditions are favourable, and could extend seasonally over a five-year period. For the purpose of this EA, seasonal offshore activities are generally assumed to occur between the spring and fall months when weather conditions are more favorable for marine activity. Specialized vessels, as listed in Section 2.6.4.2, will be engaged as required to carry out these activities; the number of vessels offshore at any one time will depend on the activities ongoing at that time. Vessels would be engaged in activities at set locations within the footprint of the subsurface installations. For instance, for well template installations, it is likely that a single vessel would be required, therefore the zone of influence during well template installation would be limited to a specific well template location and when installation is complete at one location, the vessel would move to the next well template location. Similarly, for flowline installation, the vessel engaged would be situated at one location only. While two different activities may occur at the same time (i.e., well template installation and flowline installation by two different vessels), it is not anticipated that there would be more than one vessel engaged in the same activity. The approximate sequence of SURF installation would be to install well templates and related components, install the FPSO mooring system, install the flowlines, risers and umbilicals, install the turret buoy, pull-in the risers, hook up the FPSO, and install infrastructure protection, as needed.

HUC activities may occur at any time of the year and are estimated to last approximately four months, depending on operational and/or technical issues. Vessels on site during HUC activities, in addition to the FPSO, may include, but not limited to, vessels engaged to attach flowlines, moorings, risers, etc., to the FPSO and/or well templates. Activities also include the flushing and testing of production lines on the FPSO and flowlines on the seafloor.

As noted above, marine mammals require a functional underwater acoustic environment, as they use and produce sounds both passively and actively to communicate, navigate, locate prey and predators, and gather information about their surroundings (Richardson et al. 1995; Nowacek et al. 2007; Tyack 2008; Shannon et al. 2015). The importance of underwater sound to sea turtles is not well known but is thought to be less important than marine mammals. Project activities which increase underwater sound levels are the primary interactions during offshore construction and installation and HUC activities that may affect marine mammals and sea turtles and are assessed below.

11.3.1.1 Underwater Sound Emissions from Vessels

The primary effects on Marine Mammals and Sea Turtles due to the underwater sound emissions from vessels engaged in in offshore construction and installation and HUC activities are:

- Change in Habitat Quality and Use (Behavioural Effects)
- Change in Prey Availability and/or Quality

Project-related vessel traffic has the potential to result in mortality or injury of Marine Mammals and Sea Turtles from vessel strikes. Given that vessels engaged in construction and installation activities will be either stationary or transiting at slow speeds, the potential for ship strikes is considered very low and not considered an effect.

Changes in Habitat Quality and/or Use (Behavioural Effects) is a potential effect associated with presence of vessels involved in offshore construction and installation and HUC activities. Vessels are on-site for four to six months in the Core BdN area, an area which is typically occupied by transient ocean-going vessels. Vessels would likely occupy a single location at any one time.

Baleen whales are thought to be more sensitive to sound at low frequencies that are predominantly produced by vessels than are toothed whales (e.g., MacGillivray et al. 2014), possibly causing localized avoidance of the Project vessels. Reactions of gray and humpback whales to vessels have been studied, but there is limited information available on the reactions of right whales and rorquals (e.g., fin and blue whales; fin whales are considered common in the Project Area whereas blue whales are considered rare). North Atlantic right whales (considered rare in the Project Area) can often be approached by slowly moving vessels, but swim away from vessels that approach quickly (Watkins 1986). They tend to show little responses to close passages of small steady-moving boats when mating or feeding (Mayo and Marx 1990; Gaskin 1991). The responses of North Atlantic right whales in the Bay of Fundy to ships, sounds from conspecifics, and a signal designed to alert the whales were monitored using multi-sensor acoustic recording tags (Nowacek et al. 2004). The whales reacted overtly to the signal by swimming to the surface, likely increasing rather than decreasing the risk of collision with ships. The whales reacted mildly to controlled exposure to sounds of conspecifics but showed no response to controlled sound exposure to ships as well as actual ships (Nowacek et al. 2004). North Atlantic right whales have been known to increase the source levels of their calls, shift their peak frequencies, or otherwise change their vocal behaviour in the presence of elevated ambient sound levels (e.g., Parks et al. 2007, 2011, 2012, 2016; Tenessen and Parks 2016). Rolland et al. (2012) suggested that ship sound causes stress in right whales; they showed that baseline levels of stress-related faecal hormone metabolites decreased in North Atlantic right whales with a 6-dB decrease in underwater sound from vessels.

Off New England, fin whales had shorter surfacing and dive times when whale-watch and other vessels were nearby (Stone et al. 1992). Watkins (1981) and Watkins et al. (1981) noted that fin whales showed little response to slowly moving vessels but avoided boats that altered course or speed quickly. During marine mammal monitoring from a high-speed, catamaran car ferry transiting the Bay of Fundy during the summers of 1998 to 2002, the majority of baleen whales (including fin, humpback and minke whales) sighted from the ferry appeared to exhibit avoidance behaviour including heading away, changing heading, or diving (Dufault and Davis 2003). Fin whale sightings in the western Mediterranean were negatively correlated with the number of vessels in the area (Campana et al. 2015). Fin and blue whales in the St. Lawrence estuary either moved away from ships or remained near a vessel but changed direction or dove; the most marked reactions occurred when vessels approached quickly or erratically (Edds and Macfarlane 1987). Fin whales and blue whales have been shown to increase the source levels of their calls, shift their peak frequencies, or otherwise change their vocal behaviour in the presence of elevated sound levels such as from shipping (e.g., McKenna 2011; Castellote et al. 2012; Melcón et al. 2012). Physical presence of vessels, not just ship sound, has also been shown to disturb the foraging activity of blue whales (Lesage et al. 2017). McKenna et al. (2015) noted a dive response by blue whales when a vessel approached, but no lateral avoidance, which could lead to an increase in collision risk.

Behavioural effects due to the presence of vessels would be adverse, as described above, and short-term during the construction season and during HUC activities. The geographic extent of the change in habitat quality and use are predicted to range from 1-10 km^2 to 100-1000 km^2 from the vessel position within the Core BdN Development Area. This range in geographic extent predictions is attributable to the variable avoidance distances marine mammals exhibit in response to vessels. The behavioural changes may be continuous while vessels were on-site and are considered reversible once the vessel(s) leaves the area. Behavioural changes are predicted to be within the range of natural variability with no associated adverse effect on the marine mammals in the area and, therefore of low magnitude. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. There is some uncertainty regarding the magnitude of effect as data are limited regarding marine mammals occurrence in the Core BdN Development Area. Mitigations to reduce effects on habitat quality and use during offshore construction and installation an HUC activities are not proposed.

In summary, the residual environmental effects of a Change in Habitat Quality and/or Use (Behavioural Effects) associated with the presence of vessels during Construction and Installation and HUC should Project Area Tiebacks occur are predicted to be adverse, low in magnitude, with a geographic extent ranging from 1 km^2 -10 km^2 to 100 km^2 - 1000 km^2, short-term in duration, occurring continuously and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions from vessels engaged in offshore construction, installation and HUC activities. Vessels are on-site for four to six months in the Core BdN area, an area which is typically occupied by transient ocean-going vessels. Vessels would likely occupy a single location at any one time.

There have been no specific studies of marine mammal prey use in the Project Area and limited information exists for marine mammals in the RSA. As indicted in Section 11.2, key prey species include capelin, herring, sand lance, cod, squid, and euphausiids.

As indicated in Section 9.3.1.2, underwater sound emissions may cause a variety of behavioural responses in marine fishes and invertebrates. These responses vary by species, life stage, received sound level, frequency of sound, type of sound and rise time. These behavioral changes may include both temporary responses (e.g., startle/avoidance responses) and longer-term responses (e.g., larger-scale redistribution). Changes in fish behaviour may affect prey availability for marine mammals and sea turtles. The effects assessment of underwater sound from vessels engaged in offshore construction, installation and HUC activities, on fish species predicts that behavioural effects would be adverse, localized (less than 1 km^2) to vessel, negligible in magnitude, as fish would be available in the larger Core BdN Development Area and short-term. Therefore, similar predications on prey availability for marine mammals and sea turtles during offshore construction, installation and HUC activities can be made.

The change in prey availability and/or quality due to sound emissions from vessels engaged in Offshore Construction and Installation and HUC activities are predicted to be adverse, as described in Section 9.3.1.2 and short-term in duration. The geographic extent of the change in prey availability and/or quality would be less than1 km^2 of the vessels. The change in prey availability could be continuous and is considered reversible once the vessel leaves the area. While prey species may avoid the around the vessel, the overall availability of prey species in the Core Area would not be affected, and therefore the magnitude of the effect is considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in prey availability associated with underwater sound emissions from vessels are not proposed.

In summary, the residual environmental effects of a Change in Prey Availability and/or Quality associated with the presence of vessels engaged in Offshore Construction Installation and HUC activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities are not proposed

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions.

11.3.2 Production and Maintenance Operations

Activities associated with Production and Maintenance Operations, as described in Section 2.6.2, are those activities that are undertaken once HUC activities are complete when production operations commence on the FPSO. All activities are from the FPSO and therefore in a fixed location within the Core BdN Development Area. The FPSO will be onsite for approximately 12 to 20 years at its location within the Core BdN Development Area.

As indicated in Table 11.4, the effects assessment in the following sections is focused on underwater sound emissions and produced water discharges associated with production and maintenance operations. Production and maintenance operations for the Core BdN Development is expected to occur over a 12- to 20-year period. Given that the FPSO will be onsite for the duration of the Project, acoustic modelling of a FPSO (see Zykov 2018 in Appendix D) was undertaken to assist with the effects assessment provided below. More specifically, the modelling results provide estimated ranges to published threshold values for auditory injury and for potential behavioural responses (see Section 11.1.5.1).

11.3.2.1 Underwater Sound Emissions from the FPSO

The primary effects on Marine Mammals and Sea Turtles due to underwater sound emissions from the FPSO are:

- Change in Injury and/or Mortality Levels
- Change in Habitat Quality and Use
- Change in Prey Availability and/or Quality

Changes in Injury and/or Mortality Levels is a potential effect associated with underwater sound emissions from the FPSO during production and maintenance operations. The FPSO will be onsite for approximately 12 to 20 years at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels.

Based on published threshold values for auditory injury (PTS) for marine mammals (Table 11.5), it is highly unlikely that sound produced by the FPSO will result in injury to marine mammals. The estimated broadband source level (i.e., 183.7 dB re 1 μPa (rms) @ 1 m) of a representative FPSO, operating DP thrusters modelled for the Project, is below the SPL_{peak} auditory injury thresholds for non-impulsive (i.e., continuous) sounds for all marine mammal groups (Table 11.5; Zykov 2018 in Appendix D). Based on the SEL_{cum} thresholds for PTS-onset, acoustic modelling results indicate that mid-frequency cetaceans (e.g., beaked whales and dolphins such as northern bottlenose whales and Atlantic white-sided dolphins which may occur in the Core BdN Development/Project Area) and seals would have to remain within 40 m of the FPSO for 24 hours to experience PTS. Likewise baleen whales (low-frequency cetaceans such as fin and humpback whales which are considered common in the Core BdN Development Area/Project Area) and harbour porpoise (high-frequency cetaceans), would have to occur within approximately 60 m and approximately 150 m, respectively of the FPSO for 24 hours to possibly incur PTS. It is anticipated that most marine mammals will avoid the immediate area around the FPSO, thereby further reducing the likelihood of marine mammals incurring hearing impairment. Although less is known about the effects of underwater sound on sea turtle hearing and behaviour, it is assumed turtles, should they occur in the Project Area, would also exhibit localized avoidance of the FPSO. In summary, it is highly unlikely that marine mammals or sea turtles are at risk of incurring auditory injury (PTS) from exposure to underwater sound from the FPSO. There is increased risk that marine mammals (and sea turtles) may experience temporary hearing impairment (TTS) from prolonged exposure to sound from the FPSO; however, based on published TTS-onset thresholds and acoustic modelling results undertaken for the Project (Zykov 2018 in Appendix D), this is also considered unlikely.

The Change in Injury and/or Mortality Levels due to the underwater sound emissions from the FPSO could be adverse, as described above, and in the unlikely event of PTS occurrence, it would be considered long-term at the individual level. The geographic extent is predicted to be within 1 km^2 of the FPSO at its location in the Core BdN Development Area, based on modelling as presented above. The potential injury effects would not likely occur and be reversible (at the population level), once the FPSO leaves the area. As noted above, given the assumption that marine mammals and/or sea turtles would have to remain in the area for over 24 hours for injury effects to occur, the magnitude of change in injury would range from negligible to low as there could be an interaction without effects occurring (negligible) and if changes in injury level were to occur, it would be considered within the range of natural viability (low). Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area and there are data gaps in hearing studies on marine mammals, particularly baleen whales and larger toothed whales. Therefore, there is some uncertainty whether injurious hearing effects can occur from a continuous sound source like the FPOS and as such there is uncertainty in the frequency of effect. Mitigations to reduce the change in Injury and/or Mortality due to underwater sound emissions from the FPSO are not proposed.

In summary, the residual environmental effects of a Change in Injury and/or Mortality Levels associated with underwater sound emissions from the FPSO during Production and Operations are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km^2, of long-term duration, not likely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Habitat Quality and/or Use (Behavioural effects) are potential effects associated with underwater sound emissions from the FPSO during production and maintenance operations. The FPSO will be onsite for approximately 12 to 20 years, at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels. FPSOs produce continuous underwater sound at levels that are lower than those produced by drillships (Zykov 2018 in Appendix D). Marine mammal and sea turtle response to sound produced by FPSOs has not been systematically studied; however, findings of marine mammal and sea turtle response to other continuous and predominantly low-frequency sound sources like drilling installations serve as a good proxy. Refer to Section 11.3.3 for a review of behavioural effects associated with underwater sound from drilling installation on Marine Mammals and Sea Turtles.

As noted in Section 11.1.5.1, the U.S. NMFS included thresholds for behavioural disturbance in their guidelines for assessing effects of sound on marine mammals. Applied to both cetaceans and pinnipeds, these generic threshold levels are 120 dB re 1 µPa (rms) for non-impulsive sounds (e.g., shipping, drilling) and 160 dB re 1 µPa (rms) for impulsive sounds (e.g., air sources used in seismic surveys; see Section 11.2.5). As a reminder, these thresholds are considered as a guide for the assessment of potential effects of sound on behavioural responses of marine mammals, rather than an absolute measure of such effects.

Based on acoustic modelling results for the FPSO, the 120 dB re 1 µPa (rms) sound level (using R_{max}—most conservative metric) estimate was 14 km in February and 3.8 km in August (Tables 12 and 13 in Zykov 2018; Appendix D). Sound propagates farther during the winter period because of a sound surface channel. Based on available information of marine mammal responses to sound produced by sources like a FPSO, it is unlikely that all marine mammals would avoid a FPSO at these maximum distances. Also, as described in the acoustic modelling report for the Project (Zykov 2018; Appendix D), sound from the FPSO is expected to be “bounded” by the continental shelf, west of the site. More specifically, sounds that reach the continental shelf (i.e., water depths of 100-300 m), west of the Project Area, are predicted to have higher transmission loss. Baleen whales including the three most common species in the Project Area—humpback, fin, and minke whales, which are typically more abundant on the continental shelf would therefore, in most cases be exposed to much lower sound levels in shelf waters from the FPSO which is located in deep waters. In summary, sound from the FPSO is expected to result in localized avoidance by marine mammals including those species which are known to be relatively common in the deep waters of the Core BdN Development Area—i.e., sperm whales, northern bottlenose whales, fin whales, and delphinids. Sea turtles, considered rare in the Project Area, would also be expected to exhibit localized avoidance.

The potential for masking of marine mammal calls and/or important environmental cues is considered limited from the FPSO given the relatively low source level and attenuation of sound to levels below measured ambient levels in the region (Matthews et al. 2018; Maxner et al. 2018 in Appendix L). Some baleen and toothed whales are known to continue calling in the presence of anthropogenic sounds. Some cetaceans are also known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behaviour in response to anthropogenic sounds (e.g., Blackwell et al. 2015).

The Change in Habitat Quality and/or Use (Behavioural Effects) due to the presence of the FPSO would be adverse, as described above, and the long-term, but individual marine mammals would likely experience effects in the short-term. Based on acoustic modelling, the geographic extent of the behavioural changes is estimated to be occur within 14 km (approximately 600 km^2) of the FPSO at its location in the Core BdN Development Area. Based on available information, it is likely that marine mammals will exhibit variable avoidance distances of the FPSO. It is possible that marine mammal behavioural response to FPSO could be continuous but is considered reversible once the FPSO leaves the area at end of Project. It is also possible marine mammals may habituate to the presence of the FPSO. The behavioural changes may be beyond natural variability but are not predicted to affect the viability of marine mammal populations in the area and, therefore, are considered medium magnitude. Should the drilling installation and FPSO be onsite concurrently, the geographic extent may be additive, and perhaps even synergistic but would still represent a very small area within the LSA. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development Area, and there are data gaps associate with masking studies, therefore, there is some uncertainty regarding the magnitude of effect. Geographic extent, in this case, is based on underwater sound modelling. Modelling is a predictive tool requiring various assumptions about model inputs; therefore, there is some uncertainty regarding the zone of influence of underwater sound levels predicted by the modelling as well as the response criteria and its applicability across various marine mammal and sea turtle species. Based on these uncertainties there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in habitat quality and use due to underwater sound emissions associated with the and FPSO are not proposed.

In summary, the residual environmental effects of a Change in Habitat Quality and/or Use from the presence of the FPSO during Production and Operations are predicted to be adverse, medium in magnitude, with a geographic extent between 100 km^2 to 1000 km^2, of long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions from the FPSO during production and maintenance operations. There have been no specific studies of marine mammal prey use in the Project Area and limited information exists for marine mammals in the RSA. As noted in Section 11.2, key prey species include capelin, herring, sand lance, cod, squid, and euphausiids.

As indicated in Section 9.3.2.3, underwater sound emissions from the FPSO may cause a variety of behavioural responses in marine fishes and invertebrates. These responses vary by species, life stage, received sound level, frequency of sound, type of sound and rise time. These behavioral changes may include both temporary responses (e.g., startle/avoidance responses) and longer-term responses (e.g., larger-scale redistribution). Potential effects resulting from underwater sound emissions from the FPSO on the health, abundance, and distribution of fish and invertebrate species can have indirect effects on marine mammals and sea turtles in terms of prey availability and quality. Prey availability may be adversely affected if marine mammals and/or sea turtles need to travel longer distances to locate prey, or if prey are distributed in a more dispersed (less aggregated) manner, such that foraging efficiencies are reduced. Quality would be considered adversely affected if the health of prey species was diminished, or if the ratio of preferred to less-preferred prey items was altered. There is some uncertainty due to limited data regarding if the Core BdN Development Area is an important area for foraging marine mammals, and data gaps in the prey/foraging strategies of marine mammals. Results of the assessment presented in Chapter 9 (Section 9.3.2.3) suggest that effects from presence and operation of the FPSO on prey species (including capelin, herring, sand lance, squid, and euphausiids) will be of negligible magnitude and in a localized area (less than 1 km^2) of the FPSO, and as such, indirect effects on change in prey availability and/or quality for marine mammals and sea turtles are not expected to the degree that would translate into effects on the abundance, distribution, or health of these species.

The change in prey availability and/or quality associated with underwater sound emissions from the FPSO could be adverse, as described above, and long-term. The geographic extent of the change in habitat would be within 1 km^2 of the FPSO at its location in the Core BdN Development Area. The change in prey availability would be continuous and would be considered reversible once the FPSO leaves the area. While underwater sound emissions may affect prey availability within a localized area of the FPSO, the overall prey availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in prey availability relative to baseline conditions, therefore, the magnitude of the effect is considered negligible. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above there are uncertainties associate with the foraging strategies of marine mammals and if the Core BdN Development is a foraging area, therefore there is some uncertainty regarding the magnitude of effect. Mitigations to reduce the change in prey availability and/or quality associated with the underwater sound emissions from the FPSO are not proposed.

In summary, the residual environmental effects of a Change in Prey Availability and/or Quality associated with underwater sound emissions from the FPSO during Production and Maintenance Operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with underwater sound emissions from the FPSO during Production and Maintenance Operations are not proposed

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated with underwater sound emissions from the FPSO during Production and Maintenance Operations in consideration of the residual effects predictions.

11.3.2.2 Waste Discharges during Production and Maintenance: Produced Water

The primary effects on Marine Mammals and Sea Turtles due to the discharge of produced water are:

- Change in Health
- Change in Prey Availability and/or Quality

Produced water is the largest volume of waste discharges from the FPSO. Produced water will be treated using best treatment practices that are commercially available and technically feasible and discharged to the marine environment. Produced water is predicted to be 40°C at the discharge source and maximum discharge volumes are estimated to be between 30,000 m^3/d and 50,000 m^3/d.

Produced water is composed of both formation water and injection water. The composition, therefore, depends on the geological characteristics of the reservoir and the injection water and show high variability in composition of different fields. Of concern are aromatic hydrocarbons, polycyclic aromatic hydrocarbons (PAH), related heterocyclic aromatic compounds, alkylphenols, heavy metals and naturally occurring radioactive materials (Neff et al. 2011; Bakke et al. 2013). Other compounds that are present in produced water include a variety of production chemicals including biocides, corrosion inhibitors, oxygen scavengers, scale inhibitors and gas treatment chemicals that are injected into the reservoir to extract the oil (Furuholt 1995; Lee and Neff 2011). Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff 1990). Produced water will be treated using best treatment practices that are commercially available and economically feasible before discharge to the marine environment. The treatment of produced water is intended to reduce potential impacts to water quality. The impacts from produced water on Marine Mammals and Sea Turtles are expected to be nominal given compliance with existing regulations (see BOEM 2017).

Change in Health is a potential effect associated with the discharge of produced water from production and maintenance operations. It is possible that Marine Mammals and Sea Turtles may be exposed to contaminants in produced water either directly or indirectly through prey. Based on modelling of produced water discharge scenarios undertaken for the Project (see summary in Section 9.2.2 and detailed report in DeBlois 2019 in Appendix J), the produced water plume was predicted to be of highest concentration within 100 m of the discharge source and within the upper 10 m of the water column, with no effect concentration exceedances predicted out to 1 km. The modelling simulated five produced water discharge scenarios with assumed concentrations of 15 ppm or 30 ppm dispersed oil and no dilution or dilution with cooling water. As noted above, the impacts from produced water on Marine Mammals and Sea Turtles are expected to be nominal given compliance with existing regulations (BOEM 2017). Similarly, adherence to the OWTG (NEB et al. 2010) will limit potential effects on marine mammal and sea turtle prey. Refer to Section 9.2.2 for an assessment of produced water effects on Marine Fish and Fish Habitat.

The change in health of individuals due to the discharge of produced water could be adverse as described above, and long-term. The geographic extent of the change in health would be less than 1 km^2 of the FPSO at its fixed location in the Core BdN Development Area, as supported by produced water modelling and scientific literature noted above. The change in health would be continuous, and reversible once the FPSO leaves the area. The magnitude of the change in health would be negligible as indicated above. While there may be an interaction, there would be no change in the health of marine mammals relative to baseline conditions. Overall, these predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce potential effects of produced water are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Health of marine mammals and sea turtles from produced water discharge are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with discharge of produced water from production and maintenance operation. The FPSO will be onsite for approximately 20 years at a fixed location in the Core BdN Development Area, an area typically occupied by transient ocean-going vessels.

As described in Sections 9.3.2.4, effects on fish health and prey availability associated with the discharge of produced water are predicted to be within the upper 10 m of the water column and may extend to within 1 km of the discharge point, based on produced water modelling. As noted in Section 9.3.2.4, potential changes to water quality associated with produced water discharges may result in changes in fish health and availability, thereby likely affecting prey species in pelagic areas in the upper 10 m of the water column, such as plankton and shrimp in the Core BdN Development Area,

Mitigations to reduce the change in habitat quality include discharging produced water in accordance with the OWTG, regulatory discharge limits, and the screening of chemicals in accordance with the OCSG and Equinor's best practices. Produced water will be treated using best treatment practices that are commercially available and economically feasible and discharged to the marine environment.

The change in prey availability and/or quality due to the discharge of produced water associated with produced water discharges during production and maintenance operations would be adverse, as described above, and long-term. The geographic extent of the change in habitat would be within 1 km of the FPSO (less than 10 km^2) at its location in the Core BdN Development Area, based on produced water dispersion modelling. The change in prey availability and/or quality would be continuous, and reversible once the FPSO leaves the area. While prey species may be affected by produced water discharges within a localized area of the FPSO, the overall availability and quality of prey species in the Core BdN Development Area would not be affected and is available for predators. There is no predicted change in prey availability relative to baseline conditions, therefore, the magnitude of the change is considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects of a change in Prey Availability and/or Quality associated with the discharge of produced water during Production and Maintenance Operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km^2, of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with associated with marine waste discharges include treatment of wastes in consideration of OWTG discharge limits with the use of best treatment practices that are commercially available and economically feasible (A); selection and screening of chemicals in accordance with guidelines (B); treatment of marine discharges in consideration of the Canadian and international requirements (C, D) management of solid and hazardous wastes (E).

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated with marine discharges from the FPSO during Production and Maintenance Operations in consideration of the residual effects predictions.

11.3.3 Drilling Activities

Drilling activities to be undertaken for the Core BdN Development are described in Section 2.6.3. Drilling will occur at set locations in the Core BdN Development Area, as illustrated in Figure 2-12. These set locations are illustrated on the figure as “well templates.” Depending on final project design, wells will either be drilled using templates (multiple wells drilled in one location) or at individual well locations (satellite wells). Drilling will likely commence before the FPSO arrives on site and will overlap periodically during production operations.

The effects assessment will assume that multiple wells are to be drilled at set well template locations, which provides a more conservative estimate of effects than if a single well were drilled at these well template locations. Based on current Project design, well templates may be 4-, 6- or 8-slot templates, which means that either 4, 6 or 8 wells could be drilled at a single location, from the same well template. As noted in Table 10-1, it is estimated that 45-85 days are required to drill each well. Therefore, assuming eight wells are drilled consecutively, the drilling installation could be on a well template location between one to two years, respectively. If the number of wells per well template is less than eight, the time on location would be reduced accordingly. Drilling will not be carried continuously over the life of the project, and may occur in phases, with a set number of wells drilled per drilling campaign. The drilling installation may be on-site before the FPSO arrives on site. There may be periods of time, throughout the life of the project where the drilling installation and FPSO are in the Core BdN Development Area at the same time. Drilling will be conducted by one or more drilling installations including either a semi-submersible unit or a drillship. Of note, dynamically positioned drillships are typically noisier than semi-submersibles which, in turn, are noisier than jack-ups (Richardson et al. 1995).

The effects assessment, as stated in Section 11.1.5.1 is focused on those activities “with the greatest potential to have environmental effects” (EIS Guidelines 2018). As indicated in Table 11.4, the effects assessment focuses on the interactions of underwater sound emissions.

11.3.3.1 Underwater Sound Emissions from the Drilling Installation

The primary effects on Marine Mammals and Sea Turtles due to underwater sound emissions from the drilling installation are:

- Change in Injury and/or Mortality Levels
- Change in Habitat Quality and/or Use
- Change in Prey Availability and/or Quality

Changes in Injury and/or Mortality Levels is a potential effect associated with underwater sound emissions from the drilling installation during drilling activities.

Underwater sound produced by the operation of the drilling installation (including presence of support vessels) during drilling and the use of dynamic positioning (DP) thrusters and hydroacoustic positioning systems for station keeping is unlikely to result in hearing impairment in marine mammals and sea turtles. Continuous sounds produced by vessels, DP thrusters, and drilling activities do not typically exceed threshold levels for temporary or permanent changes in hearing ability (TTS or PTS) (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007; NMFS 2016, 2018). Exposure to underwater sound from offshore drilling operations, including associated support vessels, at levels capable of causing marine mammal auditory injury (using either the SPL or SEL metric) was deemed unlikely in recent analyses of exploration drilling offshore Nova Scotia (Zykov 2016) and NL (BP 2018). Similar to marine mammals, the relative risk of injury in sea turtles is expected to be unlikely, as sea turtles are not expected to approach or remain for extended periods in close proximity to sources of underwater sound, reducing the potential for exposure to sound levels capable of causing auditory injury.

As noted above and based on published threshold values for auditory injury (PTS) for marine mammals (Table 11.5), it is highly unlikely that sound produced by drilling installations will result in injury to marine mammals and sea turtles. The estimated broadband source level (i.e., 187.6 dB re 1 µPa (rms) @ 1 m) associated with the modelled drilling installation (the *Stena Carron*, which is representative of a type of drilling installation that could be used for the Project) is below the SPL_{peak} auditory injury thresholds for non-impulsive (i.e., continuous) sounds for all marine mammal groups (Table 11.5; Zykov 2018 in Appendix D). Based on the SEL_{cum} thresholds for PTS-onset, acoustic modelling results indicate that mid-frequency cetaceans, such as beaked whales (e.g., northern bottlenose whales) and dolphins (e.g., Atlantic white-sided dolphins) which may be in the Core BdN Development / Project Areas, and seals would have to remain within 40 m of the drillship for 24 hours to experience PTS. Likewise baleen whales (low-frequency cetaceans such as fin and humpback whales which are considered common in the Core BdN Development Area/Project Area) and harbour porpoise (high-frequency cetaceans), would have to occur within approximately 100 m and approximately 230 m, respectively of the drillship for 24 hours to possibly incur PTS. It is anticipated that most marine mammals will avoid the immediate area around the drilling installation (as noted above), thereby further reducing the likelihood of marine mammals incurring hearing impairment. Although less is known about the effects of underwater sound on sea turtle hearing and behaviour, it is assumed turtles, should they occur in the Project Area, would also exhibit localized avoidance of the drilling installation. In summary, it is highly unlikely that marine mammals or sea turtles are at risk of incurring auditory injury (PTS) from exposure to underwater sound from the drilling installation. There is increased risk that marine mammals and sea turtles may experience temporary hearing impairment (TTS) from prolonged exposure to sound from the drilling installation; however, based on published TTS-onset thresholds and acoustic modelling results (Zykov 2018 in Appendix D), this is also considered unlikely.

The change in Injury and/or Mortality Levels due to the underwater sound emissions from the drilling installation could be adverse, as described above, and in the unlikely event of PTS occurrence, it would be considered long-term at the individual level. The geographic extent is predicted to be within 1 km^2 of the drilling installation at its location in the Core BdN Development Area, based on acoustic modelling. Potential injury effects would not likely occur and be reversible (at the population level), once the drilling installation leaves the area. As noted above, it is assumed that marine mammals and/or sea turtles would have to remain in the area for over 24 hours for injury effects to occur, the magnitude of change in injury would range from negligible to low as there is likely an interaction without effects occurring (negligible) and if changes in injury were to occur, it would be considered within the range of natural viability (low). Should drilling and production operations be carried out at the same time, the presence of the drilling installation and FPSO in the Core BdN Development Area would be two distinct sources of underwater sound for marine mammals. The zone of influence for either the FPSO or drilling installation is less than 1 km^2, therefore potential changes in injury levels would be localized to the locations of either installation. Given avoidance behaviours and the overall small zones of potential auditory injury, the magnitude of effect should both installations be operating at the same time would not change. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area and there are data gaps in hearing studies on marine mammals, particularly baleen whales and larger toothed whales. Therefore, there is uncertainty whether injurious hearing effects can occur from a continuous sound source and as such, there is uncertainty in the frequency of the effect. Mitigations to reduce the Change in Injury and/or Mortality due to sound emissions from the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Injury and/or Mortality Levels associated with underwater sound emissions from the drilling installation during Drilling Activities are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km^2, of long-term duration, not likely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Habitat Quality and/or Use (Behavioural Effect) is a potential effect associated with presence of the drilling installation.

It is quite possible that marine mammals and sea turtles may exhibit changes in behaviour in response to sounds produced by a drilling installation. Kapel (1979) reported numerous baleen whales – mainly fin, minke, and humpback whales (all three species occur in the Project Area) – within visual range of active drill ships off West Greenland. In more formal studies, bowhead whales responded to drillship sounds within 4 km to 8 km of a drillship when received levels were 20 dB above ambient or approximately 118 dB re 1 µPa (Greene 1985, 1987; Richardson et al. 1985b, 1990). Response was greater at the onset of the sound (Richardson et al. 1995). Bowhead whales migrating in the Beaufort Sea avoided an area with radius 10 km around a drillship, which corresponded to received sound levels of 115 dB re 1 µPa (Richardson et al. 1990). Some whales were less responsive, and habituation may occur, so that in time bowheads may be seen within 4 km to 8 km of a drillship (Richardson et al. 1985a, 1990). Sound is likely to attenuate less rapidly in the Beaufort Sea where these experiments were conducted than in temperate waters at similar depths (Miles et al. 1987).

Off the coast of California, the response zone around a semi-submersible drilling installation was much less than 1 km for grey whales (Malme et al. 1983, 1984). Humpback whales showed no clear avoidance response to received drillship broadband sounds of 116 dB re 1 µPa (Malme et al. 1985).

The proximal part of the migration corridor of bowhead whales in the Alaskan Beaufort Sea has been monitored during construction, drilling, and production activities at an artificial island (Northstar) just inshore of the migration corridor (Richardson and Williams 2004). The primary objective of the monitoring program was to determine if, at high-sound times, underwater sound propagating from Northstar and its support vessels deflected the southern part of the bowhead migration corridor. An acoustical localization method was used to determine the locations of calling bowhead whales (Greene et al. 2004). Overall, the results showed evidence consistent with slight offshore displacement of the proximal edge of the bowhead migration corridor at some times when levels of underwater sound were unusually high (Richardson 2008). The southern edge of the call distribution ranged from 0.76 km to 2.35 km farther offshore, apparently in response to industrial sound levels. This result, however, was only achieved after intensive statistical analyses, and it is not clear that this represented a biologically material effect.

Beluga whales were exposed to playback sounds from a semi-submersible drilling installation in an Alaskan river (Stewart et al. 1982). During the two tests, belugas swimming toward the sound source did not react overtly until they were within 50 m to 75 m and 300 m to 500 m, respectively; some belugas altered course to swim around the source, some increased swimming speed, and one reversed direction of travel. Reactions to sound from the semi-submersible drilling installation were less severe than were reactions to motorboats with outboards (Stewart et al. 1982). Dolphins and other toothed whales show considerable tolerance of drilling installations and their support vessels when there are not negative consequences from close approach to the activities (Richardson et al. 1995).

Ringed seals were often seen near drillships drilling in the Arctic in summer and fall (several reports summarized by Richardson et al. 1995). Ringed seals and bearded seals approached and dove within 50 m of a projector transmitting drilling sound into the water (received sound levels were 130 dB re 1 µPa). Studies of seals near active seismic vessels (Harris et al. 2001; Moulton and Lawson 2002) confirm that seals are tolerant of offshore industrial activities.

There are currently no available systematic data on sea turtle responses to sound from drilling installations.

Maxner et al. (2018) (Appendix L) reported on sound levels of the semi-submersible drilling installation *West Hercules* which was used to drill an exploration well in the Flemish Pass, within the Project’s Core BdN Development Area, in 2015. The *West Hercules* was located in approximately 1,100 m water depth and was located 13.4 km from an acoustic recorder. During an approximate four-week period in late spring, average sound levels at the acoustic recorder in the 100 Hz to 1000 Hz band were 110 to 115 dB re 1 µPa (rms) or approximately 13 dB above the baseline.

Based upon the above information regarding marine mammal disturbance reactions (including studies on fin, minke, and humpback whales which commonly occur in the BdN Core Development Area), marine mammals (and likely sea turtles) may exhibit minor, short-term disturbance responses to underwater sounds from drilling and associated vessel sounds.

There is some potential that sound from the drilling installation may mask marine mammal communication. Introduced underwater sound will, through masking, reduce the effective communication distance of a marine mammal species. Masking may occur if the frequency of the source is close to that used as a signal by the marine mammal and if the anthropogenic sound is present for a significant fraction of the time (Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014; Erbe et al. 2016; Tenessen and Parks 2016). The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small odontocetes that have been studied directly. The sounds important to toothed whales and pinnipeds are predominantly at much higher frequencies than are the dominant components of drilling installation sounds, thus limiting the potential for masking. The potential for masking of marine mammal calls and/or important environmental cues is considered limited from the drilling installation given the relatively low source level and attenuation of sound to levels below measured ambient levels in the region (Matthews et al. 2018; Maxner et al. 2018). As noted in Section 11.2.2.1, some baleen and toothed whales are known to continue calling in the presence of anthropogenic sounds. Some cetaceans are also known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behaviour in response to anthropogenic sounds (e.g., Blackwell et al. 2015). In addition, marine mammals have mechanisms that enhance the detectability of signals in the presence of sound including spatial release, comodulation masking release, as well as the within valley (or “dip”) listening strategy (Erbe et al. 2016).

As noted in Section 11.1.4, the generic behavioural threshold levels for cetaceans (such as fin whales, humpback whales, sperm whales, northern bottlenose whales, and delphinids), and pinnipeds (such as harp and hooded seals),, which are likely to be present in the Core BdN Area) are 120 dB re 1 µPa (rms) for non-impulsive sounds (e.g., shipping, drilling) and 160 dB re 1 µPa (rms) for impulsive sounds (e.g., air sources used in seismic surveys; see Section 11.2.5). As a reminder, these thresholds are considered as a guide for the assessment of potential effects of sound on behavioural responses of marine mammals, rather than an absolute measure of such effects.

Based on acoustic modelling results for a drillship, the 120 dB re 1 µPa (rms) sound level (using R_{max}—most conservative metric) estimate was 25.5 km in February and 8 km in August (Tables 12 and 13 in Zykov 2018; Appendix D). Sound propagates farther during the winter period because of a sound surface channel. Using the more representative estimate ($R_{95\%}$), the 120 dB threshold typically would be reached at 25.1 km and 5.9 km from the drillship in February and August, respectively (Tables 12 and 13 in Zykov 2018). Based on available information, it is unlikely that all marine mammals, particularly odontocetes and seals, would avoid a drilling installation at these maximum distances. Also, as described in Zykov (2018; Appendix D), sound from the drillship is expected to be “bounded” by the continental shelf, west of the site. More specifically, sounds that reach the continental shelf (i.e., water depths of 100 m to 300 m), west of the Project Area, are predicted to have higher transmission loss. Baleen whales (i.e., humpback, fin, and minke whales), which are typically more abundant on the continental shelf would therefore, in most cases be exposed to much reduced sound levels in shelf waters from the drilling installation which will be located in deep waters. In summary, sound from the drilling installation is expected to result in localized avoidance by marine mammals. Sea turtles, considered rare in the Project Area, would also be expected to exhibit localized avoidance.

As noted previously, there may be concurrent drilling and operation of the FPSO. Both the drilling installation and FPSO produce predominantly low-frequency continuous sounds. To assist with the effects assessment, sound levels from the combined operation of a FPSO and a drilling installation were predicted. It was assumed that the FPSO and drilling installation were both located in the Core BdN Development Area. The 120 dB re 1 µPa (rms) sound level (using R_{max}) estimate for the combined sound sources was 34 km in February and 10.5 km in August (Tables 12 and 13 in Zykov 2018). Using the more representative estimate ($R_{95\%}$), the 120 dB threshold typically would be reached at 31 km and 7.2 km from the drilling installation in February and August, respectively (Tables 12 and 13 in Zykov 2018). As stated above, it is unlikely that all marine mammals, particularly odontocetes and seals, would exhibit avoidance at these distances; based on available literature avoidance is expected to be more localized.

The potential for masking of marine mammal calls and/or important environmental cues is considered limited from Equinor Canada's drilling installation given the relatively low source level and attenuation of sound to levels below measured ambient levels in the region (Matthews et al. 2018; Maxner et al. 2018). Also, some baleen and toothed whales are known to continue calling in the presence of anthropogenic sounds. Some cetaceans are also known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behaviour in response to anthropogenic sounds (e.g., Blackwell et al. 2015).

Based on the information and analysis presented above, some short-term behavioural effects are likely to occur, with some species displaced at a conservative estimate of 25 km from the drilling installation. The transient, and short-term nature of these disturbances at the location of the drilling installation for a set period of time reduces the potential for adverse effects upon marine mammals and sea turtles (individuals or populations). It is therefore unlikely that individuals will be displaced over extended areas or timeframes.

The Change in Habitat Quality and/or Use (Behavioural Effects) due to the presence of the drilling installation would be adverse, as described above, and medium-term, but individual marine mammals would likely experience effects in the short-term. Based on acoustic modelling, the geographic extent of the behavioural changes is predicted to occur within 25 km (approximately 2,000 km^2) of the drilling installation at its location in the Core BdN Development Area. Based on available information, it is likely that marine mammals will exhibit variable avoidance distances of the drilling installation. It is possible that marine mammal behavioural response to a drilling installation could be continuous but is considered reversible once the drilling installation leaves the area. The behavioural changes may be beyond natural variability but are not predicted to affect the viability of marine mammal populations in the area, and, therefore, are considered medium magnitude. Should the drilling installation and FPSO be onsite concurrently, the geographic extent may be additive, and perhaps even synergistic but would still represent a very small area within the LSA. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area, and there are data gaps associated with masking studies, therefore, there is some uncertainty regarding the magnitude of effect. Geographic extent, in this case, is based on underwater sound modelling. Modelling is a predictive tool requiring various assumptions about model inputs; therefore, there is some uncertainty regarding the zone of influence of underwater sound levels predicted by the modelling as well as the response criteria and its applicability across various marine mammal and sea turtle species. Based on these uncertainties there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in habitat quality and/or use associated with underwater sound emissions from the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Habitat Quality and/or Use (Behavioural Effects) associated with underwater sound emissions from the drilling installation during Drilling Activities are predicted to be adverse, medium in magnitude, with a geographic extent less than 10,000 km^2 (approximately 2,000 km^2), of medium-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions from the drilling installation. As noted in Section 11.2, key prey species include capelin, herring, sand lance, cod, squid, and euphausiids.

Potential effects resulting from underwater sound emissions from the drilling installation on the health, abundance, and distribution of fish and invertebrate species can have indirect effects on marine mammals and sea turtles in terms of prey availability and quality. Prey availability may be adversely affected if marine mammals and sea turtles need to travel longer distances to locate food, or if prey are distributed in a more disperse (less aggregated) manner, such that foraging efficiencies are reduced. Quality would be considered adversely affected if the health of prey species was diminished, or if the ratio of preferred to less-preferred prey items was altered. Results of the assessment presented in Chapter 9 suggest that effects from presence and operation of the drilling installation on prey species (including capelin, herring, sand lance, squid, and euphausiids) will be negligible in magnitude, and as such, indirect effects on change in prey availability and/or quality for marine mammals and sea turtles are not expected to the degree that would translate into effects on the abundance, distribution, or health of these species.

The change in prey availability and/or quality due to underwater sound emissions from the drilling installation could be adverse, as described above, and medium-term, while the drilling installation was on location. The geographic extent of the change in prey availability would be within 1 km^2 of the drilling location when at a well template location in the Core BdN Development Area. The change in prey availability would be continuous, and reversible once the drilling installation leaves the area. While underwater sound emissions may affect prey availability within a localized area of the drilling installation, the overall prey availability in the Core BdN Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is considered negligible. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above there are uncertainties associate with the foraging strategies of marine mammals and if the Core BdN Development is a foraging area, therefore there is some uncertainty regarding the magnitude of effect. Mitigations to reduce the change in habitat quality and/or use due to the presence of the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Prey Availability and/or Quality from presence of the drilling installation are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of medium-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with underwater sound emissions from Drilling Activities are not proposed

Follow-up Monitoring: In consideration of the residual effects predictions and predictions of underwater sound transmission when the FPSO and drilling installation are onsite concurrently, sound transmission through the water will be measured during concurrent drilling and production operations. Refer to Section 11.7 for additional information.

11.3.4 Supply and Servicing

Activities associated with Supply and Servicing are described in Section 2.6.4. Supply and servicing to support the Project will involve marine vessel, and aircraft transiting to, from and within the Core BdN Development Area and Project Area at all times of the year throughout the Project duration.

As described in Section 2.6.4.2, the volume of vessel traffic associated with Core BdN Development activities represents a small increase to the overall vessel traffic off eastern Newfoundland. At a maximum, when Project phases overlap, albeit for a short duration, it is estimated that up to six support vessels could supporting project activities and up to 16 vessels transits per month could occur. Of the total annual transits recorded servicing offshore oil and gas activities, these 16 transits per month (or 192 per year) represents and estimated 20 percent increase to offshore oil and gas related traffic or 12 percent of all traffic in the port of St. John's. During normal operational timeframe, when only one Project activity is occurring at any one time, for instance Production and Maintenance, up to three support vessels would be supporting the Project, representing eight transits per month. This typical level of supply and servicing traffic represents an estimated 10 percent increase in offshore oil and gas related traffic and 10 percent increase in all vessel traffic in the port of St. John's. Supply and support vessels supporting the Project will transit in a straight-line approach to and from port to the Project location, a common industry practice for energy efficiency employed for over 30 years by operators with facilities offshore NL.

With regards to helicopter support traffic, helicopters will be used for the transport of crew and supplies to and from the Project. As described in Section 2.6.4.3 up to 15 trips per week are estimated at a maximum when multiple activities are occurring such as HUC and drilling. When only production activities are ongoing, up to five helicopter transits per week are estimated. Of the total annual transits for helicopter flights servicing NL offshore oil and gas activities, at a maximum15 helicopter trips per week would represent an estimated 27 percent of annual helicopter traffic when activities are simultaneous and 11 percent of annual helicopter traffic during normal production timeframe. Note that the maximum helicopter flights would only occur for a short period of time while HUC and drilling carried out simultaneously.

The primary interaction associated with vessel presence is associated with their movement in the vessel traffic corridor and transit through the Project area to supply and support drilling and production operations. The potential interactions between Marine Mammals and Sea Turtles and vessels primarily involve behavioural effects (i.e., change in habitat quality and use) related to underwater sound and the potential for ship strikes (i.e., change injury and/or mortality level). It is possible that sound from a helicopter overflight may affect marine mammal and sea turtle behaviour.

11.3.4.1 Presence of Marine Vessels

The primary effects on Marine Mammals and Sea Turtles due to the presence of marine vessels for supply and servicing are:

- Change in Injury and/or Mortality Levels

Changes in Injury and/or Mortality Levels is a potential effect associated with presence of marine vessels for supply and servicing. Project-related vessel traffic represents a small contribution to the overall vessel traffic off eastern NL. Project-related supply vessel traffic will use established routes for the Project wherever possible. Vessels will maintain a steady course and constant speed whenever possible.

Project-related vessel traffic has the potential to result in mortality or injury of marine mammals and sea turtles from vessel strikes. Mysticetes are known to be more vulnerable to vessel strikes than odontocetes and pinnipeds (Laist et al. 2001; Jensen and Silber 2003; Vanderlaan and Taggart 2007). All six baleen whale species found in the Northwest Atlantic (and in the RSA) are documented to have been struck by ships (Jensen and Silber 2003), with fin whales being the most frequently struck followed by humpback and right whales (Laist et al. 2001; Jensen and Silber 2003; Panigada et al. 2006; Douglas et al. 2008). While it is not clear why whales are unable to avoid ship strikes, even when vessels are traveling slowly, there is evidence showing that strikes may be more likely in areas where large numbers of whales congregate to feed (Panigada et al. 2006) as well as evidence that vessel sound signatures are louder from the side and stern of the vessel than from the bow (Allen et al. 2012; McKenna et al. 2012), making detection of an approaching vessel more difficult for a whale in front of the vessel. Most lethal and severe injuries to large whales resulting from documented ship strikes have occurred when vessels were travelling at ≥14 knots (25.9 km/hour; Laist et al. 2001). Reducing vessel speed has been shown to reduce the number of marine mammal deaths and severe injuries due to vessel strikes (Vanderlaan and Taggart 2007; Vanderlaan et al. 2008, 2009; van der Hoop et al. 2012). Lethal strikes are considered infrequent at vessel speeds less than 25.9 km/hour (i.e., 14 knots) and rare at speeds less than 18.5 km/hour (i.e., 10 knots) (Laist et al. 2001).

The International Whaling Commission (IWC) maintains a global ship strike database that contained almost 1,200 verified incidents as of 2016 (Van Waerebeek and Leaper 2007; Ritter and Panigada 2016). In 2017, the IWC released its Strategic Plan to Mitigate the Impact of Ship Strikes on Cetacean Populations (Cates et al. 2017). The Plan advocates reducing the spatial overlap between high numbers of whales and vessels as the best means to mitigate ship strikes, with vessel speed restrictions as an alternate strategy in areas where spatial separation is not possible.

In their most recent five-year (2011 to 2015) baleen whale serious injury and mortality determinations, NOAA Fisheries reported an average of six large whale mortalities per year resulting from ship strikes along the east coast of North America, and another seven ship strikes in the region resulting in injury (either serious or non-serious) to the whale (Henry et al. 2017). The actual number of ship strike mortalities is likely greater due to underreporting, the impossibility of recovering all carcasses, and the difficulty in determining cause of death in many cases. NOAA Fisheries reported that, on average, there were approximately 41 large whale mortalities per year during 2011 to 2015 but did not have sufficient information to determine cause of death (Henry et al. 2017).

There is potential for Project vessels to strike sea turtles resulting in injury or mortality. Propeller and collision injuries from boats and ships are common in sea turtles, at least in U.S. waters (NMFS 2008). In Australia, Hazel et al. (2007) demonstrated that the proportion of green sea turtles maneuvering to avoid a vessel decreased with increased vessel speed suggesting that turtles may not avoid faster moving vessels.

Unlike the Gulf of St. Lawrence, where recent increases in North Atlantic right whale occurrences have resulted in vessel speed restrictions in certain areas and time of year, the offshore NL area does not have prescribed speed limits or shipping lanes. North Atlantic right whales have not been reported along the vessel traffic route or in the Project Area. The speed of offshore supply vessels (OSVs) for the Project is set based on environmental conditions (e.g., wind, waves) distances and fuel efficiency, and will follow operational best practices for the area. Although there are no known concentration areas for marine mammals along the vessel traffic route to the Project Area, it is possible that groups of foraging marine mammals (such as humpback whales) may be encountered along the route during summer months. Sea turtles are considered rare along the vessel traffic route and in the Project Area. Since 2002, there have been two reports of supply vessels striking a whale at night on the Grand Banks; however, the whales were not re-sighted to allow confirmation of the incidents and such ship strikes are considered rare (Lawson, J., pers. comm., June 2018).

The change in Injury and/or Mortality Levels from vessels engaged in supply and servicing could be adverse, as described above, and long-term but is not likely to occur. The geographic extent of the change in injury and/or mortality would occur within 1 km^2 of the vessel. The change in risk of increased injury/mortality from Project vessels would be reversible once the vessel leaves the area. In consideration of the variation in population size from other known sources of mortality, the change in Injury and/or Mortality would be considered within the range of natural variability but does not affect the viability of the marine mammal population and is therefore considered low magnitude. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. There is some uncertainty in the frequency of effects due to the limited data regarding the occurrence of ship strikes data offshore NL.

Consistent with International Regulations for Preventing Collisions at Sea, 1972 with Canadian Modifications, Rule 5, every vessel shall maintain a proper lookout at all times. Project vessels will alter course and/or reduce speed if a marine mammal(s) (or sea turtle) is detected ahead of the vessel. If Equinor Canada is aware of a Project vessel striking a marine mammal or sea turtle, then Equinor Canada will inform DFO through their 24-hour emergency contact number (1-888-895-3003).

In summary, with the application of mitigation measures, the residual environmental effects of Change in Injury and/or Mortality Levels associated with marine vessels engaged in Supply and Servicing are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km^2, of long-term duration, not likely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the presence of vessels engaged in Supply and Servicing include use of common traffic route (F); vessels will alter course and/or reduce speed if a marine mammals or sea turtle is detected when vessel watch is occurring (J); Equinor Canada will notify DFO if a project vessel strikes a marine mammal or sea turtle (M).

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated the presence of vessels engaged in Supply and Servicing in consideration of the residual effects predictions.

11.3.4.2 Underwater Sound Emissions from Vessels

The primary effects on Marine Mammals and Sea Turtles due to the underwater sound emissions from marine vessels engaged in supply and servicing are:

- Change in Habitat Quality and/or Use (Behavioural Effects)
- Change in Prey Availability and/or Quality

Changes in Habitat Quality and/or Use (Behavioural effects) is a potential effect associated with underwater sound emissions from vessels engaged in supply and servicing.

Effects would be similar to underwater sound emissions described above for vessels engaged in construction and installation and HUC activities, except that supply and support vessels will be transiting to the FPSO and/or drilling installation. The stand-by vessel (SBV) would remain on site near the FPSO and/or drilling installation. Marine mammals may exhibit changes in behaviour and there is potential for masking from the continuous sound produced by vessels. As reviewed in Section 11.3.2, exposure to vessel sounds is not expected to result in PTS (i.e., injury; Richardson et al. 1995).

Marine mammal responses to vessels are variable and range from avoidance at long distances to little or no response or approach (Richardson et al. 1995). Responses depend on the speed, size, and direction of travel of the vessel relative to the marine mammal; slow approaches tend to elicit fewer responses than fast, erratic approaches (Richardson et al. 1995). Seals often show considerable tolerance to vessels but can also show signs of displacement in response to vessel traffic. Toothed whales sometimes show no avoidance reactions and occasionally approach vessels (e.g., northern bottlenose whales and delphinids, which are found in the Project Area); however, some species are displaced by vessels. Baleen whales often interrupt their normal behaviour and swim rapidly away from vessels that have strong or rapidly changing sound, especially when a vessel heads directly towards a whale. Stationary vessels or slow-moving, “non-aggressive” vessels typically elicit little response from baleen whales.

Ship sound, through masking, can also reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Richardson et al. 1995; Clark et al. 2009; Jensen et al.

2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014; Erbe et al. 2016; Jones et al. 2017; Putland et al. 2017). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (e.g., Branstetter et al. 2013, 2016; Finneran and Branstetter 2013). Sound could also be a potential source of stress for marine mammals (e.g., Wright et al. 2011; Atkinson et al. 2015).

As discussed in Section 11.1.5.1, marine mammals exhibit varying behavioural effects to underwater sound from vessels. Off the coast of New England, fin whales had shorter surfacing and dive times when whale-watch and other vessels were nearby (Stone et al. 1992). Watkins (1981) and Watkins et al. (1981) noted that fin whales showed little response to slowly moving vessels but avoided boats that altered course or speed quickly. During marine mammal monitoring from a high-speed, catamaran car ferry transiting the Bay of Fundy during the summers of 1998 to 2002, the majority of baleen whales (including fin, humpback and minke whales) sighted from the ferry appeared to exhibit avoidance behaviour including heading away, changing heading, or diving (Dufault and Davis 2003). Fin whale sightings in the western Mediterranean were negatively correlated with the number of vessels in the area (Campana et al. 2015). Fin and blue whales in the St. Lawrence estuary either moved away from ships or remained near a vessel but changed direction or dove; the most marked reactions occurred when vessels approached quickly or erratically (Edds and Macfarlane 1987). Fin whales and blue whales have been shown to increase the source levels of their calls, shift their peak frequencies, or otherwise change their vocal behaviour in the presence of elevated sound levels such as from shipping (e.g., McKenna 2011; Castellote et al. 2012; Melcón et al. 2012). Physical presence of vessels, not just ship sound, has also been shown to disturb the foraging activity of blue whales (Lesage et al. 2017). McKenna et al. (2015) noted a dive response by blue whales when a vessel approached, but no lateral avoidance, which could lead to an increase in collision risk.

There are few systematic studies on sea turtle reactions to ships and boats, but it is thought that response would be minimal relative to responses to seismic sound. Hazel et al. (2007) evaluated behavioural responses of green turtles to a research vessel approaching at slow, moderate, or fast speeds (4 km/h, 11 km/h, and 19 km/h, respectively). Proportionately fewer turtles fled from the approaching vessel as speed increased, and turtles that fled from moderate to fast approaches did so at significantly shorter distances from the vessel than those that fled from slow approaches. The authors concluded that sea turtles cannot be relied on to avoid vessels with speeds greater than 4 km/h. However, studies were conducted in a 6 m aluminum boat powered by an outboard engine, which would presumably be more challenging for a sea turtle to detect than seismic or support vessels. Lester et al. (2013) reported variable behavioural responses of semi-aquatic turtles to boat sounds.

Behavioural effects due to underwater sound from vessels engaged in supply and servicing would be adverse, as described above, and may occur sporadically to regularly over the long-term due to the presence of the SBV at the Core BdN Development Area. The geographic extent of the behavioural changes is predicted to range between 1-10 km^2 to 100-1,000 km^2 from the vessel position within the Core BdN Development Area and along the transit route. This range in geographic extent predictions is attributable to the variable avoidance distances marine mammals exhibit in response to vessels. The change in habitat quality and/or use is considered within the range of natural variability of marine mammal movements in the larger Core BdN Development Area, with no associated adverse effect on the viability of the affected populations and, therefore, of low magnitude. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. There is some uncertainty regarding the magnitude of effect as data are limited regarding marine mammals occurrence in the Core BdN Development Area. Mitigations to reduce behavioural effects are not proposed.

In summary, the residual environmental effects of a Change Habitat Quality and/or Use (Behavioural Effects) associated with the underwater sound emissions from vessels engaged in Supply and Servicing are predicted to be adverse, low in magnitude, with a geographic extent ranging from 1 km^2-10 km^2 to 100 km^2-1,000 km^2, of short- to long-term duration, occurring sporadically to regularly and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions from vessels engaged in Supply and Servicing. Effects would be the same as discussed in Section 11.3.1.1.

The effects assessment of underwater sound from vessels engaged in Supply and Servicing on fish species (Section 9.3.4.2) predicts that behavioural effects would be adverse, localized (less than 1 km2) to vessel, negligible in magnitude, as fish would be available in the larger Core BdN Development Area and short-term. Therefore, similar predictions can be made for effects of underwater sound from vessels on prey availability for marine mammals and sea turtles.

The change in prey availability and/or quality due to sound emissions from vessels engaged Supply and Servicing are predicted to be adverse, as described in Section 9.3.4.2 and long-term in duration due to the presence of the SBV. The geographic extent of the change in prey availability and/or quality would be less than1 km^2 of the vessels. The change in prey availability could be sporadic when vessels are transiting and continuous when the SBV is on site and is considered reversible once the vessel leaves the area. While prey species may avoid the around the vessel, the overall availability of prey species in the Core BdN Development Area and along the vessel traffic route would not be affected, and therefore the magnitude of the effect is considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in prey availability associated with underwater sound emissions from vessels are not proposed.

In summary, the residual environmental effects of a Change in Prey Availability and/or Quality associated with the presence of vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, occurring sporadically to continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with underwater sound emissions from vessels engaged in Supply and Servicing are not proposed

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated with underwater sound emissions from vessels engaged in Supply and Servicing in consideration of the residual effects predictions.

11.3.4.3 Aircraft (Helicopters)

The primary effects on Marine Mammals and Sea Turtles due to the presence of helicopters for supply and servicing are:

- Change in Habitat Quality and/or Use (Behavioural Effect)

Helicopters will operate out of the St. John's International Airport and will be used for crew transfers and other purposes as required. As noted in above, there could be up to 15 flights per week when HUC activities and drilling occur simultaneously and approximately 5 flights per week during normal production. Flights will use existing and common routes wherever possible. Per regulatory requirements, standard altitude profiles are between approximately 610 metres (m) (or 2,000 feet) and 2,743 m (or 9,000 feet), with an odd number altitude being flown on the eastbound flight, and an even number altitude being flown on the westbound flight for separation purposes. During the approach phase to an offshore installation, the helicopter is typically only below 152 m (or 500 feet) for three to six minutes, or approximately 2 percent of a total round-trip flight, assuming the flight is 4.5 hours. Onshore approaches to the St. John's International Airport are flown at the same approach points and altitudes as commercial air traffic.

Changes in Habitat Quality and/or Use (Behavioural Effects) is a potential effect on Marine Mammals and Sea Turtles associated with presence of helicopters for supply and servicing.

Sounds produced by helicopters are primarily related to rotor and propeller blade revolutions, with frequencies mainly below 500 Hz (Richardson et al. 1995). Transmission of sound produced by helicopters into the marine environment is related primarily to the aircraft altitude and sea surface conditions (Richardson et al. 1995). Underwater sound from helicopters is generally stronger just below the water surface and directly beneath the aircraft, with sounds attenuating over shorter distances than airborne sounds (Richardson et al. 1995).

Available information indicates that single or occasional aircraft overflights will cause no more than brief behavioural responses in baleen whales, toothed whales and seals (summarized in Richardson et al. 1995). As noted earlier, if data on species which commonly occur in the Project Area are lacking, then information from other marine mammal species is used as a proxy. In a study in the Beaufort Sea, the majority of behavioural responses elicited in beluga whales and bowhead whales by an overhead helicopter occurred when the helicopter flew at altitudes below 150 m and at lateral distances less than 250 m (Patenaude et al. 2002). The degree of sensitivity of cetaceans to sounds produced by aircrafts can depend on their state of activity at the time of exposure; individuals in a resting state (as opposed to foraging, socializing, or travelling) seem to demonstrate the highest sensitivity to such disturbances (Würsig et al. 1998; Luksenburg and Parsons 2009). Cetaceans most commonly respond to sounds produced by overhead aircrafts by diving (Luksenburg and Parsons 2009). Other behavioural responses include short surfacing periods, changes in state of activity, and breaching (Luksenburg and Parsons 2009).

There are no systematic data on sea turtle reactions to helicopter overflights. Given the hearing sensitivities of sea turtles, they can likely hear helicopters, at least when the helicopters are at lower altitudes and the turtles are in relatively shallow waters. It is unknown how sea turtles would respond, but single or occasional overflights by helicopters would likely only elicit a brief behavioural response.

Based on current practices regarding flying altitude as noted above, responses of marine mammals and sea turtles to these helicopter flights are expected to be brief and low in magnitude.

The change in Habitat Quality and/and or Use (Behavioural Effects) associated with the presence of helicopters during Supply and Servicing would be adverse as described above, and short-term. The geographic extent of the change would be less than 1 km^2 from the helicopter. The change would be sporadic as helicopter traffic would be intermittent, and reversible once the helicopter leaves the area. The behavioural changes would be low in magnitude as the change in behaviour would be considered within the range of natural variability for marine mammals without affecting the population. These predictions are made with a high level of confidence based on scientific literature, and the experience and professional judgement of the EIS Team. Mitigations such as avoidance of low-level flight operations and use of a common traffic route will reduce potential effects.

In summary, the residual environmental effects of Change in Habitat Quality and/or Use (Behavioural Effects) associated with the presence of helicopters during Supply and Servicing are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km^2, short-term in duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the helicopters engaged in Supply and Servicing include use of common traffic route (F); low-level aircraft operations will be limited or avoided where it is not required per Transport Canada protocols (G).

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated with the presence of helicopters engaged in Supply and Servicing in consideration of the residual effects predictions.

11.3.5 Supporting Surveys

As described in Section 2.6.5, throughout the Project, surveys may be required to support all Project activities. These surveys include geophysical surveys (e.g., 2D/3D/4D seismic, VSP, wellsite geohazard), geotechnical and/or geological surveys, environmental surveys, and ROV/AUV/video surveys.

Geohazard/wellsite surveys typically take between five and 21 days to complete, but the overall duration can be shorter or longer depending on the data requirements and weather /operational delays. They may involve the use of seismic sound sources, multibeam echosounder (MBES), sidescan sonar (SSS), synthetic aperture sonar (SAS) subbottom profiler (SBP), video and other non-invasive equipment. The equipment is deployed either as hull-mounted equipment, on a towfish or on ROV / AUVs. Equipment may be autonomous, towed by the vessel or hull-mounted. These surveys may occur at any time of the year over the temporal scope of the Project.

Geophysical surveys that may occur over the life of the Project and include 2D/3D/4D seismic surveys or VSP surveys. Any required survey will take place within the Project Area. As noted in Section 2.6.5, 2D seismic surveys are not anticipated. For 3D/4D surveys, multiple sound source arrays can be used, and the vessel could tow between eight and 16 streamers containing hydrophones, also called conventional seismic surveys. Another option for 4D surveys is to place the hydrophones on the seabed, in either nodes or cables. If nodes/cables are used and installed on the seafloor it is called ‘permanent reservoir monitoring’; the nodes/cables are removed at the end of the Project. The Project is considering permanent reservoir monitoring or conventional seismic. Permanent reservoir monitoring is estimated to take approximately two weeks to complete and could be carried out twice per year. Conventional seismic surveys could be between two and four weeks and occur as frequently as once per year in early Project life, with reduced frequency in later years. If permanent reservoir monitoring is chosen, the area occupied on the seabed by the installed OBC/OBN could be approximately 150 km^2. Timing and duration of these seismic surveys are estimated and will be finalized during Project design.

VSP is a tool used to further define the depth of geological features and potential petroleum reserves by obtaining high resolution images of the target. As stated in Section 2.6.5, it is estimated that one to two VSP surveys could be carried out for the Core BdN Development Area. VSP is conducted in a vertical wellbore using hydrophones inside the wellbore and a sound source near the surface at or near the well; a VSP is quieter and more localized than a surface geophysical survey, being smaller in size and volume. A VSP usually taking less than 48 hours per well to complete. VSP surveys may be carried out at any time of the year.

Environmental surveys are conducted to collect samples to analyze the physical, chemical, and biological aspects of an area. Sampling is typically carried out from a support / supply vessel or a dedicated vessel suitable to the survey. Environmental surveys may occur throughout Project life at any time of the year using vessels of opportunity associated with the Project, typically taking between five to 21 days to complete.

Geotechnical or geotechnical surveys measure the physical properties of the seabed and subsoil through the collection of sediment samples and in-situ testing. Geotechnical surveys may occur throughout the Project life at any time of the year, using dedicated vessels provided by marine geotechnical specialist suppliers.

ROV or AUV surveys are used to conduct visual inspections (camera equipped) of seafloor, facilities and/or carry out repairs of subsea equipment. They may also be used during any or all of the surveys described above. They will be conducted throughout the Project-life at any time of the year using vessels of opportunity associated with the Project.

As noted in Table 11.3, the primary interactions associated with Supporting Surveys are related to underwater sound emissions from geophysical air source arrays. The potential interactions associated with the presence of the vessels conducting supporting surveys would be the same as those assessed in Section 11.2.4 and are summarized below. While there is an interaction of underwater sound emissions from vessels engaged in supporting surveys, the focus of the assessment is on the effects of underwater sound emissions from the air source arrays used in geophysical surveys, which is the interaction with the greatest potential to have environmental effects.

11.3.5.1 Presence of Vessels

The primary effects on Marine Mammals and Sea Turtles due to presence of vessels engaged in supporting survey activities are:

- Change in Injury and/or Mortality Levels

Changes in Injury and/or Mortality Levels is a potential effect associated with presence of marine vessels engaged in survey activities. As noted above, these effects are the same as those discussed in Section 11.3.4.1. Given that vessels engaged in geophysical surveys will travel at slower speeds compared to vessels in transit, the potential for ship strikes would be lower.

In summary, with the application of mitigation measures, the residual environmental effects of Change Injury and/or Mortality Levels associated with the presence of vessels engaged in Supporting Surveys are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km^2, of long-term duration, not likely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the presence of vessels engaged in Supporting Surveys include notification of DFO if a project vessel strikes a marine mammal or sea turtle (M).

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated the presence of vessels engaged in Supply and Servicing in consideration of the residual effects predictions.

11.3.5.2 Underwater Sound Emissions from Vessels

The primary effects on Marine Mammals and Sea Turtles due to the underwater sound emissions from marine vessels engaged in Supporting Surveys are:

- Change in Habitat Quality and/or Use (Behavioural Effects)
- Change in Prey Availability and/or Quality

As noted above, these effects are the same as those discussed in Section 11.3.4.2, with the exception that supporting surveys are of short-duration.

In summary, the residual environmental effects of a **Change in Habitat Quality and/or Use (Behavioural Effects)** from presence of marine vessels engaged in Supporting Surveys are predicted to be adverse, low in magnitude, with a geographic extent ranging from 1-10 km^2 to 100-1,000 km^2, of short-term duration, occurring sporadically to regularly, and reversible. These predictions are made with a moderate to high level of confidence.

In summary, the residual environmental effects of a **Change in Prey Availability and/or Quality** associated with the presence of vessels engaged in Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of short-term duration, occurring sporadically to continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the vessels engaged in Supporting Surveys are not proposed.

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated with the presence vessels engaged in Supporting Surveys in consideration of the residual effects predictions.

11.3.5.3 Underwater Sound Emissions from Geophysical Survey Equipment

- The primary effects on Marine Mammals and Sea Turtles due to underwater sound from geophysical activities are:
- Change in Injury and/or Mortality Levels
- Change in Habitat Quality and/or Use (Behavioural Effects)
- Change in Availability and/or Quality of Prey

The potential effects of seismic surveys on marine mammals and sea turtles have previously been reviewed in the in the Southern and Eastern Newfoundland SEAs (C-NLOPB 2010, 2014), previous EAs for seismic programs offshore NL (e.g., LGL 2014, 2015a,b), and literature reviews (e.g., Richardson et al. 1995; Gordon et al. 2004; Stone and Tasker 2006; Nowacek et al. 2007; Southall et al. 2007; Abgrall et al. 2008; Gomez et al. 2016). This information is summarized here with updated information from newly available literature included as appropriate. Potential effects from geophysical surveys on toothed whales, baleen whales, seals, and sea turtles are discussed separately given their different hearing abilities and sensitivities to sound. The effects assessment considers each of the types of geophysical activities separately – 2D/3D/4D Seismic Surveys; VSPs; and Geohazard/Wellsite Surveys.

Mitigations to be employed during geophysical activities, which are intended to reduce effects on marine mammals and sea turtles include:

- Mitigations listed in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) (DFO 2007). This includes implementing shut downs of the air source array(s) when SAR listed as Endangered or Threatened on Schedule 1 of SARA (as well as all beaked whale species) are detected within the safety zone during anytime air sources are active, including ramp up.
- Shut-down of air source arrays for all beaked whales when detected within safety zone
- Equinor Canada will communicate seismic survey plans to C-NLOPB and geophysical operators as early as possible to reduce concurrent seismic surveys and/or to maximize the separation distance between surveys to the extent possible.

2D/3D/4D Surveys

Changes in Habitat Quality and/or Use (Behavioural effects) is a potential effect associated with sound produced by geophysical activities. The main mechanisms for this are auditory disturbance and masking of sounds.

Disturbance effects:

Baleen whales generally tend to avoid operating air sources, but avoidance radii are quite variable (see Appendix 4 of LGL 2015a for details). Whales are often reported to show no overt reactions to pulses from large arrays of air sources at distances beyond a few kilometers, even though the air source pulses remain well above ambient sound levels out to much longer distances. However, baleen whales exposed to strong sound pulses from air sources often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behaviour appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995). Stone (2015) examined data from 1,196 seismic surveys in the United Kingdom (UK) and adjacent waters and reported statistically significant responses to air source arrays of 500 in^3 or more in volume for minke and fin whales (both of these species regularly occur in the Project Area). This included lateral displacement, change in swimming or surfacing behaviour, and indications that cetaceans remained near the water surface. Studies examining the behavioural response of humpback whales to airsource arrays off eastern Australia have also been conducted (Cato et al. 2011, 2012, 2013, 2016), although results are not yet available for all studies. Dunlop et al. (2015) reported that humpback whales responded to a vessel operating a 20 in^3 airsource array by decreasing their dive time and speed of southward migration; however, the same responses were obtained during control trials without an active airsource array, suggesting that humpbacks responded to the source vessel rather than the airsource array. A ramp up was not superior to triggering humpbacks to move away from the vessel compared with a constant source at a higher level of 140 in^3, although an increase in distance from the airsource array was noted for both sources (Dunlop et al. 2016a). Avoidance was also shown when no airsources were operational, indicating that the presence of the vessel itself had an effect on the response (Dunlop et al. 2016 a, b, c). Responses to ramp up and use of a 3130 in^3 array elicited greater behavioural changes in humpbacks when compared with small arrays (Dunlop et al. 2016c). Overall, the results showed that humpbacks were more likely to avoid active airsource arrays (of 20 and 140 in^3) within 3 km and at received levels of at least 140 dB re 1 $\mu Pa^2 \cdot s$ (Dunlop et al. 2017). These results are consistent with earlier studies of humpback whales in Australia (e.g., McCauley et al. 2000). Matos (2015) reported no change in sighting rates of minke whales in Vestfjorden, Norway during ongoing seismic surveys outside of the fjord. Similarly, no large changes in grey whale movement, respiration, or distribution patterns were observed during a 4D seismic survey off Sakahlin Island, Russia (Bröker et al. 2015; Gailey et al. 2016). Although sighting distances of gray whales from shore increased slightly during a two-week seismic survey, this result was not statistically significant (Muir et al. 2015). However, there may have been a possible avoidance response to high sound levels in the area (Muir et al. 2016). Vilela et al. (2016) cautioned that environmental conditions should be taken into account when comparing sighting rates during seismic surveys, given that spatial modeling showed that differences in sighting rates of rorquals (fin and minke whales) during seismic periods and non-seismic periods during a survey in the Gulf of Cadiz could be explained by environmental variables.

Little systematic information is available on reactions of odontocetes to sound pulses. However, there are systematic studies on sperm whales (which are considered common in the Project Area), and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (see Appendix 4 of LGL 2015a for details). Seismic operators and marine mammal observers (MMOs) on seismic vessels regularly see dolphins and other small toothed whales near operating air source arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels. In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance. The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels (Miller et al. 2005). Captive bottlenose dolphins and beluga whales exhibited changes in behaviour when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviours (e.g., Finneran et al. 2000, 2002, 2005).

As highlighted above, odontocete reactions to large arrays of air sources are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive mysticetes and some other odontocetes. Small and medium-sized odontocetes, including beaked whales, showed a significant response (e.g., lateral displacement, localized avoidance, or change in behaviour) to large air source arrays of 500 in^3 or more in volume, with the exception of Risso’s dolphin (Stone 2015). When investigating the auditory effects of multiple underwater impulses on bottlenose dolphins, Finneran et al. (2015) reported that at the highest exposure condition (peak sound pressure levels from 196 to 210 dB re 1 µPa), two of three dolphins tested exhibited anticipatory behavioural reactions to impulse sounds presented at fixed time intervals. Preliminary data from the Gulf of Mexico showed a correlation between reduced sperm whale acoustic activity during periods with air source operations (Sidorovskaia et al. 2014). Thompson et al. (2013) reported decreased densities and reduced acoustic detections of harbour porpoise in response to a seismic survey in Moray Firth, Scotland, at ranges of 5 km to 10 km. Nonetheless, animals returned to the area within a few hours (Thompson et al. 2013).

Pinnipeds tend to be less responsive to air source sounds than many cetaceans and are not likely to show a strong avoidance reaction to the air source array (see Appendix 4 of LGL 2015a for details). Visual monitoring from seismic vessels typically has shown only slight (if any) avoidance of air sources by pinnipeds, and only slight (if any) changes in behaviour. Stone (2015) found that grey seals were displaced by large air source arrays of 500 in^3 or more in volume as indicated by the lower detection rate during periods of seismic activity. Lalas and McConnell (2015) made observations of New Zealand fur seals from a seismic vessel operating a 3,090 in^3 air source array in New Zealand during 2009. The results from the study were inconclusive in showing whether New Zealand fur seals respond to seismic sounds. When Reichmuth et al. (2016) exposed captive spotted and ringed seals to single air source pulses, only mild behavioural responses were observed.

Sea turtles can hear low-frequency sounds, particularly those with high energy levels such as air source pulses. However, there does not appear to be measurements of the absolute hearing thresholds of any sea turtle to waterborne sounds. Given the high source levels of air source pulses and the substantial received levels even at distances many kilometers away from the source, it is probable that sea turtles can also hear the sound source output from distant seismic vessels (see Appendix 4 of LGL 2015a). However, in the absence of relevant absolute threshold data, it is not possible to estimate the distance from which an air source array or other sound source might be audible to a sea turtle. Based on available data, it is likely that sea turtles would exhibit behavioural changes and/or localized avoidance near a seismic vessel (see Appendix 5 of LGL 2015a for details). To the extent that there are any impacts on sea turtles, seismic operations in or near areas where turtles concentrate are likely to have the greatest impact. Nelms et al. (2016) suggested that sea turtles could be excluded from critical habitats. There are no specific data that demonstrate the consequences to sea turtles if seismic operations with large or small arrays of air sources occur in important areas at biologically important times of year. However, turtles are considered rare in the LSA and no critical habitat has been designated in the LSA or RSA.

As summarized above, available information demonstrates that marine mammals and sea turtles exhibit variable behavioural responses to air source sounds; however, avoidance responses are typically localized and temporary. Based on acoustic modelling results of a representative air source array (5085 in^3), the NMFS recommended behavioural response criteria of 160 dB re 1 μPa (rms) for impulsive sounds are predicted to be exceeded at maximum distances ranging from 9.3 km (August) to 20.1 km (February) (Table 11.6). These are conservative distance estimates using R_{max} values. Using the more representative estimate ($R_{95\%}$), the 160 dB threshold typically would be reached at 7.5 km and 15.4 km from the air source array in August and February, respectively. Acoustic modelling results were similar at the survey location in the Core BdN Development Area (i.e., Site 1) and in the western portion of the Project Area (i.e., Site 2), which is in shallower water depths. The presence of a sound surface channel during the winter period results in increased sound propagation and as such, ranges to the 160 dB threshold in winter (February) were approximately double the estimated values in summer (August). If geophysical surveys are conducted during the summer period when the sound speed profile in the Project Area features a high negative velocity gradient at the top, which refracts the acoustic wave towards the bottom and prevents it from being trapped in the acoustic channel, sound propagation will be reduced. This would reduce potential behavioural responses of marine mammals and sea turtles at longer ranges. Based on available information, it is unlikely that all marine mammals, particularly dolphins and seals, would avoid a seismic survey at the estimated 160 dB threshold distances. Marine mammals, including baleen and beaked whales (i.e., northern bottlenose whales), have been regularly observed within one to two km of active air source arrays either on the Grand Banks or in deeper waters in and near the Project Area (e.g., Moulton and Holst 2010; Beland and Penney-Belbin 2014). Also, as described in the sound modelling report (Zykov 2018 in Appendix D), sound from the air source array is expected to be “bounded” by the continental shelf, west of the site. More specifically, sounds that reach the continental shelf (i.e., water depths of 100 m to 300 m), west of the Project Area, are predicted to have higher transmission loss. Baleen whales (i.e., humpback, fin, and minke whales), which are typically more abundant on the continental shelf would, therefore, be exposed to much lower sound levels in shelf waters from the air source array in the Project Area. It is unlikely marine mammals in shelf waters would be affected by seismic surveys in the Project Area. Based on modelling, behavioural changes associated with underwater sound from a seismic survey in the Project Area are expected to occur within approximately 15 km (i.e., <1,000 km^2) of the sound source. However, marine mammals are regularly observed within one to two km of active seismic vessels offshore Newfoundland (e.g., Moulton and Holst 2010). Sea turtles, considered rare in the Project Area, would also be expected to exhibit localized avoidance. Behavioural responses are considered to be short-term and are not predicted to extend beyond the duration of the seismic survey. The behavioural changes are predicted to be medium magnitude as the changes are beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population.

Table 11.6 Summary of Acoustic Modelling Results for the 5085 in^3 Air Source Array

Acoustic Threshold	Site 1		Site 2	
	February	August	February	August
Behaviour				
All marine mammals				
160 dB SPL rms (R_{max} value)	20.1 km	10.7 km	20.1 km	9.3 km
160 dB SPL rms ($R_{95\%}$ value)	15.4 km	8.5 km	16.0 km	7.5 km
PTS Onset				
Low-frequency cetaceans				
219 dB SPL peak	< 40 m	< 40 m	< 40 m	< 40 m
183 dB SEL cum	131 m	131 m	161 m	151 m
Mid-frequency cetaceans				
230 dB SPL peak	< 40 m	< 40 m	< 40 m	< 40 m
185 dB SEL cum	< 40 m	< 40 m	< 40 m	< 40 m
High-frequency cetaceans				
202 dB SPL peak	179 m	189 m	179 m	189 m
155 dB SEL cum	< 40 m	< 40 m	< 40 m	< 40 m
Phocids (underwater)				
218 dB SPL peak	< 40 m	< 40 m	< 40 m	< 40 m
185 dB SEL cum	< 40 m	< 40 m	< 40 m	< 40 m

Notes:
dB (decibel) SPL rms and SPL peak have a reference value of 1 µPa
dB SEL cum has a reference value of 1 µPa^{2}s
Site 1 is located within the Core BdN Development Area
Site 2 is located within the Project Area, to the west of the Core BdN Development Area

Masking Effects

Masking is the obscuring of sounds of interest by interfering sounds, generally at similar frequencies. Masking can occur if the frequency of the source is close to that used as a signal by the marine mammal and if the anthropogenic sound is present for a significant fraction of time (Richardson et al. 1995; Clark et al. 2009). Conversely, masking is not expected if little or no overlap occurs between the introduced sound and the frequencies used by the species or if the introduced sound is infrequent. Masking effects of pulsed sounds (even from large arrays of air sources) on marine mammal calls and other natural sounds are expected to be limited, although there are few specific data (see Appendix 4 of LGL 2015a for details). Because of the intermittent nature and low duty cycle of seismic pulses, marine mammals and sea turtles can receive and emit (in the case of marine mammals) sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are considered infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between air source pulses (e.g., Gedamke 2011; Guerra et al. 2011, 2016), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree.

Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses. In addition, some cetaceans are known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behaviour in response to air source sounds (e.g., Blackwell et al. 2015; Erbe et al. 2016). The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small odontocetes that have been studied directly. The sounds important to toothed whales and pinnipeds are predominantly at much higher frequencies than are the dominant components of air source sounds, thus limiting the potential for masking.

Guerra et al. (2016) reported that ambient sound levels between seismic pulses were elevated as a result of reverberation at ranges of 50 km from the seismic source. Guan et al. (2015) indicated that, in very shallow water environments (<15 m), the air source inter-pulse sound field can exceed ambient sound levels by as much as 9 dB during relatively quiet conditions. The inter-pulse sound levels can also be related to the distance to the source, probably as a result of higher reverberant conditions in shallow water. Based on preliminary modeling, Wittekind et al. (2016) reported that air source sounds could reduce the communication range of blue and fin whales occurring 2,000 km from a seismic source.

The degree to which reverberation will contribute to potential masking for marine mammals in and near the deep-water Project Area is uncertain. A desktop analysis of seismic reverberation at the southern end of Flemish Pass indicated that the “listening space” of mysticetes is reduced by 90 percent for at least half of the inter-pulse period (i.e., 12-seconds) when a seismic vessel is within 15 km of a whale (Maxner et al. 2018). Beyond 15 km, the “listening space” is reduced for 1 to 2 seconds in most cases. Relative to low-frequency vocalizations of mysticetes, the analysis indicated that masking of odontocete clicks and whistles did not occur during the seismic survey. It should be noted that the analysis did not take into consideration that marine mammals have mechanisms that enhance the detectability of signals in the presence of sound including spatial release, comodulation masking release, as well as the within valley (or “dip”) listening strategy (see Erbe et al. 2016 for a review). Also, marine mammals may change the characteristics of their vocalizations in the presence of sound as an anti-masking strategy as summarized above.

It is possible that at least for some mysticetes in deep-water near the Project Area, that masking of sounds may occur during seismic surveys, at least in areas proximate to the sound source. Any masking effects are considered adverse and short-term as they are not predicted to extend beyond the duration of the seismic survey (approximately two to four weeks). It is difficult to predict with any degree of certainty the geographic extent of potential masking effects given the numerous data gaps associated with this topic. It is assumed that the range of masking effects is within the range predicted for behavioural responses.

Overall, behavioural effects associated with underwater sound emissions from equipment used in geophysical surveys would be adverse, as described above, and short-term. Effects may occur continuously while the survey is active but reversible once the survey is completed. The geographic extent of the behavioural changes are predicated to range between 1-10 km^2 to 100-1,000 km^2 from the sound source, based on sound modelling. This range in geographic extent predictions is attributable to the variable avoidance distances marine mammals exhibit in response to underwater sound. Behavioural changes are predicted be medium magnitude as the short-term changes are beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development Area, including the important times of the year, and there are data gaps associate with masking studies, therefore, there is some uncertainty regarding the magnitude of effect. Geographic extent, in this case, is based on underwater sound modelling. Modelling is a predictive tool requiring various assumptions about model inputs; therefore, there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling as well as the response criteria and its applicability across various marine mammal and sea turtle species. Based on these uncertainties there is a moderate level of confidence in the prediction of geographic extent. Mitigation measures noted above may reduce overall effects on marine mammal behaviour.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Quality and/or Use (Behavioural Effects) associated with underwater sound during geophysical activities are predicted to be adverse, medium in magnitude, with a geographic extent ranging from 10 km^2 - 100 km^2 to 100 km^2 - 1,000 km^2, of short-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Injury and/or Mortality Levels is a potential effect associated with underwater sound emissions produced by geophysical activities. The primary mechanism of this is auditory injury and hearing impairment.

Non-auditory physiological effects (see Appendix 4 of LGL 2015a) may also occur in marine mammals and sea turtles exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur include stress (e.g., Lyamin et al. 2016), neurological effects, and organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals or sea turtles in close proximity to large arrays of air sources. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. Marine mammals that show behavioural avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, as well as sea turtles, are especially unlikely to incur non-auditory physical effects. Nonetheless, 10 cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings (Castellote and Llorens 2016). The brief duration of exposure of any given animal and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals and sea turtles to sounds strong enough to induce non-auditory physical effects. Non-auditory physical effects related to sound exposure are not considered further in this assessment.

Auditory Injury and Hearing Impairment

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds (see Appendix 4 of LGL 2015a for details) like those from air source arrays. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds (reviewed in Southall et al. 2007). There is no specific evidence that exposure to pulses of air source sound can cause PTS in any marine mammal, even with large arrays of air sources. However, given the likelihood that some mammals (e.g., harbour porpoise and seals) close to an air source array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to air sources might incur PTS (e.g., Richardson et al. 1995; Gedamke et al. 2011). Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS (e.g., Kastak and Reichmuth 2007; Kastak et al. 2008). As described earlier, NMFS (2016, 2018; see Table 11.5) has established acoustic thresholds for PTS onset from pulsed sounds, which are used as a guide for assessing hearing impairment in marine mammals (i.e., Change in Injury Level) for the Project.

At the present state of knowledge, it is necessary to assume that any impact is directly related to total received energy, although there is recent evidence that auditory effects in a given animal are not a simple function of received acoustic energy (Finneran 2015); frequency, duration of the exposure, and occurrence of gaps within the exposure can also influence the auditory effect (Mooney et al. 2009; Finneran and Schlundt 2010, 2011, 2013; Finneran et al. 2010a,b; Finneran 2012, 2015; Kastelein et al. 2012a,b, 2013a,b,c, 2014, 2015, 2016a,b; Ketten 2012; Supin et al. 2016). In addition, it is inappropriate to assume that onset of TTS occurs at similar received levels in all cetaceans (cf. Southall et al. 2007). TTS information for odontocetes is primarily derived from studies on the bottlenose dolphin and beluga, and that for pinnipeds has mostly been obtained from California sea lions and elephant seals (see Appendix 4 LGL 2015a for details). Studies on bottlenose dolphins by Finneran et al. (2015) indicate that the potential for seismic surveys using air sources to cause auditory effects on dolphins could be lower than previously thought. Based on behavioural tests, Finneran et al. (2015) reported no measurable TTS in three bottlenose dolphins after exposure to 10 impulses from a seismic air source. However, auditory evoked potential measurements were more variable, with one dolphin showing a small (9 dB) threshold shift at 8 kHz. There have been several studies on TTS which indicate that received levels that elicit onset of TTS are lower in porpoise than for other odontocetes (e.g., Lucke et al. 2009; Kastelein et al. 2012a, 2013a, 2014, 2015; Tougaard et al. 2016). Additionally, evidence from more prolonged (non-pulse and pulse) exposures suggested that harbour seals incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (e.g., Kastak et al. 1999, 2005, 2008; Ketten et al. 2001; Kastelein et al. 2013c).

Popov et al. (2017) reported that TTS produced by exposure to a fatiguing sound was larger during the first session (or naïve subject state) with a beluga whale than TTS that resulted from the same sound in subsequent sessions (experienced subject state). Similarly, several other studies have shown that some marine mammals (e.g., bottlenose dolphins, false killer whales) can decrease their hearing sensitivity in order to mitigate the impacts of exposure to loud sounds (e.g., Nachtigall and Supin 2014, 2015). When Reichmuth et al. (2016) exposed captive spotted and ringed seals to single air source pulses with SELs of 165 to 181 dB and SPLs (peak to peak) of 190 to 207 re 1 µPa, no low-frequency TTS was observed.

There is substantial overlap in the frequencies that sea turtles detect and. the frequencies in air source pulses. Sounds from an air source array may cause temporary hearing impairment in sea turtles if they do not avoid the immediate area around the air sources. However, monitoring studies show that some sea turtles do show localized movement away from approaching air sources (see Appendix 5 in LGL 2015a). At short distances from the source, received sound levels diminish rapidly with increasing distance. In that situation, even a small-scale avoidance response could result in a substantial reduction in sound exposure.

Nowacek et al. (2013) concluded that current scientific data indicate that seismic air sources have a low probability of directly harming marine life, except at close range. Several aspects of the planned monitoring and mitigation measures (e.g., compliance with SOCP (DFO 2007)) for seismic surveys are designed to detect marine mammals and sea turtles occurring near the air source array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment. In addition, many cetaceans and (to a limited degree) pinnipeds and sea turtles show some avoidance of the area where received levels of air source sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves will reduce the possibility of hearing impairment.

Estimated sound levels from the representative air source array (5,085 in^3) modelled for the Project were above SPL_{peak} injury thresholds (PTS onset) for impulsive sounds for most marine mammal groups within 40 m of the array (see Table 11.5 above). Sound levels were predicted to decrease to below the SPL_{peak} injury threshold for cetaceans with high-frequency hearing slightly farther away (i.e., within 190 m of the air source array). Considering the SEL_{cum} metric for injury, once again, most marine mammals would have to occur and remain within close range of the air source array, < 40 m to approximately 160 m, to in theory incur auditory injury (PTS; Table 11.5). This also assumes that marine mammals occur within these distances of the air source array for a 24-hour period; this is considered an unlikely scenario. The amount of acoustic energy received depends on where in the sound field, both horizontally and vertically, an animal is when the sound source is active. If PTS were to occur, it would likely to be measured in a few decibel loss in hearing sensitivity, not profound loss, because most predicted incidents of auditory injury would occur at greater distances from the source (BOEM 2017). There is increased risk that marine mammals (and sea turtles) may experience temporary hearing impairment (TTS) from prolonged exposure to sound from the seismic surveys; however, based on published TTS-onset thresholds and acoustic modelling results (Zykov 2018 in Appendix D), this is also considered unlikely.

As noted in Section 11.1.5.1, Popper et al. (2014) have proposed guidelines for threshold levels that may cause mortality and potential mortal injury in sea turtles. They propose thresholds of 210 dB SEL_{cum} and 207 dB_{peak}, which are consistent with those proposed for fish species whose swim bladder is not involved with hearing. Based on acoustic modelling undertaken for the Project, sound levels from air source operations are predicted to be below these levels at distances beyond 10s of metres (Zykov 2018 in Appendix D). It has been proposed that the rigid external anatomy of sea turtles may afford protection from the potential effects of impulsive sound (Popper et al. 2014). Thresholds for non-mortal injury of sea turtles are not available, but the relative risk has been categorized as 'high' in the 'near' field (10s of metres from the source), and 'low' at both 'intermediate' (100s of metres) and 'far' (1000s of metres) distances (Popper et al. 2014).

The change in Injury and/or Mortality Levels due to the underwater sound emissions from seismic surveys could be adverse, as described above, and in the unlikely event of PTS occurrence it would be considered long-term at the individual level. The geographic extent is predicted to be within 1 km^2 of the airsource array at its location in the Core BdN Development Area, based on acoustic modelling. Potential injury effects would not likely occur and are considered reversible (at the population level), once the seismic survey ceases. As noted above, given the assumption that marine mammals and/or sea turtles would have to remain in the area for over 24 hours for injury effects to occur, the magnitude of change in injury would range from negligible to low as there could be an interaction without effects occurring (negligible) and if changes in injury level were to occur, it would be considered within the range of natural viability (low). Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area and there are data gaps in hearing studies on marine mammals, particularly baleen whales and larger toothed whales. Therefore, there is uncertainty whether injurious hearing effects can occur during geophysical surveys, as such there is uncertainty in the frequency of the effect. Mitigation measures listed above should reduce injury effects.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Injury and/or Mortality Levels associated with underwater sound emissions during geophysical activities are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km^2, of long-term duration, unlikely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions during geophysical surveys. As noted in Section 11.2, key prey species include capelin, herring, sand lance, cod, squid, and euphausiids.

As indicated in Section 9.3.5.3, underwater sound emissions during geophysical surveys may cause a variety of behavioural responses in marine fishes and invertebrates. Mortality of fish is not likely.

These behavioral changes may include both temporary responses (e.g., startle/avoidance responses) and longer-term responses (e.g., larger-scale redistribution). Potential effects resulting from underwater sound emissions from geophysical surveys on the health, abundance, and distribution of fish and invertebrate species can have indirect effects on marine mammals and sea turtles in terms of prey availability and quality. Prey availability may be adversely affected if marine mammals and sea turtles need to travel longer distances to locate food, or if prey are distributed in a more disperse (less aggregated) manner, such that foraging efficiencies are reduced. Quality would be considered adversely affected if the health of prey species was diminished, or if the ratio of preferred to less-preferred prey items was altered. Results of the assessment presented in Chapter 9 (Section 9.3.5.3) suggest that changes to prey availability associated with underwater sound during geophysical surveys will be of low magnitude with a geographic extent between 1,000 km^2 to 10,000 km^2, short-term and reversible once the sound source is no longer active. Based on these effects, indirect effects on change in prey availability and/or quality for marine mammals and sea turtles are not expected to the degree that would translate into effects on the abundance, distribution, or health of these species.

The change in prey availability and/or quality associated with underwater sound emissions during geophysical surveys could be adverse, as described above, and short-term. The geographic extent of the change in prey availability may range between 1,000 km^2 to 10,000 km^2, based on sound modelling results (Section 9.3.5.3) for fish species. The change in prey availability is predicted to be sporadic and is considered reversible once the sound source is no longer active. As noted in Section 11.3.2.1, prey availability may be adversely affected if marine mammals and/or sea turtles need to travel longer distances to locate prey, or if prey are distributed in a more dispersed (less aggregated) manner, such that foraging efficiencies are reduced. Quality would be considered adversely affected if the health of prey species was diminished, or if the ratio of preferred to less-preferred prey items was altered. Results of the assessment presented in Chapter 9 (Section 9.3.5.3) suggest that effects of underwater sound emissions during a 4D geophysical survey on prey species (including marine mammal prey like capelin, herring, sand lance, squid, and euphausiids) will be of low magnitude with a geographic extent ranging between 1,000 km^2 to 10,000 km^2. As such, indirect effects on change in prey availability and/or quality for marine mammals and sea turtles are not expected to the degree that would translate into effects on the abundance, distribution, or health of these species. While underwater sound emissions may affect prey availability during a geophysical survey, the change in availability is considered within the range of natural variability without affecting marine mammals in the area, therefore of low magnitude. Overall, these predictions are made with a moderate to high level of confidence. There is uncertainty in the predication of geographic extent given that it is based on underwater sound modelling. Modelling is a predictive tool requiring various assumptions about model inputs, therefore, there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling as well as the response criteria and its applicability across various prey species for marine mammals. Based on this uncertainty, there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in prey availability and/or quality associated with the underwater sound emissions during geophysical surveys would be as listed in the SOCP (DFO 2007).

In summary, the residual environmental effects of a Change in Prey Availability and/or Quality associated with underwater sound emissions from geophysical equipment used in Supporting

Surveys are predicted to be adverse, low in magnitude, with a geographic extent between 1,000 km^2 to 10,000 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the underwater sound emissions from equipment used in Geophysical Surveys include implementation of mitigations listed in the SOCP (H); shut down of air source array for all beaked whales when observed within the safety zone (I); communication of survey activities to the C-NLOPB (K); marine mammal and sea turtle observation program (L).

Follow-up Monitoring: In consideration of the residual effects predictions and predictions of underwater sound transmission during 4D seismic surveys, sound transmission through the water through the water column will be measured. Refer to Section 11.7 for additional information.

Vertical Seismic Profiling

Potential types of effects underwater sound from VSP surveys on marine mammals and sea turtles are the same as described above for seismic surveys. In consideration of the smaller air source array used in a VSP survey, and the limited temporal (24 to 48 hours) and spatial scope (mostly stationary near the wellbore), the potential changes in injury level, habitat quality and/or use, and change in prey availability or quality would be similar, but of lower overall effect than the underwater sound from geophysical surveys assessed above. As noted in Section 11.3.5, it is likely that only one VSP survey would be undertaken during Core BdN Development. Mitigations will be similar to those for 4D surveys, as applicable.

In summary, with the application of mitigation measures, the residual environmental effects of a **Change in Injury and/or Mortality Levels** associated with underwater sound during a VSP survey are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, unlikely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

In summary, with the application of mitigation measures, the residual environmental effects of a **Change in Habitat Quality and/or Use (Behavioural Effects)** associated with underwater sound during a VSP survey are predicted to be adverse, low to medium in magnitude, with a geographic extent ranging from 10 km^2 - 100 km^2 to 100 km^2 - 1,000 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence

In summary, the residual environmental effects of a **Change in Prey Availability and/or Quality** associated with underwater sound underwater sound during a VSP survey are predicted to be adverse, negligible in magnitude, with a geographic extent between 1,000 km^2 to 10,000 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the underwater sound emissions from VSP survey include a marine mammal and sea turtle observation program (L) and implantation of the SOCP, as applicable for VSP surveys (H), shut down requirements (I).

Follow-up Monitoring is not proposed for effects associated with underwater sound during VSP surveys, in consideration of the residual effects predictions.

Geohazard / Wellsite and Seabed Surveys

As noted above, geohazard / wellsite and seabed surveys use different types of underwater equipment designed to assess the conditions of the seabed and its underlying structures as well as the presence of sensitive benthic habitat (e.g., corals) in the case of seabed surveys. These surveys typically involve acquisition of high resolution seismic, side scan sonar (SSS), synthetic aperture sonar (SAS), subbottom profile (SBP), and bathymetric data over defined area(s). The surveys use closer line spacing, smaller equipment with lower sound levels (and typically at higher frequencies), and typically occur over a shorter time compared to a large-scale 3D seismic survey.

The equipment and procedures typically used during geohazard / wellsite surveys include:

- Surficial data are collected using a broad band (i.e., 500 Hz to 6 kHz) boomer or sparker as a sound source which provides data as deep as 100 m into the substrate
- Seabed imagery is acquired with a digital, dual frequency SSS system
- High-resolution multichannel seismic data are acquired with a seismic source which typically consists of four or more separate air sources
- A single and/or multibeam echosounder (MBES) is used to collect bathymetry data

The potential effects of underwater sound associated with air source arrays on marine mammals and sea turtles were assessed above under 2D/3D/4D Seismic Surveys. The following effects assessment focuses on underwater sound emissions from the other survey equipment used in a geohazard / wellsite surveys.

The primary effects on Marine Mammals and Sea Turtles due to underwater sound emissions during a geohazard / wellsite surveys are:

- Change in Injury and/or Mortality Levels
- Change in Habitat Quality and/or Use (Behavioural Effects)

Changes in Habitat Quality and/or Use (Behavioural effects) is a potential effect associated with underwater sound produced by equipment used in geohazard / wellsite surveys.

A MBES is a mapping sonar system that transmits sound energy to the ocean floor and analyzes the returning signals to collect bathymetric data. Sounds from the MBES are typically emitted in short pings, occurring once every 5 s to 20 s for approximately 2 ms to 15 ms. The beam is narrow (1° to 4°) in the fore-aft extent and wide (150°) in the cross-track extent. Each ping consists of several successive fan-shaped transmissions (segments) at different cross-track angles. MBES systems used with AUVs have a higher frequency range (200 kHz to 400 kHz) than those used in a hull mounted MBES system. SSS use frequencies of 100 kHz to 850 kHz, and SBP frequencies range from 1 kHz to 16 kHz. In association with biological effects, sonars such as MBES systems with narrowband tonal or swept-tonal signals and long enough signals (relative to the frequency for there to be many cycles during the duration of one ping) are classified as non-impulsive (Southall et al. 2007).

There has been some attention given to the effects of MBES on marine mammals, as a result of a recent independent scientific review panel linking the operation of a MBES to a mass stranding of melon-headed whales (Southall et al. 2013) off of Madagascar. During May and June 2008, approximately 100 melon-headed whales entered and stranded in the Loza Lagoon system in northwest Madagascar at the same time that a 12-kHz MBES survey was being conducted approximately 65 km away off the coast. In reviewing available information on the event, an independent scientific review panel concluded that the Kongsberg EM 120 MBES was the most plausible trigger of the stranding. It should be noted that this event is the first known marine mammal mass stranding closely associated with the operation of a MBES. In association with this determination, it was identified that an unequivocal conclusion on causality of the event was limited because of a lack of information about the event and a number of potentially contributing factors. Additionally, the independent review panel report indicated that this incident was likely the result of a complicated confluence of environmental, social and other factors that have a low probability of occurring again in the future but recommended that the potential be considered in environmental planning.

Narrowband tonal or swept-tonal sounds such as those from MBES systems, do not have the sudden rise time characteristic of impulse sounds (like air source pulses) and as such are considered to have a reduced potential for causing hearing damage (see LGL 2014).

There is no available information on marine mammal behavioural response to MBES sounds (Southall et al. 2013). Much of the literature on marine mammal response to sonars relates to the types of sonars used in naval operations, including Low-Frequency Active sonars (e.g., Miller et al. 2000, 2012; Clark et al. 2001; Sivle et al. 2012) and Mid-Frequency Active (MFA) sonars (e.g., Tyack et al. 2011; Melcón et al. 2012; Miller et al. 2012; DeRuiter et al. 2013a,b; Goldbogen et al. 2013). Similarly, there is no information on sea turtle responses to MBES sounds, but sea turtles in tanks showed agitated behaviour when exposed to recordings from the U.S. Navy's Low-Frequency Active sonar (Samuel et al. 2005, 2006).

However, the MBES that is typically used in geohazard/wellsite and seabed surveys is quite different than naval sonars. Ping duration of the MBES is short relative to naval sonars. Also, at any given location, an individual marine mammal would be in the beam of the MBES for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; naval sonars often use near-horizontally-directed sound. In addition, naval sonars have higher duty cycles. These factors would all reduce the sound energy received from the MBES relative to that from naval sonars.

MBES signals have properties that reduce their potential for biological effects on marine mammals and sea turtles which include the following:

- Though the transmitted MBES signals have high source levels, the sound transmitted in any one direction is of short duration, which limits the total energy content of the sound signal received by any animal

- A MBES sound source is normally in motion, so an animal at a specific location will normally receive strong signals from only one or a few sequential pings, which would likely not be enough cumulative sound to result in any hearing impairment
- Animals close to the transducer are the ones that could potentially receive the strongest sounds, but such animals are not likely to be in the narrow beam for long enough to receive more than a single strong ping

Although limited information on the effects of MBES and SBP sounds on marine mammals and sea turtles is available, it is assumed that there may be behavioural or disturbance effects on these animals in the Core BdN Development Area, similar to those described for geophysical surveys. Based on acoustic modelling and utilizing the 160 dB re 1 µPa (rms) sound level as a guide for behavioural responses, the distance where responses would most likely occur would be up to 150 m from the MBES and 30 m form the SBP. Even if a behavioural criterion of 120 dB re 1 µPa rms were used for continuous sounds, the distance to this sound level would be less < 1 km for MBES and approximately 4 km for SBP. Sound from the geohazard / wellsite and seabed surveys in the Core BdN Development Area is expected to result in localized avoidance by marine mammals including those species considered common: fin whales, humpback whales, sperm whales, northern bottlenose whales, and delphinids. Sea turtles, considered rare in the Core BdN Development Area, would also be expected to exhibit localized avoidance.

Behavioural responses are considered to be adverse, short-term and are not predicted to extend beyond the duration of the geohazard / wellsite and seabed surveys. Effects could be continuous during the survey, and reversible. The magnitude of effects would be low to medium as it is possibly beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development Area, including the important times of the year. Geographic extent, in this case, is based on underwater sound modelling. Modelling is a predictive tool requiring various assumptions about model inputs; therefore, there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling as well as the response criteria and its applicability across various marine mammal and sea turtle species. Based on these uncertainties there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce effects of sound sources used during geohazard / wellsite surveys would be similar to those noted above for 2D/3D/4D surveys.

In summary, with mitigation measures in place, the residual environmental effects of a Change in Habitat Quality and/or Use (Behavioural Effects) associated with underwater sound emissions during a geohazard / wellsite surveys are predicted to be adverse, low to medium in magnitude, with a geographic extent ranging between 10 km^2 to 100 km^2, short-term in duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Injury and/or Mortality Levels is a potential effect associated with underwater sound produced by equipment used in geohazard / wellsite surveys.

Acoustic modelling of a typical SBP (operating frequencies ranging from 2.5 kHz to 12.5 kHz) and MBES (operating frequency of 200 kHz) was undertaken for the Project (Zykov 2018 in Appendix D). It was assumed that both the SBP and MBES would be hull mounted. Estimated sound levels from the representative MBES were above SPLpeak injury thresholds (PTS onset) for impulsive sounds for only high-frequency cetaceans (40 m) and seals (<5 m) (see Table 10 in Zykov 2018). Low- and mid-frequency cetacean injury thresholds were not reached. Considering the SELcum metric for injury, marine mammals would have to occur and remain within 5 m of the MBES to in theory incur auditory injury (PTS; see Table 11 in Zykov 2018). This also assumes that marine mammals occur within these distances of the MBES for a 24-hour period, which is considered an unlikely scenario. Furthermore, given that marine mammals are expected to exhibit at least localized avoidance of the survey vessel (see above), they are unlikely to be exposed to levels of sound from the MBES high enough to cause auditory injury. If the MBES is operated at depth from an AUV it would reduce potential effects.

Acoustic modelling results from the representative SBP (operating at a frequency range of 2.5 kHz to 12.5 kHz and hull-mounted) indicate that there is even less likelihood of a marine mammal incurring auditory injury relative to a MBES. Estimated sound levels were above SPLpeak injury thresholds (PTS onset) for impulsive sounds for only high-frequency cetaceans (10 m) (see Table 10 in Zykov 2018). Low- and mid-frequency cetacean and pinniped injury thresholds were not reached. Considering the SELcum metric for injury, marine mammals would have to occur and remain within 5 m to 43 m of the SBP to in theory incur auditory injury (PTS; see Table 11 in Zykov 2018). This also assumes that marine mammals occur within these distances of the SBP for a 24-hour period which is considered an unlikely scenario.

It is also unlikely that MBES or SBP operations would elicit hearing impairment in sea turtles given the brief exposure and the fact that the MBES frequency is far above the range of optimal hearing (100 Hz to 700 Hz) by sea turtles.

Based on the information and analysis summarized here, and with the implementation of mitigation measures, it is unlikely that geohazard / wellsite surveys will result in injuries (PTS) for marine mammals or sea turtles. Animals would have to occur close to the sound source and remain there for an extended period of time to incur auditory injury. The magnitude of potential changes in injury level is considered negligible, as there is no change relative to baseline conditions. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area and there are data gaps in hearing studies on marine mammals, particularly baleen whales and larger toothed whales. Therefore, there is uncertainty whether injurious hearing effects can occur during Supporting Surveys, and as such, there is uncertainty in the frequency of the effect. Mitigations to reduce effects of sound sources used during geohazard / wellsite surveys would be similar to those noted above for 2D/3D/4D surveys.

In summary, with the application of mitigation measures (for air source arrays), the residual environmental effects of Injury and/or Mortality Levels from underwater sound emissions during a geohazard / wellsite surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, unlikely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the underwater sound emissions from geohazard surveys include a marine mammal and sea turtle observation program (L).

Follow-up Monitoring is not proposed for effects associated with underwater sound during geohazard surveys in consideration of the residual effects predictions.

11.3.6 Decommissioning

At end of field-life, which will either be at the end of the Core BdN Development or at the end of Project life, should Project Area Tiebacks activities occur, the Project will be decommissioned in accordance with regulatory requirements in place at the time of decommissioning. Mitigations for decommissioning are listed in Section 11.5.1.2

Activities associated with decommissioning include but are not limited to vessel presence and helicopter supply and servicing, environmental, geotechnical, geological and/or ROV / AUV surveys and effects are assessed above in Sections 11.3.4 and 11.3.5.

11.3.6.1 Decommissioning of FPSO

The departure of the FPSO and the removal of associated floating equipment may interact with marine mammals and sea turtles primarily through the underwater sound generated by the FPSO and attending vessels. The potential effects of vessel presence and sound on marine mammals and sea turtles were assessed in Section 11.3.4.

11.3.6.2 Decommissioning of Subsea Infrastructure

If subsea infrastructure is removed, underwater sound from attending vessels may interact with marine mammals and sea turtles. The potential effects of vessel presence and sound on marine mammals and sea turtles were assessed in Sections 11.3.1.1 and 11.3.4. If supporting surveys are required during decommissioning, the potential effects on marine mammals and sea turtles are considered the same as those predicted in Section 11.3.5.

11.3.6.3 Well Decommissioning

There is little potential for marine mammals and sea turtles to interact directly with well abandonment activities. There is some potential that marine mammals may temporarily avoid a localized area around the wellhead during mechanical separation of the wellhead from the seabed. The change in habitat quality and/or use as a result of well abandonment will likely be neutral.

11.3.6.4 Summary of Environmental Effects: Decommissioning

In summary, with the application of mitigation measures, the residual environmental effects on Marine Mammals and Sea Turtles from Decommissioning are predicted to be adverse, low in magnitude, with a geographic extent between 1 km^2 -10 km^2 to 100 km^2 -1,000 km^2, short-term in duration, and occurring regularly. This prediction is made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with Decommissioning include management and treatment of wastes (A, B, C, D, E), common traffic route for vessels (F, G) and reporting of vessel strikes (M); implementation of mitigation measures per the SOCP, as applicable (H); submission of a decommissioning plan to C-NLOPB (N); explosives will not be used during well head removal (O); inspection of decommissioned wells in accordance with regulatory requirements (P).

Follow-up Monitoring is not proposed for effects on Marine Mammals and Sea Turtles associated with Decommissioning in consideration of the residual effects predictions.

11.4 Project Area Tiebacks

Over the life of the Project, Equinor Canada may choose to undertake additional exploration activities (e.g., exploration, appraisal, delineation drilling, 2D, 3D/4D seismic) to search for and possibly develop economically recoverable reserves. Should additional economically and technically recoverable reserves be discovered within the Project Area, they could be processed on the BdN FPSO through the installation of additional subsea templates and flowlines (“subsea tiebacks”) as described in Section 2.6.6. Between one and five well templates could be tied-back to the FPSO and/or existing well templates via flowlines and may include the drilling of up to 20 additional wells within the additional well templates. Activities associated with Project Area Tiebacks would be the same as those described in Section 2.6.6 and summarized below.

- Installation of subsea tieback(s) (well templates and flowlines)
- Continuation of production and maintenance operations from the existing FPSO
- Drilling activities associated with the drilling of up to 20 additional wells (total) in well templates
- Continuation of supply and servicing
- Additional supporting surveys, if required
- Decommissioning

The Core BdN Development has a field life of 12 to 20 years. Should Project Area Tiebacks occur, the field life of the Project may be extended while maximum daily potential production rates would remain the same. Tiebacks may be feasible up to a distance of approximately 40 km from the FPSO and/or template location. Figure 9-7 illustrates Project Area Tiebacks, providing examples of tiebacks to the FPSO and existing well templates. For the purposes of environmental effects assessment, it is assumed that the timeframe for Project Area Tiebacks would the same as those listed for the Core BdN Development. For instance, it is assumed that offshore construction and installation of well templates and flowlines, and HUC activities of the new subsea infrastructure could occur over several seasons; production and maintenance operations, supply and servicing and supporting surveys occurring during the Core BdN Development would continue until 30-year end of Project life (an additional 10 to 18 years). Mitigation measures, as described in Section 11.1.5.2 and Table 11.3, implemented for the Core BdN Development, would be applied to activities undertaken in Project Area Tiebacks.

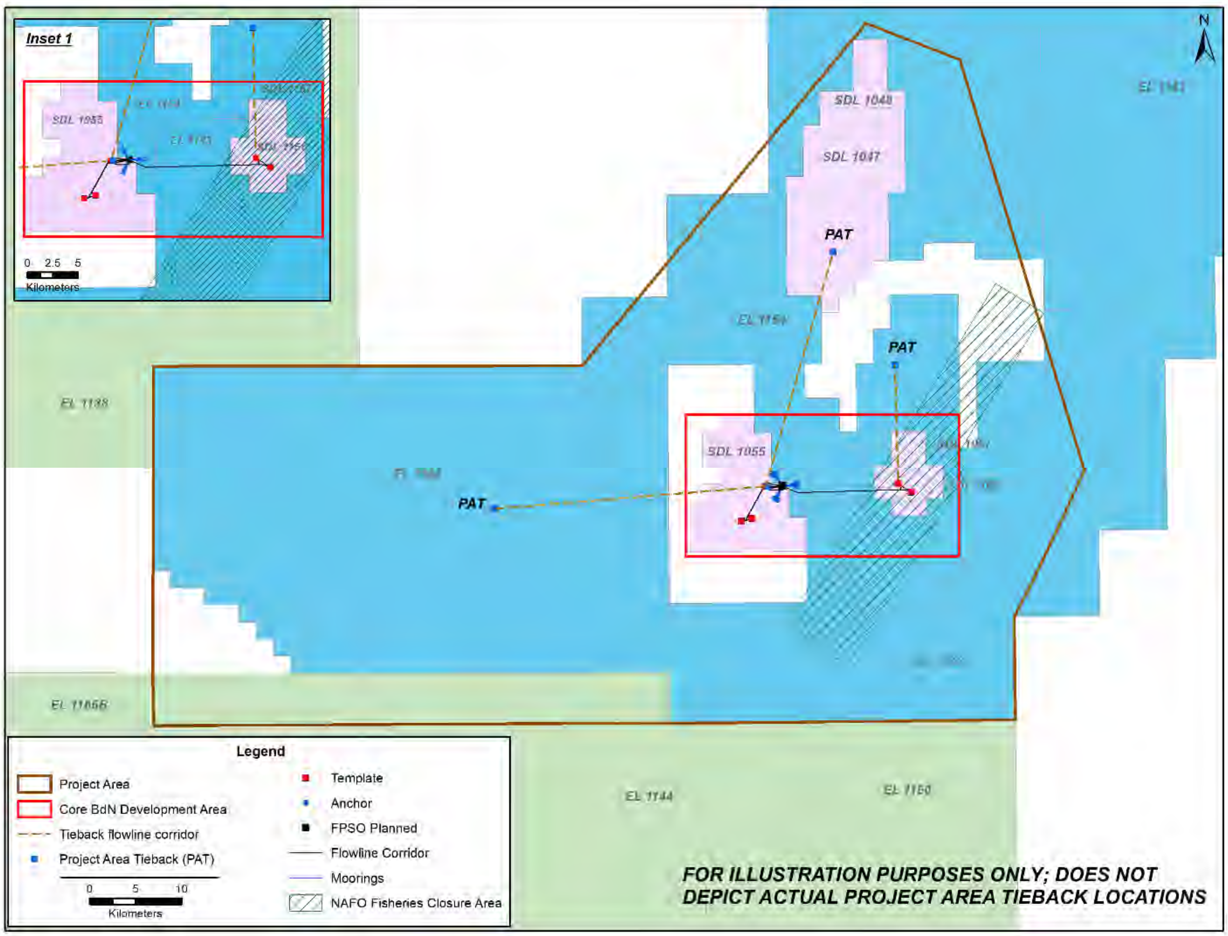

Figure 11-2 Illustration of Potential Project Area Tiebacks

11.4.1 Offshore Construction and Installation, and Hook-up and Commissioning

Project Area Tiebacks of up to five additional subsea tiebacks (flowlines, well templates) would involve seabed surveys and site preparation, installation of subsea infrastructure, and eventual HUC of newly installed well templates and flowlines, similar to those described in Section 11.3.1. Activities would occur at locations within the Project Area but would likely be seasonal and may occur over multiple years as with similar activities for the Core BdN Development. Offshore construction and installation and HUC for Project Area Tiebacks may occur at the same time as ongoing production and/or drilling operations for the Core BdN Development.

As discussed in Section 11.3.1.1, the primary interactions with Marine Mammals and Sea Turtles during this phase are associated with vessels (i.e., primarily underwater sound). There is no anticipated interaction associated with the installation of subsea equipment on the seabed. The potential interactions and effects of offshore construction and installation, and HUC for Project Area Tiebacks would be the same as those assessed in Section 11.3.1.1 for the Core BdN Development. The species of marine mammals and sea turtles which may occur in the Core BdN Development as noted in Section 11.3.1.1, is considered the same as those for the larger Project Area, where Project Area Tiebacks may occur. However, it is possible that more baleen whales may be encountered in the portion of the Project Area closest to the Shelf and that deeper diving cetaceans like sperm, pilot and beaked whales (including northern bottlenose whales), would be more common in the deeper waters of Flemish Pass and Sackville Spur.

11.4.2 Offshore Construction and Installation, Hook-up Commissioning

11.4.2.1 Sound Emissions from Vessels

The primary effects on Marine Mammals and Sea Turtles due to the underwater sound emissions from vessels engaged in in offshore construction and installation and HUC activities, should Project Area Tiebacks be undertaken, are:

- Change in Habitat Quality and/or Use (behavioural effects)
- Change in Prey Availability and/or Quality

Changes in Habitat Quality and Use (Behavioural Effects) is a potential effect associated with presence of vessels involved in offshore construction and installation and HUC activities should Project Area Tiebacks occur.

As noted in Section 11.3.1.1, the marine mammals and sea turtles present in the Core BdN Development Area include several species of baleen whales and large toothed whales that would also be present in the larger Project Area during the offshore construction/installation season. Behavioural effects on these marine mammals due to the presence of vessels would potentially be adverse, as described in Section 11.3.1.1, but short-term during the construction season and during HUC activities. The geographic extent of the change in habitat quality and/or use could be variable, possibly ranging from 1-10 km^2 to 100-1000 km^2 from the vessel position within the Project Area. This range in geographic extent predictions is attributable to the variable avoidance distances marine mammals exhibit in response to vessels. The behavioural changes may be continuous while vessels were on-site and are considered reversible once the vessel(s) leaves the area. The change in habitat quality and/or use are predicted to be within the range of natural variability with no associated adverse effect on the marine mammals in the area and, therefore of low magnitude. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. There is some uncertainty regarding the magnitude of effect as data are limited regarding marine mammals occurrence in the Core BdN Development Area. Mitigations to reduce effects on habitat quality and use during offshore construction and installation an HUC activities are not proposed.

In summary, the residual environmental effects of a Change Habitat Quality and/or Use (Behavioural Effects) from the presence of vessels during Construction and Installation and HUC, should Project Area Tiebacks be undertaken, are predicted to be adverse, low in magnitude, with a geographic extent ranging from 1 km^2 -10 km^2 to 100 km^2 - 1000 km^2, short-term in duration, occurring continuously and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions from vessels engaged in offshore construction, installation and HUC activities for Project Area Tiebacks. As noted above, marine mammals and sea turtles presence in the Project Area are the same as those in Core BdN Development Area, therefore interactions and effects with vessels would be the same during construction, installation and HUC activities for Project Area Tiebacks.

As noted in in Section 11.3.1.1, changes in fish behaviour may affect prey availability for marine mammals and sea turtles. The effects assessment of underwater sound from vessels engaged in offshore construction, installation and HUC activities, on fish species predicts that behavioural effects would be adverse, localized (less than 1 km^2) to vessel, negligible in magnitude, as fish would be available in the larger Core BdN Development Area and short-term. Therefore, similar predications on prey availability for marine mammals and sea turtles during offshore construction, installation and HUC activities can be made. The change in prey availability and/or quality due to sound emissions from vessels engaged in Offshore Construction and Installation and HUC activities are predicted to be adverse and short-term in duration. The geographic extent of the change in prey availability and/or quality would be less than1 km^2 of the vessels. The change in prey availability could be continuous and is considered reversible once the vessel leaves the area. While prey species may avoid the around the vessel, the overall availability of prey species in the Core Area would not be affected, and therefore the magnitude of the effect is considered negligible. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in habitat quality and use associated with underwater sound emissions from vessels are not proposed.

In summary, the residual environmental effects of a change in prey availability or quality associated with the presence of vessels engaged in Offshore Construction Installation and HUC activities for Project Area Tiebacks are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities are not proposed

Follow-up Monitoring is not proposed for the effects on Marine Mammals and Sea Turtles associated with underwater sound emissions from vessels engaged in Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions.

11.4.3 Production and Maintenance Operations

The addition of subsea development tiebacks would extend the life of the Project (12 to 20 years) to 30 years (total). The potential effects of production and maintenance operations are detailed in Section 11.3.2. As there would be no changes to the production rates, marine discharges or sound emissions, the potential effects on Marine Mammals and Sea Turtles are considered the same as that described and assessed for the Core BdN Development (Section 11.3.2). The extended life would increase the timeframe for the interactions to occur.

The effects associated with the underwater sound emissions and discharges associated with the FPSO, as assessed in Section 11.3.2, would be the same for Project Area Tiebacks as the FPSO would remain in its position in the Core BdN Development Area. The only change is that the FPSO could be on-station until end of Project at 30 year, verses the estimated 12- to 20-year timeframe for the Core BdN Development. While the timeframe is extended, the duration of effects would remain as long term. All other effects characterizations would be the same as assessed for the Core BdN Development. Effects assessment for interactions associated with the Production and Maintenance Operations (underwater sound emissions, produced water discharges) would not change should Project Area Tiebacks be undertaken. The effects assessment for these interactions are provided in Section 11.3.2. Mitigation measures, as applicable, employed for the Core BdN Development would continue for Project Area Tiebacks.

11.4.4 Drilling Activities

As stated in Section 2.6.6, should potential Project Area Tiebacks be undertaken, up to 20 additional wells may be drilled at either individual well locations or in well templates (4-, 6- or 8-slot) in the Project Area. Drilling activities could occur at any time of the year, and as noted in Section 11.3.3, the drilling installation could be site at a well template location between one and two years if eight wells were drilled consecutively. Drilling activities in well templates in the Project Area will likely occur while ongoing production at the FPSO is occurring.

As identified in Section 11.1.5.1 and assessed in Section 11.3.3, potential interactions from drilling activities on Marine Mammals and Sea Turtles which warrant a detailed effects assessment includes underwater sound emissions from the drilling installation. Marine mammals and sea turtles species present in the Project Area would be the same as those present in the Core BdN Development Area. If drilling activity occurred closer to the Sackville Spur, it is possibly that more northern bottlenose whales may be present than in the Core BdN Development Area. Regardless, the interactions would be the same at these well template locations should Project Area Tiebacks be undertaken.

11.4.4.1 Underwater Sound Emissions from the Drilling Installation

The primary effects on Marine Mammals and Sea Turtles due to underwater sound emissions from the drilling installation are:

- Change in Injury and/or Mortality Levels
- Change in Habitat Quality and/or Use
- Change in Prey Availability or Quality

Changes in Injury and/or Mortality Levels is a potential effect associated with underwater sound emissions from the drilling installation during drilling activities for Project Area Tiebacks.

The change in Injury and/or Mortality Levels due to the underwater sound emissions associated with drilling activities during Project Area Tiebacks would be the same as assessed in Section 11.3.3.1 and would be adverse. If PTS did occur, it would be considered long-term at the individual level. The geographic extent is expected to be within 1 km^2 of the drilling installation at its location in the Project Area. As noted in Section 11.3.3.1, injury effects are unlikely to occur and reversible (at the population level), once the drilling installation leaves the area. The changes in injury level related to underwater sound from the drilling installation ranges from negligible to low magnitude (there is likely an interaction without effects occurring (negligible) to if effects occurred, they would be in the range of natural variability (low)). Should drilling occur at the same time as production operations, the presence of the drilling installation in the Project Area and the FPSO on location would be two distinct sources of underwater sound for marine mammals. The zone of influence for either the FPSO or drilling installation is less than 1 km^2, therefore potential changes in injury levels would be localized to the locations of either installation. Given avoidance behaviours and the overall small zones of auditory injury, the magnitude of effect should both installations be operating at the same time would not change. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area and there are data gaps in hearing studies on marine mammals, particularly baleen whales and larger toothed whales. Therefore, there is uncertainty whether injurious hearing effects can occur from a continuous sound source and as such, there is uncertainty in the frequency of the effect. Mitigations to reduce the Change in Injury and/or Mortality associated with sound emissions from the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Injury and/or Mortality Levels associated with the underwater sound emissions from the drilling installation during Drilling Activities should Project Area Tiebacks occur are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km^2, of long-term duration, not likely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Habitat Quality and/or Use (Behavioural Effect) is a potential effect associated with underwater sound emissions from the drilling installation during drilling activities for Project Area Tiebacks.

The Change in Habitat Quality and/or Use (Behavioural Effects) due to the presence of the drilling installation would be adverse, as described in Section 11.3.3.1 and medium-term, but individual marine mammals would likely experience effects in the short-term. Based on acoustic modelling, the geographic extent of the behavioural changes is predicted to occur within 25 km (approximately 2,000 km^2) of the drilling installation at the well template location in the Project Area. It is possible that marine mammal behavioural response to drilling installation could be continuous but is considered reversible once the drilling installation leaves the area. The behavioural changes may be beyond natural variability but are not predicted to affect the viability of marine mammal populations in the area and, therefore are considered medium magnitude. Should the drilling installation and FPSO operate concurrently, the geographic extent may be additive, and perhaps even synergistic but would still represent a very small area within the LSA. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area, and there are data gaps associated with masking studies, therefore, there is some uncertainty regarding the magnitude of effect. Geographic extent, in this case, is based on underwater sound modelling. Modelling is a predictive tool requiring various assumptions about model inputs; therefore, there is some uncertainty regarding the zone of influence of underwater sound levels predicted by the modelling as well as the response criteria and its applicability across various marine mammal and sea turtle species. Based on these uncertainties there is a moderate level of confidence in the prediction of geographic extent. Mitigations to reduce the change in habitat quality and use due to underwater sound emissions from the drilling installation are not proposed.

In summary, the residual environmental effects of a Change in Habitat Quality and/or Use (Behavioural Effects) due to underwater sound emissions from the drilling installation, should Project Area Tiebacks be undertaken, are predicted to be adverse, medium in magnitude, with a geographic extent less than 10,000 km^2 (approximately 2,000 km^2), of medium-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions from the drilling installation during drilling activities for Project Area Tiebacks.

As discussed in Section 11.3.3.1, potential effects resulting from underwater sound emissions from the drilling installation on the health, abundance, and distribution of fish and invertebrate species can have indirect effects on marine mammals and sea turtles in terms of prey availability and quality. Prey availability may be adversely affected if marine mammals and sea turtles need to travel longer distances to locate prey, or if prey are distributed in a more disperse (less aggregated) manner, such that foraging efficiencies are reduced. Quality would be considered adversely affected if the health of prey species was diminished, or if the ratio of preferred to less-preferred prey items was altered. Results of the assessment presented in Chapter 9 suggest that effects from presence and operation of the drilling installation on prey species (including capelin, herring, sand lance, squid, and euphausiids) in the Project Area will be of low magnitude and in a localized area, and as such, indirect effects on change in prey availability and/or quality for marine mammals and sea turtles are not expected to the degree that would translate into effects on the abundance, distribution, or health of these species.

The change in prey availability and/or quality due to underwater sound emissions from the drilling installation at its well template location in the Project Area would be adverse, as described in Section 11.3.3.1, and medium-term, while the drilling installation was on location. The geographic extent of the change in habitat would be within 1 km^2 of the drilling location when at a well template location in the Project Area. The change in prey availability would be continuous, and reversible once the drilling installation leaves the area. While underwater sound emissions may affect prey availability within a localized area of the drilling installation, the overall prey availability in the Core BdN

Development Area is not affected and is available for predator species. There is no change in food availability relative to baseline conditions, therefore, the magnitude of the effect is considered negligible. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above there are uncertainties associate with the foraging strategies of marine mammals and if the Core BdN Development is a foraging area, therefore there is some uncertainty regarding the magnitude of effect. Mitigations to reduce the change in prey availability associated with underwater sound from the drilling installation are not proposed.

In summary, the residual environmental effects of a change in prey availability or quality associated with underwater sound from drilling activities should Project Area Tiebacks occur are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of medium-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with underwater sound emissions from Drilling Activities are not proposed

Follow-up Monitoring: is not proposed for the effects on Marine Mammals and Sea Turtles associated with underwater sound emissions from Drilling Activities should Project Area Tiebacks be undertaken in consideration of the residual effects predictions.

11.4.5 Supply and Servicing

The addition of subsea tiebacks may extend the life of the Project (12 to 20 years) to 30 years. Supply and servicing operations, as described in Section 2.6.4 and as assessed for the Core BdN Development in Section 11.3.4 would be the same should Project Area Tiebacks be undertaken and would be carried out for an additional 10 - 18 years. The longer life of the Project would increase the timeframe for the interactions between supply and servicing activities and marine mammals and sea turtles to occur.

The vessel and aircraft traffic route to the Project Area would be same as for Core BdN Development. Vessel traffic in the Project Area would be the same as vessel traffic in the Core BdN Development Area. Depending on the distance between the drilling installation in the Project Area and the FPSO at its fixed location, a second SBV may be required, which would be short-term while the drilling installation was on location.

Effects assessment for interactions associated with Supply and Servicing would not change should Project Area Tiebacks be undertaken. The effects assessment for these interactions are provided in Section 11.3.4. Mitigation measures, as applicable, employed for the Core BdN Development would continue for Project Area Tiebacks.

11.4.6 Supporting Surveys

As with the Core BdN Development, supporting surveys, including geophysical activities, environmental, geotechnical, geological and ROV / AUV surveys may be required should Project Area Tiebacks be undertaken. The species of marine mammals and sea turtles which may occur in the Core BdN Development, is considered the same as those for the larger Project Area, where Project Area Tiebacks may occur. However, it is possible that more baleen whales may be encountered in the portion of the Project Area closest to the Shelf and that deeper diving cetaceans like sperm, pilot and beaked whales (including northern bottlenose whales), would be more common in the deeper waters of Flemish Pass and Sackville Spur.

Should supporting surveys be required, the interactions and associated effects due to vessel presence and underwater sound emissions from vessels would be the same as those assessed in supporting surveys for the Core BdN Development. The effects assessment for these interactions are provided in Section 11.3.5.1 and Section 11.3.5.2, respectively.

Should 4D seismic surveys be required to assess changes in reservoir properties from potential new reservoirs being exploited at the tieback locations, it is anticipated that the type and frequency of surveys would be the same as described in Section 11.3.5.1. While the locations of these surveys would be within the broader Project Area, the interaction with marine mammals and sea turtles would be the same as discussed and assessed in Section 11.3.5.1. In the event that 4D seismic surveys are required at the tieback locations, it is likely that all locations would be surveyed within the same survey season. The overall duration of seismic activity may be longer to include multiple locations, the time at each location would likely be within the two- to four-week timeframe noted in Section 2.6.5.

11.4.6.1 Underwater Sound Emissions from Geophysical Survey Equipment

The primary effects on Marine Mammals and Sea Turtles due to underwater sound from geophysical activities should Project Area Tiebacks be undertaken are:

- Change in Injury and/or Mortality Levels
- Change in Habitat Quality and/or Use (Behavioural Effects)
- Change in Availability and/or Quality of Prey

The possible types of effects are considered the same as those presented and assessed in Section 11.3.5.1. The species of marine mammals present in the Project Area are the same as those identified for the Core BdN Development Area. Should geophysical activities occur outside of the Core BdN Development Area but in the Project Area, the underwater sound emissions are predicted to result in the same effects characterization, regardless of survey location in the Project Area. It is possible that if a geophysical survey occurs in the northern portion of the Project Area, i.e., closer to the Sackville Spur, that more northern bottlenose whales could be exposed to sounds from air source arrays.

2D / 3D / 4D Seismic Surveys

Changes in Habitat Quality and/or Use (Behavioural effects) is a potential effect associated with underwater sound produced by geophysical activities. The main mechanisms for this are auditory disturbance and masking of sounds. Mitigations to be employed during geophysical activities, which are intended to reduce effects on marine mammals and sea turtles include:

- Mitigations listed in the Statement of Canadian Practice with respect to the *Mitigation of Seismic Sound in the Marine Environment* (SOCP) (DFO 2007). This includes implementing shut downs of the air source array(s) when SAR listed as Endangered or Threatened on Schedule 1 of SARA (as well as all beaked whale species) are detected within the safety zone during anytime air sources are active, including ramp up.
- Shut-down of air source arrays for all beaked whales when detected within safety zone
- Equinor Canada will communicate seismic survey plans to C-NLOPB and geophysical operators as early as possible to reduce concurrent seismic surveys and/or to maximize the separation distance between surveys to the extent possible.

Disturbance effects:

As summarized in Section 11.3.5.1, available information demonstrates that marine mammals and sea turtles exhibit variable behavioural responses to air source sounds; however, avoidance responses are typically localized and temporary. Based on acoustic modelling results of a representative air source array (5085 in^3), the NMFS recommended behavioural response criteria of 160 dB re 1 µPa (rms) for impulsive sounds are predicted to be exceeded at maximum distances ranging from 9.3 km (August) to 20.1 km (February) (Table 11.5). These are conservative distance estimates using R_{max} values. Using the more representative estimate ($R_{95\%}$), the 160 dB threshold typically would be reached at 7.5 km and 15.4 km from the air source array in August and February, respectively. Acoustic modelling results were similar at the survey location in the Core BdN Development Area (i.e., Site 1) and in the western portion of the Project Area (i.e., Site 2), which is in shallower water depths. The presence of a sound surface channel during the winter period results in increased sound propagation and as such, ranges to the 160 dB threshold in winter (February) were approximately double the estimated values in summer (August). If geophysical surveys are conducted during the summer period when the sound speed profile in the Project Area features a high negative velocity gradient at the top, which refracts the acoustic wave towards the bottom and prevents it from being trapped in the acoustic channel, sound propagation will be reduced. This would reduce potential behavioural responses of marine mammals and sea turtles at longer ranges. Based on available information, it is unlikely that all marine mammals, particularly dolphins and seals, would avoid a seismic survey at the estimated 160 dB threshold distances. Marine mammals, including baleen and beaked whales (i.e., northern bottlenose whales), have been regularly observed within one to two km of active air source arrays either on the Grand Banks or in deeper waters in and near the Project Area (e.g., Moulton and Holst 2010; Beland and Penney-Belbin 2014). Also, as described in the sound modelling report (Zykov 2018 in Appendix D), sound from the air source array is expected to be "bounded" by the continental shelf, west of the site. More specifically, sounds that reach the continental shelf (i.e., water depths of 100 m to 300 m), west of the Project Area, are predicted to have higher transmission loss. Baleen whales (i.e., humpback, fin, and minke whales), which are typically more abundant on the continental shelf would, therefore, be exposed to much lower sound levels in shelf waters from the air source array in the Project Area. It is unlikely marine mammals in shelf waters would be affected by seismic surveys in the Project Area. Based on modelling, behavioural changes associated with underwater sound from a seismic survey in the Project Area are expected to occur within approximately 15 km (1,000 km^2) of the sound source. Sea turtles, considered rare in the Project Area, would also be expected to exhibit localized avoidance. Behavioural responses are considered to be short-term and are not predicted to extend beyond the duration of the seismic survey. The behavioural changes are predicted to be medium magnitude as the changes in behaviour are beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population.

Masking Effects

As noted in Section 11.3.5.1, it is possible that at least for some mysticetes in deep-water near the Project Area, that masking of sounds may occur during seismic surveys, at least in areas proximate to the sound source. Any masking effects are considered to be adverse and short-term as they are not predicted to extend beyond the duration of the seismic survey (approximately two to four weeks). It is difficult to predict with any degree of certainty the geographic extent of potential masking effects given the numerous data gaps associated with this topic. We have assumed that the range of masking effects is within the range predicted for behavioural responses.

Overall, behavioural effects associated with underwater sound emissions from equipment used in geophysical surveys would be the same as those in the Core BdN Area and would be adverse, as described above, and may occur continuously while the survey is active. Behavioural effects would be short-term, and reversible once the survey is complete. The geographic extent of the behavioural changes could range between 1-10 km^2 to 100-1,000 km^2 from the sound source, based on sound modelling. This range in geographic extent predictions is attributable to the variable avoidance distances marine mammals exhibit in response to vessels. Behavioural changes are predicted be medium magnitude as the changes are beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population. Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Project Area, including the important times of the year, and there are data gaps associate with masking studies, therefore, there is some uncertainty regarding the magnitude of effect. Geographic extent, in this case, is based on underwater sound modelling. Modelling is a predictive tool requiring various assumptions about model inputs; therefore, there is some uncertainty regarding the zone of influence of underwater sound emissions predicted by the modelling as well as the response criteria and its applicability across various marine mammal and sea turtle species. Based on these uncertainties there is a moderate level of confidence in the prediction of geographic extent. Mitigation measures listed above would reduce overall effects.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Quality and/or Use (Behavioural Effects) associated with underwater sound during geophysical activities, should Project Area Tiebacks occur, are predicted to be adverse, medium in magnitude, with a geographic extent ranging from 10 km^2 – 100 km^2 to 100 km^2 -

1,000 km^2, of short-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Injury and/or Mortality Levels is a potential effect associated with underwater sound emissions produced by geophysical activities. The primary mechanism of this is auditory injury and hearing impairment.

Auditory Injury and Hearing Impairment

As indicated in Section 11.3.5.1, temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds (see Appendix 4 of LGL 2015a for details) like those from air source arrays. Based on the information and analysis summarized here, and with the implementation of mitigation measures, it is unlikely that seismic surveys will result in injuries (PTS) for marine mammals or sea turtles. Animals would have to occur close to the airsource array(s) and remain there for an extended period of time to incur auditory injury. The geographic extent is predicted to be within 1 km^2 of the airsource array at its location in the Project Area. Potential injury effects would not likely occur and are considered reversible (at the population level), once the seismic survey ceasesThe magnitude of change in injury would range from negligible to low as there could be an interaction without effects occurring (negligible) and if changes in injury level were to occur, it would be considered within the range of natural viability (low). changes in injury level were to occur, it would be considered within the range of natural viability (low). Overall, these predictions are made with a moderate to high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. As noted above, data are limited regarding marine mammal occurrence in the Core BdN Development area and there are data gaps in hearing studies on marine mammals, particularly baleen whales and larger toothed whales. Therefore, there is uncertainty whether injurious hearing effects can occur during geophysical surveys, as such there is uncertainty in the frequency of the effect. Mitigation measures listed above should reduce injury effects.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Injury and/or Mortality Levels associated with underwater sound emissions during geophysical activities for Project Area Tiebacks are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km^2, long-term in duration, unlikely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Prey Availability and/or Quality is a potential effect associated with underwater sound emissions during geophysical surveys. As noted in Section 11.2, key prey species include capelin, herring, sand lance, cod, squid, and euphausiids and are the same for the Project Area.

As indicated in Section 9.3.5.3, underwater sound emissions during geophysical surveys may cause a variety of behavioural responses in marine fishes and invertebrates. Mortality of fish is not likely. Potential effects resulting from underwater sound emissions from geophysical surveys on the health, abundance, and distribution of fish and invertebrate species can have indirect effects on marine mammals and sea turtles in terms of food availability and quality. Food availability may be adversely affected if marine mammals and sea turtles need to travel longer distances to locate food, or if prey are distributed in a more disperse (less aggregated) manner, such that foraging efficiencies are reduced. Quality would be considered adversely affected if the health of prey species was diminished, or if the ratio of preferred to less-preferred prey items was altered. Results of the assessment presented in Chapter 9 (Section 9.4.5.1) suggest that changes to prey availability associated with underwater sound emissions during geophysical surveys in the Project Area will be of low magnitude with a geographic extent between 1,000 km^2 to 10,000 km^2, short-term and reversible once the sound source is no longer active. Based on these effects, indirect effects on change in food availability and/or quality for marine mammals and sea turtles are not expected to the degree that would translate into effects on the abundance, distribution, or health of these species.

The change in prey availability and/or quality associated with underwater sound emissions during geophysical surveys would be adverse, as described above, and short-term. The geographic extent of the change in prey availability would be between 1,000 km^2 to 10,000 km^2, based on sound modelling (Section 9.3.5.3) and behavioural effects on fish species. The change in prey availability would be sporadic and would be considered reversible once the sound source is no longer active. While underwater sound emissions may affect prey availability during a geophysical survey, the change in prey availability would be considered within the range of natural variability therefore of low magnitude. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team. Mitigations to reduce the change in prey availability and/or quality associated with the underwater sound emissions during geophysical surveys would be as listed in the SOCP (DFO 2007).

In summary, the residual environmental effects of a Change in Prey Availability and/or Quality associated with underwater sound emissions from geophysical surveys during Survey Operations predicted to be adverse, low in magnitude, with a geographic extent between 1,000 km^2 to 10,000 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the underwater sound emissions from equipment used in Geophysical Surveys include implementation of mitigations listed in the SOCP (H); shut down of air source array for all beaked whales when observed within the safety zone (I); communication of survey activities to the C-NLOPB (K); marine mammal and sea turtle observation program (L).

Follow-up Monitoring: In consideration of the residual effects predictions and predictions of underwater sound transmission during 4D seismic surveys, sound transmission through the water through the water column will be measured. Refer to Section 11.7 for additional information.

Vertical Seismic Profiling

Potential types of effects underwater sound from VSP surveys, if undertaken, on marine mammals and sea turtles in the Project Area would be the same as those for the Core BdN Development Area. In consideration of the smaller air source array used in a VSP survey, and the limited temporal (24 to 48 hours) and spatial scope (within the wellbore), the potential changes in injury level, habitat quality and use, and change in prey availability or quality would be similar, but of lower overall effect than the underwater sound from geophysical surveys assessed above. Mitigations would be similar to those described above for 2D/3D/4D surveys.

In summary, with the application of mitigation measures, the residual environmental effects of a **Change in Habitat Quality and/or Use (Behavioural Effects)** associated with underwater sound during a VSP survey, should Project Area Tiebacks be undertaken, are predicted to be adverse, low to medium in magnitude, with a geographic extent ranging from 10 km^2 - 100 km^2 to 100 km^2 - 1,000 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a moderate to high level of confidence.

In summary, with the application of mitigation measures, the residual environmental effects of a **Change in Injury and/or Mortality Levels** associated with underwater sound during a VSP survey, should Project Area Tiebacks be undertaken, are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term duration, unlikely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

In summary, the residual environmental effects of a **Change in Prey Availability and/or Quality** associated with underwater sound underwater sound during a VSP survey are predicted to be adverse, negligible in magnitude, with a geographic extent between 1,000 km^2 to 10,000 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the underwater sound emissions from VSP survey include a marine mammal and sea turtle observation program (L) and implantation of the SOCP, as applicable for VSP surveys (H), shut down requirements (I).

Follow-up Monitoring is not proposed for effects associated with underwater sound during VSP surveys, in consideration of the residual effects predictions.

Geohazard / Wellsite and Seabed Surveys

As noted above, geohazard / wellsite and seabed surveys use different types of underwater equipment designed to assess the conditions of the seabed and its underlying structures as well as the presence of sensitive benthic habitat (e.g., corals) in the case of seabed surveys.

The primary effects on Marine Mammals and Sea Turtles due to underwater sound emissions during a geohazard / wellsite surveys are:

- Change in Injury and/or Mortality Levels
- Change in Habitat Quality and/or Use (Behavioural Effects)

The potential effects on Marine Mammals and Sea Turtles from geohazards surveys in the Project Area are considered to be the same as those for the Core BdN Development Area (Section 11.3.5.1).

Changes in Habitat Quality and/or Use (Behavioural effects) is a potential effect associated with underwater sound produced by equipment used in geohazard / wellsite surveys.

As indicated in Section 11.3.5.1, while limited information on the effects of MBES and SBP sounds on marine mammals and sea turtles is available, it is assumed that there may be behavioural or disturbance effects on these animals in the Project Area, similar to those described for geophysical surveys. Based on acoustic modelling and utilizing the 160 dB re 1 µPa (rms) sound level as a guide for behavioural responses, the distance where responses would most likely occur would be up to 150 m from the MBES and 30 m form the SBP. Even if a behavioural criterion of 120 dB re 1 µPa rms were used for continuous sounds, the distance to this sound level would be less < 1 km for MBES and approximately 4 km for SBP. Sound from the geohazard / wellsite and seabed surveys in the Project Area may result in localized avoidance by marine mammals including those species considered common: fin whales, humpback whales, sperm whales, northern bottlenose whales, and delphinids. Sea turtles, considered rare in the Project Area, would also be expected to exhibit localized avoidance. Behavioural responses are considered to be adverse, short-term and are not predicted to extend beyond the duration of the geohazard / wellsite and seabed surveys survey which may range from one to two weeks to a couple of months. Effects could be continuous during the survey, and reversible. The magnitude of effects would be low to medium as it is possibly beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population. These predictions are made with a moderate to high level of confidence based on the uncertainties noted in Section 11.4.6.1. Mitigations to reduce behavioural effects during geohazard / wellsite would be similar to those noted above for 2D/3D/4D surveys.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Habitat Quality and/or Use (Behavioural Effects) from underwater sound emissions during geohazard / wellsite surveys are predicted to be adverse, low to medium in magnitude, with a geographic extent ranging from between 10 km^2 to 100 km^2, short-term in duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Changes in Injury and/or Mortality Levels is a potential effect associated with underwater sound from geohazard / wellsite surveys.

As reviewed in Section 11.3.5.1, and with the implementation of mitigation measures, it is unlikely that geohazard/wellsite surveys will result in injuries (PTS) for marine mammals or sea turtles. Animals would have to occur close to the sound source and remain there for an extended period of time to incur auditory injury. The magnitude of potential changes in injury level is considered negligible, i.e., no change relative to baseline conditions.

In summary, with the application of mitigation measures (for air source arrays), the residual environmental effects of Injury and/or Mortality Levels from underwater sound emissions during a geohazard / wellsite surveys are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km^2, of long-term in duration, unlikely to occur, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with the underwater sound emissions from geohazard surveys include a marine mammal and sea turtle observation program (L).

Follow-up Monitoring is not proposed for effects associated with underwater sound during geohazard surveys in consideration of the residual effects predictions.

11.4.7 Decommissioning

At end of field-life, which will either be at the end of the Core BdN Development or at the end of Project life, should Project Area Tiebacks be undertaken, the Project will be decommissioned in accordance with regulatory requirements in place at the time of decommissioning. Section 11.3.6 provides an effects assessment of decommissioning activities on Marine Mammals and Sea Turtles. The timeframe for decommissioning, whether at the end of the Core BdN Development or at the end of Project life is anticipated to be the same. The interactions and associated effects, due to the removal of the FPSO would be the same as discussed in Section 11.3.6.

In summary, with the application of mitigation measures, the residual environmental effects on Marine Mammals and Sea Turtles from Decommissioning are predicted to be adverse, low in magnitude, with a geographic extent between 1 km^2 -10 km^2 to 100 km^2 -1,000 km^2, short-term in duration, occurring regularly and reversible. This prediction is made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Marine Mammals and Sea Turtles associated with Decommissioning include management and treatment of wastes (A, B, C, D, E), common traffic route for vessels (F, G) and reporting of vessel strikes (M); implementation of mitigation measures per the SOCP, as applicable (H); submission of a decommissioning plan to C-NLOPB (N); explosives will not be used during well head removal (O); inspection of decommissioned wells in accordance with regulatory requirements (P).

Follow-up Monitoring is not proposed for effects on Marine Mammals and Sea Turtles associated with Decommissioning in consideration of the residual effects predictions.

11.5 Species at Risk: Overview of Potential Effects and Mitigation Measures

Marine mammal and sea turtles listed as SAR are those species that are listed as Endangered, Threatened or of Special Concern under Schedule 1 of SARA (and are therefore, formally and legally protected) and/or which are otherwise designated by COSEWIC as Endangered, Threatened or of Special Concern. There are currently no marine mammal or sea turtle species listed under the NL ESA. Based on a review of scientific literature, status updates, other EAs, and records from marine surveys and sightings databases, there are nine marine mammal and two sea turtle SAR/SOCC that may occur in the Project Area and LSA/RSA, including blue whale, North Atlantic right whale, bowhead whale, fin whale, northern bottlenose whale, Sowerby's beaked whale, killer whale, beluga whale, harbour porpoise, leatherback sea turtle, and loggerhead sea turtle.

Table 11.6 summarizes information on potential presence and timing of SAR in relation to the Project Area and RSA, as well as potential for Project interactions. The potential environmental interactions between the Project and SAR are the same as those for the Marine Mammals and Sea Turtles VC, as are the planned mitigation measures to reduce potential adverse effects. Marine mammal and sea turtle SAR are highly mobile, and many have broad ranges and undertake long annual migration. Large seasonal and even daily changes in abundance within the Project Area and RSA are therefore likely, and potential for overlap and interaction with Project activities is likely to be far more transient and temporary than presented within this assessment. The Project will not occur within any identified concentration areas or designated marine mammal or sea turtle critical habitat. However, there is uncertainty as to whether the Project Area provides important habitat for deep-water cetaceans including northern bottlenose whales (see Section 6.3; Delarue et al. 2018; Maxner et al. 2018).

11.5.1 Blue Whale

There may be fewer than 250 adult blue whales in the Endangered Atlantic population and recruitment appears to be low (COSEWIC 2002). Blue whales have been predominantly sighted in the Gulf of St. Lawrence and St. Lawrence Estuary with most sightings offshore NL along the south coast and west of the RSA (see Section 6.3.7). Blue whale calls have been detected on an acoustic recorder deployed in the Project Area during late summer and early fall in 2014 and 2015 (Maxner et al. 2018). Available information indicates that this species does occur in the Project Area during summer and early fall but likely in low numbers, which reduces the potential for interactions with Project activities. As recently reaffirmed in a proposed Action Plan prepared by DFO (2018), the main threats to the recovery of the Atlantic blue whale population were determined by experts to be anthropogenic sound, which causes a degraded underwater acoustic environment and can alter behaviour, and the lack of prey availability which could result from ecosystem changes caused by climate change. Contaminants, vessel collisions, disturbances caused by whale watching activities, entanglements in fishing gear, epizootics, toxic algal blooms and toxic spills are also threats for this species. Several of these main threats to recovery have been identified as potential effects from Equinor Canada's Project activities. If small numbers of blue whales occur in the Project Area it is quite possible that they may exhibit localized avoidance of Project activities that produce sound at predominantly low-frequencies (i.e., air source arrays, vessels). The duration of any behavioural response will likely be short-term but could occur regularly over the life of the Project (12 to 30 years) for blue whales that may occur in the area. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP will reduce potential auditory injury effects of air source arrays on blue whales. The potential for ship strikes is unlikely.

11.5.2 North Atlantic Right Whale

The best estimate for the Endangered North Atlantic population is 451 individuals (Pettis et al. 2017), but the population size has been declining since 2010 (Pace et al. 2017). In Atlantic Canada, North Atlantic right whales are found during summer and fall in the Bay of Fundy, on the Scotian Shelf, the Gulf of St. Lawrence and, rarely, in the waters off NL (COSEWIC 2013), although there have been recent acoustic detections in Placentia Bay and in slope waters off the south coast of NL. This species has not been detected (visually or acoustically) in or near the Project Area. As such, the potential for this SAR to interact with Project activities is considered quite low. If a right whale did occur in the Project Area it may experience minor and temporary behavioural responses to Project activities. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP will reduce potential auditory injury effects of air source arrays on right whales. The potential for ship strikes is unlikely.

Table 11.7 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA Schedule 1 Status	COSEWIC Designation	Summary of Presence and Potential Interactions/Effects
Blue whale (Atlantic population)	Endangered	Endangered	• Considered rare in the Project Area and LSA, with possibly more frequent occurrences in the shelf waters of the RSA. Most likely to occur in the RSA during summer. • Low potential for interaction with Project activities given rare occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)
North Atlantic right whale	Endangered	Endangered	• Considered rare in the Project Area and LSA, with possibly more frequent occurrences in the shelf waters of the RSA. Most likely to occur in the RSA during summer. • Low potential for interaction with Project activities given rare occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)
Bowhead whale (Eastern Canada-West Greenland population)	Not Listed	Special Concern	• Considered rare in the Project Area, LSA, and RSA • Low potential for interaction with Project activities given rare occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)
Fin whale (Atlantic Population)	Special Concern	Special Concern	• Considered common in the Project Area, LSA, and RSA with likely peak numbers in summer and lower numbers occurring year-round • High potential for interaction with Project activities given common occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)

Table 11.7 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA Schedule 1 Status	COSEWIC Designation	Summary of Presence and Potential Interactions/Effects
Northern bottlenose whale (1: Scotian Shelf population/ 2: Davis Strait-Baffin Bay-Labrador Sea population)	1: Endangered 2: Not Listed	1: Endangered 2: Special Concern	• Possibly common in the Project Area but likely in low numbers year-round. It is uncertain which population of northern bottlenose whales occurs in the Project Area. • Moderate to high potential for interaction with Project activities given this species is possibly common in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)
Sowerby's beaked whale	Special Concern	Special Concern	• Considered uncommon in the Project Area, LSA, and RSA but likely to occur in deep-water areas year-round • Low potential for interaction with Project activities given uncommon occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)
Killer whale (Northwest Atlantic population)	Not Listed	Special Concern	• Considered uncommon in the Project Area, LSA, and RSA but likely to occur year-round. • Low potential for interaction with Project activities given uncommon occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)
Beluga whale (St. Lawrence Estuary population)	Endangered	Endangered	• Considered rare in the Project Area and LSA, with more frequent occurrences in the eastern and southern RSA. Most likely to occur in the RSA during spring to fall. • Low potential for interaction with Project activities given rare occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing

Table 11.7 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	SARA Schedule 1 Status	COSEWIC Designation	Summary of Presence and Potential Interactions/Effects
Harbour porpoise (Northwest Atlantic subspecies)	Not Listed (Threatened on Schedule 2)	Special Concern	• Considered uncommon in the Project Area and LSA with more frequent occurrences in other areas of the RSA but likely to occur year-round. • Low to moderate potential for interaction with Project activities given uncommon occurrence in the Project Area • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing (vessel transits)
Leatherback sea turtle	Endangered	Endangered	• Considered rare in the Project Area and LSA, with more frequent occurrences in the eastern and southern RSA. Most likely to occur in the RSA during spring to fall. • Low potential for interaction with Project activities given rare occurrence in the Project Area. • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing
Loggerhead sea turtle	Endangered	Endangered	• Considered rare in the Project Area and LSA, with more frequent occurrences in the southern RSA. Most likely to occur in the RSA during spring to fall. • Low potential for interaction with Project activities given rare occurrence in the Project Area. • Proposed mitigation will reduce risk of effects from underwater sound (i.e., seismic surveys, geohazard surveys, VSP), discharges, and supply and servicing

11.5.3 Bowhead Whale

The Eastern Canada-West Greenland population of bowhead whale remains listed as a species of Special Concern by COSEWIC, despite a recent rise in numbers to an estimated 6,000-7000 individuals from post-commercial whaling lows (COSEWIC 2009; Doniol-Valcroze et al. 2015; Fraiser et al. 2015). The bowhead whale is an arctic species and it is highly unlikely to occur in or near the Project Area. It has not been visually or acoustically detected within or near the Project Area. As such, the potential for this SAR to interact with Project activities is considered negligible to low. If a bowhead whale did occur in the Project Area, it may experience minor and temporary behavioural responses to Project activities. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP will reduce potential auditory injury effects of air source arrays on bowhead whales. The potential for ship strikes is unlikely.

11.5.4 Fin Whale

Despite being listed as Special Concern, fin whales are considered common in the Project Area and RSA. During the ESRF acoustic study, fin whales were by far the most commonly detected mysticete. This species was acoustically detected year-round in offshore waters of NL, including at the Sackville Spur acoustic recorder which was located in the Project Area (Delarue et al. 2018). However, fin whales are generally considered more abundant during summer. The key threats to fin whales as identified by DFO in the Management Plan for this species are habitat degradation from anthropogenic sound, changes in prey availability and quality, ship strikes, and entanglement in fishing gear (DFO 2017a). With the exception of fishing gear entanglement, these main threats to recovery have been identified as potential effects from Equinor Canada’s Project activities. Fin whales that occur in the Project Area may exhibit localized avoidance of Project activities that produce sound at predominantly low frequencies (i.e., air source arrays, vessels). The duration of any behavioural response will likely be short-term but could occur regularly over the life of the Project (12 to 30 years) for fin whales. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP will reduce potential auditory injury effects of air source arrays on fin whales. The potential for ship strikes is unlikely.

11.5.5 Northern Bottlenose Whale

There are two recognized populations of northern bottlenose whales which occur in Atlantic Canada. The Scotian Shelf population (Endangered) is estimated at 143 individuals (O’Brien and Whitehead 2013), but there are no estimates of the size of the Davis Strait-Baffin Bay-Labrador Sea population (Special Concern) or the total number of northern bottlenose whales in the Northwest Atlantic (COSEWIC 2011). Visual and acoustic detections of northern bottlenose whales in and near the Project Area indicate this species is common in the area and that it occurs there year-round. However, it is uncertain which of the two known populations the detected northern bottlenose whales belong or whether these whales belong to a separate population. Regardless, available information indicates that northern bottlenose whales regularly occur in and near the Project Area and that the Sackville Spur area may represent important habitat for this species since it is a deep-water species with an affinity for canyon/slope habitat. As such, the potential for interactions with the Project are considered moderate to high. Threats to northern bottlenose whale recovery have been identified as entanglement in fishing gear, acoustic disturbance from oil and gas activities (including geophysical surveys), and exposure to contaminants (COSEWIC 2011; DFO 2017b). Northern bottlenose whales will be regularly exposed to underwater sound from Project activities throughout the year for a 12 to 30-year period. However, most Project activities which will occur continuously throughout the year have relatively low source levels with most acoustic energy at low-frequencies (FPSO, supply and support vessels) and will occur from a fixed location, which should reduce the extent of avoidance responses. At various times throughout the Project life, there will be concurrent drilling activities and supporting surveys (i.e., seismic surveys, VSP, geohazard surveys). Although it is predicted with a moderate to high level of confidence that the adverse effects of these activities will be localized and likely short-term, the confidence decreases when multiple activities will occur concurrently in the Core BdN Development Area and Project Area. Effects from sound produced by multiple concurrent Project activities and indeed regular geophysical surveys could pose more of an issue for northern bottlenose whales if the Project Area represents finite habitat which is important for foraging, migrating, nursing, and/or breeding. There is limited information to ascertain whether the Sackville Spur area (i.e., the Project Area) provides important habitat for northern bottlenose whales. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP, as well as the implementation of air source shut downs for beaked whales, will reduce potential auditory injury effects of air source arrays on northern bottlenose whales. The potential for ship strikes is unlikely.

11.5.6 Sowerby's Beaked Whale

The Atlantic population of Sowerby's beaked whale is listed as Special Concern both under Schedule 1 of SARA and by COSEWIC. There are currently no estimates for the size of this population in Atlantic Canada (COSEWIC 2007; DFO 2016b). Available information indicates that this species occurs in low numbers in the Project Area and RSA throughout the year. As such, the likelihood for interactions with Project activities is considered low. Threats to this population as identified by COSEWIC (2007) and DFO (2017c) include acoustic disturbance, entanglement in fishing gear, vessel strikes, and exposure to contaminants. If small numbers of Sowerby's beaked whales occur in the Project Area it is quite possible that they may exhibit localized avoidance of Project activities that produce sound at high levels (i.e., air source arrays). The duration of any behavioural response will likely be short-term but could occur regularly over the life of the Project (12 to 30 years) for Sowerby's beaked whales that may occur there. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP as well as the implementation of air source shut downs for beaked whales will reduce potential auditory injury effects of air source arrays on Sowerby's beaked whale. The potential for ship strikes is unlikely.

11.5.7 Killer Whale

Killer whales (Northwest Atlantic/Eastern Arctic population) are listed as a species of Special Concern by COSEWIC but are currently not listed by SARA. Killer whales are considered uncommon in the Project Area (only one reported sighting) and RSA with most sightings recorded during May to September; however, sightings offshore NL have been more frequent over the last decade (Lawson and Stevens 2014; Waring et al. 2015). The potential for this SAR to interact with Project activities is considered low. Killer whales may exhibit localized avoidance of Project activities that produce high sound levels (i.e., air source arrays). The duration of any behavioural response will likely be short-term but could occur regularly over the life of the Project for the small number of killer whales that may occur there. As assessed previously, there is minimal risk of injury or mortality from Project activities with mitigation measures in place. The potential for ship strikes is unlikely.

11.5.8 Beluga Whale

The Endangered St. Lawrence Estuary population of beluga whale primarily occurs in the Gulf of St. Lawrence Estuary during summer months and then migrates eastward into the northwestern Gulf of St. Lawrence during the fall and winter (COSEWIC 2014). The critical habitat of the St. Lawrence beluga whale is located in the Gulf of St. Lawrence, more specifically from the Upper Estuary, from the Battures aux Loups Marins down into the Saguenay River, and in the southern portion of the Lower Estuary (DFO 2012). The occurrence of this beluga population in the Project Area and RSA is considered rare. As such, the potential for this SAR to interact with Project activities is considered quite low. If a beluga whale did occur in the Project Area, it may experience minor and temporary behavioural responses to Project activities. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP will reduce potential auditory injury effects of air source arrays on beluga whales. The potential for ship strikes is unlikely.

11.5.9 Harbour Porpoise

The Northwest Atlantic population of harbour porpoise has been observed throughout the RSA but it is generally considered more abundant in coastal waters. This species is considered uncommon in the Project Area given the limited number of reported sightings there, but this may be attributable to lack of dedicated survey effort. For example, north of the Project Area, in Orphan Basin, numerous sightings of harbour porpoise were made during a marine mammal monitoring for Chevron's seismic program in 2005 (Moulton et al. 2006; see Figure 6-62). The potential for this SAR to interact with Project activities is considered low to moderate. Harbour porpoises in the Project Area may exhibit localized avoidance of Project activities, that produce sound at predominantly high-frequencies (i.e., MBES) and those with high sound levels but within the range of harbour porpoise hearing (i.e., air source arrays). The duration of any behavioural response will likely be short-term but could occur regularly over the life of the Project for harbour porpoises that may occur there. As assessed previously, there is minimal risk of injury or mortality from Project activities with mitigation measures in place. The potential for ship strikes is unlikely.

11.5.10 Leatherback Sea Turtle

Three proposed critical habitat areas have been identified for the Endangered leatherback sea turtle: the Southwestern Scotian Slope Area, the Gulf of St. Lawrence-Laurentian Channel Area, and the Placentia Bay Area (DFO 2016c. This species is considered rare in the Project Area; it has not been reported there. As such, the potential for leatherbacks to interact with Project activities is considered quite low. If a leatherback did occur in the Project Area, it may experience minor and temporary behavioural responses to Project activities. As assessed previously, there is minimal risk of injury or mortality from Project activities. Adherence to the SOCP will reduce potential auditory injury effects of air source arrays on sea turtles. The potential for ship strikes is unlikely.

11.5.11 Loggerhead Sea Turtle

Like leatherbacks, the loggerhead sea turtle is considered rare in the Project Area; it has not been reported there. The potential for loggerhead sea turtles to interact with Project activities is considered quite low. If a loggerhead did occur in the Project Area, it may experience minor and temporary behavioral responses to Project activities. As assessed previously, there is minimal risk of injury or mortality from Project activities with the implementation of mitigation measures. The potential for ship strikes is unlikely.

11.6 Significance of Residual Environmental Effects

This section summarizes the residual environmental effects of the Project on Marine Mammals and Sea Turtles and presents a determination of significance for the environmental effects assessment for this VC.

11.6.1 Ecosystem Component Linkages

The interconnections between the physical, biological and human environment have been considered in the EIS and are summarized in Table 11.8. Overall, the EIS is based on the interactions between project activities and VCs using source-pathway-receptor relationships as addressed in Section 11.1.5.1. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not affect significance determinations, as the potential effects (via direct and indirect pathways) on marine mammals and sea turtles have been assessed.

Table 11.8 Ecosystem Linkages Marine Mammals and Sea Turtles (including SAR)

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Offshore Construction and Installation, Hook-Up and Commissioning (in Core BdN and Project Area Tiebacks)			
Presence of Vessels	• Vessels transiting • Underwater sound emissions	**Core BdN and Project Area Tiebacks– PA** • Vessel traffic has potential to cause mortality or injury through collisions. • Sounds may cause sensory disturbance which may be responsible for the avoidance response in the immediate vicinity of vessels. • Some potential for masking of marine mammal communication and foraging due to sound interference.	Avoidance/attraction behaviours of prey species could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
HUC Activities	• Marine Discharges	**Core BdN and Project Area Tiebacks– PA** • The marine discharges may affect the health of marine mammals and sea turtles.	Avoidance/attraction behaviours of prey species could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
Production and Maintenance Operations (in Core BdN Area)			
Presence of FPSO and Subsea Infrastructure	• Underwater sound emissions	**Core BdN and Project Area Tiebacks– PA** • Sounds may cause sensory disturbance which may be responsible for the avoidance response in the immediate vicinity of offshore facilities. • Some potential for masking of marine mammal communication and foraging.	Avoidance/attraction behaviours of prey species could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.

Table 11.8 Ecosystem Linkages Marine Mammals and Sea Turtles (including SAR)

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Drilling Activities (in Core BdN and Project Area Tiebacks)			
Presence of Drilling Installation	• Underwater sound emissions	**Core BdN and Project Area Tiebacks– PA** • Sounds may cause sensory disturbance which may be responsible for the avoidance response in the immediate vicinity of offshore facilities. • Some potential for masking of marine mammal communication and foraging due to sound interference.	Avoidance/attraction behaviours of prey species could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
Supply and Servicing (in Core BdN and Project Area Tiebacks)			
Marine Vessels	• Vessel traffic • Sound emissions	**Core BdN and Project Area Tiebacks– PA** • Vessel traffic has potential to cause mortality or injury through collisions. • Presence of vessels may cause localized, short-term changes in habitat use, including displacement from the immediate area around vessels. • Sounds may cause sensory disturbance which may be responsible for the avoidance response in the immediate vicinity of vessels. • Some potential for masking of marine mammal communication and foraging due to sound interference.	Avoidance/attraction behaviours of prey species could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
Aircraft (helicopters)	• Sound	**Core BdN and Project Area Tiebacks– PA** • At low altitudes (during takeoff and landing), presence of helicopters may result in minor disturbance from sound or overflight effects.	

Table 11.8 Ecosystem Linkages Marine Mammals and Sea Turtles (including SAR)

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Supporting Surveys (in Core BdN and Project Area Tiebacks)			
Supporting Surveys	• Presence of vessels • Sound	**Core BdN and Project Area Tiebacks– PA** • Vessel traffic has potential to cause mortality or injury through collisions. • Presence of vessels may cause localized, short-term changes in habitat use, including displacement from the immediate area around vessels. • Sounds, such as those from seismic surveys, may cause sensory disturbance which may be responsible for the avoidance response. • During seismic surveys, permanent auditory injury may occur in the immediate vicinity of the sound source; use of ramp-up and shut down procedures and avoidance of seismic sound will reduce the potential for this effect. • Some potential for masking of marine mammal communication and foraging due to sound interference in areas proximate to the sound source.	Avoidance/attraction behaviours of prey species could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
Decommissioning (in Core BdN and Project Area Tiebacks)			
Decommissioning	• Decommissioning of FPSO • Removal of subsea infrastructure • Well decommissioning	**Core BdN and Project Area Tiebacks– PA** • Vessel traffic has potential to cause mortality or injury through collisions. • Presence of vessels may cause localized, short-term changes in habitat use, including displacement from the immediate area around vessels. • Sounds may cause sensory disturbance which may be responsible for the avoidance response in the immediate vicinity of vessels. • Marine mammals may temporarily avoid a localized area around the wellhead during mechanical separation of the wellhead from the seabed.	Avoidance/attraction behaviours could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles. Damage to, or mortality of, benthic plants, fish and invertebrate species could result in loss of refugia and change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals.

11.6.2 Residual Environmental Effects Summary

Project activities within the Core BdN Development Area will occur year-round over a 12- to 20-year period, and Project Area Tiebacks may extend activities out to 30 years (total), should it occur. Project activities will interact with Marine Mammals and Sea Turtles and may result in a change in injury and/or mortality levels, habitat quality and/or use, and prey availability and/or quality. Only marine discharges during production and maintenance operations were identified as potentially resulting in a change in Marine Mammal and Sea Turtle health through the release of produced water, respectively.

Marine Mammals and Sea Turtles may experience injury and/or mortality if they are struck by a Project vessel. Based upon a review of available information, the potential for this to occur in the Project Area and along the vessel traffic route to/from the Project Area is considered low and is further reduced by mitigation measures. Likewise, the assessment for potential auditory injury resulting from exposure to underwater sound from impulsive sound sources (i.e., air source arrays, MBES used during supporting surveys) and continuous sound sources (i.e., Project vessels including the FPSO and drillship) concluded that with mitigation measures (i.e., adherence to the SOCP) in place, auditory injury in marine mammals and sea turtles was considered unlikely to occur. Underwater sound generated during all Project components was assessed as potentially resulting in localized and likely short- to long-term avoidance of sound sources by Marine Mammals and Sea Turtles, depending on the activity. Based on behavioural threshold criteria, acoustic modelling results and a review of the literature, the extent of this avoidance was predicted to be highest for activities using air sources (i.e., seismic surveys and to a lesser extent geohazard surveys and VSP) and for the FPSO and drillship which will employ DP thrusters. There is some uncertainty in how marine mammals (and sea turtles should they occur there) will respond to multiple sound sources from concurrent Project activities.

Tables 11.9 and 11.10 summarize the environmental effects assessment for the Core BdN Development and Project Area Tiebacks, respectively, that comprise the Project being assessed under CEAA 2012.

Table 11.9 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles (including SAR) - Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Marine Vessels										
Underwater Sound Emissions from vessels	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km^2 to 100 km^2 - 1,000 km^2	S	C	Y	M - H	Not Proposed	Not Proposed
	Change in Prey Availability and/or Quality	A	N	<1 km^2	S	C	Y	H		
PRODUCTION AND MAINTENANCE OPERATIONS										
Presence of the FPSO										
Underwater Sound Emissions	Change in Injury and/or Mortality Levels	A	N - L	<1 km^2	L	N	Y	M - H	Not Proposed	Not Proposed
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	M	<1,000 km^2	L	C	Y	M - H		
	Change in Prey Availability or Quality	A	N	<1 km^2	L	C	Y	M - H		
Produced Water	Change in Health	A	N	<1 km^2	L	C	Y	M - H	A, B, C, D, E	Not Proposed
	Change in Prey Availability or Quality	A	N	<10 km^2	L	C	Y	H		
DRILLING ACTIVITIES										
Drilling Installation										
Underwater Sound Emissions from the Drilling Installation	Change in Injury and/or Mortality Levels	A	N-L	<1 km^2	L	N	Y	M - H	Not Proposed	Proposed when FPSO and drilling installation operating concurrently
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	M	<10,000 km^2	M	C	Y	M - H		
	Change in Prey Availability and/or Quality	A	N	<1 km^2	M	C	Y	M - H		
SUPPLY AND SERVICING										
Marine Vessels										
Presence of Vessels	Change in Injury and/or Mortality Levels	A	L	<1 km^2	L	N	Y	M-H	F, J, M	Not Proposed
Underwater Sound Emissions from Vessels	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km^2 to 100 km^2-1,000 km^2	S -L	S - R	Y	M-H	Not Proposed	Not Proposed
	Change in Prey Availability and/or Quality	A	N	<1 km^2	L	S-C	Y	H		
Aircraft (Helicopters)										
Movement/Sound	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<1 km^2	S	S	Y	H	F, G	Not Proposed

Table 11.9 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles (including SAR) - Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
SUPPORTING SURVEYS										
Marine Vessels										
Presence of Vessels	Change in Injury and/or Mortality Levels	A	L	<1 km^2	L	N	Y	M - H	M	Not Proposed
Underwater Sound Emissions from Vessels	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km^2 to 100 km^2-1,000 km^2	S	S - R	Y	M - H	Not Proposed	Not Proposed
	Change in Prey Availability and/or Quality	A	N	<1 km^2	S	S-C	Y	H		
Underwater Sound Emissions from Geophysical Survey Equipment										
2D/3D/4D Surveys	Change in Injury and/or Mortality Levels	A	N	<1 km^2	L	N	Y	M - H	H, I, K, L	Proposed
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	M	<10 km^2 to 100 km^2-1,000 km^2	S	C	Y	M - H		
	Change in Prey Availability and/or Quality	A	L	1,000 km^2 to 10,000 km^2	S	S	Y	H		
VSP Surveys	Change in Injury and/or Mortality Levels	A	N	<1 km^2	L	N	Y	M - H	H, I, L	Not Proposed
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L-M	<10 km^2 to 100 km^2-1,000 km^2	S	S	Y	M - H		
	Change in Prey Availability and/or Quality	A	N	1,000 km^2 to 10,000 km^2	S	S	Y	H		
Wellsite/Geohazard Surveys	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L-M	< 100 km^2	S	C	Y	M - H	L	Not Proposed
	Change in Injury and/or Mortality Levels	A	N	<1 km^2	L	N	Y	M - H	L	Not Proposed
DECOMMISSIONING										
Underwater sound emissions associated with decommissioning (all activities)	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km^2 to 100 km^2-1,000 km^2	S	R	N/A	M-H	A, B, C, D, E, F, G, H, M, N, O. P	Not Proposed

Table 11.9 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles (including SAR) - Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		

Evaluation of Significance

- Based on the nature and characteristics of the Core BdN Development activities and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Core BdN Development is not likely to result in significant adverse effects on the Marine Mammals and Sea Turtles.
- Although Project-related components, activities, and emissions may result in some short- to long-term effects on individuals, the number of individuals and areas that may be affected, and the likely temporary and reversible nature of these interactions, indicates that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Table 11.10 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY

Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Marine Vessels										
Underwater Sound Emissions from vessels	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km² to 100 km²-1,000 km²	S	C	Y	M - H	Not Proposed	Not Proposed
	Change in Prey Availability and/or Quality	A	N	<1 km²	S	C	Y	H		
PRODUCTION AND MAINTENANCE OPERATIONS										
Presence of the FPSO										
Underwater Sound Emissions	Change in Injury and/or Mortality Levels	A	N-L	<1 km²	L	N	Y	M-H	Not Proposed	Not Proposed
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	M	<1,000 km²	L	C	Y	M - H		
	Change in Prey Availability and/or Quality	A	N	<1 km²	L	C	Y	M - H		
Produced Water	Change in Health	A	N	<1 km²	L	C	Y	M-H	A, B, C, D, E	Not Proposed
	Change in Prey Availability and/or Quality	A	N	<10 km²	L	C	Y	H		

Table 11.10 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		
DRILLING ACTIVITIES										
Drilling Installation										
Underwater Sound Emissions from the Drilling Installation	Change in Injury and/or Mortality Levels	A	N-L	<1 km^2	L	N	Y	M-H	Not Proposed	Proposed
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	M	<10,000 km^2	M	C	Y	M - H		
	Change in Prey Availability or Quality	A	N	<1 km^2	M	C	Y	H - H		
SUPPLY AND SERVICING										
Marine Vessels										
Presence of Vessels	Change in Injury and/or Mortality Levels	A	L	<1 km^2	L	N	Y	M-H	F, J, M	Not Proposed
Underwater Sound Emissions from Vessels	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km^2 to 100 km^2-1,000 km^2	S - L	S - R	Y	M - H	Not Proposed	Not Proposed
	Change in Prey Availability or Quality	A	N	<1 km^2	L	S - C	Y	H		
Aircraft (Helicopters)										
Movement/Sound	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<1 km^2	S	S	Y	H	F, G	Not Proposed
SUPPORTING SURVEYS										
Marine Vessels										
Presence of Vessels	Change in Injury and/or Mortality Levels	A	L	<1 km^2	L	N	Y	M - H	M	Not Proposed
Underwater Sound Emissions from Vessels	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km^2 to 100 km^2-1,000 km^2	S	S - R	Y	M - H	Not Proposed	Not Proposed
	Change in Prey Availability and/or Quality	A	N	<1 km^2	S	S-C	Y	H		
Underwater Sound Emissions from Geophysical Survey Equipment										
2D/3D/4D Surveys	Change in Injury and/or Mortality Levels	A	N	<1 km^2	L	N	Y	M - H	H, I, K, L	Not Proposed
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	M	<10 km^2 to 100 km^2-1,000 km^2	S	C	Y	M - H		
	Change in Prey Availability and/or Quality	A	L	1,000 km^2 to 10,000 km^2	S	S	Y	H		
VSP Surveys	Change in Injury and/or Mortality Levels	A	N	<1 km^2	L	N	Y	M - H	H, I, L	Not Proposed
	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L-M	<10 km^2 to 100 km^2-1,000 km^2	S	S	Y	M - H		
	Change in Prey Availability and/or Quality	A	N	1,000 km^2 to 10,000 km^2	S	S	Y	H		
Wellsite/Geohazard Surveys	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L-M	< 100 km^2	S	C	Y	M - H	L	Not Proposed
	Change in Injury and/or Mortality Levels	A	N	<1 km^2	L	N	Y	M - H	L	Not Proposed

Table 11.10 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles (including SAR) – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
DECOMMISSIONING										
Underwater sound emissions associated with decommissioning (all activities)	Change in Habitat Quality and/or Use (Behavioural Effects)	A	L	<10 km^2 to 100 km^2-1,000 km^2	S	R	N/A	M-H	A, B, C, D, E, F, G, H, M, N, O. P	Not Proposed

Evaluation of Significance

- Based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant adverse effects on the Marine Mammals and Sea Turtles.
- Although Project-related components, activities, and emissions may result in some, short- to long-term effects on individuals, the number of individuals and areas that may be affected, and the likely temporary and reversible nature of these interactions, indicates that the Project will not have any overall ecological or population-level effects, and will not result in any detectable decline in overall abundance or changes in the spatial and temporal distributions of populations within the RSA.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km^2

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

11.6.3 Determination of Significance

It is predicted that the Project will not result in significant adverse effects on Marine Mammals and Sea Turtles. Although Project-related activities are generally predicted to result short- to long-term effects on marine mammals and possibly sea turtles in the Project Area (possibly extending to the LSA), the number of individuals that may be affected, and the reversible nature of these effects, indicates that the Project will not result in a detectable decline in overall marine mammal and sea turtle abundance or changes in the spatial and temporal distributions of marine mammal and sea turtle populations. The potential for interactions between individuals of SAR and the Project is considered limited (with the likely exception of fin whales, northern bottlenose whales, and possibly Sowerby's beaked whales), and no identified critical habitat is present in the Project Area, LSA, or RSA. The Project is not predicted to jeopardize the overall abundance, distribution, or health of SAR. With mitigation and environmental protection measures, the residual environmental effects on Marine Mammals and Sea Turtles (including SAR) are predicted to be not significant.

This overall determination is generally made with a moderate to high level of confidence given there are several uncertainties in predicting the effects of the Project on Marine Mammals and Sea Turtles. There are limited baseline data on Marine Mammal and Sea Turtle use of the Project Area. Therefore, there is uncertainty as to whether the Project Area or certain portions of the Project Area are regularly used as important foraging areas, migratory corridors, and/or breeding areas for marine mammals—particularly northern bottlenose whales. There is also uncertainty due to the lack of systematic information on marine mammal response to multiple, concurrent oil and gas activities, like those that will occur periodically during the Project.

11.7 Environmental Monitoring and Follow-up

Equinor Canada will develop and implement a marine mammal and sea turtle observation program for 4D seismic surveys. The plan will be provided to DFO for review and acceptance. The plan will include MMO requirements, shutdown and ramp-up procedures and reporting requirements. A report of the observational program will be submitted annually to the C-NLOPB and DFO, including documentation of marine mammal and sea turtle sightings.

When the FPSO and drilling installation are in the Project Area at the same time, Equinor Canada will monitor sound transmissions through the water column to validate the modelled sound emission estimates. In addition, during 4D seismic surveys, sound transmission through the water through the water column will also be measured. Details regarding the underwater sound monitoring program will be developed based on the specific attributes of the FPSO, drilling installation and the 4D seismic survey. Equinor Canada will engage DFO in the design of the underwater sound monitoring program. In keeping with adaptive management, the effects monitoring program will be designed such that monitoring parameters can be modified or discontinued over time. For instance, underwater sound emissions when the FPSO and drilling installation are on site would only be undertaken the first time both operations are concurrent, thereby providing a determination of underwater sound transmission during concurrent operations. Monitoring for underwater sound transmissions during 4D seismic, would also only occur during the first instance to verify modelling estimates.

Equinor Canada will engage with the ESRF Management Board to advocate for the establishment of a regional study regarding the use of deep-water areas (Flemish Pass, Orphan Basin) by marine mammals.

Additional information respecting follow-up and monitoring programs is provided in Section 18.4.

11.8 References

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12.0 SPECIAL AREAS: ENVIRONMENTAL EFFECTS ASSESSMENT

Special areas in offshore Newfoundland and Labrador (NL) have been identified based on their defining environmental features, including the presence of sensitive habitats and species such as marine fish and fish habitat, marine and migratory birds and marine mammals and sea turtles and their human use and societal value. The effects of the Project from routine operations on the associated Valued Components (VCs) (i.e., Marine Fish and Fish Habitat, Marine and Migratory Birds, Marine Mammals and Sea Turtles) are discussed in Chapters 9 to 11, respectively, and this information is foundational to this Chapter. Various types of special areas in marine and coastal environments have been identified and/or protected based on socioeconomic interests such as economic or recreational / cultural activities. These include protective measures to reduce the effects of bottom-trawl fishing, which supports long-term sustainability of commercial fisheries, meaning that these special areas are not currently used for fishing. Effects on Commercial Fisheries and Other Ocean Uses are addressed in more detail in Chapter 13.

This Chapter provides an assessment of potential effects of the Project on the Special Areas VC based on the defining features for which special areas have been identified and/or protected. While there are a number of special areas in the Project Regional Study Area (RSA) (additional information can be found in Section 6.4), the focus of the effects assessment is on those special areas that are within the Local Study Area (LSA), including the vessel traffic route.

12.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

The following sections define the spatial and temporal context within which potential environmental effects on Special Areas are assessed and provide the definition of a significant residual adverse environmental effect. These have been established to direct and focus the environmental effects assessment for the VC.

12.1.1 Spatial Boundaries

Four spatial assessment boundaries have been defined for the environmental effects assessment of this VC. They reflect the Core Bay du Nord (BdN) Development, Project Area Tiebacks, and the varying ways in which the Project and VC may interact. The boundaries are informed by the nature, scale, timing, and other characteristics of the Project and the existing environmental setting, and potential environmental interactions. These Study Areas are defined as follows and are shown in Figure 12-1.

Core BdN Development Area: The Core BdN Development Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct disturbance to the marine environment may occur. It occupies an offshore area of approximately 470 km², encompassing the proposed location of the floating production, storage and offloading (FPSO) and supporting subsea infrastructure and activities. The actual seabed footprint of Project facilities within the Core BdN Development Area is approximately 7 km², representing approximately 1.5 percent of the entire Core BdN Development Area.

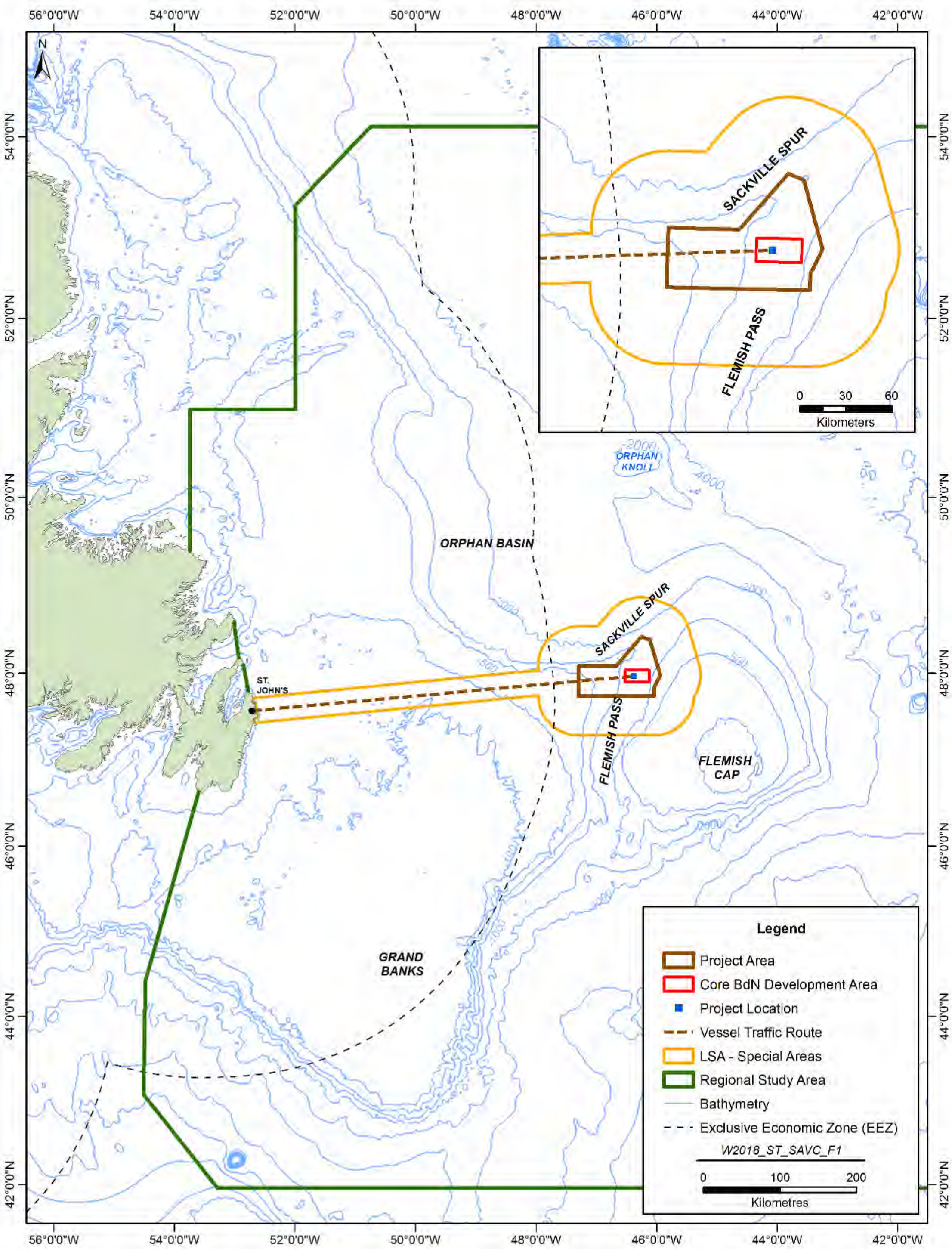

Figure 12-1 Environmental Assessment Study Areas: Special Areas

Project Area: The broader Project Area is where Project Area Tiebacks (as described in Section 2.6.6) may occur. While the Project Area is defined as an overall area that encompasses all activities for the duration of the Project, different components and activities may occupy smaller areas within this overall area, as described in Chapter 2. The Core BdN Development Area is located entirely within the Project Area. The Project Area is approximately 4,900 km². The footprint of the Core BdN Development subsea infrastructure is approximately 0.1 percent of the Project Area. If Project Area Tiebacks were to be undertaken (see Section 12.4), as illustrated in Figure 12-3, the footprint of potential new tiebacks represents approximately 15 km², or less than 0.5 percent of the Project Area.

Local Study Area (LSA): The LSA encompasses the overall geographic area over which all routine Project-related environmental interactions may occur. It represents the predicted environmental zone of influence of the Project's components and activities, within which Project-related environmental changes to Special Areas may occur and can be assessed and evaluated. The LSA is conservatively defined as a 50 km wide area around the offshore Project Area and 15 km around the associated vessel traffic route to encompass the zones of influence for the three preceding biological VCs (i.e. Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles).

Regional Study Area (RSA): The environmental effects assessment also recognizes and considers the characteristics, distributions, and movements associated with the individual VCs under consideration from an ecological and socioeconomic perspective. The RSA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). The RSA is defined based on the predicted zone of influence of a potential oil spill event, as summarized in Section 16.4, specifically, the area of maximum cumulative surface oil thickness for the 95th percentile surface oil exposure case at the ecological threshold of 10 g/m² (0.01 mm). The RSA captures the marine waters offshore eastern NL, including all or part of Northwest Atlantic Fisheries Organization (NAFO) Divisions 2J, 3K, 3L, 3M, 3N and 3O.

12.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the frequency and duration of routine Project-related activities as well as the likely timing of resulting environmental effects. The overall schedule for the Project is provided in Section 2.1.1, and the temporal boundaries of each Project phase are provided in Table 12.1.

Table 12.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Core BdN Development Phases	
Offshore Construction and, Installation, and Hook-up and Commissioning (HUC)	• Site surveys as early as 2021 • Offshore construction as early as 2023, but may occur later • Approximately 5 years; seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of year
Production and Maintenance Operations	• Commencement anticipated in 2026 • 12 to 20 years; year-round

Table 12.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Drilling Activities	• Commencement in or around 2024 • On average, drilling time is approximately 45 to 85 days per well (may be shorter for pilot wells and/or tiebacks) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2021 • Ongoing throughout life of Project; year-round
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed. • Approximately 2 to 4 years; seasonal or year-round
Project Area Tiebacks	*Extension of Project life to a maximum of 30 years*
Offshore Construction and Installation, and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to five tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but some activities could occur year-round • May occur at any time over life of Project
Production and Maintenance Operations	• Continuation of activities from existing FPSO out to end of Project life • Year-round
Drilling Activities	• Total timeframe for drilling depends on number of wells required • On average, drilling time is approximately 45-85 days per well • May occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Year-round, when drilling occurs
Supply and Servicing	• Continuation of ongoing activities to end of Project life • Year-round
Supporting Surveys	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

12.1.3 Approach and Methods

The analysis and description of potential environmental effects of the Project on this VC are based on the EA methodology detailed in Chapter 4 of this EIS and include the nature, scale and timing of the Project's components and activities (Chapter 2), and the existing environment for this VC (Section 6.4). This analysis has focused on identifying key potential Project-VC interactions and anticipated changes to the existing biophysical environment resulting from Project activities that may, through one or more associated pathways, lead either directly or indirectly to overall effects on the biological or sociocultural aspects of special areas.

The assessment for this VC considers what is known or can reasonably be deduced about Special Areas that are likely to be affected by Project activities in the LSA, with a focus on important defining features for which these areas have been identified and/or protected. The assessment and description of environmental effects and the identification of mitigations has been informed by a review of existing and available literature, including scientific studies and monitoring initiatives that have investigated and documented the actual effects of such activities on sensitive defining features of relevant Special Areas likely to be affected by Project activities. In addition, the planning process for this environmental assessment has included modelling to define the nature of potential interactions and effects resulting from Project-induced discharges such as drill cuttings, produced water, air emissions and underwater sound emissions. A summary of the modelling is described in Section 4.3.4 and is discussed as appropriate in Chapters 9, 10 and 11, which assess potential effects on marine species and habitats, and is included in this VC as relevant.

12.1.4 Environmental Effect Significance Definitions

The definitions used to characterize environmental effects are provided for in Chapter 4 (Table 4.5) and are provided below specific to the Special Areas VC. These characterizations will be used throughout this VC assessment in describing residual environmental effects on Special Areas from routine Project Activities.

Table 12.2 Characterization of Residual Effects on Special Areas

Characterization	Description	Definition of Categories
Nature/Direction of effect	The long-term trend of the residual environmental effect relative to baseline	• **Positive** – a residual environmental effect on the defining ecological and/or sociocultural features of the special area that is considered beneficial to special areas relative to baseline conditions • **Adverse** – a residual environmental effect on the defining ecological and/or sociocultural features of the special area that is considered harmful to special areas relative to baseline conditions • **Neutral** – no change in the defining ecological and/or sociocultural features of the special area relative to baseline conditions

Table 12.2 Characterization of Residual Effects on Special Areas

Characterization	Description	Definition of Categories
Magnitude of effect	The degree of change to the defining ecological and/or sociocultural features of the special area relative to baseline	• **Negligible** – although there is a potential for a Project-VC interaction, there would be no change in the defining ecological and/or sociocultural features of the special area relative to baseline conditions • **Low** – a change in the defining ecological and/or sociocultural features of the special area that is considered within the range of natural variability but with no associated adverse effect on the defining ecological and /or sociocultural features of the special area • **Medium** – a change in the defining ecological and/or sociocultural features of the special area that is considered beyond the range of natural variability, but with no associated adverse effect on the defining ecological and /or sociocultural features of the special area • **High** – a change in the defining ecological and/or sociocultural features of the special area that is considered beyond the range of natural variability, with an adverse effect on the defining ecological and/or sociocultural characteristics features of the special area
Geographic Extent of effect	The spatial area within which the residual environmental effect will likely occur	• Less 1 km² • Less than 10 km² • Less than 100 km² • Less than 1,000 km² • Less than 10,000 km² • Greater than 10,000 km²
Duration of effect	The period of time required until the change in the defining ecological and/or sociocultural features of the special area returns to its baseline condition, or the residual effect can no longer be measured or otherwise perceived	• Short Term – less than 12 months (1 year) • Medium Term – 1 to 5 years • Long Term – more than 5 years • Permanent – recovery to baseline conditions unlikely
Frequency of effect	Identifies how often a residual effect will likely occur	• Not likely to occur • Occurs once – effect occurs one time • Occurs sporadically – effect occurs episodically, a no set schedule • Occurs regularly – effect occurs at regular intervals • Occurs continuously – effect occurs continuously

Table 12.2 Characterization of Residual Effects on Special Areas

Characterization	Description	Definition of Categories
Reversibility of effect	Pertains to the change in the defining ecological and/or sociocultural features of the special area can return to baseline conditions after the Project/activity stops	• **Reversible**: Will eventually recover to baseline conditions • **Irreversible**: Permanent

Significant residual adverse environmental effects are considered to be those that could cause a change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. In consideration of the descriptors listed in Table 12.2, as well as a consideration of regulatory requirements, a significant residual adverse environmental effect on Special Areas is defined as one that would cause:

- A detectable adverse change in one or more of the important and defining ecological and sociocultural characteristics of such an area, resulting in a decrease in its overall integrity, value and use.

The potential environmental effects of accidental events on Special Areas are evaluated and assessed in Chapter 16 (Accidental Events).

12.1.5 Potential Environmental Changes, Effects and Mitigation Measures

The following sections provide an overview of potential environmental effects resulting from routine Project activities on Special Areas. Mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable. The potential environmental effects of accidental events on Special Areas are evaluated and assessed in Chapter 16.

The assessment is focused on Project activities and their environmental interactions. To assist with the effects assessment, modelling was undertaken at representative sites within the Core BdN Development Area to evaluate the potential dispersion and predicted "footprint" of produced water and drill cutting discharges, and underwater sound emissions (Appendices J and I and D respectively).

12.1.5.1 Potential Project-Related Environmental Changes and Effects

Potential environmental interactions between Project activities and Special Areas have been identified through review of the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014), the Flemish Pass Exploration Drilling EIS (herein referred to as the Drilling EIS) (Statoil 2017), the information required by the Canadian Environmental Assessment Agency (the CEA Agency) arising from its technical review of the Drilling EIS (the "IRs"). In addition, the EIS Guidelines issued by the CEA Agency in September 2018 identify and specify a number of issues and potential effects on this VC that are also considered in the EIS (refer to Section 7.3.8.3 in Appendix A). Based on review of these resources, it has been determined that potential direct and indirect adverse effects on Special Areas that could be caused by Project activities are:

- Change in environmental features and/or processes
- Change in human use and/or societal value

Equinor Canada has completed an environmental assessment process per the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) for its Drilling EIS. Comments related to Special Areas from the Drilling EIS EA process, as well as those received during ongoing engagement with Indigenous groups and stakeholders with regard to the BdN Development (as identified in Sections 3.3.1.2 and 3.4 of this EIS) are as follows and are addressed, as applicable to the scope of the assessment, herein.

Government Department and Agencies

- Potential effects of drilling wastes on sensitive benthic habitat (e.g., corals and sponges)
- Survey methodology for coral and sponge survey and the drill cuttings model
- Potential effects of disposal of discharges in the marine environment
- Use of marine mammal and bird observers

Indigenous Groups

- Potential effects of discharges (e.g., drill cuttings, produced water) and emissions on fish and sensitive benthic habitat (e.g., corals and sponges)
- Potential effects of vessel and helicopter traffic (including increased traffic, risk of vessel strikes, lighting, sound, emissions, discharges) on marine birds, whales, dolphins and seals
- Potential effects of sound, including geophysical testing, on marine life (i.e., mammals, birds, fish and fish habitat) and resulting changes in animal behavior
- Potential effects of artificial lighting, flaring and emissions on marine and migratory birds and marine mammals
- Potential effects on marine mammals (i.e., right whales and seals)

Stakeholder Organizations

- Potential effects on Marine Fish and Fish Habitat
- Potential effects on Marine and Migratory Birds
- Potential effects on Marine Mammals and Sea Turtles
- Potential effects on Commercial Fisheries and Other Ocean Uses
- Environmental effects monitoring (EEM)

The environmental effects assessment for this VC considers and focuses on the issues and questions identified through these issues scoping exercises, and as identified in Section 7.3.8.3 of the EIS Guidelines (Appendix A), including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from them. These are summarized in Table 12.3.

Table 12.3 Potential Project-Related Environmental Changes and Resulting Effects: Special Areas

Potential Environmental Effect	Potential Environmental Change
Change in Environmental Features and/or Processes *Change in Human Use and/or Societal Value*	• Special areas have been identified under provincial, federal, and/or other legislation and processes because of their ecological, biological, historical, and/or socio-cultural characteristics and importance. • Direct or indirect changes to the existing natural or human environments resulting from Project-related interactions may affect key environmental characteristics and processes that define and distinguish special areas, and thus, affect their overall and underlying characteristics, integrity and value. • Disturbance, injury or mortality of benthic habitat and marine species, in special areas, resulting from sound, sedimentation, smothering, or direct contact. • Changes in presence, abundance, diversity, and health of marine species in special areas. • Changes in water quality that affect marine species endemic to special areas. • Attraction of marine species (endemic to special areas) to installations and vessels due to artificial lighting, and associated increased foraging, injury or mortality.

Information provided in Chapters 9, 10 and 11 of the EIS was used to determine if the Project would interact with those species and/or habitats for which the special areas in the LSA have been identified or designated. An overview of the potential interactions between each of the Project's components and activities and Special Areas, and specifically, the potential for these to result in environmental changes to the various aspects of this VC, are presented in Table 12.4. In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of Project activities is based on those discharges/activities "with the greatest potential to have environmental effects." This is based on scientific literature, research studies, Indigenous knowledge, input from Indigenous groups and stakeholders, and professional experience of the EIS team. Those Project activities with the potential to interact with the defining features of special areas are the focus of the effects assessment.

Table 12.4 Potential Project-VC Interactions and Associated Effects: Special Areas

Project Component / Activity	Potential Environmental Effects		Mitigation (see Section 12.1.5.2)
	Change in Environmental Features and/or Processes	Change in Human Use and/or Societal Value	
CORE BdN DEVELOPMENT			
OFFSHORE CONSTRUCTION AND INSTALLATION, HOOK-UP AND COMMISSIONING (HUC)			
Marine Vessels			
• Presence	No Interaction		
• Light Emissions	No Interaction		

Table 12.4 Potential Project-VC Interactions and Associated Effects: Special Areas

Project Component / Activity	Potential Environmental Effects: Change in Environmental Features and/or Processes	Potential Environmental Effects: Change in Human Use and/or Societal Value	Mitigation (see Section 12.1.5.2)
• Underwater Sound Emissions	No Interaction		
• Marine Discharges	No Interaction		
Installation of Subsea Infrastructure	•		A, C
Hook-up and Commissioning			
• HUC Discharges	No Interaction		
PRODUCTION AND MAINTENANCE OPERATIONS			
• Presence FPSO and Subsea Infrastructure	•		C
• Light Emissions	No Interaction		
• Underwater Sound Emissions	No Interaction		
Marine Waste Discharges from the FPSO			
• Produced Water	No Interaction		
• Marine Discharges	No Interaction		
• Non-routine Flaring	No Interaction		
DRILLING ACTIVITIES			
• Presence of Drilling Installation	No Interaction		
• Light Emissions	No Interaction		
• Underwater Sound Emissions	No Interaction		
Waste Discharges from Drilling Installation			
• Drill Cuttings	•		B, E, F
• Marine Discharges	No Interaction		
• Flaring during formation flow testing	No Interaction		
Supply and Servicing			
Marine Vessels			
• Presence	•		K, L, Q, R
• Light Emissions	•		K, L
• Underwater Sound Emissions	•		K, L
• Marine Discharges	No Interaction		
Aircraft (helicopters)			
• Movement/Sound	•		J, K

Table 12.4 Potential Project-VC Interactions and Associated Effects: Special Areas

Project Component / Activity	Potential Environmental Effects: Change in Environmental Features and/or Processes	Potential Environmental Effects: Change in Human Use and/or Societal Value	Mitigation (see Section 12.1.5.2)
Supporting Surveys			
• Presence of Vessels and Towed Equipment	No Interaction		
• Light Emissions from Vessels	No Interaction		
• Underwater Sound Emissions from Vessels	No Interaction		
• Contact with Seabed	No Interaction		
• Marine Discharges	No Interaction		
• Underwater Sound Emissions from Geophysical Survey Equipment	No Interaction		
Decommissioning			
Decommissioning of FPSO	No Interaction		
Decommissioning of Subsea Infrastructure	•		U
Well Decommissioning	•		U, W
PROJECT AREA TIEBACKS			
Offshore Construction and Installation, and HUC			
Installation of Subsea Infrastructure	•		A, C
Drilling Activities			
Waste Discharges from Drilling Installation			
• Drill Cuttings	•		B, E, F
Supply and Servicing			
Marine Vessels			
• Presence	•	•	K, L, Q, R
• Light Emissions	•	•	K, L
• Underwater Sound Emissions	•	•	K, L
Aircraft Helicopters			
• Presence/Movement of Helicopters	•		J, K
Supporting Surveys			
• Underwater Sound Emissions from Geophysical Survey Equipment	No Interaction		
Decommissioning			
• Decommissioning of Subsea Infrastructure	•		U
• Well Decommissioning	•		U, W

The defining features for those special areas that overlap with the Core BdN Development Area and the Project Area are benthic species (e.g., corals, sponges, corals and sea pens) and/or biogenic habitats. Therefore, the focus of the effects assessment for activities within the Core BdN Development Area and PA is on those Project activities that interact with benthic habitats. Based on the effects assessment for Marine Fish and Fish Habitat, it was determined that the installation of subsea infrastructure and its presence during Production and Maintenance Operations phase, and the discharge of drill cuttings are the primary interactions of Project activities with benthic habitat. Other Project activities in the Core BdN Development and Project Areas, do not interact with benthic habitats (see Chapter 9) and therefore are not identified in Table 12.4.

Underwater sound generated by geophysical activities (i.e., seismic surveys) is not identified as a potential interaction associated with the Core BdN Development or Project Area Tiebacks due to the distance between these activities and special areas with marine species that may be affected by underwater sound. The nearest special area identified for the presence of species is the Northeast Slope EBSA, which is noted for aggregations of marine mammals, particularly harp seals, hooded seals and pilot whales as well as fish species. At its nearest point, the Northeast Slope EBSA is approximately 89 km from the Core BdN Development Area and approximately 31 km from the Project Area (Section 12.2). Based on available scientific literature and as summarized in Section 9.3.5.4, marine invertebrates and fish in these special areas will not be exposed to levels of Project-associated sound that have potential to cause either physical or behavioural effects. Based on acoustic modelling undertaken for the EIS, the maximum distance for behavioural effects from seismic sounds on marine mammals and sea turtles would be 20.1 km (see Table 11-5 in Section 11.3). Given the distance of the Northeast Slope EBSA from the Core BdN Development Area and Project Area, geophysical activities are highly unlikely to affect marine mammals in this special area.

Marine discharges, including those from vessels, drilling installation(s) and the FPSO are not considered interactions with Special Areas within the LSA, including the vessel traffic route. The defining features for those special areas that overlap with the Core BdN Development Area and the Project Area (i.e., a NAFO FCA, five VMEs and the Slopes of the Flemish Cap and Grand Bank EBSA) are benthic species (e.g., corals, sponges, corals and sea pens) and/or biogenic habitats. As noted in Chapter 9, marine discharges are not anticipated to interact with benthic species or benthic habitats. For vessels engaged in Supply and Servicing, marine discharges are identified as not having an interaction with fish and marine mammals (see Section 9.1.5.1 and 11.1.5.1, respectively). For marine and migratory birds, Chapter 10 predicts that effects would be negligible and localized to the vessel. Therefore, there is no interaction of marine discharges with special areas noted to support marine mammals, birds or fish species and which intersects the vessel traffic route.

For supply and servicing, the focus of the assessment will be on the potential effects of marine vessel and helicopter traffic on special areas in the LSA, which includes the zone of influence for the vessel traffic route. The defining features of special areas in the LSA include marine fish and fish habitat, marine and migratory birds and marine mammals and sea turtles. However, supply and servicing activities are not anticipated to interact with benthic species or habitats. Potential interactions include presence of marine vessels and lighting and sound emissions from vessels, as well as the presence of helicopters.

Special areas used by humans for commercial, recreation, subsistence, or tourism activities, are in coastal and onshore areas, which are approximately 500 km from the Project (Section 6.4). Therefore, changes in human use and/or societal value would only be affected by Supply and Servicing activities in Special Areas along the vessel traffic corridor. Two National Historic Sites and a crab fishing closure area are located within vessel traffic corridor (Section 12.2). Users of these special areas could potentially experience increased sound from marine vessel and helicopter traffic, but such sound is generally consistent with the overall marine traffic that has occurred throughout the region for many years and is therefore not considered an interaction. As identified in Section 13.3.4.1, the primary interaction with supply and servicing along the vessel traffic route is with fixed gear associated with the crab fishery. The special area intersecting the vessel traffic area, is a crab fishing closure area, therefore there would be no interaction with crab fishing and therefore there is no activity which would interact with changes in human use and/or societal value.

12.1.5.2 Summary of Mitigation Measures

Mitigation measures to prevent or reduce adverse effects upon Special Areas and the features for which they have been identified, as listed below, are identified and considered in an integrated manner within and throughout the environmental effects analysis that follows, as applicable. Mitigations for the associated interactions are identified in Table 12.4.

A. With regards to subsea layout, well templates will not be placed over *Lophelia pertusa* corals
B. Discharge locations for water-based cuttings, when cuttings transport system is used, will be determined based on the C-NLOPB requirements to avoid *Lophelia pertusa* complexes and/or assemblages of 5 or more corals in $100m^2$ with heights greater than 30 cm within 100 metres (m) of the discharge location.
C. Where Project activities may affect fish habitat, and it is determined through DFO’s “Request for Review” process pursuant to the Fisheries Act that a Fisheries Act Authorization is required, a habitat offsetting program will be developed in conjunction with DFO and in consultation with Indigenous Groups and stakeholders as a mitigation measure for the net loss of fish habitat resulting from the Project (See Appendix O).
D. Ballast water and hull fouling will be managed in consideration of applicable Canadian and international requirements to reduce the potential spread of invasive species.
E. In consideration of the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010) and regulatory discharge limits, for discharges associated with the Project, the use of best treatment practices that are commercially available and economically feasible will be implemented.
F. The selection and screening of chemicals to be discharged, will be undertaken in consideration of the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG) (NEB et al. 2009) and Equinor Canada’s chemical selection and screening processes.
G. Marine discharges (e.g., bilge water) will be treated in accordance with MARPOL and Canadian requirements prior to discharge
H. Sewage and food waste will be treated in consideration of the OWTG and in accordance with Canadian and international regulatory requirements (e.g., IMO).

I. Appropriate procedures will be implemented for the handling, storage, transportation, and onshore disposal of solid and hazardous waste.
J. Use of anti-fouling paint on hull of FPSO
K. Use of common traffic routes for vessels and helicopters will be used where possible and practicable
L. Helicopter flight paths and offshore supply vessel (OSV) transit routes will adhere to the periods of avoidance, and specific set back distances, associated with specific, established migratory bird nesting colonies outlines in the *NL Seabird Ecological Reserve Regulations, 2015* and in consideration of federal guidelines in order to reduce disturbance to colonies.
M. Low-level aircraft (helicopters) operations will be limited or avoided where it is not required per Transport Canada protocols.
N. In consideration of the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2019), mitigation measures applied during the Project's geophysical surveys where air source arrays are used will be consistent with those outlined in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) (DFO 2007). This includes implementing a shut-down of the air source array(s) when SAR listed as Endangered or Threatened on Schedule 1 of SARA (as well as all beaked whale species) are detected within the safety zone during anytime air sources are active, including ramp up.
O. Shut-down of air source arrays for all beaked whales when detected within safety zone
P. Equinor Canada will develop a marine mammal and sea turtle monitoring plan for 4D seismic surveys which will be provided to Fisheries and Oceans Canada (DFO) for review and input
Q. Consistent with International Regulations for Preventing Collisions at Sea, 1972 with Canadian Modifications, Rule 5, every vessel shall maintain a proper lookout at all times. Project vessels will alter course and/or reduce speed if a marine mammal(s) (or sea turtle) is detected ahead of the vessel.
R. If Equinor Canada is aware of a Project vessel striking a marine mammal or sea turtle, the Equinor Canada will inform DFO through their 24-hour emergency contact number (1-888-895-3003).
S. Equinor Canada will communicate seismic survey plans to C-NLOPB and geophysical operators as early as possible to reduce concurrent seismic surveys and/or to maximize the separation distance between surveys to the extent possible
T. Communications and notifications of Project activities, as applicable, with commercial fisheries and other ocean users (see Section 13.1.5.2 for a complete list)
U. A decommissioning plan will be developed and submitted to the C-NLOPB for review and acceptance. The plan will be made in consideration of regulatory requirements, engagement with Indigenous groups, commercial fisheries and other stakeholders and likely effects on the environment.

V. At the time of decommissioning, all surface facilities (e.g., FPSO, turret, anchor lines) will be removed.
W. Use of explosives will not be employed for removal of wellheads.
X. At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements.

12.2 Overview of Special Areas

Chapter 6 identifies and describes the defining environmental features (and protection, as applicable) of special areas within the RSA, including recent or known upcoming changes to their status or their defined boundaries to the extent that this information is available. Information on the defining features of special areas is varied as agencies that identify or protect them have differing reporting systems and protocols meaning that publicly available information for some types of special areas is robust, while limited for others. In some cases, available information on special areas is based on modelling and/or likely presence of species and/or habitats based on known indicator features. The effects assessment for this VC is based on known and available information about special areas and closely linked to the assessment of Marine Fish and Fish Habitat (Chapter 9), Marine and Migratory Birds (Chapter 10) and Marine Mammals and Sea Turtles (Chapter 11).

Various special areas intersect with the Core BdN Area, the Project Area and/or LSA including the supply vessel route where marine vessels and aircraft are anticipated to transit. Summaries of the defining features of these special areas in the LSA (including any information on species for which they have been identified or protected) along with the distance between Project spatial boundaries and these special areas are included in Table 12.5. The Core BdN Area intersects three special areas: NAFO fishery closure area Northwest Flemish Cap (10), a VME identified for sea pens and the Slopes of the Flemish Cap and Grand Banks United Nations (UN) Convention on Biological Diversity (CBD) Ecologically or Biologically Significant Areas (EBSA). Each of these special areas has been identified and/or protected due to the presence of high concentrations of sensitive benthic species such as corals, sponges and sea pens. In addition to the special areas in the Core BdN Development Area, the Project Area also intersects with four other VMEs, which are identified for sponges or large gorgonian corals. The LSA intersects spatially with 20 additional special areas both in the offshore area and along the vessel traffic route (Figure 12.2).

Table 12.5 Summary of Special Areas in the LSA

Special Area	Defining Features	Nearest Distance[1] to Special Area (km)		
		CBdN	PA	LSA
Canadian Ecologically and Biologically Significant Areas (EBSAs)				
Northeast Slope	Concentrations of corals. High aggregations of Greenland halibut and spotted wolffish (Threatened status) in spring. Aggregations of marine mammals particularly harp seals, hooded seals and pilot whales	89	31	Intersect
Eastern Avalon	Seabird feeding areas. Cetaceans, leatherback turtles and seals feed in the area from spring to fall	418	358	Intersect (TR)[2]
Baccalieu Island	Capelin spawning area. Aggregations of killer whales, shrimp, piscivores, spotted wolfish. Foraging area of Atlantic puffin, black-legged kittiwake and razorbill	409	351	Intersect (TR)
Marine Refuges				
Northeast Newfoundland Slope Closure	High density of corals and sponges; high biodiversity. Bottom contact fishing activities prohibited to protect corals and sponges and contribute to long-term conservation	92	34	Intersect
Newfoundland and Labrador Shelves Bioregion Significant Benthic Areas (SiBAs)				
Sea Pens	Predicted presence probability of sea pens or large gorgonian corals	90	32	Intersect (1)[3]
Large Gorgonian Corals		116	58	Intersect (TR) (1)
Snow Crab Stewardship Exclusion Zones				
Crab Fishing Area Near Shore	Crab fishing closure	415	356	Intersect (TR)
Crab Fishing Area 6C	Crab fishing closure	420	359	Intersect (TR)
Representative Marine Areas (RMAs)				
III-East Avalon / Grand Banks	Description not available.	415	356	Intersect (TR)
Coastal National Parks and Historic Sites				
Cape Spear National Historic Site	Historical lighthouse and lighthouse keeper's home, most eastern point of North America	460	401	Intersect (TR)

Table 12.5 Summary of Special Areas in the LSA

Special Area	Defining Features	Nearest Distance[1] to Special Area (km)		
		CBdN	PA	LSA
Signal Hill National Historic Site	Historic site of wireless communication and military defense of St. John's Harbour	463	405	Intersect (TR)
United Nations Convention on Biological Diversity (UNCBD) EBSAs				
Slopes of the Flemish Cap and Grand Bank	Aggregations of corals and sponges, high diversity of marine taxa including threatened and listed species. Greenland halibut fishery grounds in international waters	Intersect	Intersect	Intersect
Vulnerable Marine Ecosystems (VMEs)				
Sponge	Concentrations of sponges, sea pens or corals	1	Intersect (3)	Intersect (6)
Sea Pen		Intersect (1)	Intersect (1)	Intersect (2)
Large Gorgonian Coral		31	Intersect (1)	Intersect (1)
Northwest Atlantic Fisheries Organization (NAFO) Fishery Closure Areas (FCAs)				
Sackville Spur (6)	High sponge and coral concentration areas where bottom fishing is prohibited	32	3	Intersect
Northern Flemish Cap (9)		63	37	Intersect
Northwest Flemish Cap (10)		Intersect	Intersect	Intersect
Northwest Flemish Cap (11)		44	26	Intersect
Northwest Flemish Cap (12)		25	10	Intersect
Important Bird Areas (IBAs)				
Quidi Vidi Lake	Daytime resting site for gulls (e.g., herring, great black-backed, Iceland, glaucous, common black-headed) late fall to early spring; ring-billed gull, mew gull and lesser black-backed gull; waterfowl (e.g., American black ducks, mallards and northern pintails) common in winter	462	404	Intersect (TR)

Notes:
1. All distances are calculated in NAD83 UTM Zone 23N Projection
2. TR refers to the Traffic Route. Special areas intersecting the LSA along the Traffic Route is noted with a TR in parentheses.
3. For SiBAs and VMEs, numbers in parentheses indicate the number of this type of special area intersecting with the CBdN, PA or LSA.

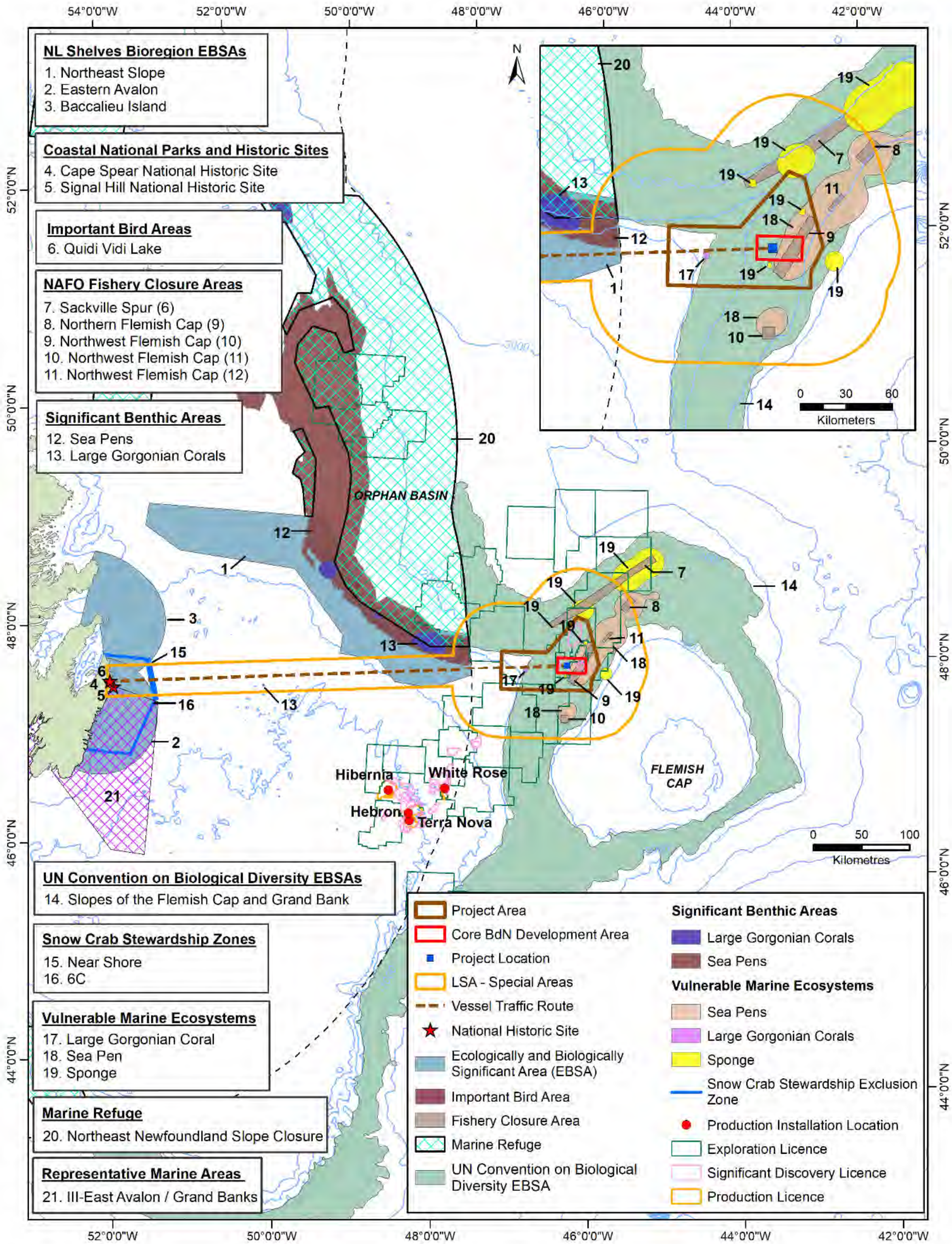

Figure 12-2 Overview of Special Areas in or Intersecting the LSA

12.3 Core BdN Development

The Core BdN Development includes six broad phases / categories of activities as described in Chapter 2:

- Offshore Construction and Installation, and HUC
- Production and maintenance operations
- Drilling activities
- Supply and servicing
- Supporting surveys
- Decommissioning

The assessment in the following sections is based on these activities and associated interactions as identified in Table 12.4.

12.3.1 Offshore Construction and Installation, and Hook-Up and Commissioning

Activities associated with Offshore Construction and Installation and HUC, as described in Section 2.6.1, are those activities that are undertaken before and during the arrival of the FPSO at the Core BdN Development Area.

Offshore construction and installation activities include site preparation for, and the installation of subsea infrastructure (i.e., well templates, flowlines, risers, riser base, umbilicals, fibre optic cable). As noted in Section 2.6.1.2, options for installation of flowlines, umbilicals, and/or cables include placement on seafloor, or laid via trenching. In certain cases, there may be a requirement for protection of the flowlines/cables/umbilicals. Options for protection include rock placement, concrete mattresses or trenching. These protection measures would be undertaken during offshore construction and installation.

These activities will likely be carried seasonally, when offshore weather conditions are favourable, and could extend seasonally over a five-year period. For the purpose of this EA, seasonal offshore activities are generally assumed to occur between the spring and fall months when weather conditions are more favorable for marine activity. Specialized vessels, as listed in Section 2.6.4.2, will be engaged as required to carry out these activities; the number of vessels offshore at any one time will depend on the activities ongoing at that time. Vessels would be engaged in activities at set locations within the footprint of the subsurface installations. For instance, for well template installations, it is likely that a single vessel would be engaged for installation, therefore the zone of influence during well template installation would be limited to a specific well template location and when installation is complete at one location, the vessel would move to the next well template location. Similarly, for flowline installation, the vessel engaged would be situated at one location only. While two different activities may occur at the same time (i.e., well template installation and flowline installation by two different vessels), it is not anticipated that there would be more than one vessel engaged in the same activity. The approximate sequence of SURF installation would be to install well templates and related components, install the FPSO mooring system, install the flowlines, risers and umbilicals, install the turret buoy, pull-in the risers, hook up the FPSO, and install infrastructure protection, as needed.

HUC activities may occur at any time of the year and are estimated to last approximately four months, depending on operational and/or technical issues. Vessels on site during HUC activities, in addition to the FPSO, may include, but not limited to, vessels engaged to attach flowlines, moorings, risers, etc., to the FPSO. Activities also include the flushing and leak testing of production lines on the FPSO and flowlines on the seafloor.

As indicated in Section 12.1.5.1, the effects assessment for Offshore Construction and Installation and HUC is focused on those interactions and activities "with the greatest potential to have environmental effects" (Part 2, Section 3.2 of the EIS Guidelines) and therefore for Special Areas, is focused on the installation of subsea infrastructure.

12.3.1.1 Installation of Subsea Infrastructure

The primary effect on Special Areas associated with the installation of subsea infrastructure is:

- Change in Environmental Features and/or Processes

Change in human use and/or societal value is not identified as an effect associated with the installation of subsea infrastructure because this activity will occur in the offshore environment and special areas used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are approximately 500 km from the Project (Section 6.4).

Change in Environmental Features and/or Processes is a potential effect associated with associated with the installation of subsea infrastructure.

As discussed in Section 9.2.1.1, the Offshore Construction and Installation Phase of the Project will include localized physical interaction with the seabed and may result in direct disturbance to the seafloor and benthic habitats and fauna. This may also result in exposure, injury, and/or mortality of benthic organisms, including corals, sponges and sea pens such as those found in the three special areas that intersect the Core BdN Development Area (Table 12.5), through direct contact, burial by deposition of cuttings and the introduction of suspended solids in the water (Whatling and Norse 1998; Thrush and Dayton 2002; Clark et al. 2016; Cordes et al. 2016). These organisms are vulnerable to physical disturbance due to their low avoidance capabilities (Clark et al. 2016; Cordes et al. 2016).

In fine mud substrate habitat, such as that common in the Flemish Pass (Murillo et al. 2016), sampling, site preparation and installation activities will temporarily disturb the seabed environment, resuspending sediments and introducing particles of different shapes and sizes (see Section 9.2.1.1). An increase or change in suspension solids may clog feeding structures of filter-feeding organisms, including corals, sponges, and sea pens (Bell et al. 2015; Liefmann et al. 2018; Vad et al. 2018). Coral and sponge biogenic habitats, where habitat is created by an organism itself, are of concern due to their fragile nature and slow recovery (Henry and Hart 2005; Cordes et al. 2016; NAFO 2016). Coral densities have been shown to decrease in areas of disturbance (i.e., trawling), however, some sea pen species have been able to re-anchor themselves into sediment after dislodgement (Malecha and Stone 2009; NAFO 2011). As noted in Section 9.3.1.4, colonization of hard substrates is evident in the Core BdN Development Area with colonization taking multiple years in deeper waters.

Installation of subsea infrastructure will result in a small footprint within the special areas in the Core BdN Development Area. The footprint of the subsea infrastructure is approximately 7 km². For the three special areas that intersect the Core BdN Development Area, the Northwest Flemish Cap (10) FCA (sometimes referred to as VME closure) is the smallest, with an area of 316 km². Conservatively, using the smaller special area, an estimate of area affected with the placement of subsea infrastructure can be provided. Based on preliminary Project design, as described in Chapter 2, up to two templates and a portion of a flowline corridor are proposed within the portion of the Northwest Flemish Cap (10) FCA that intersects the Core BdN Area. Approximately 126 km² (40 percent) of this special area intersects the Core BdN. In this portion of the FCA, the footprint of the templates plus cuttings dispersion area would represent approximately 1 km². The flowline corridor represents approximately 1 km². Therefore, total area of the FCA that could potentially be affected by subsea infrastructure and drilling is approximately 2 km², representing approximately 1.4 percent of the area of the FCA intersecting the Core BdN Development Area that could be affected by Project activities, or less than 0.5 percent of the total area of the FCA. Since this is the smallest of the three special areas intersecting the Core BdN Development Area, the very conservative estimate of 1.4 percent will be used in the effect assessment for the total seabed area affected by subsea infrastructure for all special areas intersecting the Core BdN Development Area.

Mitigations to reduce the change in mortality, injury and/or health include no placement of well templates over *Lophelia pertusa* corals and, if required by DFO, habitat offsetting measures. If DFO determines that the placement of subsea infrastructure and/or protection measures requires an authorization pursuant to Section 35(2) of the *Fisheries Act*, offsetting measures if required, will mitigate fish and fish habitat losses (see Appendix O). Equinor Canada will commence the DFO process for a “Request for Review” pursuant to the provisions of the *Fisheries Act* prior to the commencement of the Offshore Construction and Installation phase of the Project.

The change in environmental features and/or processes associated with the installation of subsea infrastructure would be adverse, as described above, but medium- to long-term, depending on species in the area and/or length of time for recolonization. The geographic extent of the change environmental features and/or processes would be within tens of meters of the location of the subsea infrastructure within the Core BdN Development Area that overlaps with the noted special areas. Overall the subsea infrastructure covers approximately 2 km² of the seabed within the FCA. The change would range from sporadic for turbidity effects to regular for changes to seabed effects during installation. As the change in environmental features and/or processes is approximately 1.4 percent of the area of the FCA intersecting the Core BdN Development Area, or less than 1 percent of the total area of the FCA, the change in environmental features and/or processes is considered within the range of natural variability, therefore the magnitude of change would be low. Mitigations to reduce the change in environmental features and/or processes are noted above. These predictions are made with a high level of confidence, with the exception of duration of effect. Due to uncertainties associated with benthic recolonization, as discussed above, the predictions of duration of effect and timeframe to recovery are made with a moderate level of confidence.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Environmental Features and/or Processes of Special Areas associated with the installation of subsea infrastructure are predicted to be adverse, low in magnitude, less than 10 km², medium- to long-term in duration, occurring sporadically to regularly, and reversible. This prediction is made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with the installation of subsea infrastructure and/or protection measures during Offshore Construction and Installation and HUC include placement of well templates to avoid *Lophelia pertusa* (A) and habitat offsetting measures, if determined by DFO through its Fisheries Act authorization process that they are required (C).

Follow-up Monitoring is not proposed for the effects on Special Areas associated with the installation of subsea infrastructure. However, if DFO determines through its *Fisheries Act* authorization process that habitat offsetting measures are required, a monitoring program may be required.

12.3.2 Production and Maintenance Operations

Activities associated with production and maintenance operations, as described in Section 2.6.2, are those activities that are undertaken once HUC activities are complete when production operations commence on the FPSO. All activities are from the FPSO and therefore in a fixed location within the Core BdN Development Area. The FPSO will be onsite for approximately 12 to 20 years at its location within the Core BdN Development Area.

Special Areas that intersect the Core BdN Development Area are identified and/or protected due to the presence of sensitive benthic species and biogenic habitats. As discussed in Section 12.1.5.1, and noted in Table 12.4, the only interaction associated with Production and Maintenance Operations and the benthic environment is the presence of subsea infrastructure. Production and Maintenance Operations, including discharges and emissions, will not interact with benthic species and biogenic habitats, as discussed in Section 9.3.2.

12.3.2.1 Presence of Subsea Infrastructure

The primary effect on Special Areas associated with the presence of subsea infrastructure is:

- Change in environmental features and/or processes

Change in human use and/or societal value is not identified as an effect for Installation of Subsea Infrastructure because this activity will occur in the offshore environment and special areas used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are approximately 500 km from the Project (Section 6.4).

Change in environmental features and/or processes is a potential effect on benthic habitat and species associated with the presence of subsea infrastructure.

As discussed in Section 9.3.2.1, artificial structures introduced to environments can have local influences on invertebrate community structure, species diversity, and abundance through the addition of hard substrate and habitat complexity (Wolfson et al. 1979; Bomkamp et al. 2004; Apolinario and Coutinho 2009; Macreadie et al. 2011; Ajemian et al. 2015, Reynolds et al. 2018; Lacey and Haynes 2019). Over time, there may be a shift from a soft bottom benthic invertebrate community (e.g., sea pens, sea urchins, infaunal species), to communities associated with hard substrate (e.g., sponges, soft corals, anemones). The presence of subsea infrastructure (i.e., flowlines, anchors, well templates, umbilicals, riser base) and potential protection measures (e.g., rock placement, wellhead protection, concrete mattresses) may locally increase habitat complexity through introduction of available hard structures for colonization by sessile species (Sargent et al. 2006; Bergström et al. 2014; Cordes et al. 2016; Lacey and Haynes 2019) including soft corals, sponges, and sea anemones, and shelter for mobile fish and invertebrate species.

Introduced subsea infrastructure provides stepping-stone habitat for colonizing benthic species to increase their distribution (Cordes et al. 2016). Deep-sea invertebrates use a variety of strategies to promote dispersal including delayed and slower egg development, and planktotrophic larvae with high parental investment (Young et al. 2018). As deep-sea larvae have been observed in the upper water column (Young et al. 2018), it suggests that certain species are able to disperse widely and may take advantage of temporary infrastructure structures for settling and colonization.

As noted above, changes in the environmental features and/or processes of special areas due to the presence of the subsea infrastructure are predicted to be adverse for soft bottom communities and positive for hard bottom communities, and reversible should subsea infrastructure be removed. The change in would be long term and continuous while the subsea infrastructure is in place. The geographic extent of the change in environmental features would be approximately 7 km², the area of the seafloor occupied by the subsea infrastructure, which presents approximately 1.5 percent of the total 470 km² area of the Core BdN Development Area. For special areas, as noted above, the footprint of subsea infrastructure in special areas intersecting the Core BdN Development Area represents conservatively approximately 1.4 percent of their total area. The change in environmental features and/or processes of these special areas is therefore considered within the range of natural variability and would be of low magnitude. These predictions are made with a high level of confidence, with the exception of duration of effect. Due to uncertainties associated with recolonization, as discussed above, the predictions of duration of effect and timeframe to recovery are made with a moderate level of confidence.

As noted in Section 12.3.1.1, if DFO determines a *Fisheries Act Authorization* is required for the placement of subsea infrastructure, including the requirement for habitat offsetting measures, these measures would mitigate changes in fish habitat associated with the presence of subsea infrastructure. As noted above, Equinor Canada will commence the process for a “Request for Review” pursuant to the provisions of the *Fisheries Act* prior to the commencement construction and installation activities

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Environmental Features and/or Processes associated with the presence of subsea infrastructure during Production and Maintenance Operations are predicted to be positive to adverse, low in magnitude, with a geographic extent less than 10 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with the presence of subsea infrastructure habitat are offsetting measures, if DFO determines through its Fisheries Act authorization process that they are required (C).

Follow-up Monitoring is not proposed for the effects on Special Areas associated with the installation of subsea infrastructure. However, if DFO determines through its *Fisheries Act* authorization process that habitat offsetting measures are required, a monitoring program may be required.

12.3.3 Drilling Activities

Drilling activities to be undertaken for the Core BdN Development are described in Section 2.6.3. Drilling will occur at set locations in the Core BdN Development Area, as illustrated in Figure 2-1. These set locations are illustrated on the figure as “well templates.” Depending on final project design, wells will either be drilled using templates (multiple wells drilled in one location) or at individual well locations (satellite wells). Drilling will likely commence before the FPSO arrives on site and will overlap periodically during production operations.

The effects assessment will assume that multiple wells are to be drilled at set well template locations, which provides a more conservative estimate of effects than if a single well were drilled at these well template locations. Based on current Project design, well templates may be 4-, 6- or 8-slot templates, which means that either 4, 6 or 8 wells could be drilled at a single location, from the same well template. As noted in Table 12-1, it is estimated that 45-85 days are required to drill each well. Therefore, assuming eight wells are drilled consecutively, the drilling installation could be on a well template location between approximately one to two years, respectively. If the number of wells per well template is less than eight, the time on location would be reduced accordingly.

The effects assessment, as stated in Section 12.1.5.1 is focused on those activities “with the greatest potential to have environmental effects” (EIS Guidelines 2018). As indicated in Table 12.4, the effects assessment focuses on the interactions of discharge of drill cuttings with benthic habitat.

12.3.3.1 Drill Cuttings

The primary effect on Special Areas associated with the discharge of drill cuttings is:

- Change in environmental features and/or processes

Change in human use and/or societal value is not identified as an effect associated with the discharge of drill cuttings because this activity will occur in the offshore environment and special areas used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are approximately 500 km from the Project (Section 6.4).

Change in environmental features and/or processes is a potential effect associated with the discharge of drill cuttings. Benthic habitat features may be affected by the deposition of drill cuttings on the seafloor. Based on cuttings modelling results discussed in Section 9.3.3.3, the zone of influence of drill cuttings discharge is approximately 200 from the well template location. Assuming the worst-case scenario in which eight wells are drilled at each template, the zone of influence per template would be 0.5 km², or 2.5 km² for all templates, representing approximately 0.5 percent of the Core BdN Development Area. Within the FCA, assuming two well templates the total area affected by drill cuttings would be approximately 1 km², or less than 1 percent of area of the FCA intersecting the Core BdN Development Area or less than 0.5 percent of the entire FCA.

Environmental effects of drill cuttings deposition on fish and fish habitat is discussed in detail in Section 9.3.3.3. The following is a summary of that discussion as it pertains to effects on benthic fish and fish habitat.

During Drilling Activities, synthetic-based mud (SBM) and water-based mud (WBM) associated drill cuttings will be discharged into the marine environment. Drill cutting deposition will likely interact with corals and sponges, including soft corals, sea pens, glass sponges, and demosponges in the Core BdN Area (Section 6.1.7.6) within the 200 m zone of influence of drill cuttings deposition on the sea floor. Alterations to seabed characteristics (cuttings deposition, potential seabed disturbance and burial, smothering habitat) and injury or mortality to biogenic habitat area likely to result from discharge of drill cuttings but they would be localized to the deposition area of thicknesses above PNET and be within 200 m from the cuttings discharge location. Benthic species and habitats, such as those that may be present in the three special areas that intersect the Core BdN Development Area (Table 12.5), are particularly sensitive to deposited drill cuttings and suspended mud particles as well as smothering through burial (Larsson and Purser 2011; Allers et al. 2013; Bell et al. 2015; Purser 2015; Järnegren et al. 2016; Ragnarsson et al. 2017; Liefmann et al. 2018; Vad et al. 2018, Baussant et al., 2018). Suspension-feeding structures of sessile species may become clogged by suspended drill cuttings or sediment (Neff et al. 2000; Smit et al. 2006). Increased larval mortality and change in feeding behaviour of corals has been identified due to exposure to cuttings particles (Raimondi et al. 1997, Neff 2010; Buhl-Mortensen et al. 2015; Järnegren et al. 2016; Ragnarsson et al. 2017), although some corals have higher tolerance to drill fluid deposition (Allers et al. 2013).

WBMs have varied effects on marine species but due to the non-toxic nature of the drilling fluid components (Neff 2010), are not likely to result in chemical toxicity (Holdway 2002; Trannum et al. 2010, 2011; Bakke et al. 2013; Purser 2015). Released WBM and WBM-associated drill cuttings resulting from the Project have potential for low adverse effects as these materials are associated with low toxicity, have low bioaccumulation and only localized biological effects (Deblois et al. 2014).

Acute toxicity of SBMs is considered to be relatively low based on laboratory experiments and field evaluations of SBM-associated drill cuttings piles (Still et al. 2000; Tsvetnenko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016). Potential effects on special areas that intersect the Core BdN Development Area (Table 12.5) are likely to be temporary in nature as SBMs biodegrade within a few years (Terrens et al. 1998; Ellis et al. 2012; IOGP 2016). As previously stated, Equinor Canada will use proven and practicable best available technologies and practices for the treatment of SBM cuttings prior to discharge.

As noted above, based on drill cuttings modelling (see Section 9.3.3.3) at a location within the Northwest Flemish Cap (10) FCA, drill cuttings were primarily localized to within 200 m of the wellsite, where cuttings discharge would be above the PNET of 1.5 mm. As indicated in Section 9.3.3.3, there is evidence of recovery in shallower waters occurring on time scales of three and 10 years and in deeper water it is predicted that recovery would occur over a longer timeframe. Therefore, it is estimated that the changes in environmental features and/or processes associated with drill cuttings deposition would be long-term, but reversible, once recovery occurs. The change in environmental features and/or processes would be continuous while the drilling was ongoing. As noted above, the predicted zone of influence of drill cuttings is conservatively 0.5 km² for each well template location, and less than 0.5 percent of the FCA. The change in environmental features and/or processes in represents less than 0.5 percent of total area available within FCA and is considered within the range of natural variability, but with no associated adverse effects on the defining ecological and /or sociocultural features of the special area. Therefore, the magnitude of change would be low. The above predications are made with a high level of confidence, with the exception of geographic extent and the timeframe for recovery. Uncertainties with the timeframe for recovery are above. As noted above there are uncertainties noted with recovery in deeper water depths. Geographic extent is based on modelling predictions and due to the nature of modelling as a predictive tool and inherent limitations with any model, a moderate level of confidence is assigned to geographic extent and timeframe for recovery.

Mitigations to reduce the changes in environmental features and/or processes include adhering to C-NLOPB guidance regarding the avoidance of *Lophelia pertusa* and/or coral colonies of 5 or more corals in 100 m² with heights greater than 30 cm within 100 m of the drill cutting discharge location. SBM cuttings will be treated with the use of best treatment practices that are commercially available and economically feasible and discharged in adherence to minimum discharge limits in the OWTG. For chemicals that may be discharged, per Equinor's chemical management system, and in accordance with the OCSG (NEB et al. 2009), the chemical selection and management process enables the selection of chemicals that, once discharged at sea, would have the least effect on the receiving environment.

In summary, with the application of mitigation measures, the residual environmental effects of a Changes in Environmental Features and/or Processes associated with the discharge of drill cuttings during Drilling Activities are predicted to be adverse, low in magnitude, with a geographic extent less than 1 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with drill cuttings discharge include adherence to C-NLOPB requirements for the avoidance of *Lophelia pertusa* complexes and/or coral colonies of 5 or more corals in 100 m² area with heights greater than 30 cm within 100 m of the discharge location (B); treatment and discharge of all discharges in accordance with the OWTG (E); selection and screening of chemicals in accordance with the OCSG and Equinor Canada's chemical selection and management processes (F).

Follow-up Monitoring: In consideration of the residual effects predictions based on drill cuttings dispersion modelling results, follow-up monitoring will include a component to validate the drill cutting model with respect to the zone of influence for cuttings dispersion. See Section 12.8 for additional information.

12.3.4 Supply and Servicing

Activities associated with Supply and Servicing are described in Section 2.6.4 of the EIS. Supply and servicing to support the Project will involve marine vessels (supply and support, crude shuttle tankers), shuttle tankers, and aircraft transiting to, from and within the Core BdN Development Area and Project Area at all times of the year throughout the Project duration.

As described in Section 2.6.4.2, the volume of vessel traffic associated with Core BdN Development activities represents a small increase to the overall vessel traffic off eastern Newfoundland. At a maximum, when Project phases overlap, albeit for a short duration, it is estimated that up to six support vessels could supporting Project activities and up to 16 vessels transits per month could occur. Of the total annual transits recorded servicing offshore oil and gas activities, these 16 transits per month (or 192 per year) represents and estimated 20 percent increase to offshore oil and gas related traffic or 12 percent of all traffic in the port of St. John's. During normal operational timeframe, when only one Project activity is occurring at any one time, for instance Production and Maintenance, up to three support vessels would be supporting the Project, representing eight transits per month. This typical level of supply and servicing traffic represents an estimated 10 percent increase in offshore oil and gas related traffic and 10 percent increase in all vessel traffic in the port of St. John's. Supply and support vessels supporting the Project will transit in a straight-line approach to and from port to the Project location, a common industry practice for energy efficiency employed for over 30 years by operators with facilities offshore NL.

Marine discharges from offshore vessels (e.g., bilge and ballast water, deck drainage, organic waste) are treated in accordance with international and regulatory requirements prior to discharge. Solid and hazardous wastes are disposed of onshore at approved waste management facilities, thereby reducing potential interactions with the marine environment.

With regards to helicopter support traffic, helicopters will be used for the transport of crew and supplies to and from the Project. As described in Section 2.6.4.3 up to 15 trips per week are estimated at a maximum when multiple activities are occurring such as HUC and drilling. When only production activities are ongoing, up to five helicopter transits per week are estimated. Of the total annual transits for helicopter flights servicing NL offshore oil and gas activities, at a maximum15 helicopter trips per week would represent an estimated 27 percent of annual helicopter traffic when activities are simultaneous and 11 percent of annual helicopter traffic during normal production timeframe. Note that the maximum helicopter flights would only occur for a short period of time while HUC and drilling carried out simultaneously. Helicopters will operate out of the St. John's International Airport and will be used for crew transfers and other purposes as required. Flights will use existing and common routes wherever possible. Per regulatory requirements, standard altitude profiles are between approximately 610 m (or 2,000 feet) and 2,743 m (or 9,000 feet), with an odd number altitude being flown on the eastbound flight, and an even number altitude being flown on the westbound flight for separation purposes. During the approach phase to an offshore installation, the helicopter is typically only below 152 m (or 500 feet) for three to six minutes, or approximately 2 percent of a total round-trip flight, assuming the flight is 4.5 hours. Onshore approaches to the St. John's International Airport are flown at the same approach points and altitudes as commercial air traffic.

Vessels and helicopters may interact with special areas as a result of light or underwater sound emissions. Table 12.5 identifies seven special areas in the LSA as intersecting with the traffic route. As indicated in Table 12.5, these special areas are identified for the presence of marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles. One special area along the vessel traffic route is identified for large gorgonian corals.

As discussed in Section 9.3.4, is not anticipated to result in interactions with benthic habitats. Furthermore, as noted in Section 12.1.5.1, a change in human use and/or societal value is not identified as an effect associated with Supply and Servicing. Therefore, the following effects assessment is focused on potential effects on Change in Environmental Features and/or Processes in special areas identified for fish species that inhabit the water column or sea surface, marine and migratory birds and marine mammals and sea turtles. The effects of Supply and Servicing on the Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles are described in detail in Section 9.3.4, 10.3.4 and 11.3.4, respectively. Summary information is provided herein for the effects assessment of Special Areas.

12.3.4.1 Marine Vessels

Presence of Vessels

The primary effect on Special Areas associated with the presence of vessels engaged in Supply and Servicing activities for the Project is:

- Change in environmental features and/or processes

Change in human use and/or societal value is not identified as an effect presence of vessels as noted in Section 12.1.5.1.

Change in Environmental Features and/or Processes is a potential effect associated with presence of vessels engaged in Supply and Servicing.

The LSA, including the vessel traffic route, intersects special areas (i.e., Eastern Avalon EBSA, Baccalieu Island EBSA, and Quidi Vidi Lake IBA), identified as coastal feeding, resting and wintering areas for diverse marine and migratory bird populations (Table 12.5). The effects on marine and Migratory Birds associated with the presence of vessels is discussed in Section 10.3.4.1. Vessel presence may lead to the temporary disturbance of and displacement of birds along the vessel traffic route and may change habitat availability through the use of vessels as roosting or resting sites. As noted in Section 10.3.4.1, during transit, along the vessel transit route, although the presence of these vessels may result in a change in habitat availability and behavioural effects, overall the VC is unlikely to be affected by Project-related vessel activity due to its transitory nature and thus its short-term presence at any one location. Project-related supply vessel traffic will use common routes wherever possible. Vessels will avoid coastal seabird colonies during the nesting season as per the *Seabird Ecological Reserve Regulations, 2015.*

Portions of the LSA, including the vessel traffic route intersects special areas (i.e., Northeast Slope, Baccalieu Island and Eastern Avalon EBSAs) identified for the presence of marine mammals. Project-related vessels in transit along the vessel traffic route have the potential to result in mortality or injury of marine mammals and sea turtles due to vessel strikes. All six baleen whale species found in the Northwest Atlantic, including humpbacks common to eastern Newfoundland, are documented to have been struck by ships (Jensen and Silber 2003). Also, potential exists for Project vessels to strike sea turtles resulting in injury or mortality. Propeller and collision injuries from boats and ships are common in sea turtles, at least in U.S. waters (NMFS 2008). As indicated in Section 11.3.4.1, the potential for vessel strikes on Marine Mammals and Sea Turtles is not likely to occur. Consistent with International Regulations for Preventing Collisions at Sea, 1972 with Canadian Modifications, Rule 5, every vessel shall maintain a proper lookout at all times. Project vessels will alter course and/or reduce speed if a marine mammal(s) (or sea turtle) is detected ahead of the vessel. If Equinor Canada is aware of a Project vessel striking a marine mammal or sea turtle, then Equinor Canada will inform DFO through their 24-hour emergency contact number (1-888-895-3003).

The Change in Environmental Features and/or Processes associated with the presence of vessels engaged in Supply and Servicing would be adverse, as described above and short-term due to transitory nature of vessel traffic. The geographic extent of the changes in environmental features and/or processes would be less than 1 km² of the location of the vessel along its transit route. In transit the change in changes in environmental features and/or processes would be sporadic, and reversible once the vessel(s) leaves the area. While there is a potential for an interaction of vessel presence with Special Areas, there would be no change in the defining ecological and/or sociocultural features of the special areas affected relative to baseline conditions. Therefore, the magnitude of effect is negligible. Mitigations to reduce the changes in environmental features and/or processes are noted above. This prediction is made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Environmental Features and/or Processes of Special Areas associated with the presence of vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, less than 1 km² from any vessel, short-term in duration, occurring regularly, and reversible. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with vessel presence during Supply and Servicing include use of common traffic routes (K), adherence to regulatory requirements regarding set-back distances for helicopters and vessels from nesting colonies (L), reducing speed or altering course if a marine mammal or sea turtle is observed ahead of the vessel (Q), and notifying DFO if Equinor Canada is aware of vessel strikes with marine mammals (R).

Follow-up Monitoring is not proposed for the effects on Special Areas associated with vessel presence during Supply and Servicing in consideration of residual effects predictions.

Light Emissions from Vessels

The primary effect on Special Areas associated with the light emissions from vessels engaged in Supply and Servicing activities for the Project is:

- Change in environmental features and/or processes

Change in human use and/or societal value is not identified as an effect associated with light emissions form vessels as noted in Section 12.1.5.1.

Change in Environmental Features and/or Processes is a potential effect associated with light emissions from vessels engaged in Supply and Servicing.

As noted in Section 9.3.4.1. Light emissions from vessels in the vessel traffic route may result in attraction or avoidance behaviour which may also shift the spatial distribution of prey species and effect food availability. The Northeast Slope EBSA is identified for high aggregations of Greenland halibut and spotted wolffish (Table 12.5), the latter of which is a species at risk (SAR) (listed as Threatened by the *Species at Risk Act* and COSEWIC). As discussed in Section 9.3.4, although the light and sound emissions from marine vessels may result in some level of attraction, avoidance or other behavioural responses by individual fish and invertebrates (Røstad et al. 2006; De Robertis and Handegard 2013), disturbances to marine fishes and invertebrates will be temporary as Project-related vessel activity will be transitory in nature and short-term at any one location. Mitigations to reduce the change in fish and invertebrate presence and/or abundance associated with vessel lighting are not proposed.

As presented in Section 10.3.4.1, birds are likely to experience some localized and short-term behavioural effects (change in presence and abundance), with some species being displaced by, and others attracted to, lighting. The greatest potential for interaction between artificial light emissions and marine and migratory birds is attraction of Leach's storm-petrels, for which no special areas in the LSA have been identified (Table 12.5). Light attraction has also been reported for Atlantic puffins in coastal areas near nesting colonies in both Scotland and Newfoundland (Miles et al. 2010; Wilhelm et al. 2013). As noted in Section 10.3.4.1, at typical transiting speeds between the Project Area and shore, Leach's storm-petrels are unlikely to overtake the vessels and become stranded. Food availablity may be affected by light emissions, however, as noted above, any change would be temporary as the vessels are in transit. Given that vessels along the vessel traffic route at one time or location will intersect with a small proportion of the feeding, breeding or migration area of some bird species, birds such as those found in the Eastern Avalon or Baccalieu EBSAs (Table 12.5) will not be displaced from key habitats or during important activities or be otherwise affected in a manner that causes adverse and detectable effects to overall populations in the region. Support vessels will use existing and common routes wherever possible. Vessels will avoid coastal seabird colonies during the nesting season as per the *Seabird Ecological Reserve Regulations, 2015* and federal guidelines. The various bird species that occupy special areas within the LSA will not likely be affected by supply vessel activity, due to its transitory nature and thus, its short-term presence at any one location, and because it is generally consistent with the overall marine traffic that has occurred throughout the region for many years

Based on the effects assessment for fish and bird species, as noted in Sections 9.3.4 and 10.3.4, the change in environmental features and/or processes related to fish and/or migratory birds associated with vessel lighting would be adverse, as described above, but short-term due to transitory nature of vessel traffic. The geographic extent along the vessel traffic corridor of the change in environmental features and/or processes would less than 1 km² for fish species and less than 1,000 km² for bird species due to potential light attraction effects at 15 km from vessels. The change in behaviour would be regular and reversible once the vessel(s) leaves the area. Although there is a potential for vessel lighting to interact with fish and/or bird species along the vessel transit route, there would be no change in the defining ecological and/or sociocultural features of the special areas affected relative to baseline conditions, the magnitude of change is therefore negligible. Mitigations to reduce the change in fish and invertebrate presence and/or abundance are not proposed. Mitigations to reduce affects on seabird colonies are noted above. This prediction is made with a high level of confidence based on scientific literature scientific literature and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Environmental Features and/or Processes related to marine fish and fish habitat and marine and migratory birds associated with light emissions from vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1,000 km², of short-term duration, occurring regularly and reversible. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with light emissions from vessel engaged in Supply and Servicing include use of common traffic routes (K), adherence to regulatory requirements regarding set-back distances for helicopters and vessels from nesting colonies (L)

Follow-up Monitoring is not proposed for the effects on Special Areas associated with vessel presence during Supply and Servicing in consideration of residual effects predictions.

Underwater Sound Emissions from Vessels

The primary effect on Special Areas associated with the underwater sound emissions from vessels engaged in Supply and Servicing activities for the Project is:

- Change in Environmental Features and/or Processes

Change in human use and/or societal value is not identified as an effect associated with underwater sound emissions from vessels as noted in Section 12.1.5.1.

Change in Environmental Features and/or Processes is a potential effect associated with underwater sound emissions from vessels engaged in Supply and Servicing.

As discussed in Section 11.3, marine mammals and sea turtles (such as those found in the Northeast Slope, Baccalieu Island and Eastern Avalon EBSAs) have the potential to interact with supply and servicing vessels along the vessel traffic route in the LSA (Table 12.5). The primary interactions between Marine Mammals and Sea Turtles and vessels are behavioural effects (i.e., change in habitat quality and use) and masking related to underwater sound. As noted in Section 11.3 continuous sounds produced by vessels (as well as dynamic positioning thrusters) do not typically exceed threshold levels for temporary or permanent changes in hearing ability (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007; NMFS 2016).

As noted in Section 11.3.4.1, vessel sound, through masking, can also reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014; Erbe et al. 2016; Jones et al. 2017; Putland et al. 2017). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (e.g., Branstetter et al. 2013, 2016; Finneran and

Branstetter 2013). Sound could also be a potential source of stress for marine mammals (e.g., Wright et al. 2011; Atkinson et al. 2015).

Marine mammal responses to vessels are variable and range from avoidance at long distances to little or no response or approach (Richardson et al. 1995). Responses depend on the speed, size, and direction of travel of the vessel relative to the marine mammal; slow approaches tend to elicit fewer responses than fast, erratic approaches (Richardson et al. 1995). Seals often show considerable tolerance to vessels but can also show signs of displacement in response to vessel traffic. Toothed whales sometimes show no avoidance reactions and occasionally approach vessels (e.g., northern bottlenose whales and delphinids, which are found in the Project Area); however, some species are displaced by vessels. Baleen whales, such as humpback whales, often interrupt their normal behaviour and swim rapidly away from vessels that have strong or rapidly changing sound, especially when a vessel heads directly towards a whale. Stationary vessels or slow-moving, “non-aggressive” vessels typically elicit little response from baleen whales. Overall, marine mammals (and likely sea turtles) may exhibit negligible, short-term disturbance responses to underwater sounds from vessels.

Based on the effects assessment for marine mammals and sea turtles, as summarized above and addressed in Section 11.3.4.1, the change in environmental features and/or processes related to marine mammals and sea turtles associated with sound emission from vessels is predicted to be adverse, occurring sporadically to regularly over the long-term due to the presence of the SBV, and reversible. The geographic extent along the vessel traffic corridor of the change in environmental features and/or processes could range between 1-10 km^2 to 100-1,000 km^2 (10 km zone of influence around Project vessels in transit). This range in geographic extent predictions is attributable to the variable avoidance distances marine mammals exhibit in response to vessels. The change in habitat quality and/or use is considered within the range of natural variability of marine mammal movements in the larger Core BdN Development Area, and therefore of low magnitude. Mitigations to reduce changes in the environmental features and/or processes related to marine mammals and sea turtles from vessel sound emissions are not proposed. The above predications are made with a moderate to high level of confidence as noted in Section 11.3.4.2.

In summary, with the application of mitigation measures, the residual environmental effects of a Change in Environmental Features and/or Processes associated with underwater sound emissions from vessels engaged in Supply and Servicing are predicted to be adverse, low in magnitude, with a geographic extent ranging from 1-10 km^2 and 100-1000 km^2, of short to long-term duration, occurring sporadically to regularly, and reversible. This prediction is made with moderate to high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with underwater sound emissions from vessels engaged in Supply and Servicing are not proposed.

Follow-up Monitoring is not proposed for the effects on Special Areas associated with underwater sound emissions from vessels engaged in Supply and Servicing in consideration of residual effects predictions.

12.3.4.2 Aircraft (Helicopters)

Presence/Movement of Helicopters

The primary effect on Special Areas associated with the presence/movement of helicopters engaged in Supply and Servicing activities for the Project is:

- Change in Environmental Features and/or Processes

Change in human use and/or societal value is not identified as an effect associated with presence/movement of helicopters as noted in Section 12.1.5.1.

Change in Environmental Features and/or Processes is a potential effect associated with presence/movement of helicopters.

Figure 12.2 shows the locations of special areas in the LSA. Three of these special areas are identified for the presence of marine and migratory birds: Eastern Avalon and Baccalieu Island EBSAs and Quidi Vidi Lake IBA (Table 12.5). The Eastern Avalon, Baccalieu Island and Northeast Slope EBSAs are identified for presence of marine mammals and/or sea turtles

As discussed in Section 10.3.4.2, interactions associated with helicopter use on Marine and Migratory Birds are disturbance effects of aircraft overflights and increased energy expenditure of birds due to escape reactions, increased heart rate, and lower food intake due to interruptions (Ellis et al. 1991; Trimper et al. 2003; and Komenda-Zehnder et al. 2003

Disturbance effects can lead to a temporary loss of useable habitat. Helicopter presence (due to movement and sound) can disturb nesting seabirds at colonies, although seabird response to helicopters and other aircraft depends on a number of factors including species, previous exposure levels, and the location, altitude, and number of flights (Hoang 2013). Helicopter sound may also deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure (Larkin 1996 and Beale 2007). The presence of helicopters along the vessel traffic route may cause a change in habitat availability for birds along the helicopter flight path. As discussed above, helicopters in transit will be at altitudes along the transit route which are above those of birds, except long-distance migrant shorebirds and landbirds. Consequently, the majority of marine and migratory birds in the LSA and along the vessel traffic route will not be affected by helicopter presence. With the application of mitigations and the distance of the airport from coastal nesting seabird colonies, interaction with coastal colonies are not anticipated.

In terms of behavioural effects of helicopter presence on birds, flushing of breeding birds from the nest in response to helicopter presence is perhaps the most obvious and can have immediate negative consequences including predation of eggs and chicks and decreased incubation and brooding (Burger 1981; Brown 1990; Bolduc and Guillemette 2003; Beale 2007; and Burger et al. 2010). Nestlings may also be vulnerable to exposure, and adults may inadvertently knock eggs and flightless young from the nest, which is of concern for cliff-nesting species (Burger 1981; Carney and Sydeman 1999). Other behavioural effects may include reduced foraging and provisioning rates (Davis and Wiseley 1974; Lynch and Speake 1978; Belanger and Bedard 1990; Delaney et al. 2002; Goudie 2006). Research has shown that overt behavioural responses to aircraft traffic, such as flushing, may occur at a distance of 366 m for common murres (Rojek et al. 2007), although there is inherent variability in behavioural responses between and even within species (Blumstein et al. 2005 and Hoang 2013). Bird colonies in the LSA and larger RSA are not within the typical flight path of aircraft from the St. John's International Airport to the Project Area. The nearest seabird nesting colony, a black-legged kittiwake colony on Freshwater Bay, is over 5 km south of existing helicopter routes. The nearest IBA with nesting seabirds, Witless Bay Islands Ecological Reserve, is 40 km south of the St. John's International Airport and is outside the LSA. Low-level aircraft operations will be avoided, as applicable. In keeping with *Seabird Ecological Reserve Regulations*, 2015, helicopters will avoid seabird breeding colonies during the times outlined in the regulations. This use of existing helicopter routes and operating altitudes, regulatory requirement to avoid seabirds breeding colonies and avoidance of low-level operations will avoid marine bird concentrations and consequently will reduce interactions with marine and migratory birds.

The change in environmental features and/or processes for marine and migratory birds due to the presence of helicopters would be adverse, as described above and short-term while the helicopter is in the area. The geographic extent would be less than 1 km² from the helicopter along its flight path and on approach and takeoff. The change in environmental features and/or processes would be sporadic as helicopter traffic would be intermittent and reversible once the helicopter leaves the area. While there may be an interaction from helicopters, there would be no change in environmental features and/or processes relative to baseline conditions, and therefore the magnitude of the change is negligible. Mitigations to reduce effects are noted above.

With regards to marine mammals, as noted in Section 11.3.4.2, available information indicates that single or occasional aircraft overflights will cause no more than brief behavioural responses in baleen whales, toothed whales and seals (summarized in Richardson et al. 1995). The degree of sensitivity of cetaceans to sounds produced by aircrafts can depend on their state of activity at the time of exposure; individuals in a resting state (as opposed to foraging, socializing, or travelling) seem to demonstrate the highest sensitivity to such disturbances (Würsig et al. 1998; Luksenburg and Parsons 2009). Cetaceans most commonly respond to sounds produced by overhead aircrafts by diving (Luksenburg and Parsons 2009). Other behavioural responses include short surfacing periods, changes in state of activity, and breaching (Luksenburg and Parsons 2009).

The change in environmental features and/or processes from presence of helicopters during Supply and Servicing for Marine Mammals and Sea Turtles would be adverse as described above, and short-term. The geographic extent of the change would be less than 1 km² from the helicopter. The change would be sporadic as helicopter traffic would be intermittent, and reversible once the helicopter leaves the area. While there may be an interaction from helicopters, there would be no change in environmental features and/or processes relative to baseline conditions, and therefore the magnitude of the change is negligible. This prediction is made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects on of a Change in Environmental Features and/or Processes of Special Areas associated with the presence of helicopters are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring sporadically and reversible. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with helicopters engaged in Supply and Servicing include use of common traffic routes (K), adherence to regulatory requirements regarding set-back distances for helicopters and vessels from nesting colonies (L), avoidance of low-level operations (M).

Follow-up Monitoring is not proposed for the effects on Special Areas associated with helicopters engaged in Supply and Servicing in consideration of residual effects predictions.

12.3.5 Supporting Surveys

Special Areas that intersect the Core BdN Development Area are identified and/or protected due to the presence of sensitive benthic species and biogenic habitats. As noted in Section 9.3.5 and Section 12.1.5.1, and noted in Table 12.4, Supporting Surveys will not interact with benthic species and biogenic habitats and therefore will not affect Special areas in the Core BdN Development Area.

12.3.6 Decommissioning

At end of field-life, which will either be at the end of the Core BdN Development or at the end of Project life, should Project Area Tiebacks occur, the Project will be decommissioned in accordance with regulatory requirements in place at the time of decommissioning.

Activities associated with Decommissioning include, but are not limited to, vessel and helicopter supply and servicing, removal of infrastructure, environmental, geotechnical, geological, and/or ROV/AUV surveys and are assessed above in Sections 9.2.5 and 9.2.6.

Special Areas that intersect the Core BdN Development Area are identified and/or protected due to the presence of sensitive benthic species and biogenic habitats, therefore Decommissioning activities that may interact with benthic communities will be assessed and include the decommissioning of subsea infrastructure and the decommissioning of wells.

12.3.6.1 Decommissioning of Subsea Infrastructure

The primary effect on Special Areas associated with the decommissioning of subsea infrastructure is:

- Change in environmental features and/or processes

Change in human use and/or societal value is not identified as an effect for decommissioning because this activity will occur in the offshore environment and special areas used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are approximately 500 km from the Project (Section 6.4).

Change in Environmental Features and/or Processes is a potential effect associated with decommissioning of subsea infrastructure. The effect may be adverse or positive, depending on whether sea infrastructure are removed or left in place. These options will be further examined at the time of decommissioning in consultation with C-NLOPB and other regulatory authorities such as DFO. Over time, and depending on potential protection measures, infrastructure may have become fish habitat and the effects of removing them would have to be assessed. As illustrated in Table 12.5 and Figure 12.2, three special areas intersect the Core BdN which are identified and/or protected due to the presence of sensitive benthic species and biogenic habitats.

The potential effects of decommissioning on corals and sponges are described in Section 9.3.6.1 and summarized here. As the Core BdN Development will last 12 to 20 years, subsea infrastructure will likely be colonized by sessile invertebrates, which may affect special areas within the Core BdN Development Area or Project Area. Potential removal of subsea infrastructure would also remove the positive effects on fish habitat. Removal of the infrastructure will likely result in a localized decline in sessile or low-mobile invertebrates that were supported by the associated food and habitat subsidies, but mobile opportunistic species would be supported for a short time. Bomkamp et al. (2004) observed a difference in predatory gastropods and sea stars that were dependent on the bivalve food subsidies between present and former oil platform sites. Crab species were not different between the sites, indicating that mobile opportunistic species were not negatively affected (Bomkamp et al. 2004). Some small disturbances in deep-sea areas are also suggested to enhance diversity in deep-sea environments (Grassle and Morse-Porteous 1987). There may also be short-term localized suspended particle and sedimentation disturbance effects to benthic species, such as corals, sponges and sea pens similar to initial construction activities (see Section 12.2.1). If infrastructure remains in place, it would continue to provide support for benthic invertebrates. Where it is removed, recovery and recolonization of the area may be enhanced if the infrastructure had supported connectivity to areas previously inaccessible by benthic invertebrates.

The change in habitat availability and/or quality associated with the removal of the subsea infrastructure would be neutral, as conditions would be reversed to baseline described above, and long-term. The geographic extent of the change in habitat would be less than 10 km², based on the footprint of the subsea infrastructure in the Core BdN Development Area. The magnitude of change in habitat would be negligible, as there would be no change in the defining ecological and/or sociocultural features of the special areas affected relative to baseline conditions. Mitigations to reduce the changes to environmental features and/or processes are not proposed. This prediction is made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, the residual environmental effects on Special Areas from decommissioning of subsea infrastructure are predicted to be adverse, negligible in magnitude, less than 10 km², of long-term duration and occurring once. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with decommissioning of subsea infrastructure are not proposed.

Follow-up Monitoring for the effects on Special Areas associated with decommissioning of subsea infrastructure is not proposed.

12.3.6.2 Well Decommissioning

At the end of field life, well template protection and wellheads will likely be removed. Wellhead decommissioning activities are described in Section 2.6.7.2. As noted in Section 2.6.7.2, wellheads can be removed by internal cutting of the wellbore via the drilling installation or external cutting via an ROV from a support vessel. The focus of the effects assessment of well decommissioning is associated with the removal of the wellhead itself.

The primary effect on Special Areas associated with well decommissioning is:

- Change in environmental features and/or processes

Change in human use and/or societal value is not identified as an effect for decommissioning because this activity will occur in the offshore environment and special areas used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are approximately 500 km from the Project (Section 6.4).

Change in Environmental Features and/or Processes is a potential effect associated with well decommissioning.

As noted in Section 9.3.6.3, at water depths in the Core BdN Development Area (approximately 1,100 m) wellheads could be removed by external cutting via a vessel equipped with an ROV. The cutting of the wellheads above the seafloor will result in a portion of the casing (pipe stub) above the sea floor. The pipe stub would likely have a maximum height of approximately 0.85 m, but with cutting as close to the seafloor as possible, the height can be reduced. Remaining wellhead structures left in place after decommissioning (500 to over 1500 m) may provide localized increased habitat structures in the Core BdN Development Area as discussed in Section 9.3.2.1. There may be sedimentation at the wellhead created by the external cutting, but it would be temporary and short-term. Effects would be permanent but of negligible magnitude given the small area affected in relation baseline conditions and reversible. Explosives will not be used to remove wellheads. This prediction is made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, the residual environmental effects on Special Areas associated with well decommissioning are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², short-term in duration, and occurring once. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with well decommissioning include not using explosives to remove wellheads (W).

Follow-up Monitoring for the effects on Special Areas associated with well decommissioning is not proposed.

12.4 Project Area Tiebacks

Over the life of the Project, Equinor Canada may choose to undertake additional exploration activities (e.g., exploration, appraisal, delineation drilling, 2D, 3D/4D seismic) to search for and possibly develop economically recoverable reserves. Should additional economically and technically recoverable reserves be discovered within the Project Area, they could be processed on the BdN FPSO through the installation of additional subsea templates and flowlines (“subsea tiebacks”) as described in Section 2.6.6. Between one and five well templates could be tied-back to the FPSO and/or existing well templates via flowlines and may include the drilling of up to 20 additional wells within the additional well templates. Activities associated with Project Area Tiebacks would be the same as those described in Section 2.6.6 and summarized below.

- Installation of subsea tieback(s) (well templates and flowlines)
- Continuation of production and maintenance operations from the existing FPSO
- Drilling activities associated with the drilling of up to 20 additional wells (total) in well templates
- Continuation of supply and servicing
- Additional supporting surveys, if required
- Decommissioning

The Core BdN Development has a field life of 12 to 20 years. Should Project Area Tiebacks occur, the field life of the Project may be extended while maximum daily potential production rates would remain the same. Tiebacks may be feasible up to a distance of approximately 40 km from the FPSO and/or template location. Figure 12-3 illustrates examples of tieback layouts that could occur should Project Area Tiebacks. Tiebacks could be direct to the FPSO and/or connected to existing well templates. All illustrated in Figure 12-3 and noted in Table 12.5, in addition to the three special areas that intersect with the Core BdN Development Area (NAFO fishery closure area; a sea pens VME Slopes of the Flemish Cap and Grand Banks EBSA), there are four Special Areas intersecting with the Project Area, three Sponge VMEs and a Large Gorgonian Coral VME, for a total of seven special areas intersecting with the Project Area. Each of these special areas has been identified and/or protected due to the presence of high concentrations of sensitive benthic species such as corals, sponges and sea pens.

For the purposes of environmental effects assessment, it is assumed that the timeframe for Project Area Tiebacks would the same as those listed for the Core BdN Development. For instance, it is assumed that Offshore Construction and Installation of well templates and flowlines, and HUC activities of the new subsea infrastructure could occur over several seasons; Production and Maintenance Operations, Supply and Servicing and Supporting Surveys occurring during the Core BdN Development would continue until 30-year end of Project life (an additional 10 to 18 years). Mitigation measures, as listed in Section 12.1.5.2 and Table 12-4 and implemented for the Core BdN Development would be applied to activities undertaken should Project Area Tiebacks occur.

As discussed in Section 12.3.1 and indicated in Table 12.4, the primary interactions with Special Areas should Project Area Tiebacks occur are similar to those associated with Core BdN Development activities: installation of subsea infrastructure, discharge of drill cuttings, supply and servicing for vessels and helicopters (e.g., presence, lighting, sound), and decommissioning.

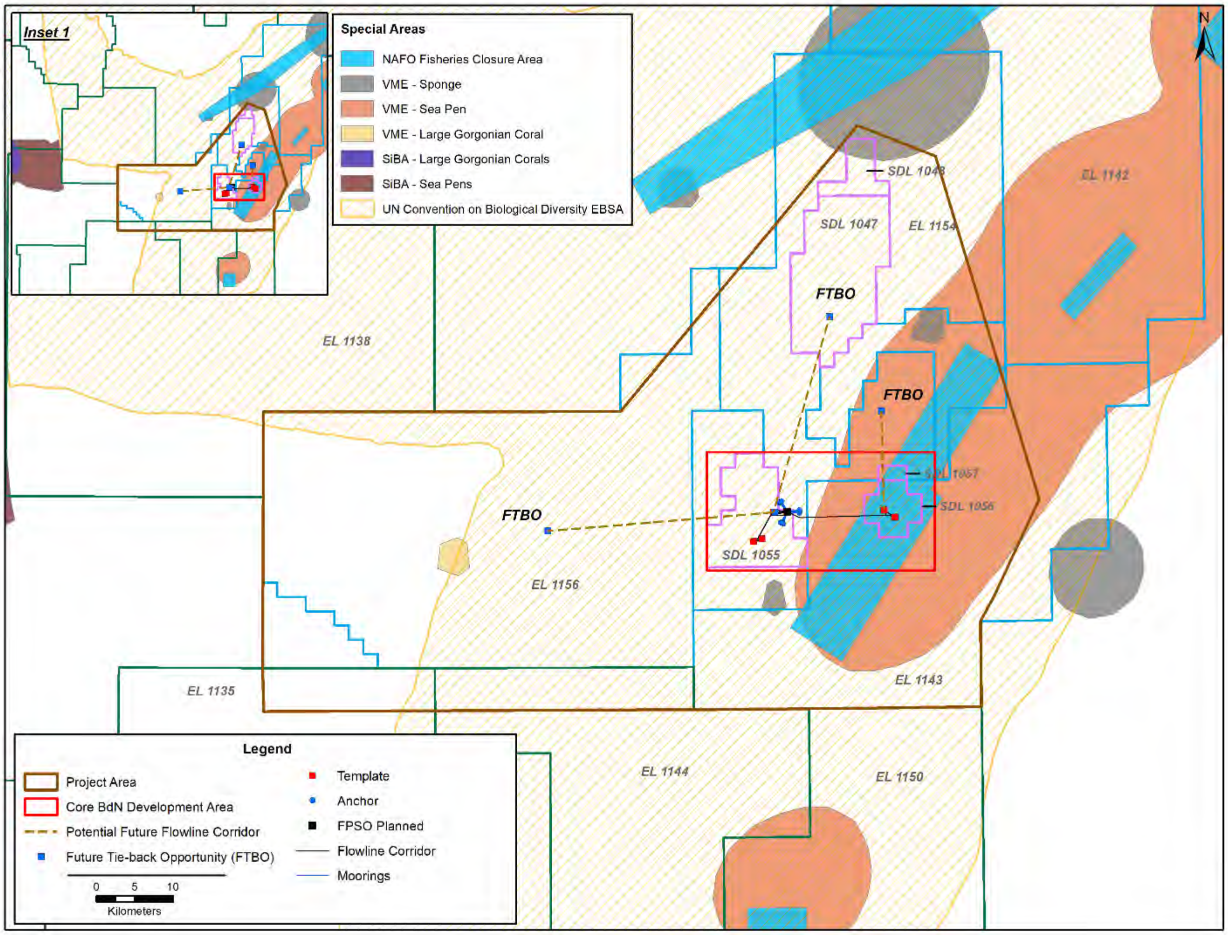

Figure 12-3 Project Area Tiebacks and Special Areas

12.4.1 Offshore Construction and Installation, and Hook-up and Commissioning

Project Area Tiebacks of up to five additional subsea tiebacks (flowlines, well templates) may involve seabed surveys and site preparation, installation of subsea infrastructure, and eventual HUC of newly installed well templates and flowlines, similar to those described in Section 12.3.1. Activities would likely be seasonal and may occur over multiple years. Offshore Construction and Installation and HUC of Project Area Tiebacks may occur at the same time as ongoing production and/or drilling operations for the Core BdN Development.

The potential interactions and effects of Offshore Construction and Installation, and HUC, namely the installation of subsea infrastructure for Project Area Tiebacks would be the same as those assessed in Section 12.3.1 for the Core BdN Development. As special areas in the Project Area are also identified for the presence of benthic species and habitats (Table 12.5), the potential effects would be similar for activities in the Project Area.

12.4.1.1 Installation of Subsea Infrastructure

As noted and assessed in Section 12.1.5, the primary effect on Special Areas associated with the installation of subsea infrastructure is:

- Change in Environmental Features and/or Processes

Change in human use and/or societal value is not identified as an effect for Installation of Subsea Infrastructure because this activity will occur in the offshore environment and special areas used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are approximately 500 km from the Project (Section 6.4).

Change in Environmental Features and/or Processes is a potential effect associated with the installation of subsea infrastructure for Project Area Tiebacks. As discussed in Section 9.3.1.3, 9.4.1.3.and in Section 12.3.1.1, offshore construction and installation of subsea infrastructure will result in localized physical interaction with the seabed and may result in direct disturbance to the seafloor. This may also result in injury and/or mortality of benthic organisms, including corals, sponges and sea pens such as those found in the four special areas (in addition to the three in the Core BdN Development Area) that intersect the Project Area (Table 12.5).

As discussed in Section 9.4.1.4, in fine mud substrate habitat, such as that common in the Flemish Pass (Murillo et al. 2016), including the Project Area site preparation and installation activities will temporarily disturb the seabed environment, resuspending sediments and introducing particles of different shapes and sizes (see Section 9.3.1.3). An increase or change in suspension solids may clog feeding structures of filter-feeding organisms, including corals, sponges and sea pens (Bell et al. 2015; Liefmann et al. 2018; Vad et al. 2018. Injury or mortality may occur through direct contact, burial by deposition of cuttings and the introduction of suspended solids in the water (Whatling and Norse 1998; Thrush and Dayton 2002; Clark et al. 2016; Cordes et al. 2016). As noted in Section 9.3.1.3, evidence of recovery in shallower waters occurred on time scales of between three and ten years and in deeper water it is predicted that it would likely occur over a longer timeframe.

Similar to the discussion in Section 12.3.1.1, and illustrated in Figure 12-3, installation of subsea infrastructure will result in small footprints within special areas intersecting the Project Area. Based on preliminary Project design, for each flowline corridor, including well template, approximately 3 km² of seabed could be affected. Assuming up to five tiebacks, it is conservatively estimated that up to 15 km² of seabed in the Project Area could be affected should Project Area Tiebacks be undertaken. As noted above, seven special areas intersect with the Project Area Tiebacks with a total area of 4,015 km² within the Project Area. Therefore, with a total subsea infrastructure footprint of 15 km² for Project Area Tiebacks and 7 km² for Core BdN Development Area (approximately 22 km² in total), collectively, the placement of subsea infrastructure could interact with approximately 0.5 percent of special areas in the Project Area.

The following mitigations are applicable to effects on benthic habitat in Special Areas. For subsea layout, well templates will not be placed over *Lophelia pertusa* corals. If the installation of subsea infrastructure in the Project Area is determined by DFO to require a *Fisheries Act* Authorization, a habitat offsetting program will be developed in conjunction with DFO as a mitigation measure for the net loss of fish habitat resulting from the Project. Should Project Area Tiebacks be undertaken, Equinor Canada will commence the DFO process for a “Request for Review” pursuant to the provisions of the *Fisheries Act* prior to the commencement of the offshore construction and installation phase of the tiebacks.

The change in environmental features and/or processes of special areas in the Project Area associated with subsea infrastructure installation would be adverse, as described above, but medium- to long-term, depending on species in the area and/or length of time for recolonization. The geographic extent of the change in environmental features and/or processes habitat would be within tens of meters of the location of the subsea infrastructure. Overall subsea infrastructure for Project Area Tiebacks would affect approximately 15 km^2 of the seabed, or 22 km^2 including Core BdN development, which represents approximately 0.5 percent of the area of all special areas intersecting with the Project Area. The change in environmental features and/or processes would range from sporadic for turbidity effects to regular for changes to seabed effects during installation and reversible once construction activities cease. Conservatively, the change in environmental features and/or processes of benthic habitat is approximately 0.5 percent of total seabed available within the Project Area, therefore the change would be considered within the range of natural variability, and the magnitude of change would be low. Mitigations to reduce the change in environmental features and/or processes are noted above. These predictions are made with a high level of confidence based on scientific literature and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects on Change in Environmental Features and/or Processes associated with installation of subsea infrastructure should Project Area Tiebacks be undertaken are predicted to be adverse, low in magnitude, less than 100 km^2 (22 km^2), of medium- to long-term in duration, occur sporadically to regularly, and reversible. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with the installation of subsea infrastructure and/or protection measures during Offshore Construction and Installation and HUC include placement of well templates to avoid *Lophelia pertusa* (A) and habitat offsetting measures, if determined by DFO through its Fisheries Act authorization process that they are required (C).

Follow-up Monitoring is not proposed for the effects on Special Areas associated with the installation of subsea infrastructure. However, if DFO determines through its *Fisheries Act* authorization process that habitat offsetting measures are required, a monitoring program may be required.

12.4.2 Production and Maintenance Operations

The addition of subsea developments and wells would extend the life of the Project (12 to 20 years) to 30 years (total). The FPSO would remain on its location in the Core BdN Development Area. As stated in Section 12.1.5.1, and indicated in Table 12.5, there are no interactions between Production and Maintenance Operations and maintenance and those special areas within the Project Area.

12.4.3 Drilling Activities

As stated in Section 2.6.6, should potential Project Area Tiebacks be undertaken, up to 20 additional wells may be drilled at either individual wells or in well templates (4-, 6- or 8-slot) at locations within the Project Area. Drilling Activities could occur at any time of the year, and as noted in Section 9.3.3, the drilling installation could be on site at a well template location for up to two years if eight wells were drilled consecutively. Drilling Activities under Project Area Tiebacks phase will likely occur while ongoing production at the FPSO is occurring.

For the deeper water depths of the Project Area, as described in Section 9.3.3.3 and 9.4.3.3, drill cuttings modelling for the Core BdN Development Area at approximately 1,200 m indicated that cuttings were mainly localized to within 200 m of the wellsite. Drill cuttings dispersion modelling from the Drilling EIS (Statoil 2017) estimates that the furthest extent of drill cuttings above 1.5 mm PNET is within 2 km from the release site. Therefore, the geographic extent would be approximately 13 km² per well template. Assuming, conservatively, there are three tiebacks in shallower waters and two in deeper waters, the total seabed area potentially affected by drilling in the Project Area is estimated to be 40 km², or approximately 1 percent of the 4,015 km² of special areas within the Project Area. Cumulatively, a conservative estimate of the potential seabed area affected by drilling for the Core BdN Development (2.5 km² estimate; see Section 9.3.3.4) and from Project Area Tiebacks (40 km²; see above) would be 42.5 km², or approximately 1 percent of the Project Area. Based on these zones of influence and drill cuttings modelling, should drilling be carried out at any location within the Project Area, cuttings deposition would likely remain within the boundaries of the Project Area and there is little or no potential for these environmental releases from individual wells or multiple wells to interact or accumulate beyond the Project Area.

12.4.3.1 Waste Discharges during Drilling: Drill Cuttings

As noted and assessed in Section 12.3.3, the primary effect on Special Areas associated with the discharge of drill cuttings is:

- Change in Environmental Features and/or Processes

Change in human use and/or societal value is not identified as an effect for Drilling Activities because this activity will occur in the offshore environment and special areas used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are approximately 500 km from the Project (Section 6.4).

Change in Environmental Features and/or Processes is a potential effect associated with the discharge of drill cuttings. Drilling will include discharge of synthetic-based mud (SBM) and water-based mud (WBM) associated cuttings. As noted above, benthic species and habitats are identified as present within the Special Areas intersecting the Project Area (Table 12.5).

As identified in Section 12.1.5.1 and assessed in Section 12.3.3, benthic habitat features may be affected by the deposition of drill cuttings on the seafloor. Coral and sponge community presence within the larger Project Area is similar to that described for the Core BdN Development Area. In the western portion of the Project Area, in shallower waters and near the slopes soft corals, stony corals are likely present. In the northern parts of the that are of similar depths to the Core BdN Area, solid/massive sponges (e.g., *Geodia sp.*), soft corals, and sea pens are likely present. As discussed in Section 9.3.3.3 and summarized in Section 12.3.3.1.1, benthic species and habitats are sensitive to deposited drill cuttings and suspended mud particles as well as smothering through burial (Larsson and Purser 2011; Allers et al. 2013; Bell et al. 2015; Purser 2015; Järnegren et al. 2016; Ragnarsson et al. 2017; Liefmann et al. 2018; Vad et al. 2018, Baussant et al., 2018). Suspension-feeding structures of sessile species may become clogged by suspended drill cuttings or sediment (Neff et al. 2000; Smit et al. 2006). Increased larval mortality and change in feeding behaviour of corals has been identified due to exposure to cuttings particles (Raimondi et al. 1997, Neff 2010; Buhl-Mortensen et al. 2015; Järnegren et al. 2016; Ragnarsson et al. 2017), although some corals have higher tolerance to drill fluid deposition (Allers et al. 2013). Potential effects on special areas that intersect the Project Area (Table 12.5) are likely to be temporary in nature as SBMs biodegrade within a few years (Terrens et al. 1998; Ellis et al. 2012; IOGP 2016). As previously stated, Equinor Canada will use proven and practicable best available technologies and practices for the treatment of SBM cuttings prior to discharge. When a cuttings transport system is used, discharge locations for water-based cuttings, will be determined based on the C-NLOPB requirements to avoid *Lophelia pertusa* complexes and/or assemblages of five (5) or more corals in 100 m² with heights greater than 30 cm within 100 m of the discharge location.

As described above, in deeper waters of the Project Area, the zone of influence associated with drill cutting deposition is approximately 0.5 km² per well template in deeper waters and 13 km² in shallower waters. area.

Based on recovery rate estimates noted above and discussed in Section 9.3.3.3, evidence of recovery in shallower waters occurred on time scales of between three and 10 years and in deeper water it is predicted that it would likely occur over a longer timeframe. Therefore, it is estimated that the effects on the change in habitat from drill cuttings would be medium to long-term, depending on water depth, but reversible, once recovery occurs. As noted above, the predicted zone of influence for drill cuttings is approximately 0.5 km² for deeper waters and approximately 13 km² for shallower waters. The change in habitat would be continuous while the drilling was ongoing. The change in environmental features and/or processes represents less than one percent of total area of special areas within Project Area and is considered within the range of natural variability, but with no associated adverse effects on the defining ecological and /or sociocultural features of the special areas. Therefore, the magnitude of change would be low. The above predications are made with a high level of confidence, with the exception of geographic extent and the timeframe for recovery. Uncertainties with the timeframe for recovery are above. Geographic extent is based on modelling predictions and due to the nature of modelling as a predictive tool and inherent limitations with any model, a moderate level of confidence is assigned to geographic extent.

In summary, with the application of mitigation measures, the residual environmental effects on **Change in Environmental Features and/or Processes** associated with discharge of drill cuttings should Project Area Tiebacks be undertaken are predicted to be adverse, low in magnitude, with a geographic extent ranging from less than 1 km² to less than 100 km² (approximately 13 km^2), medium- to long-term in duration, occurring continuously, and reversible. This prediction is made with a moderate to high level of confidence.

Mitigations to reduce potential effects to Special Area associated with drill cuttings discharge include adherence to C-NLOPB requirements for the avoidance of *Lophelia pertusa* complexes and/or coral colonies of 5 or more corals in 100 m² area with heights greater than 30 cm within 100 m of the discharge location (B); treatment and discharge of all discharges in accordance with the OWTG (E); selection and screening of chemicals in accordance with the OCSG and Equinor Canada's chemical selection and management processes (F).

Follow-up Monitoring: In consideration of the residual effects predictions based on drill cuttings dispersion modelling results, follow-up monitoring will include a component to validate the drill cutting model with respect to the zone of influence for cuttings dispersion. See Section 12.8 for additional information.

12.4.4 Supply and Servicing

The addition of subsea tiebacks would extend the life of the Project (12 to 20 years) to 30 years. Supply and Servicing operations, as described in Section 2.6.4 and as assessed for the Core BdN Development in Section 12.3.4 would be the same should Project Area Tiebacks be undertaken but would be carried out for an additional 10 years. The vessel and aircraft traffic route to the Project Area would be same as for Core BdN Development. Vessel traffic in the Project Area would be the same as vessel traffic in the Core BdN Development Area.

As discussed in Section 10.3.4, Supply and Servicing is not anticipated to result in interactions with benthic habitats. Furthermore, as noted in Section 12.1.5.1, a change in human use and/or societal value is not identified as an effect associated with Supply and Servicing. Therefore, as assessed for the Core BdN Development, the effects assessment for Supply and Servicing should Project Area Tiebacks be undertaken would be the same as for the Core BdN Development Area and is focused on potential effects on Change in Environmental Features and/or Processes in special areas identified for fish species that inhabit the water column or sea surface, marine and migratory birds and marine mammals and sea turtles.

Presence of Vessels

The primary effect on Special Areas associated with the presence of vessels engaged in Supply and Servicing activities for the Project is:

- Change in Environmental Features and/or Processes

Change in human use and/or societal value is not identified as an effect presence of vessels as noted in Section 12.1.5.1.

In summary, with the application of mitigation measures, the residual environmental effects of a **Change in Environmental Features and/or Processes** of Special Areas associated with the presence of vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, less than 1 km² from any vessel, short-term in duration, occurring regularly, and reversible. This prediction is made with a high level of confidence.

Light Emissions from Vessels

The primary effect on Special Areas associated with the light emissions from vessels engaged in Supply and Servicing activities for the Project is:

- Change in Environmental Features and/or Processes

Change in human use and/or societal value is not identified as an effect presence of vessels as noted in Section 12.1.5.1.

In summary, with the application of mitigation measures, the residual environmental effects of a **Change in Environmental Features and/or Processes** related to marine fish and fish habitat and marine and migratory birds due to the light emissions from vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1,000 km², of short-term duration, occurring regularly and reversible. This prediction is made with a high level of confidence.

Underwater Sound Emissions from Vessels

The primary effect on Special Areas associated with the light emissions from vessels engaged in Supply and Servicing activities for the Project is:

- Change in Environmental Features and/or Processes

In summary, with the application of mitigation measures, the residual environmental effects of a **Change in Environmental Features and/or Processes** associated with underwater sound emissions from vessels engaged in Supply and Servicing are predicted to be adverse, low in magnitude, with a geographic extent ranging from 1-10 km² and 100-1000 km², of short- to long-term duration, occurring sporadically to regularly, and reversible, and reversible. This prediction is made with moderate to high level of confidence.

12.4.4.1 Aircraft (Helicopters)

Presence/Movement of Helicopters

The primary effect on Special Areas associated with the presence/movement of helicopters engaged in Supply and Servicing activities for the Project is:

- Change in Environmental Features and/or Processes

In summary, with the application of mitigation measures, the residual environmental effects on of a **Change in Environmental Features and/or Processes of Special Areas** associated with the presence of helicopters are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring sporadically and reversible. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Special Areas associated with Supply and Servicing should Project Area Tiebacks be undertaken would the same as those discussed in Section 12.3.4 and include: use of common traffic routes (K), adherence to regulatory requirements regarding set-back distances for helicopters and vessels from nesting colonies (L), avoidance of low-level operations (M), reducing speed or altering course if a marine mammal or sea turtle is observed ahead of the vessel (Q), and notifying DFO if Equinor Canada is aware of vessel strikes with marine mammals (R).

Follow-up Monitoring is not proposed for the effects on Special Areas associated with Supply and Servicing in consideration of residual effects predictions.

12.4.5 Supporting Surveys

Special Areas that intersect the Core BdN Development Area are identified and/or protected due to the presence of sensitive benthic species and biogenic habitats. As noted in Section 9.3.5 and Section 12.1.5.1, and noted in Table 12.4, Supporting Surveys will not interact with benthic species and biogenic habitats and therefore will not affect Special areas in the Core BdN Development Area.

12.4.6 Decommissioning

At end of field-life, which will either be at the end of the Core BdN Development or at the end of Project life, should Project Area Tiebacks be undertaken, the Project will be decommissioned in accordance with regulatory requirements in place at the time of decommissioning. Section 12.3.6 provides an effects assessment of decommissioning activities on Special Areas. The timeframe for decommissioning, whether at the end of the Core BdN Development or at the end of Project life is anticipated to be the same. The interactions and effects associated with decommissioning of subsea infrastructure and well decommissioning on Special Areas in the Project Area would be the same as discussed in Section 12.3.6 and are not repeated here.

12.5 Significance of Residual Effects of the Project

This section summarises the residual environmental effects of the Project on the Special Areas VC and presents the determination of significance.

12.5.1 Ecosystem Component Linkages

The interconnections between the physical, biological and human environment have been considered in the EIS and are summarized in Table 12.6. Overall the EIS is based on the interactions between project activities and select VC’s using source-pathway-receptor relationships as addressed in Section 12.1. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not affect significance determinations, as the potential effects (via direct and indirect pathways) on Special Area have been assessed.

Table 12.6 Ecosystem Linkages: Special Areas

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Offshore Construction and Installation, Hook-Up and Commissioning (in Core BdN and Project Area Tiebacks)			
Presence of Vessels	• Light • Sound • Marine Discharges	**Core BdN and Project Area Tiebacks - PA** • No pathway	Avoidance/attraction behaviours could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles. There is potential for effects on Commercial Fisheries in Special Areas within the PA if future development occurs.
Installation of subsea infrastructure	• Disturbance of the seafloor and benthic habitats and fauna • Suspended sediments and introduction of sediments of different shapes and sizes	**Core BdN and Project Area Tiebacks – PA** • These activities may result in exposure, injury, burial and/or mortality of benthic organisms if present. • Suspended sediment may clog feeding structures of filter-feeding organisms (e.g. corals, sponges and sea pens)	Benthic habitats provide refuge for small planktonic and benthic invertebrates. Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
HUC Activities	• Marine discharges	**Core BdN Core BdN and Project Area Tiebacks - PA** • No interaction	
Production and Maintenance Operations (in Core BdN and Potential Future Development)			
Presence of FPSO and Subsea Infrastructure	• Light • Sound	**Core BdN and Project Area Tiebacks – PA** • No interaction	
Waste Management	• Produced water • Marine discharges • Non-routine Flaring	**Core BdN and Project Area Tiebacks – PA** • No interaction	

Table 12.6 Ecosystem Linkages: Special Areas

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Drilling Activities (in Core BdN and Potential Future Development)			
Presence of Drilling Installation	• Light • Sound	**Core BdN and Project Area Tiebacks – PA** • No interaction	
Waste Management	• Discharge of drill cuttings	**Core BdN** • Discharge of SBM and WBM cuttings could result in increased larval mortality and change in feeding behaviour of benthic species up to 200 m from drill site. • Suspended sediment could clog the feeding structures of filter-feeding organisms (e.g. corals, sponges and sea pens) • Deposition of drill cuttings could result in mortality of benthic species through burial, up to 200 m from drill site. Potential Future Development – PA • Discharge of SBM and WBM cuttings could result in increased larval mortality and change in feeding behaviour of benthic species up to 2 km m in from drill site in shallow waters and up to 200 m in deeper waters. • Suspended sediment could clog the feeding structures of filter-feeding organisms (e.g. corals, sponges and sea pens) • Deposition of drill cuttings could result in mortality of benthic species through burial, up to 2 km from the drill site in shallow water and up to 200 m in deeper waters.	Benthic habitats provide refuge for small planktonic and benthic invertebrates. Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.

Table 12.6 Ecosystem Linkages: Special Areas

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Supply and Servicing (in Core BdN and Potential Future Development)			
Marine Vessels	• Vessel traffic • Light emissions • Underwater sound emissions	**Core BdN and Potential Future Development – PA** • Special Areas in the LSA around the Vessel Traffic Route have been identified and/or protected for the presence of marine and migratory birds and to a lesser extent marine mammals and fish and fish habitat, including benthic species. • Artificial light may attract marine and migratory birds resulting in injury or mortality from collisions or stranding on vessels and disorientation that may disrupt foraging or migratory activities. • Sound from marine vessels may disturb marine and migratory birds resulting in temporary disruption of foraging or migratory activities. • Underwater sound from marine vessels may disturb marine mammals and reduce effective communication distance. Based on existing information, marine mammals show various responses to vessels. These include attraction, little or no response or avoidance. • Vessel strikes could result in injury or mortality for marine mammals	Mobile fish species, which are the prey of marine and migratory birds and marine mammals, may show avoidance behaviour in the presence of marine vessels.
Aircraft (helicopters)	• Sound	**Core BdN and Potential Future Development – PA** • Presence of helicopters may result in disruptions to marine and migratory birds. • Marine mammals may show temporary avoidance of noise from helicopters.	Avoidance behaviours could result in temporary change in food availability and quality for marine and migratory birds and marine mammals.

Table 12.6 Ecosystem Linkages: Special Areas

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Supporting Surveys (in Core BdN and Potential Future Development)			
Supporting surveys	• Presence of vessels • Lighting • Underwater sound emissions from vessels • Underwater sound emissions from geophysical equipment	**Core BdN and Potential Future Development – PA** • Underwater sound from marine vessels may disturb marine mammals and reduce effective communication distance. Based on existing information, marine mammals show various responses to vessels. These include attraction, little or no response or avoidance. • Seismic surveys such as those planned for this Project, are not expected to cause auditory injury to marine mammals. Some of these mammals may exhibit minor behavioural responses such as avoidance. • Presence of vessels, lighting and sound could result in behavioural changes attraction or avoidance) by mobile fish and invertebrates.	Attraction or avoidance behaviours could result in change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.
Decommissioning (in Core BdN and Potential Future Development)			
Decommissioning	• Removal of subsea infrastructure • Well decommissioning	**Core BdN and Potential Future Development – PA** • Removal of subsea infrastructure will result in decline is sessile or low-mobility benthic invertebrates that were supported by the infrastructure • Suspended sediment could clog the feeding structures of filter-feeding organisms (e.g., corals, sponges and sea pens)	Damage to, or mortality of, benthic species could result in loss of refugia and change in food availability and quality for larger marine fish, marine and migratory birds and marine mammals and sea turtles.

12.5.2 Residual Environmental Effects Summary

Special Areas have been selected as a VC for this EIS due to their importance for environmental, economic, and/or socio-cultural reasons and associated regulatory and/or Indigenous and stakeholder interests and their intrinsic ecological or anthropogenic value.

Special areas intersecting with the LSA have been identified for the presence of sensitive benthic habitats and species, fish species and marine mammals. Various offshore special areas have been closed to bottom contact fishing to protect sensitive benthic habitats from bottom fishing activities, but with no associated prohibitions of petroleum exploration and development activities within their boundaries. Coastal special areas are identified for the presence of Marine and Migratory Birds.

Human use of the special areas is mainly limited to activities such as marine fisheries, oil and gas exploration and production, and marine transportation. There is limited commercial fisheries within the Core BdN Development Area. In the western areas of the Project Area, commercial fishing activity is greater along the shelf edge. Special areas used by humans for tourism and recreation are located in coastal and nearshore environments. Potential Project effects on human uses of marine and coastal environments, including fisheries, recreation and tourism, are addressed in Commercial Fisheries and Other Ocean Uses (Chapter 13).

The potential effects of Project activities on Marine Fish and Fish Habitat, Marine and Migratory Birds, and Marine Mammals and Sea Turtles such as those found in the special areas, are discussed in Chapters 9, 10 and 11 of the EIS. Project activities have the potential to result in residual effects on defining features of special areas that intersect with LSA. A number of Project activities in the Core BdN Development Area and Project Area may result in injury or mortality to benthic species but the introduction of hard surfaces may result in benefits through increased colonization. As discussed in Section 9.3.2.1, the presence of subsea infrastructure (i.e., anchors, well templates, risers) and potential protection measures (e.g., rock placement, wellhead protection, concrete mattresses) may increase local habitat complexity through availability of hard structures for colonization by sessile species and shelter for mobile fish and invertebrate species. Changes to benthic communities would be dependent on a variety of factors including local biotic communities, depths, oceanographic processes, structure design and configuration, material composition. Subsea infrastructure and drill cuttings deposition will represent small areas of disturbance to benthic habitats of special areas within the Core BdN Development Area and Project Area. Overall, for Core BdN Development, approximately 1.4 percent of the FCA that intersects with the Core BdN Development Area and approximately 0.5 percent of special areas intersecting the Project Area could be affected. Subsea infrastructure may provide habitat replacement for corals and sponges. Mitigations applicable to benthic habitat will be implemented to prevent or reduce environmental effects on the defining features of these special areas.

Light and sound emissions from vessel within the vessel traffic route of the LSA, may result in result in temporary behavioural changes in marine species, during activities such as foraging or migration. These effects will be relatively localized along the vessel traffic route in the LSA. The implementation of mitigation measures, such as common vessel traffic route, marine and air traffic adherence to regulatory requirements regarding avoidance of migratory bird nesting colonies, avoiding low level aircraft operations as applicable, marine vessels altering course if marine mammals are detected ahead of the vessels, will reduce direct or indirect potential effects on the Marine Fish and Fish Habitat, Marine and Migratory Birds, and Marine Mammals and Sea Turtles VCs and will prevent or reduce environmental effects on the defining features of these special areas.

Tables 12.7 and 12.8 summarize the environmental effects assessment for the Core BdN Development and Project Area Tiebacks that comprise the Project being assessed under CEAA 2012

12.5.3 Determination of Significance

It is predicted that the Project will not result in a significant adverse effect on Special Areas. This conclusion has been reached with a moderate to high level of confidence based on the on the nature and scope of the Project, knowledge about the existing environment within the LSA and RSA, and current understanding of the effects of similar projects on the VC and relevant, planned mitigation measures. Project activities will not contribute to a detectable adverse change in one or more of the important and defining ecological and sociocultural characteristics of Special Areas that would result in a decrease in its overall integrity, value and use. As described for the various preceding biophysical VCs (Chapters 9, 10, and 11), the Project is not expected to result in significant adverse effects on Marine Fish and Fish Habitat, Marine and Migratory Birds, Marine Mammals and Sea Turtles, SAR or their habitats. Chapter 13 determined that the Project is also unlikely to have significant adverse effects on the Commercial Fisheries and Other Ocean Uses.

12.6 Environmental Monitoring and Follow-up

The various environmental monitoring and follow-up initiatives outlined earlier in relation to relevant components of the biophysical environment will be indirectly applicable to effects on Special Areas. This includes those that apply to the Marine Fish and Fish Habitat, Marine and Migratory Birds, and Marine Mammals and Sea Turtles VCs. The purpose of the follow-up monitoring programs is to determine the effectiveness of mitigation measures in protecting the defining features for which special areas have been identified and Project effects have been anticipated. These follow-up monitoring initiatives are described above. Refer to Sections 9.7, 10.7, and 11.7 for detailed information on proposed monitoring and follow-up. Section 18.4.2 provides an overview of the objectives of a follow-up monitoring program.

Table 12.7 Environmental Effects Assessment Summary: Special Areas – Core BdN Development Activities

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Installation of Subsea Infrastructure										
Installation of Subsea Infrastructure	Change in Environmental Features and/or Processes	A	L	<10 km^2	M - L	S - R	Y	M-H	A, C	Monitoring under Offsetting Plan, if required
PRODUCTION AND MAINTENANCE OPERATIONS										
Presence of Subsea Infrastructure										
Presence of Subsea Infrastructure	Change in Environmental Features and/or Processes	P-A	L	<10 km^2	L	C	Y	M-H	C	Monitoring under Offsetting Plan, if required
DRILLING ACTIVITIES										
Waste Discharges										
Drill Cuttings	Change in Environmental Features and/or Processes	A	L	<1 km^2	L	C	Y	M-H	B, E, F	Proposed
SUPPLY AND SERVICING										
Marine Vessels										
Presence	Change in Environmental Features and/or Processes	A	N	<1 km^2	S	R	Y	H	K, L, Q, R	Not Proposed
Light Emissions from Vessels	Change in Environmental Features and/or Processes	A	N	<1,000 km^2	S	R	Y	H	K, L	Not Proposed
Underwater Sound Emissions from Vessels	Change in Environmental Features and/or Processes	A	L	<10 km^2 - <1,000 km^2	S - L	S - R	Y	M-H	Not Proposed	Not Proposed
Aircraft (Helicopters)										
Movement/Sound	Change in Environmental Features and/or Processes	A	N	<1 km^2	S	S	Y	H	K, L, M	Not Proposed
DECOMMISSIONING										
Decommissioning of Subsea Infrastructure	Change in Environmental Features and/or Processes	A	N	<10 km^2	L	O	N/A	H	Not Proposed	Not Proposed
Well Decommissioning	Change in Environmental Features and/or Processes	A	N	<1 km^2	S	O	N/A	H	W	Not Proposed

Evaluation of Significance

Oil and gas development activities such as those being proposed for this Project are not prohibited within special areas that intersect the Core BdN Development, Project Area or LSA. For the special areas that do intersect or otherwise interact with Project activities and the zones of influence for the Project, the defining features (i.e., physical, biological, and socioeconomic) within these areas will not be adversely changed by the Project. The Project is therefore not likely to result in significant adverse environmental effects on the Special Areas VC.

Note: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km^2
Less than 10 km^2
Less than 100 km^2
Less than 1,000 km^2
Less than 10,000 km^2
Greater than 10,000 km^2

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Table 12.8 Environmental Effects Assessment Summary: Special Areas – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-Up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Installation of Subsea Infrastructure										
Installation of Subsea Infrastructure	Change in Environmental Features and/or Processes	A	L	<100 km^2	M - L	S - R	Y	M - H	A, C	Monitoring under Offsetting Plan, if required
PRODUCTION AND MAINTENANCE OPERATIONS										
Presence of Subsea Infrastructure										
Presence of Subsea Infrastructure	Change in Environmental Features and/or Processes	P-A	L	<10 km^2	L	C	Y	M-H	C	Monitoring under Offsetting Plan, if required
DRILLING ACTIVITIES										
Waste Discharges										
Drill Cuttings	Change in Environmental Features and/or Processes	A	L	<100 km^2	M-L	C	Y	M-H	B, E, F	Proposed
SUPPLY AND SERVICING										
Marine Vessels										
Presence	Change in Environmental Features and/or Processes	A	N	<1 km^2	S	R	Y	H	K, L, Q, R	Not Proposed
Light Emissions from Vessels	Change in Environmental Features and/or Processes	A	N	<1,000 km^2	S	R	Y	H	K, L	Not Proposed
Underwater Sound Emissions from Vessels	Change in Environmental Features and/or Processes	A	L	<10 km^2 - <1,000 km^2	S - L	S - R	Y	M-H		Not Proposed
Aircraft (Helicopters)										
Movement/Sound	Change in Environmental Features and/or Processes	A	N	<1 km^2	S	S	Y	H	K, L, M	Not Proposed
DECOMMISSIONING										
Decommissioning of Subsea Infrastructure	Change in Environmental Features and/or Processes	A	N	<10 km^2	L	O	N/A	H		Not Proposed
Well Decommissioning	Change in Environmental Features and/or Processes	A	N	<1 km^2	S	O	N/A	H	W	Not Proposed

Evaluation of Significance

Oil and gas development activities such as those being proposed for this Project are not prohibited within special areas that intersect the Core BdN Development, Project Area, or LSA. For the special areas that do intersect or otherwise interact with Project activities and the zones of influence for the Project, the defining features (i.e., physical, biological, and socioeconomic) within these areas will not likely be adversely changed by the Project. The Project is therefore not likely to result in significant adverse environmental effects on the Special Areas VC.

Note: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature/Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

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13.0 COMMERCIAL FISHERIES AND OTHER OCEAN USES: ENVIRONMENTAL EFFECTS ASSESSMENT

Commercial Fisheries and Other Ocean Uses have been identified and included as a valued component (VC) for this Environmental Impact Statement (EIS) due to the economic and socio-cultural importance of commercial fishing and other marine activities to Newfoundland and Labrador (NL) and other jurisdictions that are known to undertake these activities off eastern NL, and the associated potential for interactions between these ocean uses and Project-related components and activities during the temporal scope of the Project.

Commercial fishing is a key economic activity within Newfoundland and Labrador and the surrounding areas, and fisheries within the eastern NL offshore area are extensive and diverse, involving a range of participants, species, gear types and other characteristics at various times of the year. This includes fishing activity by Canadian enterprises and vessels, primarily within Canada's 200-nautical mile (NM) Exclusive Economic Zone (EEZ), and by both Canadian and non-Canadian fishers outside of the EEZ. The EIS Guidelines (Appendix A) identify Commercial Fisheries and Other Ocean Uses as having a potential for interaction with Project-related activities. A range of other anthropogenic components and human activities occur throughout the marine environment offshore eastern NL (as described in Section 7.2) including other marine shipping and transportation, marine tourism, other oil and gas exploration and production, military exercises and in situ submarine infrastructure, such as communication cables, shipwrecks and unexploded ordnance (UXO). Like commercial fisheries, these have economic, strategic and/or security importance within the region and beyond and are also considered collectively as part of this VC. The existing conditions of all of these ocean uses are discussed in Chapter 7 and are assessed in the sections below. These sections address the potential for interactions between the marine components and activities and Project-related components and activities during the temporal scope of the Project and assesses potential effects that might result from these interactions.

13.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

The following sections define the spatial and temporal context within which potential environmental effects on Commercial Fisheries and Other Ocean Uses are assessed. These have been established to direct and focus the environmental effects assessment for the VC.

13.1.1 Spatial Boundaries

Four spatial assessment boundaries have been defined for the environmental effects assessment of this VC. They reflect the Core Bay du Nord (BdN) Development, the Project Area Tiebacks, and the varying ways in which the Project and VC may interact. The boundaries are informed by the nature, scale, timing, and other characteristics of the Project and the existing environmental setting, and potential environmental interactions. These Study Areas are defined below and illustrated in Figure 13-1.

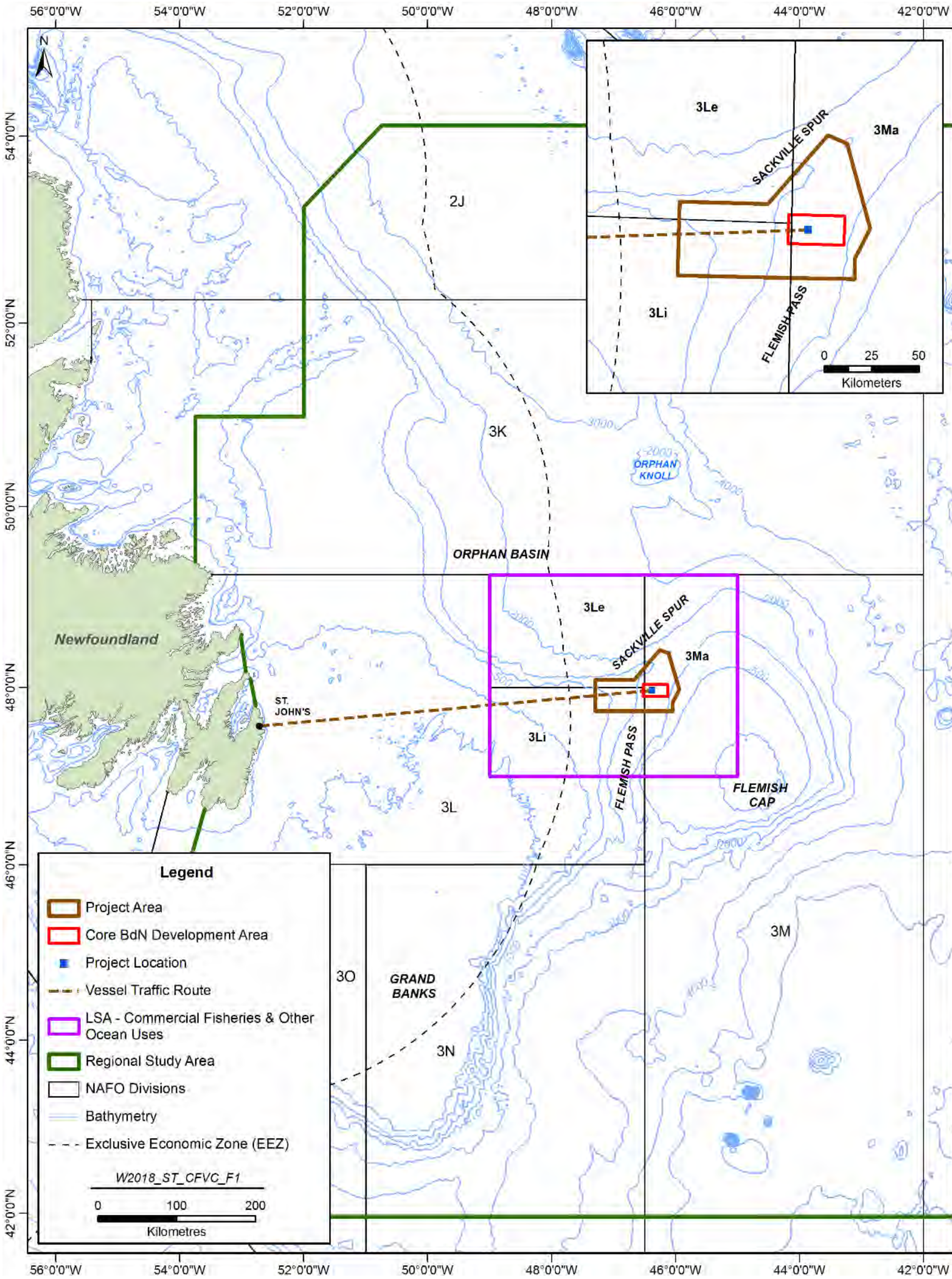

Figure 13-1 Environmental Assessment Study Areas: Commercial Fisheries and Other Ocean Uses

Core BdN Development Area: The Core BdN Development Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbance to the marine environment may occur. It occupies an offshore area of approximately 470 km², encompassing the proposed location of the floating production, storage and offloading installation (FPSO) and supporting subsea infrastructure and activities, including the associated collision and safety zones. The actual seabed footprint of subsea infrastructure within the Core BdN Development Area is approximately 7 km², representing approximately 1.5 percent of the entire Core BdN Development Area. See Section 2.5.4 for more information on the safety and anti-collision zones for the Project.

Project Area: This broader Project Area is where Project Area Tiebacks (as described in Section 2.6.6) may occur. While the Project Area is defined as an overall area that encompasses such activities for the duration of the Project, different components and activities may occupy smaller areas within this overall area, as described in Chapter 2. The Core BdN Development Area is located entirely within the Project Area. This Project Area is approximately 4,900 km². The footprint of the Core BdN Development subsea infrastructure is approximately 0.1 percent of the Project Area. If Project Area Tiebacks were to be undertaken, using the illustration presented in Figure 13-# the footprint of the subsea infrastructure for potential new tiebacks, including Core BdN Development subsea infrastructure, represents less than 0.5 percent of the Project Area.

Local Study Area (LSA): The LSA encompasses the overall geographic area within which all routine Project-related environmental interactions may occur. As described in Section 7.1.1, the LSA for this VC is defined as Northwest Atlantic Fisheries Organization (NAFO) Unit Areas (UAs) 3Le, 3Li and 3Ma, the three UAs that overlap the Project Area. The LSA includes the vessel traffic route. In total, the Project Area represents about 6.5 percent of the LSA, which is approximately 75,000 km².

Regional Study Area (RSA): The environmental effects assessment recognizes and considers the characteristics, distributions, and movements associated with the individual VCs under consideration from an ecological and socioeconomic perspective. The RSA is the area within which Project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out (i.e., cumulative effects). The RSA is defined based on the predicted zone of influence of a potential oil spill event, as summarized in Section 16.4, specifically, the area of maximum cumulative surface oil thickness for the 95th percentile surface oil exposure case at the ecological threshold of 10 g/m² (0.01 mm). The RSA captures the marine waters offshore eastern NL including all or part of NAFO Divisions 2J, 3K, 3L, 3M, 3N and 3O.

13.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the frequency and duration of routine Project-related activities as well as the likely timing of resulting environmental effects. The overall schedule for the Project is provided in Section 2.1.1, and the temporal boundaries of each Project Phase are provided in Table 13.1.

Table 13.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Core BdN Development Phases	
Offshore Construction and Installation, and Hook-up, and Commissioning (HUC)	• Site surveys commencing as early as 2021 • Offshore construction as early as 2023, but may occur later • Approximately 5 years; seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of year
Production and Maintenance Operations	• Commencement anticipated in 2026 • 12 to 20 years; year-round
Drilling Activities	• Commencement as early as 2024 • On average, drilling time is approximately 45-85 days per well (may be shorter for pilot wells and/or tiebacks) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2021 • Ongoing throughout life of Project; year-round
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed. • Approximately 2 to 4 years; seasonal or year-round
Project Area Tiebacks	*Extension of Project life to maximum 30 years*
Offshore Construction and Installation, and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to five tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but activities could occur year-round • May occur at any time over life of Project
Production and Maintenance Operations	• Continuation of activities from existing FPSO out to end of Project life • Year-round
Drilling Activities	• Total timeframe for drilling depends on number of wells required • On average, drilling time is approximately 45-85 days per well • May occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Year-round, when drilling occurs

Table 13.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Supply and Servicing	• Continuation of activities to end of Project life • Year-round
Supporting Surveys	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

13.1.3 Approaches and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on the EA methodology detailed in Chapter 4 of this EIS and include the nature, scale, and timing of the Project's components and activities (see Chapter 2), and the existing environment for this VC (see Chapter 7).

This analysis is focused on identifying the key potential Project-VC interactions. Potential Project-related changes and resulting effects are identified and assessed by considering the available data, assessments and studies, consultations and other information about the type and distribution of fisheries and other activities in and near the Core BdN Development Area, the Project Area, the LSA including the vessel traffic route, and the RSA. In the following sections, each Project component where an interaction might occur (Table 13.2) is considered in terms of its potential to cause changes that might affect these VCs, and in light of the nature and predicted effectiveness of the mitigation measures (Section 13.1.5.2). Potential Project-related residual effects are then identified and evaluated for significance. As described below, potential biophysical effects on commercial fish species, their prey and their habitat are assessed separately in Chapter 9.

Table 13.2 Characterization of Residual Effects on Commercial Fisheries and Other Ocean Uses

Characterization	Description	Definition of Categories
Nature/Direction of effect	The long-term trend of the residual environmental effect relative to baseline conditions	• **Positive** – a residual environmental effect that moves the distribution, intensity, function, and/or value in a direction that is beneficial to Commercial Fisheries and Other Ocean Uses relative to baseline conditions • **Adverse** – a residual environmental effect that moves the distribution, intensity, function and/or value in a direction that is harmful to Commercial Fisheries and Other Ocean Uses relative to baseline conditions • **Neutral** – no change to the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions

Table 13.2 Characterization of Residual Effects on Commercial Fisheries and Other Ocean Uses

Characterization	Description	Definition of Categories
Magnitude of effect	The degree of change in distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions	• **Negligible** – although there is a potential for a Project-VC interaction, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions • **Low** – a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses that is considered within the range of natural variability, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses • **Medium** – A change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses that is considered beyond the range of natural variability, but with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses • **High** – A change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses that is considered beyond the range of natural variability, with an adverse effect on the overall distribution, intensity, function and/or value of Commercial Fisheries or Other Ocean Uses
Geographic Extent of effect	The spatial area within which the residual environmental effect will likely occur	• Less than 1 km^2 • Less than 10 km^2 • Less than 100 km^2 • Less than 1,000 km^2 • Less than 10,000 km^2 • Greater than 10,000 km^2
Duration of effect	The period of time required until the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses returns to its baseline condition, or the residual effect can no longer be measured or otherwise perceived	• **Short Term** - less than 12 months (1 year) • **Medium Term** - 1 to 5 years • **Long Term** - more than 5 years • **Permanent** - recovery to baseline conditions unlikely

Table 13.2 Characterization of Residual Effects on Commercial Fisheries and Other Ocean Uses

Characterization	Description	Definition of Categories
Frequency of effect	Identifies how often a residual effect will likely occur	• **Not likely to occur** • **Occurs once** - effect occurs one time • **Occurs sporadically** – effect occurs episodically, a no set schedule • **Occurs regularly** – effect occurs at regular intervals • **Occurs continuously** – effect occurs continuously
Reversibility of effect	Pertains to whether the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses can return to baseline conditions after the Project/activity stops	• **Reversible**: Will eventually recover to baseline conditions • **Irreversible**: Permanent

13.1.4 Environmental Effect Significance Definitions

The definitions used to characterize environmental effects are provided in Chapter 4 (Table 4.5) and are provided below specific to Commercial Fisheries and Other Ocean Uses. These characterizations will be used throughout this VC assessment in describing residual environmental effects on Commercial Fisheries and Other Ocean Uses from routine Project Activities.

Significant residual environmental effects are considered to be those that could cause a change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. In consideration of the descriptors listed in Table 13.2, as well as a consideration of regulatory requirements, a significant residual adverse environmental effect on Commercial Fisheries and Other Ocean Uses resulting from the Project is defined as one that would cause one or more of the following:

- A detectable reduction in the overall economic returns generated from commercial fisheries or other ocean activities within the RSA over more than one year
- A detectable reduction in the overall nature, intensity, location or timing of current marine-based activities within the LSA for a community or region over more than one year

Summary effects assessment statements are provided for each phase/activity (e.g., Offshore Construction and Installation and HUC; Production and Maintenance, etc.) and characterizes the greatest effect from each interaction.

The potential environmental effects of accidental events on Commercial Fisheries and Other Ocean Uses are evaluated and assessed in Chapter 16 (Accidental Events).

13.1.5 Potential Environmental Changes, Effects, and Mitigation Measures

The following sections provide an assessment and evaluation of the potential effects of the Project on Commercial Fisheries and Other Ocean Uses. The mitigation measures to prevent or reduce adverse effects upon this VC are identified and considered integrally within and throughout the environmental effects analysis that follows, as applicable.

13.1.5.1 Potential Project-Related Environmental Changes and Effects

Potential environmental interactions between Project activities and Commercial Fisheries and Other Ocean Uses have been identified through review of the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014), the Flemish Pass Exploration Drilling EIS (herein referred to as the Drilling EIS) (Statoil 2017) and the information required by the Canadian Environmental Assessment Agency (the CEA Agency) arising from its technical review of the Drilling EIS (the "IRs"). In addition, the EIS Guidelines issued by the CEA Agency in September 2018 identify and specify a number of issues and potential effects on this VC that are also considered in the EIS (refer to Section 7.1.3 in Appendix A). Based on review of these resources, it has been determined that the potential direct and indirect adverse effects on Commercial Fisheries and Other Ocean Uses include but are not limited to:

- Direct interference caused by Project activities with fishing harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference Caused by the Project)
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage Caused by the Project)
- Change in abundance, distribution and/or quality of marine resources, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Change in Abundance, Distribution and/or Quality of Marine Resources)

Equinor Canada completed an environmental assessment process per the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) environmental assessment (EA) process for its Drilling EIS. Commercial Fisheries and Other Ocean Uses associated comments from the Drilling EIS (Statoil 2017) assessment process, as well as those received during ongoing engagement with Indigenous groups and stakeholders in regards to the BdN Development (as identified in Section 3.3.2 and 3.4 of this EIS) are as follows and are addressed, as applicable to the scope of the assessment, herein.

- Government Departments and Agencies
- No issues raised regarding Commercial Fisheries and Other Ocean Uses

Indigenous Groups

- Issues and concerns identified by Indigenous groups for commercial-communal fisheries are noted in Chapter 3 and highlighted in Chapter 14

Stakeholder Organizations

- Potential interactions of Project infrastructure and vessels with commercial fishers
- Potential damage to fishing gear due to the presence of subsea infrastructure
- Possible impacts on crab, sea cucumber, shrimp, and migratory fish stocks

Potential impacts on snow crab and shrimp harvesting and other fisheries are considered below; as indicated in Section 7.1, there are no records of sea cucumber fisheries within or near the Project Area. Potential species impacts, including on prey and migratory stocks, are considered in Chapter 9. Aspects associated with commercial-communal fishers are incorporated into Chapter 14.

The environmental effects assessment for this VC considers and focuses on the issues and questions identified through these issues scoping exercises, including an initial identification of the key potential environmental changes and possible environmental effects on the VC that may result from them. These are summarized in Table 13.3.

Table 13.3 Potential Project-Related Environmental Changes and Potential Effects: Commercial Fisheries and Other Ocean Uses

Potential Environmental Changes	Potential Environmental Effects
Direct interference caused by the Project with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference Caused by the Project)	• Loss of access to localized marine areas due to the anti-collision zone associated with the presence the FPSO and/or drilling installation(s) • Temporary interference/disruption of fishing or fisheries surveys, or actual or perceived loss of access to fishing grounds necessitating altered vessel routes or movement to alternative grounds • This might affect the efficiency of harvesting with consequent lower catches and/or revenues, lost time and additional operating costs • Associated interference/disruption of other shipping (including other petroleum exploration) • Avoidance of subsea infrastructure by future commercial activities
Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch and income for harvesters or other marine operators (Damage Caused by the Project)	• Project activities may result in damage to fishing gear or vessels if they come into direct contact with subsea infrastructure Project vessels and survey equipment, and components may tangle or foul fishing gear • Possible damage to subsea cables or other objects / artifacts; UXO / legacy site interaction
Change in abundance, distribution and/or quality of marine resources, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Change in Abundance, Distribution and/or Quality of Marine Resources)	• A potential change in the abundance, distribution and availability of commercial fish species on established grounds due of Project activities (e.g., sound and other emissions) may result in diminished fishing success (e.g., lower catches and revenues, lost time, additional operating costs) • A change in the (real or perceived) quality of marine resources has a potential to result in lower market demand and/or commercial prices

Chapter 9 provides the effects assessment for Marine Fish and Fish Habitat and is relevant to fisheries component of this VC as it considers various potential biophysical and behavioural effects on Marine Fish and Fish Habitat which could have an indirect effect on fish harvesting. Effects identified and considered included changes in habitat availability and quality, changes in food availability and quality, changes in fish and invertebrate mortality, injury, health, and changes in fish and invertebrate presence and abundance (behavioural effects). However, with the proposed mitigation measures, the Project is not predicted to result in significant adverse environmental effects on Marine Fish and Fish Habitat (Section 9.5.2).

In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of Project activities is based on those discharges/activities “with the greatest potential to have environmental effects”. The principal types of potential interactions between routine Project activities and Commercial Fisheries and Other Ocean Uses are physical or logistical, such as interference with or displacing fish harvesters or other shipping, or fishing gear conflicts (snagging) with towed Project equipment. Sound from geophysical surveys are also a potential source of interaction with fishing (scaring fish away from harvesting gear) as indicated in Table 13.3. This is based on data analysis, scientific literature, research studies, Indigenous knowledge, input from Indigenous groups and stakeholders, and the professional experience of the EIS team.

Other potential interactions (e.g., lighting, marine discharges, produced water, drill cuttings discharges) have negligible to low interactions with fish and prey species (see Chapter 9) and it is predicted that there would be no significant residual adverse effect on Marine Fish and Fish Habitat. Considering the marketability / saleability of fish from the general area (the Project Area or the LSA), resulting specifically from market perceptions that would affect price and reduce economic returns, this has not been recorded in relation to other production facilities and operations in the NL region and is anticipated to be similar for the BdN Project operations. Based on the effects predictions in Chapter 9, there will be no effect on the biophysical health or quality of fish species and therefore these interactions not considered in the effects assessment on Commercial Fishing and Other Ocean Uses.

There are no known recreational fisheries carried out in the Project Area LSA, though it is possible that some limited activity, such as during the Newfoundland and Labrador recreational groundfish fishery, could occur at times in inshore areas near the vessel traffic route.

The effects assessment focusses on identified interactions. Where there is no interaction identified, there is no further discussion.

Table 13.4 Potential Project-VC Interactions and Associated Effects: Commercial Fisheries and Other Ocean Uses

Project Component / Activity	Potential Environmental Effects			Mitigation (see Section 13.1.5.2)
	Direct Interference Caused by the Project	Damage Caused by the Project	Change in Abundance, Distribution and/or Quality of Marine Resources	
CORE BdN DEVELOPMENT ACTIVITIES				
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING				
Offshore Construction and Installation				
Marine Vessels				
• Presence	No Interaction			
• Light Emissions	No Interaction			
• Underwater Sound Emissions	No Interaction			
• Marine Discharges	No Interaction			
Installation of Subsea Infrastructure (including establishment of safety zone)	•	•		C, D, E, F, G, H, I, K, L,
Hook-up and Commissioning				
• Anti-collision Zone(s)	•			D, E, F, G, H, K, L,
HUC Activities				
• Marine Discharges	No Interaction			
PRODUCTION AND MAINTENANCE OPERATIONS				
FPSO and Subsea Infrastructure				
• Presence	•	•		D, E, F, I, K, L
• Sound	No Interaction			No Interaction
• Lighting	No Interaction			
Waste Discharges from FPSO				
• Produced Water	No Interaction			
• Other Waste Discharges	No Interaction			
• Non-routine Flaring	No Interaction			

Table 13.4 Potential Project-VC Interactions and Associated Effects: Commercial Fisheries and Other Ocean Uses

Project Component / Activity	Potential Environmental Effects			Mitigation (see Section 13.1.5.2)
	Direct Interference Caused by the Project	Damage Caused by the Project	Change in Abundance, Distribution and/or Quality of Marine Resources	
DRILLING ACTIVITIES				
Drilling Installation				
• Presence	•			D, E, F, G, H, K, L
• Lighting				
• Sound				
Waste Discharges from Drilling Installation				
• Drill Cuttings				
• Marine Discharges				
• Flaring during formation flow testing				
SUPPLY AND SERVICING				
Marine Vessels				
• Presence		•		A, E, F, G, H, I, J, K
• Light Emissions	No Interaction			
• Underwater Sound Emissions	No Interaction			
Aircraft (helicopters)				
• Presence/Movement	No Interaction			
SUPPORTING SURVEYS				
• Presence of Vessels and Towed Equipment	•	•		E, F, G, H, I, K, L
• Light emissions from vessels	No Interaction			
• Underwater Sound Emissions from Vessels	No Interaction			
• Underwater Sound Emissions from Geophysical Survey Equipment			•	E, F, G, H, K, L

Table 13.4 Potential Project-VC Interactions and Associated Effects: Commercial Fisheries and Other Ocean Uses

Project Component / Activity	Potential Environmental Effects			Mitigation (see Section 13.1.5.2)
	Direct Interference Caused by the Project	Damage Caused by the Project	Change in Abundance, Distribution and/or Quality of Marine Resources	
DECOMMISSIONING				
Decommissioning of FPSO	No Interaction			
Decommissioning of Subsea Infrastructure	•	•		E, F, G, K, L, M, N
Well Decommissioning	•			E, F, G, K, L, M, N
PROJECT AREA TIEBACKS				
Offshore Construction and Installation, and HUC				
• Installation of Subsea Infrastructure	•	•		C, D, E, F, G, H, I, K, L,
Production and Maintenance Operations				
• Presence of Subsea Infrastructure	•	•		D, E, F, G, H, I, K, L,
Drilling Activities				
• Presence of Drilling Installation	•			D, E, F, G, H, K, L,
Supply and Servicing				
• Presence	•	•		A, E, F, G, H, I, K
Supporting Surveys				
• Presence of Vessels and Towed Equipment	•	•		E, F, G, H, I, K, L
• Underwater Sound Emissions from Geophysical Survey Equipment			•	E, F, G, H, K, L
Decommissioning				
Decommissioning of Subsea Infrastructure	•	•		E, F, G, K, L, M, N
Well Decommissioning	•			E, F, G, K, L, M, N

13.1.5.2 Summary of Mitigation Measures

A. The following sections provide an assessment and evaluation of the potential effects of the Project on Commercial Fisheries and Other Ocean Uses. Mitigation measures to prevent or reduce adverse effects upon this VC, as listed below, are identified and considered in an integrated manner within and throughout the environmental effects analysis that follows, where applicable.
B. Common traffic routes for vessels and helicopters will be used where possible and practicable.
C. The use of obstruction lights, navigation lights, and foghorns on board the FPSO and drilling installation(s)
D. Equinor Canada is evaluating the need for subsea infrastructure protection for flowlines. In determining the need for protection measures, the level and types of historical fishing effort in the Project and Core BdN Development Area will be considered. Options for trawl protection will be in consideration of Equinor's global experience.
E. Equinor Canada will provide appropriate regulatory authorities the coordinates of the safety zone and/and or anti-collision zone for addition to marine navigational charts
F. Ongoing communication with commercial fishers through One Ocean, Fish, Food and Allied Workers Union (FFAW-Unifor) and seafood producers regarding Project activities, including notification of coordinates of safety and/or anti-collision zones.
G. Ongoing communications with the NAFO Secretariat, through Fisheries and Oceans Canada (DFO) as the Canadian representative, regarding Project activities, including timely communication of the anti-collision and/or safety zones
H. Ongoing communication with regulatory agencies to share information regarding the timing and location of activities (e.g., DFO research surveys, Department of National Defence (DND) offshore military exercises)
I. Equinor Canada will engage with DND to determine appropriate communication protocols regarding Project activities
J. Equinor Canada will develop and implement a compensation program for damages or losses in consideration of the C-NLOPB Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (2017) and aligned with the Best Practices Document for Compensation Processes and Procedures that One Ocean is currently preparing.
K. In consideration with the One Ocean Risk Management Matrix Guidelines (n.d.(a)), the need for a Fisheries Liaison Officer (FLO) and/or fisheries guide vessels during drilling installation movement from a NL port to its offshore location will be determined in consideration of the guidelines.
L. Equinor Canada will implement a standard marine communication protocol to promote safe practices between commercial fishing enterprises, other marine users and BdN operations. The protocol will be in accordance with the One Ocean Protocols for Communication with Oil Installations on the Grand Banks (n.d.(b)), which outlines communication requirements upon approach to the safety zone.
M. Issuance of Navigational Warnings (formerly Notices to Shipping) and Notices to Mariners (where appropriate) regarding Project activities.

N. A decommissioning plan will be developed and submitted to the C-NLOPB for review and acceptance. The plan will be made in consideration of regulatory requirements, engagement with Indigenous groups, commercial fisheries and other stakeholders and likely effects on the environment.
O. Upon final decommissioning, if applicable, the communication through Notices to Mariners and DFO for inclusion on nautical charts, of the locations of subsea infrastructure that may be left in the Project Area.

13.2 Overview of Commercial Fisheries and Other Ocean Uses

As detailed in Section 7.1, commercial fisheries are the principal human activity offshore Newfoundland and Labrador. Current fisheries within the LSA are primarily for groundfish, such as redfish, Greenland halibut and Atlantic cod, taken year-round by doth domestic and foreign harvesters employing mobile gear (e.g., otter trawls) and fixed gear (e.g., gillnets). Snow crab is taken by Canadian harvesters using fixed bottom gear (pots) during the spring and summer, mainly along and near the vessel traffic route. Some other species are harvested to a lesser extent within the LSA and adjacent waters, using mainly mid-water and near-surface gear. These fisheries include capelin (seines) near the vessel traffic route, and sharks, swordfish and tunas closer to the shelf break beyond the EEZ. Shrimp harvesting was important in the LSA in the past but is currently closed to both foreign and domestic fishers in that area. Canadian and foreign fisheries science studies/surveys may also take place in the vicinity of Project activities.

Within the Project Area, available records indicate overall lower harvesting (primarily trawling for groundfish; small amount of snow crab with fixed gear) compared in other parts of the LSA. Within the Project Area, fishing intensity is greatest in the western area near the slope and is carried out primarily with otter trawls. There is very little to no activity within the Core BdN Development Area. The harvesting that might occur in the Core area would be limited groundfish trawling and possibly some surface longlining for large pelagic species.

As described in Section 7.2, other important human activities within and near the Core BdN Development Area, the Project Area and the LSA (including the vessel traffic route) include marine transportation involving Canadian and international shipping (primarily tankers and other cargo ships), as well as vessels supporting other offshore petroleum exploration and production operations, mainly in the Jeanne d'Arc Basin area. Canadian and/or allied military operations (surveillance, monitoring, training, rescue) may also occur within areas of the northwest Atlantic offshore. Recreational fisheries, such as the annual recreational/food groundfish fishery, typically take place in areas close to shore and may occur in or near the vessel traffic route.

There are no known recreational fisheries carried out in the Project Area or LSA though it is possible that some limited activity, such as during the Newfoundland and Labrador recreational groundfish fishery, could occur at times in inshore areas near the vessel traffic route.

One active subsea communications cable passes through the Project Area, outside the Core BdN Development Area. No shipwrecks or military Legacy Sites are known within the Project Area (though there is one legacy site near the vessel traffic route); however, undocumented artifacts including UXO may be present.

13.3 Core BdN Development Area

The Core BdN Development includes six broad phases / categories of activities (Table 13.3):

- Offshore construction and installation, and HUC
- Production and maintenance operations
- Drilling activities
- Supply and servicing
- Supporting surveys
- Decommissioning

The assessment in the following sections is based on these activities and associated potential interactions.

Some or all of these activities may also be part of Project Area Tiebacks which may occur in the larger Project Area; their interactions and potential environmental effects are discussed in Section 13.4.

Subsea infrastructure will be demarcated by a safety zone, pursuant to the *Offshore Petroleum Drilling and Production Regulations* (O.C. 2009-386). As defined in Section 2.5.4, the safety zone does not prohibit entry by other ocean users; it is a zone in which the operator (Equinor Canada) has a duty to take reasonable measures to warn persons who are in charge of vessels and aircraft of the safety zone boundaries, of the facilities within the safety zone and of any related hazards (e.g., the presence of subsea infrastructure).

An anti-collision zone will be established for the FPSO at its location in the Core BdN Development Area. It is estimated it will be approximately 8.5 km² in area. Similarly, when drilling installations are on-site, an anti-collision zone will be established for the drilling installation, which is approximately 1 km². The cumulative footprint of the anti-collision zones represents less than two percent of the Core BdN Development Area or less than 0.5 percent of the Project Area, and less than 0.01 percent of the LSA. Per Canadian and international regulations, other marine traffic is not permitted to enter the anti-collision zone(s). Consequently, most of the potential interactions that might occur between the Project and commercial and commercial-communal fisheries will be limited to the presence of the anti-collision zone. Table 13.6 provides the size of the various areas (e.g., Core BdN Development Area, Project Area) and zones in relation to the LSA. Communications regarding the safety and anti-collision zones will be distributed via Canadian Coast Guard Navigational Warnings and Notices to Mariners. Although the anti-collision zones may reduce access for fishing and other activities in certain areas of the LSA, such disturbances will be localized to the Core BdN Development Area and the Project Area if Project Area Tiebacks are undertaken.

As noted, there is little commercial fishing currently conducted in the Core BdN Development Area and therefore there is limited potential for interactions between Project activities and commercial fishing activity.

Table 13.5 Size of the Various Areas and Zones in relation to the LSA

Area/Zone	Size (approximate)	Purpose	Percentage of LSA (approximate)
Subsea infrastructure Footprint - Core BdN Development	7 km²	Physical area occupied by subsea infrastructure	0.01 percent
Anti-collision zone	8.5 km² (FPSO) 1 km² (Drilling installation)	Per Transport Canada regulations, to protect safety of installations	0.01 percent
Safety zone	30 km²	Per Production and Drilling Regulations; demarcation of subsea infrastructure	0.04 percent
Core BdN Development Area	470 km²	Area where Core BdN Development activities will occur	0.65 percent
Project Area	4,900 km²	Area where Project Area Tiebacks may occur; includes Core BdN Development Area	6.5 percent
Subsea infrastructure footprint – Project Area Tiebacks	3 km² per tieback	Physical area occupied by subsea infrastructure	0.004 percent

13.3.1 Offshore Construction and Installation, Hook-up and Commissioning

Activities associated with offshore construction and installation and HUC, as described in Section 2.6.1, are those activities that are undertaken before and during the arrival of the FPSO at the Core BdN Development Area.

Offshore construction and installation activities include site preparation for, and the installation of subsea infrastructure (i.e., well templates, flowlines, risers, riser base, umbilicals, fibre optic cable). As noted in Section 2.6.1.2, options for installation of flowlines, umbilicals, and/or cables include placement on seafloor, or laid via trenching. In certain cases, there may be a requirement for protection of the flowlines / cables / umbilicals. Options for protection include rock placement, concrete mattresses or trenching. These protection measures would be undertaken during the offshore construction and installation phase.

These activities will likely be carried seasonally, when offshore weather conditions are favourable, and could extend seasonally over a five-year period. For the purpose of this EA, seasonal offshore activities are assumed to occur from May to October. Specialized vessels, as listed in Section 2.6.4.2, will be engaged as required to carry out these activities; the number of vessels offshore at any one time will depend on the activities ongoing at that time. Vessels would be engaged in activities at set locations within the footprint of the subsurface installations. For instance, for well template installations, it is likely that a single vessel would be engaged for installation, therefore the zone of influence during well template installation would be limited to a specific well template location and when installation is complete at one location, the vessel would move to the next well template location. Similarly, for flowline installation, the vessel engaged would be situated at one location only. While two different activities may occur at the same time (i.e., well template installation and flowline installation by two different vessels), it is not anticipated that there would be more than one vessel engaged in the same activity, simultaneously. The approximate sequence of SURF installation would be to install well templates and related components, install the FPSO mooring system, install the flowlines, risers and umbilicals, install the turret buoy, pull-in the risers, hook up the FPSO, and install infrastructure protection, as needed.

HUC activities may occur at any time of the year and are estimated to last approximately four months, depending on operational and/or technical issues. Vessels on site during HUC activities, in addition to the FPSO, may include, but not limited to, vessels engaged to attach flowlines, moorings, risers, etc., to the FPSO and/or well templates. Activities also include the flushing of production lines on the FPSO and flowlines on the seafloor and the establishment of the anti-collision zone for the FPSO.

As indicated in Section 9.1.5.1, the effects assessment for Offshore Construction and Installation and HUC is focused on those interactions and activities “with the greatest potential to have environmental effects” ((Part 2, Section 3.2 of the EIS Guidelines) and therefore includes: the installation and presence of subsea infrastructure, the establishment of the safety and anti-collision zones (once the FPSO is on site).

Based on the environmental effects analysis on fish and fish habitat in Section 9.3.1, which concluded that Offshore Construction and Installation and HUC activities did not have a significant effect on commercial or prey species, there is no predicted loss of catch for harvesters from biophysical effects on fish or fish habitat during offshore construction and installation and HUC activities.

13.3.1.1 Installation of Subsea Infrastructure

The primary effects on Commercial Fisheries and Other Ocean Uses associated with the installation of subsea infrastructure during offshore construction and installation are:

- Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)
- Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)

Direct Interference Caused by the Project is a potential effect associated with offshore construction and installation of subsea infrastructure activities, including the choice fishers and other marine operators may make to avoid ongoing construction activity.

As noted, based on historical catch data, fishing within Core BdN Development Area has been very limited and it is anticipated that fishing and other vessel traffic will also continue to be very low. Furthermore, there is a fisheries closure area (FCA) that intersects the Core BdN Development Area where fishing is closed to bottom trawling activities. Therefore, there is limited potential for interactions between fishing activities and the installation of subsea infrastructure. A safety zone will be established to demarcate the area occupied by subsea infrastructure. As noted above, the safety zone does not prohibit marine users and fish harvesters from entering the area.

As described in Section 7.1.9, NAFO fisheries studies are conducted by some individual signatory states, and locations and timing vary depending on the matter being investigated from year to year. Domestic fisheries science surveys are not known to occur within the Core BdN Development Area.

Communication with NAFO, through DFO, regarding Project activities will reduce potential for interference given the availability of other nearby areas for fish harvesting and scientific surveys. Standard marine notification protocols will allow for fishing and other vessels to adjust course, if needed, without economic loss or other interference. Military operations that might be in the area during subsea infrastructure construction and installation will be informed of Project marine activities through the specific point of contact for DND. Equinor Canada, will inform fisheries interests and other ocean users of planned activities through Navigational Warnings and ongoing communications with One Ocean and DFO (regarding communications to NAFO). Once the safety zone is established for the subsea infrastructure, Equinor Canada will provide appropriate regulatory authorities the coordinates of the safety zone for addition to marine navigational charts and will communicate these coordinates to NAFO and One Ocean.

Direct Interference Caused by the Project is predicated to be adverse, as described above, but short-term during the construction season. The geographic extent of Direct Interference would be limited to location of vessels engaged in subsea infrastructure installation and the footprint of the subsea infrastructure (approximately 7 km² or less than 0.001 percent of the LSA). The safety zone once established represents less than 0.04 percent of the LSA. The effect would be continuous during installation activities, and reversible once activities are completed. The magnitude of effect of Direct Interference would be negligible. While there is a potential for the installation activities to interact with fishing activities and marine uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions given the small area occupied by the subsea infrastructure relative to the size of the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations to reduce direct interference with fishing activity and marine use are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference Caused by the Project associated with the installation of subsea infrastructure during Construction and Installation are predicted to be adverse, negligible in magnitude, with a geographic extent of approximately less than 10 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with presence of subsea infrastructure, once installed on the seafloor. The presence of subsea infrastructure on the seabed has the potential to result in gear damage should trawling activity occur in the area. Based on historical catch data, fishing activity within Core BdN Development Area has been very limited to no activity. It is anticipated that fishing and other vessel traffic will continue to be very low. Equinor Canada is evaluating the need for subsea infrastructure protection for flowlines. In determining the need for protection measures, the level and types of historical fishing effort in the Project and Core

BdN Development Area will be considered. Options for trawl protection will be in consideration of Equinor's global experience. The likelihood of gear or vessel damage will also be reduced with notification of the safety zone so that fishing vessels which might have planned to pass through the area can take alternative routes when transiting through the Flemish Pass, especially since the location of subsea infrastructure will be communicated to harvesters, and locations can be considered during trip planning. As a result, the likelihood of interaction between fishing activity and subsea infrastructure is negligible. Equinor Canada will development and implement a compensation program for damages or losses attributable to the Project.

For other marine traffic, the presence of subsea infrastructure will not have a potential for interaction (e.g., with freighters, tankers, cruise ships, other oil and gas exploration); as noted above, active work areas will be easily avoidable, considering the use of Navigational Warnings and other at-sea communications. Although no marine communications cables are known to be within the Core BdN Development Area and there are no known shipwrecks or UXOs in the area (see Figure 7-48), if such artifacts are found, their location would be considered in the layout of subsea infrastructure. In the case of a suspected UXO being identified, it will be reported to DND. Equinor Canada, will inform fisheries interests and other ocean users of planned activities through Navigational Warnings and ongoing communications with One Ocean and DFO (regarding communications to NAFO).

Damage Caused by the Project is predicated to be adverse, as described above, but short-term during the construction season. The geographic extent of the effect would be limited to the footprint of the subsea infrastructure (approximately 7 km² or less than 0.01 percent of the LSA). The safety zone once established represents less than 0.04 percent of the LSA. The effect would be sporadic, occurring only if fishing activity is carried out in the Core BdN Development Area and if gear is damaged, and reversible once subsea infrastructure is removed. The magnitude of effect of Damage and Loss of Income is negligible. While there is a potential for the presence of subsea infrastructure to interact with fishing activities, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by subsea infrastructure relative to the size of the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations to reduce damage interference with fishing activity and marine use are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with the installation of subsea infrastructure during Construction and Installation are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with installation of subsea infrastructure during Offshore Construction, Installation and HUC activities include the potential inclusion of trawl protection on subsea infrastructure (C); communication of ongoing activities, including the provision of safety zone coordinates, to marine users and regulatory agencies (D, E, F, G, H, K, L), implementation of a compensation program for damages or losses (I).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with installation of subsea infrastructure during Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions is not proposed.

13.3.1.2 Hook-up and Commissioning

Establishment of Anti-Collision Zone

The primary effects on Commercial Fisheries and Other Ocean Uses during HUC associated with the establishment of the anti-collision zone are:

- Direct interference caused by the Project with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)

Direct Interference caused by the Project is a potential effect associated with establishment of the anti-collision zone when the FPSO arrives on site.

Once the FPSO is on its location in the Core BdN Development Area, an anti-collision zone of approximately 8.5 km² will be established around the FPSO within which fishing and other marine traffic will not be permitted. An 8.5 km² anti-collision would represent less than 2 percent of the Core BdN Development Area, less than 0.2 percent of the Project Area and approximately 0.01 percent of the LSA. The anti-collision zone will exist as long as the FPSO is its location in the Core BdN Development Area, for a period of 12 to 20 years. As noted, communication with NAFO and other marine harvesters regarding the anti-collision zones would reduce the potential for interference with fisheries given the availability of other nearby areas for data collection.

While the presence of the anti-collision zone will result in loss of access to the area by fish harvesters, as noted above in Section 13.2, and documented in Sections 7.1.4 and 7.1.5, the Core BdN Development Area has a history of little to no domestic or foreign harvesting, based on DFO and NAFO data. Therefore, the presence of the anti-collision zone for the FPSO is not anticipated to interfere with domestic or international harvesting activities.

For other surface marine traffic, the presence of anti-collision zone will not have a potential for interaction (e.g., with freighters, tankers, cruise ships, other oil and gas exploration). The anti-collision zone can be easily avoidable with a slight route deviation. Equinor Canada will communicate the establishment and provide coordinates for, the anti-collision zone to marine users and regulatory agencies.

Based on the small size of the anti-collision zone in comparison to available fish harvesting areas within the larger LSA, and the limited to no harvesting in the Core BdN Development Area, there will likely be little to no displacement of harvesters from currently active fishing areas and will not result in financial losses to fish harvesters. Since the locations of the anti-collision zone will be communicated to all mariners, diversions required by fish harvesters and/or other marine users to avoid the anti-collision zone would be minor and easily accommodated in route planning, without economic consequences.

Direct Interference from the Project is predicted to be adverse, as described above, and long-term as the anti-collision zone will be in place while the FPSO is onsite for the 12- to 20-year duration of the Core BdN Development. The geographic extent of direct interference would be approximately 8.5 km², or less than 0.01 percent of the available fish harvesting areas of the LSA. The effect would be continuous and reversible once the FPSO leaves the area. The magnitude of effect of Direct Interference is negligible. While there is a potential for the presence of anti-collision zone to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by anti-collision zone relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team.

Mitigations to reduce interference associated with the establishment of the anti-collision zone include notification and communication with marine harvesters and users, and the provision of coordinates to regulatory agencies for addition to marine navigational charts.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference associated with the anti-collision zone Construction and Installation and HUC are predicted to be adverse, negligible in magnitude, with a geographic extent of less than 10 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the anti-collision zone during Offshore Construction, Installation and HUC activities include communication of ongoing activities, including the provision of anti-collision zone coordinates, to marine users and regulatory agencies (D, E, F, G, H, K, L).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with installation of subsea infrastructure include during Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions is not proposed.

13.3.2 Production and Maintenance Operations

Activities associated with production and maintenance operations, as described in Section 2.6.2, are those activities that are undertaken once HUC activities are complete when production operations commence on the FPSO. All activities are from the FPSO and therefore in a fixed location, with an anti-collision zone, within the Core BdN Development Area. Production and maintenance operations for the Core BdN Development is expected to between 12 to 20 years.

The primary interaction associated with Production and Maintenance Operations with Commercial Fisheries and Other Ocean is the continuing existence of the FPSO anti-collision zone, established during HUC activities, as discussed above in Section 13.3.1.2. The effect assessment associated with the anti-collision zone are not repeated.

13.3.2.1 Presence of the FPSO and Subsea Infrastructure

The primary effects on Commercial Fisheries and Other Ocean Uses associated with presence of subsea infrastructure during Production and Maintenance Operations are:

- Direct interference caused by Project activities with fishing harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage and Loss of Income)

Direct Interference caused by the Project is a potential effect associated with continued presence of the FPSO and the anti-collision zone, which was established during HUC activities, during Production and Maintenance Operations.

The potential effects of the 8.5 km² anti-collision zone are discussed and assessed in Section 13.3.1 and would be the same during Production and Maintenance operations. The anti-collision zone would prevent fish harvesting in the area surrounding the FPSO. However, as noted above, there is little to no fish harvesting activities within the Core BdN Development Area. The timeframe for the duration of the effect assessed under HUC activities was long-term and would continue to be long-term as the FPSO will be onsite for 12 to 20 years. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations regarding notification and communication of the anti-collision zone would be implemented, as noted in Section 13.3.1.2.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference associated with the anti-collision zone are predicted to be adverse, negligible in magnitude, with a geographic extent of less than 10 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with presence of subsea infrastructure during Production and Maintenance Operations.

As discussed in Section 13.3.1.1, the presence of subsea infrastructure on the seabed has the potential to result in gear damage should trawling activity occur in the area. However, there is limited to no fishing activity within the Core BdN Development Area; historical data indicates very low to no fishing activity and the presence of the FCA reduces overall fishing intensity (as noted in Section 13.3.1.1). As noted above, trawl protection measures may be installed on subsea infrastructure. The likelihood of gear or vessel damage will also be reduced with notification of the safety zone, which demarcates the subsea infrastructure on the seafloor, so that fishing vessels which might have planned to pass through the area can take alternative routes when transiting through the Flemish Pass. Equinor Canada will development and implement a compensation program for damages or losses attributable to the Project.

Damage to fishing gear is predicted to be adverse, as described above, and long-term due to its presence on the seafloor for 12 to 20 years. The geographic extent will be limited to footprint of the subsea infrastructure (approximately 7 km² or less than 0.01 percent of the LSA). The effect would be sporadic, occurring only if trawling activities occur in the area and if gear is damaged, and reversible once subsea infrastructure is removed. The magnitude of effect of Damage and Loss of Income is negligible. While there is a potential for the presence of subsea infrastructure to interact with fishing activities, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by subsea infrastructure relative to the size of the LSA and available fish harvesting areas within the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations to reduce damage interference with fishing activity and marine use are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with the Presence of the FPSO and Subsea Infrastructure during Production and Maintenance Operations are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km², of long-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the Presence of the FPSO and Subsea Infrastructure during Production and Maintenance Operations include ongoing communications with marine users including information regarding the anti-collision and safety zone (D, E, F, K, L); implementation of a compensation program (I); and provision the coordinates of the safety zone and/and or anti-collision zone to regulatory authorities for addition to marine navigational charts (D).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with the Presence of the FPSO and Subsea Infrastructure during Production and Maintenance Operations in consideration of the residual effects predictions is not proposed.

13.3.3 Drilling Activities

Drilling activities to be undertaken for the Core BdN Development are described in Section 2.6.3. Drilling will occur at locations in the Core BdN Development Area, as illustrated in Figure 2-12. These locations are illustrated on the figure as “well templates.” Depending on final project design, wells will either be drilled using templates (multiple wells drilled in one location) or at individual well locations (satellite wells). Drilling will likely commence before the FPSO arrives on site and will overlap periodically during production operations. As noted in Table 13.1, it is estimated that 45-85 days are required to drill each well. Therefore, assuming eight wells are drilled consecutively, the drilling installation could be on a well template location between approximately one to two years, respectively. Drilling will not be carried continuously over the life of the project, but will occur in phases, with a set number of wells drilled per drilling campaign.

As listed in Table 13.3 and discussed in the Section 13.1.5.1, the primary interactions from drilling activities with Commercial Fisheries and Other Ocean Uses are the presence of the drilling installation(s) and the associated anti-collision zone (approximately 1 km² in area at each drilling location) where other marine uses, including fishing and other activities are prohibited. Transits of drilling installations between port and the Core BdN Development Area are considered under Section

13.3.4 Supply and Servicing (Marine Vessels) since potential interactions would be the same as for other Project vessel transits.

13.3.3.1 Presence of Drilling Installation

The primary effect on Commercial Fisheries and Other Ocean Uses associated with the presence of the drilling installation during Drilling Activities is:

- Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses

Direct interference Caused by the Project is a potential effect associated with the establishment of an anti-collision zone(s) for the drilling installation during Drilling Activities.

When a drilling installation is on-site, and for the duration of drilling activities at any one location in the Core BdN Development Area, a temporary (one to two years) anti-collision zone will be established around the drilling installation. It is estimated that the anti-collision zone will be approximately 1 km^2 per drilling installation when on-station at a well template location. Interactions associated with the anti-collision zone and Commercial Fisheries and Other Ocean Uses will be similar to those addressed above for the presence of the FPSO and its associate anti-collision zone. (Section 13.3.2.1), but with a smaller and temporary zone. The establishment of an anti-collision zone prohibits other marine users, including fish harvesters from entering the zone. Therefore, the presence of the drilling installation would prohibit fishing and other marine use in these areas while the drilling installation was on-station. However, as noted above, there is little to no fish harvesting activities within the Core BdN Development Area, with available fish harvesting areas in the larger LSA. Navigational Warnings will communicate the location of drilling installation(s), including the anti-collision zone.

Direct Interference from the Project is predicted to be adverse, as described above, and medium-term as the anti-collision zone will be in place while the drilling installation is onsite for approximately one two years. The geographic extent of direct interference would be approximately 1 km^2 for the drilling installation or 9.5 km^2, should the drilling installation and FPSO be in the Core BdN Development area at the same time. The 9.5 km^2 area represents less 0.01 percent of the available fish harvesting areas of the LSA. The effect would be continuous while drilling activities are ongoing and reversible once the drilling installation leaves the area. The magnitude of effect of Direct Interference is negligible. While there is a potential for the presence of drilling installation, with the establishment of the anti-collision zone ,to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by anti-collision zone relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations include communication of activities with fish harvesters and marine users and notification of the anti-collision zone.

In summary, with the application of mitigation measures, the residual environmental effects associated with the presence of a drilling installation during Drilling Activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², of medium-term duration, occurring continuously and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the Presence of the drilling installation during Drilling Activities include ongoing communications with marine users including information regarding the anti-collision and safety zone (D, E, F, G, H, K, L).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with the presence of the drilling installation during Drilling Activities in consideration of the residual effects predictions is not proposed.

13.3.4 Supply and Servicing

Activities associated with Supply and Servicing are described in Section 2.6.4. Supply and servicing to support the Project will involve marine vessels (supply and support, crude shuttle tankers) and aircraft transiting to, from and within the Core BdN Development Area and Project Area at all times of the year throughout the Project duration. These activities also include transits of drilling installations between port and drilling locations within the Project Area.

As described in Section 2.6.4.2, the volume of vessel traffic associated with Core BdN Development activities represents a negligible contribution to the overall vessel traffic off eastern Newfoundland. At a maximum, when Project phases overlap, albeit for a short duration, it is estimated that up to six support vessels could supporting Project activities and up to 16 vessels transits per month could occur. Of the total annual transits recorded servicing offshore oil and gas activities, these 16 transits per month (or 192 per year) represents and estimated 20 percent increase to offshore oil and gas related traffic or 12 percent of all traffic in the port of St. John's. During normal operational timeframe, when only one Project activity is occurring at any one time, for instance Production and Maintenance, up to three support vessels would be supporting the Project, representing eight transits per month. This typical level of supply and servicing traffic represents an estimated 10 percent increase in offshore oil and gas related traffic and 10 percent increase in all vessel traffic in the port of St. John's. Supply and support vessels supporting the Project will transit in a straight-line approach to and from port to the Project location, a common industry practice for energy efficiency employed for over 30 years by operators with facilities offshore NL.

As indicated in Table 13.3, only the presence and movements of the vessels along the vessel traffic route (which are within the LSA) are considered as potential interactions with Commercial Fisheries and Other Ocean Uses.

13.3.4.1 Presence of Vessels

The primary effects on Commercial Fisheries and Other Ocean Uses associated with the presence of marine vessels during supply and servicing are:

- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage and Loss of Income)

Damage caused by the Project is a potential effect associated with presence of vessels involved in Supply and Servicing.

Supply and support vessels in transit along the vessel traffic route may damage fishing gear, particularly fixed fishing gear, which may be left unattended within or near the vessel traffic route. Considering the identified fisheries near the vessel traffic route (see Section 7.1), the most likely fishing gear interaction is with fixed snow crab fishing gear, which may be distributed, unattended, in areas in or near the vessel traffic route. Crab harvesting is more active during the summer months, and during the post-season collaborative snow crab fisheries science survey (see Section 7.1.6.2). Other fixed gear (though less common) that might occur along or near the vessel traffic route, typically within 50 km of St. John’s, are gillnets. There is little or no potential for interaction with fisheries using mobile gear in these areas. Based on historic evidence, damage to other vessels is highly unlikely; there have been no incidents reported regarding interaction between a supply vessel and a commercial fishing or other ocean-going vessel (C-NLOPB 2018). Use of common vessel traffic routes and adherence to the nautical “rules of the road” will reduce the likelihood of any occurrences.

Ongoing coordination and communication between Equinor Canada and the fishing industry (e.g., the FFAW-Unifor, One Ocean), will also reduce the potential for effects between Project-related vessel traffic and commercial fishers. The need for a FLO and/or fisheries guide vessel during drilling installation transits between a NL port and its offshore location will be determined in consideration of the One Ocean guidelines. Equinor Canada will develop and implement a compensation program for damages which will be developed in consideration of the Canada-Newfoundland and Labrador Offshore Petroleum Board’s (C-NLOPB’s) Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (2017) and will be aligned with the “Best Practices Document for Compensation Processes and Procedures” that One Ocean is currently preparing.

Damage Caused by the Project is predicted to be adverse, as described above, and short-term as it would only occur when vessels are transiting, and reversible. The geographic extent of effect would be less than 10 km^2 as the potential for damage to occur would be along the vessels path in the vessel in the vessel traffic corridor. The effect would be sporadic and short-term, as it would depend on timing and location of fishing gear in relation to timing and location of support vessels. The magnitude of the effect is negligible. While there is a potential for supply and support vessels to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions; should gear damage occur mitigation will compensate for losses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with vessels engaged in Supply and Servicing are predicted to be adverse, negligible in magnitude, with a geographic extent of less than 10 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the Supply and Servicing include use of common traffic routes (A); ongoing communications with marine users including (E, F, G, H, K) information and compensation for damages caused by the Project (I); use of FLO during rig transits from NL ports, if required (J).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with the presence vessels engaged in Supply and Servicing in consideration of the residual effects predictions is not proposed.

13.3.5 Supporting Surveys

As described in Section 2.6.5, throughout the Project, surveys may be required to support all Project activities. These surveys include geophysical surveys (e.g., 2D/3D/4D seismic, VSP, wellsite geohazard), geotechnical and/or geological surveys, environmental surveys, and ROV/AUV/video surveys. Surveys will be carried out in the Core BdN Development Area and/or Project Area should Project Area Tiebacks be undertaken.

Geohazard/wellsite surveys typically take between five and 21 days to complete, but the overall duration can be shorter or longer depending on the data requirements and weather /operational delays. They may involve the use of seismic sound sources, multibeam echosounder (MBES), sidescan sonar (SSS), synthetic aperture sonar (SAS) subbottom profiler (SBP), video and other non-invasive equipment. The equipment is deployed either as hull-mounted equipment, on a towfish or on ROV / AUVs. Equipment may be autonomous, towed by the vessel or hull-mounted. These surveys may occur at any time of the year over the temporal scope of the Project.

Geophysical surveys that may occur over the life of the Project and include 2D/3D/4D seismic surveys or VSP surveys. Any required survey will take place within the Project Area. As noted in Section 2.6.5, 2D seismic surveys are not anticipated. For 3D/4D surveys, multiple sound source arrays can be used, and the vessel could tow between eight and 16 streamers containing hydrophones, also called conventional seismic surveys. Another option for 4D surveys is to place the hydrophones on the seabed, in either nodes or cables. If nodes/cables are used and installed on the seafloor it is called ‘permanent reservoir monitoring’; the nodes/cables are removed at the end of the Project. The Project is considering permanent reservoir monitoring or conventional seismic. Permanent reservoir monitoring is estimated to take approximately two weeks to complete and could be carried out twice per year. Conventional seismic surveys could be between two and four weeks and occur as frequently as once per year in early Project life, with reduced frequency in later years. If permanent reservoir monitoring is chosen, the area occupied on the seabed by the installed

OBC/OBN could be approximately 150 km² and it is likely within the safety zone. Timing and duration of these seismic surveys are estimated and will be finalized during Project design.

VSP is a tool used to further define the depth of geological features and potential petroleum reserves by obtaining high resolution images of the target. As stated in Section 2.6.5, it is estimated that one to two VSP surveys could be carried out for the Core BdN Development Area. VSP is conducted in a vertical wellbore using hydrophones inside the wellbore and a sound source near the surface at or near the well; a VSP is quieter and more localized than a surface geophysical survey, being smaller in size and volume. A VSP usually taking less than 48 hours per well to complete. VSP surveys may be carried out at any time of the year.

Environmental surveys are used to collect samples to characterize the physical, chemical, and biological aspects of the selected area. Sampling is typically carried out from an OSV or dedicated vessel suitable to the survey. Environmental surveys may occur throughout Project life at any time of the year using vessels of opportunity associated with the Project, typically taking five to 21 days to complete.

Geotechnical or geotechnical surveys measure the physical properties of the seabed and subsoil through the collection of sediment samples and in-situ testing. Geotechnical surveys may occur throughout the Project life at any time of the year, using dedicated vessels provided by marine geotechnical specialist suppliers.

ROV or AUV surveys are used to conduct visual inspections (camera equipped) of seafloor, facilities and/or carry out repairs of subsea equipment. They may also be used during any or all of the surveys described above. They will be conducted throughout the Project-life at any time of the year using vessels of opportunity associated with the Project.

In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of project activities is based on those discharges/activities “with the greatest potential to have environmental effects.” For supporting surveys, the interaction with the greatest potential to have effects on Commercial Fisheries and Other Ocean Uses is the presence of the vessels and towed equipment, and underwater sound emissions from geophysical survey equipment.

13.3.5.1 Presence of Vessels and Towed Equipment

The primary effects on Commercial Fisheries and Other Ocean Uses associated with the presence of vessels and towed equipment during Supporting Surveys are:

- Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage and Loss of Income)

Direct Interference Caused by the Project is a potential effect associated with the presence of vessels and survey equipment.

Depending on the option chosen for 4D geophysical surveys for the Project, fixed ocean bottom nodes or cables may be installed on the seafloor (called permanent reservoir monitoring). If permanent reservoir option is undertaken, the location of ocean bottom nodes or cables might interfere with fishing activity, particularly bottom-tending gear. Based on preliminary project design, the area that could be occupied by the nodes or cables is estimated to be approximately 135 km². It is anticipated that the survey location will be within the safety zone established for the Core BdN Development. As noted in previous sections, there is limited to no fishing activity within the Core BdN Development Area, therefore the potential for interaction with fisheries and other ocean uses is limited. The location and timing of surveys will be communicated to marine fish harvesters and other ocean users so that they take alternate routes when transiting through the Flemish Pass.

If towed hydrophones were the chosen option for 4D seismic, the potential for interaction is similar. Vessels towing streamers travel at slower speeds require a wide berth especially during turns and other marine vessels in the area, to avoid interference, would be requested to remain out of the path of the supporting vessels. However, with limited to no fishing in the Core BdN Development Area the potential for interaction is very low.

Direct Interference by the Project is predicted to be adverse, as described above. The effect could be short- to long-term in duration, depending on the survey method chosen (short term for towed hydrophones and long-term for permanent reservoir monitoring). The geographic would be approximately 135 km², if permanent reservoir monitoring was chosen, representing less than 0.5 percent of the LSA. If towed streamers are an option, the geographic extent would be approximately 100 km², based on the turning radius of the vessel towing gear. The effect would be continuous and reversible once the survey was completed or the nodes/cables were removed from the seafloor. The magnitude of the effect is negligible. While there is a potential for the presence of survey vessels and/or survey gear to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference caused by the Project associated with the presence of vessels and survey equipment during Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent between 100 km² and 1000 km², short- to long-term duration, occurring continuously and reversible. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with the of presence of vessels and towed survey equipment during Supporting Surveys.

Fishing gear may be snagged by transiting vessels and/or towed gear. However, as geophysical surveys will occur within the Core BdN Development Area where there is limited to no commercial fishing activity, particularly fixed gear fishery, the likelihood of gear damage is very low to not likely. Ongoing communication between Equinor Canada and the fishing industry and the availability of a compensation program for commercial fish harvesters will further reduce the potential for effects between Project-related surveys and commercial fisheries. Continuing communications with DFO and NAFO will inform science survey managers, and other marine operators will be informed through Navigational Warnings. Equinor Canada will develop and implement a compensation program for damages which will be developed in consideration of the Canada-Newfoundland and Labrador Offshore Petroleum Board's (C-NLOPB's) Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (2017) and will be aligned with the "Best Practices Document for Compensation Processes and Procedures" that One Ocean is currently preparing

Damage Caused by the Project is predicted to be adverse, as described above. The effect would be short-term as surveys will be undertaken within a two- to four-week timeframe, and reversible once the survey is complete. The geographic is anticipated to be localized to the location of the vessel and/or fixed gear, less than 1 km². The effect would be sporadic, occurring only if survey vessels or towed gear came in contact with fixed gear in the water. The magnitude of the effect is negligible. While there is a potential for the presence of survey vessels and/or towed gear to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with the presence of vessels and towed equipment during Supporting Surveys are predicted to be adverse, negligible in magnitude, with a geographic extent between 1 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence based on data analysis and the experience and professional judgement of the EIS Team.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the presence of vessels during Supporting Surveys include ongoing communications with marine users including (E, F, G, H, K, L) information and compensation for damages caused by the Project (I).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with the presence vessels during Supporting Surveys in consideration of the residual effects predictions is not proposed.

13.3.5.2 Underwater Sound Emissions from Survey Equipment

The primary effects on Commercial Fisheries and Other Ocean Uses associated with the underwater sound emission from survey equipment used during Supporting Surveys are:

- Change in abundance, distribution and/or quality of marine resources, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Change in Abundance, Distribution and/or Quality of Marine Resources)

Change in Abundance, Distribution and/or Quality of Marine Resources is a potential effect associated with underwater sound emissions from geophysical survey equipment.

As discussed in Section 9.3.5.5, underwater sound emissions from geophysical survey equipment has the potential to affect fish behaviour and avoidance of certain areas, and therefore has the potential to indirectly affect commercial fishing activity. Fish avoidance behaviours could reduce catch rates of fish areas where geophysical surveys are undertaken, therefore resulting in lower economic returns for fishers. Fish avoidance may also affect the results of fisheries science surveys if in the area at the same time. There is no predicted interaction of survey sound with other ocean operations.

The effects of underwater sound associated with Project-related surveys on marine fish species have been assessed in Chapter 9. It was concluded that there would not be a significant effect on marine fish species (including commercial fish species) from the presence of underwater sound from Project-related surveys. While operation of a source array could injure fish species if they are within close proximity to the sound source, it is likely that mobile fish will disperse from the source during ramp-up or vessel approach and avoid harm. The more likely effect is that fish species, including commercial species, will move away from an area due to the presence of underwater sound. Skalski et al. (1992), for example, cite geophysical activity as a contributing factor for decreased fish abundance, and Løkkeborg (1991) observed reduced fish catches for days following 2D/3D seismic survey exposure as a result of changes in fish behaviour. Catches for some species / gear types (such as gillnet catches of orange rockfish and halibut) have actually increased during geophysical activity, whereas others (such as longline catches of haddock) have been observed to decrease (Løkkeborg et al. 2010). At larger scales, regions with geophysical survey activity had decreased catches for only a few species for certain gear types (e.g., saithe and haddock with gill nets; Vold et al. 2009). In other studies, the effects of geophysical survey exposure on cod catches off the coast of Norway found that catch rates decreased by at least 50 percent within the geophysical survey area, lasting for approximately 24 hours within a 10 km radius (Engås et al. 1996). The potential effects of geophysical survey activity on fish catch rates therefore appear to vary by species and gear type (Hirst and Rodhouse 2000; Løkkeborg et al. 2012; Worcester 2006; Vold et al. 2012). More recently, Morris et al. (2018) conducted a two-year (2015 to 2016) study examining the effects of 2D seismic surveys on catch rates of snow crab along the eastern slope of the Grand Banks. The study concluded that the results suggest “that if seismic effects on snow crab harvests do exist, they are smaller than changes related to natural spatial and temporal variation” (Morris et al 2018).

Overall, while there may be behavioural response of fish to sound from geophysical surveys the indirect effects to Commercial Fisheries and Other Ocean Uses is expected to be unlikely due to the transient, localized, and short-term nature of the surveys, particularly since the surveys will be conducted in the Core BdN Development Area where past harvesting and science surveys have been very low to none, as discussed in previous sections. Harvesters and science survey managers will be informed of survey locations in advance; other mitigation measures to further reduce effects of underwater sound on marine fish are presented in Section 9.1.5.2.

Change in Abundance, Distribution and/or Quality of Marine Resources associated with underwater sound emissions is predicted to be adverse, as described above. Behavioural effects on fish, and therefore would short-term as surveys will be undertaken within a two- to four-week timeframe, and reversible once the survey is complete. Based on sound modelling, the geographic extent of the behavioural effects would between 1,000 km² and 10,000 km² of the location of underwater sound source within the Core BdN Development Area (See Section 9.3.5.3). The effect would be continuous while the survey is active. The magnitude of the effect is low. Underwater sound emissions may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses, it is considered within the range of natural variability as a very small area of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Change in Abundance, Distribution and Quality of Marine Resources associated with underwater sound emissions from survey equipment used during Geophysical Activities are predicted to be adverse, low in magnitude, with a geographic extent between 1,000 km² and 10,000 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with underwater sound emissions during Supporting Surveys include ongoing communications with marine users including (E, F, G, H, K, L).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with underwater sound emissions during Supporting Surveys in consideration of the residual effects predictions is not proposed.

13.3.6 Decommissioning

As described in Section 2.6.7, at end of field-life the Project, either at the end of the Core BdN Development or the end of Project life should Project Area Tiebacks be undertaken, will be decommissioning in accordance with regulatory requirements in place at the time of decommissioning. A decommissioning plan will be submitted to the C-NLOPB for review and acceptance. Depending on the activity undertaken, decommissioning may occur seasonally or at any time of the year. It is anticipated that decommissioning will be carried out over multiple seasons, similar to Offshore Construction and Installation (Section 9.3.1) and be completed within a two to four-year timeframe. Decommissioning of the FPSO may occur at any time of the year.

As a base case, the FPSO will be decommissioned and removed from the Project location. It is likely that the FPSO will be decommissioned and removed from site in the initial phases of decommissioning. As noted above, vessels may be engaged to support decommissioning of the FPSO. All floating equipment (turret, mooring lines) will be removed. Subsea infrastructure, including flowlines and well templates may be removed or left in place. As noted in Section 2.6.7, these options will be further examined at the time of decommissioning.

Wells will be abandoned in accordance with regulatory requirements and as described in Section 2.6.7.2. Depending on water depth, the wellhead will either be removed during decommissioning or left in place. Well decommissioning may be carried out with a drilling installation (internal cutting of the well casing), which typically occurs at shallower water depths, or in deeper waters via a vessel and ROV-equipped with a mechanical cutter (external cutting of wellhead). Explosives will not be used to remove wellheads.

Activities associated with decommissioning are the same as described and the above sections, including vessels engaged in decommissioning activities, supply and servicing, helicopter supply and servicing, ROV / AUV surveys. Marine vessel and aircraft support activity levels during decommissioning would likely be similar to the construction and installation phase of the Project. Environmental, geotechnical, and/or geological surveys may be required during decommissioning.

In consideration of the interaction and associated effects of vessel-based interactions, as noted above, the effects assessment of decommissioning will focus on removal of the subsea infrastructure and wellheads, which have the potential for interaction with Commercial Fisheries and Other Ocean Uses. Decommissioning of the FPSO involves its disconnection from its moorings at which point, the FPSO as a vessel will transit to its final destination. As a vessel that is not engaged in offshore oil and gas production activities, the anti-collision zone is no longer in effect and therefore there is no interaction with fish harvesters or other ocean users.

13.3.6.1 Decommissioning of Subsea Infrastructure

The primary effect on Commercial Fisheries and Other Ocean Uses associated with decommissioning of subsea infrastructure is:

- Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage Caused by the Project)

Direct Interference Caused by the Project is a potential effect associated with Decommissioning of Subsea Infrastructure.

Should subsea infrastructure be removed at the time of decommissioning, decommissioning activities would be similar to activities described under Offshore Construction and Installation activities, and would involves marine vessels in the Core BdN Development Area engaged in the removal of flowlines, umbilicals, cables, wellhead template infrastructure, moorings, etc. Due to the presence to vessels in the area, fish harvesters and other marine users may need to avoid the area. Mitigations, such as communication with mariners, fish harvesters and regulatory agencies would continue to ensure they are aware of decommissioning activities at site. With the removal of subsea infrastructure, interactions and thereby direct interference with Commercial Fishers and Other Ocean Uses would no longer be likely, as the area would return to baseline conditions.

Should subsea infrastructure remain in place, all flowlines will be flushed to ensure no hydrocarbons remain. Water depths are approximately 1100 m, so there may be interference with fish trawling activities that occur at this water depth. However, based on historical fishing data, and with the FCA in the Core BdN Development Area, the fishing activity in this area is very low to no fishing. Navigational Warnings and Notices to Mariners would be issued and the coordinates of any remaining subsea infrastructure will be provided to NAFO, One Ocean, FFAW-Unifor, DFO and regulatory agencies (for inclusion on marine navigational charts).

Direct Interference Caused by the Project associated with Decommissioning of Subsea Infrastructure is predicted to be adverse if subsea infrastructure remains in place or neutral if infrastructure is removed, as it is a return to baseline conditions. Effects would be long-term and occur once. The geographic extent would be 7 km², based on the footprint of he subsea infrastructure. The magnitude of the effect is negligible. While there is a potential for the decommissioning activities to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference Caused by the Project associated with the Decommissioning of Subsea Infrastructure are predicted to be neutral to adverse, negligible in magnitude, with a geographic extent less than 10 km², long-term in duration and occurring once. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with Decommissioning of Subsea Infrastructure.

Should subsea infrastructure be removed at the time of decommissioning, potential interactions of subsea infrastructure and gear damage would be eliminated. However, should subsea infrastructure remain in place there is potential for gear damage should bottom trawling occur in the area. However, based on historical fishing data, and with the FCA in the Core BdN Development Area, the fishing activity in this area is very low to no fishing. Navigational Warnings and Notices to Mariners would be issued and the coordinates of any remaining subsea infrastructure will be provided to NAFO, One Ocean, FFAW-Unifor, DFO and regulatory agencies (for inclusion on marine navigational charts).

Damage Caused by the Project associated with Decommissioning of Subsea Infrastructure is predicted to be adverse if subsea infrastructure remains in place or neutral if infrastructure is removed, as it is a return to baseline conditions. Effects would be sporadic and long-term if subsea infrastructure remains in place occurring only if there is trawling in the area and if gear is damaged to no interactions (neutral) if subsea infrastructure was removed. The geographic extent would be 7 km², based on the footprint of the subsea infrastructure. The magnitude of the effect is negligible. While there is a potential for the decommissioning activities to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with the Decommissioning of Subsea Infrastructure are predicted to be neutral to adverse, negligible in magnitude, with a geographic extent less than 10 km², of long-term duration and occurring sporadically. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with Decommissioning of Subsea Infrastructure include communications with marine users (E, F, G, K, L), and submission of a decommissioning plan to the C-NLOPB (M), and provision of coordinates of remaining subsea infrastructure to regulatory agencies for inclusion on nautical charts (N).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with Decommissioning of Subsea Infrastructure in consideration of the residual effects predictions is not proposed.

13.3.6.2 Well Decommissioning

The primary effects on Commercial Fisheries and Other Ocean Uses due to wellhead decommissioning are:

- Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage Caused by the Project)

Direct interference caused by the Project is a potential effect associated with Well Decommissioning.

As noted above, at water depths in the Core BdN Development area, wellheads will likely be removed by external mechanical cutting, and therefore a pipe stub of approximately 0.85 m could remain above the seafloor posing a potential hazard to bottom-trawling fishing activities. However as noted above, there is little to no fishing activity within the Core BdN Development Area, therefore the potential for interaction is limited. Fish harvesters will be notified of the location of decommissioned wells and the coordinates of decommissioned wells will be provided to regulatory agencies for inclusion on marine navigational charts.

Direct Interference Caused by the Project associated with the Decommissioning of Wells is predicted to be adverse, as note above and long-term in duration. Effects would be permanent due to the presence of the pipe stub above the seafloor. The geographic extent limited to the location of the wellheads at each well template location, therefore less than 1 km² per template location. The magnitude of the effect is negligible. While there is a potential for the decommissioning of wells to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference Caused by the Project associated with Well Decommissioning are predicated to be adverse, negligible in magnitude, less than 1 km², long-term and occurring continuously. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with Well Decommissioning.

The pipe stub remaining above the seafloor may damage fishing gear, should trawling occur in the area of the decommissioned wells. However, based on historical fishing data, and with the FCA in the Core BdN Development Area, the fishing activity in this area is very low to no fishing. Fish harvesters will be notified of the location of decommissioned wells and the coordinates of decommissioned wells will be provided to regulatory agencies for inclusion on marine navigational charts.

Damage Caused by the Project associated with Well Decommissioning is predicted to be adverse, as described above and sporadic, occurring only if trawling is carried out in the area. The geographic extent limited to the location of the wellheads at each well template location, therefore less than 1 km² per template location. The magnitude of the effect is negligible. While there is a potential for the decommissioning of wells to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with Well Decommissioning are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², long-term and occurring sporadically. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with Well Decommissioning communications with marine users including (E, F, G, K, L), submission of a decommissioning plan to the C-NLOPB (M), and provision of coordinates of decommissioned wells to regulatory agencies for inclusion on nautical charts (N).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with Well Decommissioning in consideration of the residual effects predictions is not proposed.

13.4 Project Area Tiebacks

Over the life of the Project, Equinor Canada may choose to undertake additional exploration activities (e.g., exploration, appraisal, delineation drilling, 2D, 3D/4D seismic) to search for and possibly develop economically recoverable reserves. Should additional economically and technically recoverable reserves be discovered within the Project Area, they could be processed on the BdN

FPSO through the installation of additional subsea templates and flowlines ("subsea tiebacks") as described in Section 2.6.6. Between one and five well templates could be tied-back to the FPSO and/or existing well templates via flowlines, and may include the drilling of up to 20 additional wells within the additional well templates Activities associated with Project Area Tiebacks would be the same as those described in Section 2.6.6, and summarized below:

- Installation of subsea tieback(s) (well templates and flowlines)
- Continuation of production and maintenance operations from the existing FPSO
- Drilling activities associated with the drilling of up to 20 additional wells (total) in well templates
- Continuation of supply and servicing
- Additional supporting surveys, if required
- Decommissioning

The Core BdN Development has a field life of 12 to 20 years. Should Project Area Tiebacks occur, the field life of the Project may be extended while maximum daily potential production rates would remain the same. Tiebacks may be feasible up to a distance of approximately 40 km from the FPSO and/or template location. Figure 13-2 illustrates examples of tieback layouts that could occur, should Project Area Tiebacks be undertaken. For the purposes of environmental effects assessment, it is assumed that the timeframe for Project Area Tiebacks would the same as those listed for the Core BdN Development. For instance, it is assumed that offshore construction and installation of well templates and flowlines, and HUC activities of the new subsea infrastructure could occur over several seasons; production and maintenance operations, supply and servicing and supporting surveys occurring during the Core BdN Development would continue until 30-year end of Project life (an additional 10 to 18 years). Mitigation measures, as described in Section 13.1.5.2 and Table 13.4, implemented for the Core BdN Development would be applied to activities undertaken in Project Area Tiebacks.

The primary interactions associated with Project Area Tiebacks are the same as those for the Core BdN Development through the same pathways: (1) loss of access to fishing grounds due to the establishment of temporary anti-collision zones that would be required when a drilling installation is on site, (2) potential for gear damage from various Project operations, including subsea infrastructure in the Project area, supporting surveys, and (3) change in abundance, distribution and quality of marine resources associated most specifically with any additional geophysical surveys. There is, however, a potential for an increased level of interaction with commercial fisheries if Project Area Tiebacks occur in areas with higher fishing intensity than in the Core BdN Development Area. For instance, fishing activities tend to be more concentrated in the north and northwest parts of the Project Area, towards the shallower waters of the Sackville Spur in NAFO UAs 3Le or 3Ma, or to the west towards the Nose of the Grand Banks (see Sections 7.1.4 and 7.1.5). Fishing in these areas is principally by bottom trawling. Since specific locations of tiebacks and activities are not known, for the purpose of this EA, the following discussions assume that operations and infrastructure in the Project Area will be located in and/or pass through currently used harvesting areas, thereby considering a potential "worst-case" situation with respect to locations for interactions with commercial fisheries. For other ocean uses (e.g., other cargo or passenger shipping), the interaction will be the same in terms of potential effects as for the Core BdN Development Area though involving a larger geographical area.

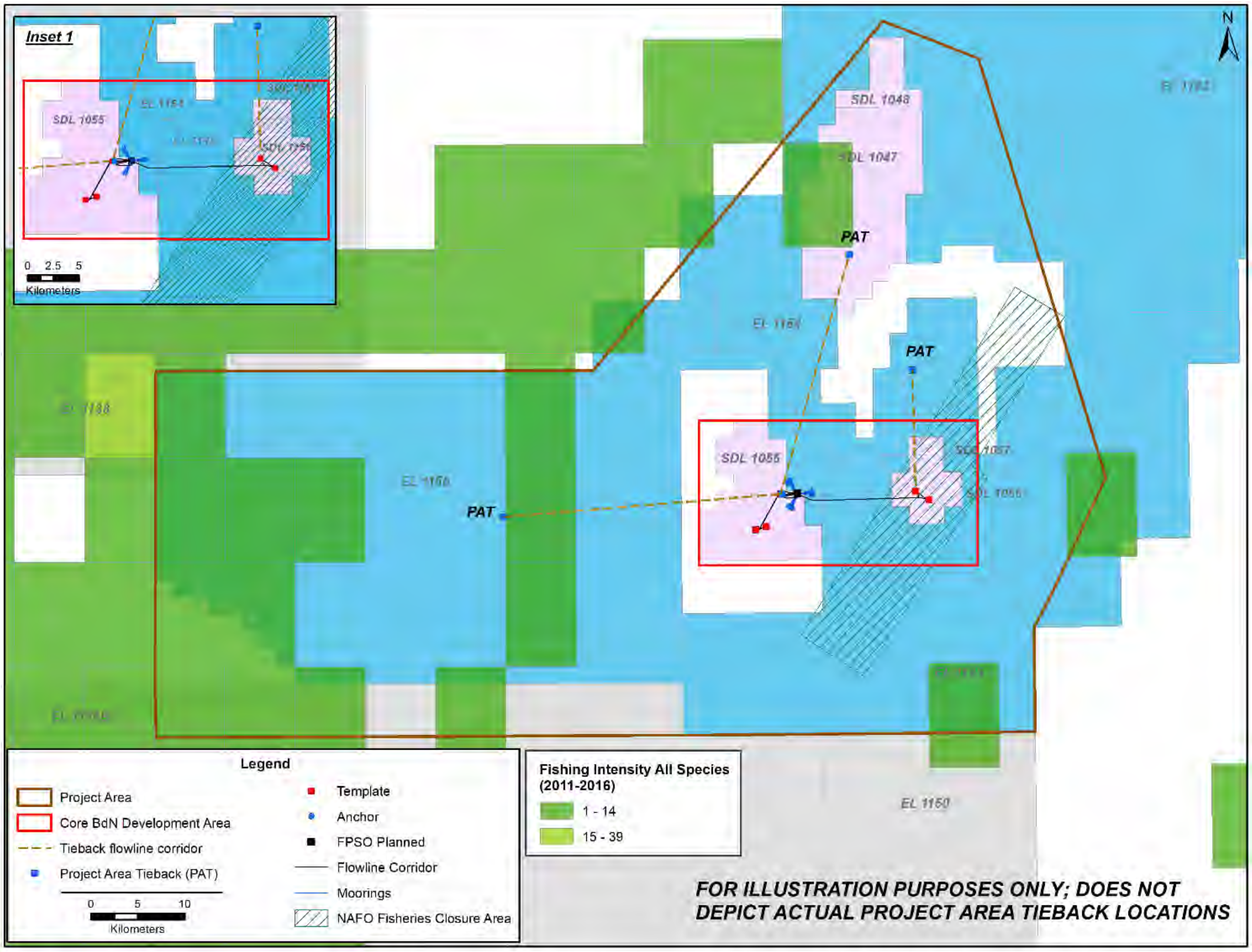

Figure 13-2 Illustration of Examples of Project Area Tiebacks

Except for the greater geographic extent and how additional locations might interact with fisheries (e.g., how these might affect the magnitude and or geographic extent of an effect), the potential effects on Commercial Fisheries and Other Ocean Uses are the same as those discussed in the context of the Core BdN Development, with the same mitigations in place. The following effects assessment of Project Area Tiebacks is therefore focused primarily on how the identified potential interactions might affect Commercial Fisheries and Other Ocean Uses in ways or to degrees that are not predicted for the Core BdN Development phase.

13.4.1 Offshore Construction and Installation, Hook-up and Commissioning

Project Area Tiebacks of up to five additional subsea tiebacks (flowlines, well templates) would involve seabed surveys and site preparation, installation of subsea infrastructure, and eventual HUC of newly installed well templates and flowlines, similar to those described in Section 9.3.1. Activities would occur at locations within the Project Area but would likely be seasonal and may occur over multiple years as with similar activities for the Core BdN Development. Offshore construction and installation and HUC of Project Area Tiebacks may occur at the same time as ongoing production and/or drilling operations for the Core BdN Development.

As discussed in Section 13.3.1, the primary interactions with Commercial Fisheries and Other Ocean Uses are associated with the offshore construction and installation of subsea infrastructure and would be similar to those assessed for the Core BdN Development Area. As the anti-collision zone was established for the FPSO, and the FPSO remains on its location in the Core BdN Development Area, there are no additional interactions of the FPSO anti-collision zone for Project Area Tiebacks. The duration of the established anti-collisions zone would be longer as the FPSO would be on location for an additional 10 to 18 years.

13.4.1.1 Installation of Subsea Infrastructure

Should Project Area Tiebacks occur, as noted an assessed in Section 13.3.1.1, the primary effects on Commercial Fisheries and Other Ocean Uses associated with the installation of subsea infrastructure during offshore construction and installation are:

- Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)
- Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)

Should Project Area Tiebacks occur, well templates, flowlines, umbilicals and/or cables (and associated protection measures, if required) would likely be installed on the seafloor in the Project Area in the same manner as described and assessed for the Core BdN Development in Section 10.3.1.1. The installation of tieback infrastructure would have the same interactions with Commercial Fisheries and Other Ocean Uses as described in Section 10.3.1.1 for the Core BdN Development. Figure 13-2 provides an illustration of examples of subsea tieback in the Project Area. Assuming five tiebacks were undertaken, each at separate locations, the footprint of the five tiebacks is estimated to be approximately 15 km², which represents approximately less than 0.5 percent of Project Area and approximately 0.02 percent of the LSA. Considering the footprint of the Core BdN Development Area at 7 km², combined with the footprint of potential Project Area Tiebacks, the total footprint in the Project area would be approximately 22 km², representing approximately 0.5 percent of the Project Area and approximately 0.03 percent of the LSA.

Direct Interference Caused by the Project is a potential effect associated with the installation of subsea infrastructure in areas beyond the Core BdN Development Area.

If activities were to occur in the larger Project Area, the potential for interaction with fishing activity and with fisheries science surveys would be greater than for the Core BdN Development Area (see Section 13.3.1) area. For instance, a tieback in the northwest of the Project Area, towards the shallower waters of the Sackville Spur in NAFO UAs 3Le or 3Ma, or west towards the Nose of the Grand Banks, could place subsea infrastructure in areas used more frequently by domestic and international fishers (based on the available DFO and NAFO data; see Sections 7.1.4 and 7.15). These are principally bottom trawling for the same groundfish species as in the Core BdN Development Area by both domestic and international harvesters, though in the past the Project Area harvesting has included shrimp trawling, and likely would again if this fishery is reopened during the potential 30-year life of the Project (see Sections 7.1.4 to 7.1.8).

A safety zone will be established within the Project Area and may be an extension of the Core BdN Development Area safety zone. As noted in Section 13.3.1.1, the safety zone does not prohibit marine users and fish harvesters from entering the area; it demarcates the area occupied by subsea infrastructure for the Project.

Standard marine notification protocols, as listed in Section 13.1.5.2, will allow for vessels to adjust course, as needed, without operational interference. Equinor Canada, will inform fisheries interests and other ocean users of planned activities through Navigational Warnings and ongoing communications with One Ocean and DFO (regarding communications to NAFO). Once the safety zone is established for the subsea infrastructure, Equinor Canada will provide appropriate regulatory authorities the coordinates of the safety zone for addition to marine navigational charts and will communicate these coordinates to NAFO and One Ocean.

Direct Interference with fishing activity and other marine activities is predicated to be adverse, as described above, but short-term during the construction season. The geographic extent of Direct Interference would be limited to location of vessels engaged in subsea infrastructure installation and the footprint of the subsea infrastructure (approximately 15 km² or less than 0.02 percent of the LSA). The effect would be continuous during installation activities, and reversible once activities are completed. The magnitude of effect of Direct Interference would be low in areas of higher fishing intensity and negligible in areas with little to no fishing activity. Construction and installation activities may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses, which is considered within the range of natural variability as less than 0.02 percent of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations to reduce direct interference with fishing activity and marine use are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference Caused by the Project associated with the installation of subsea infrastructure during Construction and Installation should Project Area Tiebacks occur, are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 100 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with the installation of subsea infrastructure in areas beyond the Core BdN Development Area.

With the installation of subsea infrastructure for potential tiebacks to the FPSO at distances up to 40 km, the spatial area occupied by subsea infrastructure will increase, potentially into areas with more fishing activity, and there is an increased potential for instances of fishing gear damage associated with subsea infrastructure. As noted in the discussion for the Core BdN Development Area, trawl protection on subsea infrastructure is being considered based on level of fishing activity. In areas with higher fishing intensity trawl protection may be included in Project design and will be based on international best practices and Equinor experience in the Norwegian Continental Shelf. Overall, while the area of the seabed occupied by subsea infrastructure represents a very small percentage of available fishing areas in the LSA (less than 0.02 percent), there is potential for gear damage from bottom trawling activities in areas with higher fishing intensity (i.e., in the northwest areas of the Project Area, towards the shallower waters of the Sackville Spur in NAFO UAs 3Le or 3Ma, or west towards the Nose of the Grand Banks). As with the Core BdN Development, a safety zone demarcating the area occupied by subsea infrastructure will be established and will be communicated to marine users. Equinor Canada will development and implement a compensation program for damages or losses attributable to the Project.

Damage Caused by the Project is predicated to be adverse, as described above, but short-term during the construction season. The geographic extent of the change would be limited to the footprint of the subsea infrastructure (approximately 15 km^2 for Project Area Tiebacks or 22 km^2 including Core BdN Development Area; or less than 0.02 percent of the LSA). The change would be sporadic, occurring only if fishing activity occurs in the area of subsea equipment and gear becomes damaged, and reversible once subsea infrastructure is removed. The magnitude Damage Caused by the Project would be negligible in areas with little to no fishing activity and low in areas with higher fishing intensity. Construction and installation activities may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses in areas where fishing intensity is higher, which is considered within the range of natural variability as less than 0.02 percent of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations to reduce Damage Caused by the Project are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with the installation of subsea infrastructure during Construction and Installation should Project Area Tiebacks occur are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 100 km^2, of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with installation of subsea infrastructure, should Project Area Tiebacks occur, include the potential inclusion of trawl protection on subsea infrastructure (C); communication of ongoing activities, including the provision of safety zone coordinates, to marine users and regulatory agencies (D, E, F, G, H, K, L), implementation of a compensation program for damages or losses (I).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with installation of subsea infrastructure during Offshore Construction, Installation and HUC activities in consideration of the residual effects predictions is not proposed.

13.4.2 Production and Maintenance Operations

The addition of subsea developments and wells would extend the life of the Project (12 to 20 years) to 30 years (total). The potential effects of production and maintenance operations are detailed in Section 9.3.2. The FPSO would remain on its location in the Core BdN Development Area. As there would be no changes to the light and sound emissions, marine discharges, produced water discharge, the potential effects would be the same as that described and assessed for the Core BdN Development. The extended life would increase timeframe for the interactions to occur.

The effects associated with the presence of the FPSO, as assessed in Section 13.3.2.1, would be the same as the FPSO would remain in its position in the Core BdN Development area; the anti-collision zone would remain in effect until end of Project at 30 years, verses the estimated 12 to 20-year timeframe for the Core BdN Development. While the timeframe is extended, the duration of effects would remain as long term. With regards to the presence of subsea infrastructure, an effects assessment for the effects on Commercial Fisheries and other Ocean Uses is provided below.

Should Project Area Tiebacks occur, additional subsea infrastructure, as described above, would be installed in the Project Area, and would be in addition to the subsea infrastructure already in place for Core BdN Development Area. As noted above, it is estimated that the area of the seafloor occupied by subsea infrastructure for a single tieback would be 3 km². Therefore, should five tiebacks be undertaken, the total area of the seafloor occupied by subsea infrastructure would be 15 km².

13.4.2.1 Presence of the FPSO and Subsea Infrastructure

The primary effects on Commercial Fisheries and Other Ocean Uses associated with presence of subsea infrastructure during Production and Maintenance Operations, should Project Area Tiebacks occur, are:

- Direct interference caused by Project activities with fishing harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage and Loss of Income)

Direct Interference caused by the Project is a potential effect associated with continued presence of the anti-collision zone, established during HUC activities, during Production and Maintenance Operations. The timeframe for the duration of the effect assessed under HUC activities was long-term and would continue to be long-term as the FPSO will be onsite for 30 years, should Project Area Tiebacks occur. Mitigations regarding notification and communication of the anti-collision zone would be implemented, as noted in Section 13.3.1.2.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference associated with the anti-collision zone are predicted to be adverse, negligible in magnitude, with a geographic extent of less than 10 km², of long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with presence of subsea infrastructure during Production and Maintenance Operations.

As discussed in Section 13.4.1.1, the presence of subsea infrastructure on the seabed has the potential to result in gear damage should trawling activity occur in the area. As noted, in Section 13.4, areas of the Project Area (i.e., in the northwest areas of the Project Area, towards the shallower waters of the Sackville Spur in NAFO UAs 3Le or 3Ma, or west towards the Nose of the Grand Banks) historically have higher fishing intensities than the Core BdN Development Area. Therefore, should subsea infrastructure be installed in these areas, there is a greater potential for interaction with commercial fishing activities and gear damage. Overall, while the area of the seabed occupied by subsea infrastructure represents a very small percentage of available fishing areas in the LSA (less than 0.02 percent), there is potential for gear damage from bottom trawling activities in these areas with higher fishing intensity. As noted above, trawl protection measures may be installed on subsea infrastructure. The likelihood of gear or vessel damage will also be reduced with notification of the safety zone, which demarcates the subsea infrastructure on the seafloor, so that fishing vessels may be able to avoid the area. Equinor Canada will development and implement a compensation program for damages or losses attributable to the Project.

Damage to fishing gear is predicted to be adverse, as described above, and long-term due to its presence on the seafloor for up to 30 years. The geographic extent will be limited to footprint of the subsea infrastructure (approximately 15 km² for Project Area Tiebacks or 22 km² including Core BdN Development Area; or less than 0.02 percent of the LSA). The effect would be sporadic, occurring only if trawling activities occur in the area and if gear is damaged, and reversible once subsea infrastructure is removed. The magnitude of Damage Caused by the Project could be negligible in areas with little to no fishing activity and low in areas with higher fishing activity. The presence of the subsea infrastructure may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses, which is considered within the range of natural variability as less than 0.02 percent of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations to reduce damage interference with fishing activity and marine use are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with the Presence of the FPSO and Subsea Infrastructure during Production and Maintenance Operations, should Project Area Tiebacks occur, are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 100 km², of long-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the Presence of the FPSO and Subsea Infrastructure during Production and Maintenance Operations, should Project Area Tieback occur, include ongoing communications with marine users including information regarding the safety zone (D, E, F, K, L); implementation of a compensation program (I); and provision the coordinates of the safety zone to regulatory authorities for addition to marine navigational charts (D).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with the Presence of the FPSO and Subsea Infrastructure during Production and Maintenance Operations in consideration of the residual effects predictions is not proposed.

13.4.3 Drilling Activities

As stated in Section 2.6.6, should Project Area Tiebacks be undertaken, up to 20 additional wells may be drilled at either individual wells or in well templates (4-, 6- or 8-slot) at locations within the Project Area. Drilling activities could occur at any time of the year, and as noted in Section 9.3.3, the drilling installation could be on site at a well template location for up to 2 year if eight wells were drilled consecutively. Drilling activities under Project Area Tiebacks phase will likely occur while ongoing production at the FPSO is occurring.

The primary additional interaction associated with drilling activities during Project Area Tiebacks is the presence of a temporary anti-collision zone while the drilling installation(s) is present in waters beyond the Core BdN Development Area, in parts of the Project Area where fishing intensity may be higher.

13.4.3.1 Presence of Drilling Installation

The primary effects on Commercial Fisheries and Other Ocean Uses associated with the presence of the drilling installation during Drilling Activities should Project Area Tiebacks be undertaken is:

- Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses

Direct Interference Caused by the Project is a potential effect associated with the establishment of the anti-collision zone(s) for the drilling installation in the Project Area.

As described in Section 13.3.3.1, when a drilling installation is on-site, a temporary (one to two years) anti-collision zone of approximately 1 km² would be established around the installation. It is estimated that the anti-collision zone will be approximately 1 km² per drilling installation when on-station at a well template location. Interactions associated with the establishment of the anti-collision zone would be the same as described above, in Section 13.3.3.1, notably the establishment of an anti-collision zone prohibits other marine users, including fish harvesters from entering the zone. Therefore, the presence of the drilling installation would prohibit fishing and other marine use in these areas while the drilling installation was on-station. If the drilling installation is in an area of the Project area where fishing intensity is higher (i.e., in the northwest areas of the Project Area, towards the shallower waters of the Sackville Spur in NAFO UAs 3Le or 3Ma, or west towards the Nose of the Grand Banks) than in the Core BdN Development Area, there is a greater potential for direct interference with commercial fishing activity and marine transportation than assessed in the Core BdN Development Area. Overall, a 1 km² anti-collision zone for a drilling installation represents a very small area of available fishing areas within the LSA. As noted above, Equinor Canada will communicate presence of the anti-collision zone to fish harvesters and marine users.

Direct Interference from the Project is predicted to be adverse, as described above, and short-term as the anti-collision zone will be in place while the drilling installation is onsite for approximately one two years. The geographic extent of direct interference would be approximately 1 km² for the drilling installation or 9.5 km², should the drilling installation and FPSO be in the Project Area at the same time. The 9.5 km² area represents less 0.01 percent of the available fish harvesting areas of the LSA. The effect would be continuous while drilling activities are ongoing and reversible once the drilling installation leaves the area. The magnitude of effect of Direct Interference would be negligible in areas with little to no fishing activity or low in areas with higher fishing intensity. The presence of the drilling installation may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses in areas of higher fishing intensity, which is considered within the range of natural variability as less than 0.1 percent of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations include communication of activities with fish harvesters and marine users and notification of the anti-collision zone.

In summary, with the application of mitigation measures, the residual environmental effects associated with the presence of a drilling installation during Drilling Activities, should Project Area Tieback occur, are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the Presence of the drilling installation during Drilling Activities include ongoing communications with marine users including information regarding the anti-collision and safety zone (D, E, F, G, H, K, L).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with the presence of the drilling installation during Drilling Activities in consideration of the residual effects predictions is not proposed.

13.4.4 Supply and Servicing

The addition of subsea tiebacks would extend the life of the Project (12 to 20 years) to 30 years. Supply and servicing operations, as described in Section 2.6.4 and as assessed for the Core BdN Development in Section 9.3.4 would be the same should Project Area Tiebacks be undertaken but would be carried out for an additional 10 to 18 years. The vessel and aircraft traffic route to the Project Area would be same as for Core BdN Development. Vessel traffic in the Project Area would be the same as vessel traffic in the Core BdN Development Area. Depending on the distance between the drilling installation in the Project Area and the FPSO at its fixed location, a second SBV may be required, which would be short-term while the drilling installation was on location.

The potential for Damage Caused by the Project on Commercial Fisheries and Other Ocean Uses associated with Supply and Servicing should Project Area Tiebacks be undertaken are the same as those described in Section 13.3.4 for the Core BdN Development. While the duration of the activities would be longer (i.e., 12 to 18 years longer) the duration of effect would remain as short-term as the change would only occur when vessels are transiting. Mitigations (i.e., communications with fish harvesters and marine users, compensation for damage) noted for Supply and Servicing under the Core BdN Development would be implemented should Project Area Tiebacks occur.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with vessels engaged in Supply and Servicing, should Project Area Tieback occur, are predicted to be adverse, negligible in magnitude, with a geographic extent of less than 10 km², of short-term duration, occurring sporadically, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the Supply and Servicing include use of common traffic routes (A); ongoing communications with marine users including (E, F, G, H, K) information and compensation for damages caused by the Project (I); use of a FLO for rig transits from NL port if required (J).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with vessels engaged in Supply and Servicing in consideration of the residual effects predictions is not proposed.

13.4.5 Supporting Surveys

As with the Core BdN Development, supporting surveys, including geophysical activities, environmental, geotechnical, geological and ROV / AUV surveys may be required should Project Area Tiebacks be undertaken. Should supporting surveys be required, the interactions associated with vessel presence and underwater sound emissions from geophysical equipment would be the same as discussed in Section 13.3.5. The effects assessment for these interactions on Commercial Fisheries and Other Ocean Uses, should Project Area Tieback occur in the broader Project Area is provided below.

Should 4D seismic surveys be required to assess changes in reservoir properties from potential new reservoirs being exploited at the tieback locations, it is anticipated that the type and frequency of surveys would be the same as described in Section 13.3.5. While the locations of these surveys would be within the broader Project Area, the interactions with Commercial Fisheries and Other Ocean Uses would be the same as discussed Section 13.3.5.1. In the event that 4D seismic surveys are required at the tieback locations, it is likely that all locations would be surveyed within the same survey season. The overall duration of seismic activity may be longer to include multiple locations, the time at each location would likely be within the two- to four-week timeframe noted in Section 2.6.5.

13.4.5.1 Presence of Vessels and Towed Equipment

The primary effects on Commercial Fisheries and Other Ocean Uses associated with the presence of vessels and towed equipment during Supporting Surveys should Project Area Tieback occur are:

- Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage and Loss of Income)

Direct Interference Caused by the Project is a potential effect associated with the presence of vessels and survey equipment.

The interactions associated with presence of vessels and survey equipment would be similar to those discussed in Section 13.3.5.1, except that they might occur in areas of the Project Area where fishing intensity is higher. If permanent reservoir monitoring is chosen, the presence of node or cables on the seafloor may interfere with fishing activity, particularly bottom-trawling. As noted above, in certain areas of the Project Area fishing intensity is higher than in the Core BdN Development area. If tiebacks, and subsequently supporting surveys, were to occur in these areas, notably the northwest areas of the Project Area, towards the shallower waters of the Sackville Spur in NAFO UAs 3Le or 3Ma, or west towards the Nose of the Grand Banks, the potential for interference is greater. The location and timing of surveys will be communicated to marine fish harvesters and other ocean users so that they take alternate routes when transiting through the Flemish Pass.

If towed hydrophones were the chosen option for 4D seismic, the potential for interaction in these higher intensity fishing areas is similar. Vessels towing streamers travel at slower speeds require a wide berth especially during turns and other marine vessels in the area, to avoid interference, would be requested to remain out of the path of the supporting vessels.

Direct Interference by the Project is predicted to be adverse, as described above. The effect could be short- to long-term in duration, depending on the survey method chosen (short term for towed hydrophones and long-term for permanent reservoir monitoring). The geographic extent is estimated to be 100 km² as the area of the seabed occupied by nodes or cables is unknown at this time. 100 km² represents less than 0.5 percent of the LSA. The effect would be continuous and revisable once the survey was completed or the nodes/cables were removed from the seafloor. The magnitude of the effect would be negligible in areas with little to no fishing activity or low in areas with higher fishing activity. The presence of the drilling installation may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses in areas of higher fishing activity, which is considered within the range of natural variability as less than 0.5 percent of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference Caused by the Project associated with the presence of vessels and survey equipment during Geophysical Activities are predicted to be adverse, negligible to low in magnitude, with a geographic extent of 100 km², of short- to long-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Damage caused by the Project is a potential effect associated with the of presence of vessels and towed survey equipment during Supporting Surveys should Project Area Tiebacks be undertaken.

The interactions with Commercial Fisheries and Other Ocean Uses would be similar to those assessed in 13.3.5.2. Fishing gear may be snagged by transiting vessels and/or their towed gear. In areas of higher intensity fishing in the Project Area, interaction is more likely, especially fisheries employing fixed gear such as longlines or crab pots, though as Section 7.1 indicates recorded fixed gear harvests are rare in the Project Area. Ongoing communication between Equinor Canada and the fishing industry and the availability of a compensation program for commercial fish harvesters will further reduce the potential for effects between Project-related surveys and commercial fisheries. Continuing communications with DFO and NAFO will inform science survey managers, and other marine operators will be informed through Navigational Warnings.

Damage Caused by the Project is predicted to be adverse, as described above. The effect would be short-term as surveys will be undertaken within a two- to four-week timeframe, and reversible once the survey is complete. The geographic is anticipated to be localized to the location of the vessel and/or fixed gear, less than 1 km². The effect would be sporadic, occurring only if survey vessels or towed gear came in contact with fixed gear in the water. The magnitude of the effect would be negligible in areas with little to no fishing activity or low in areas with higher fishing activity. The magnitude of the effect is low. The presence of the vessel or towed gear may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses in areas of higher fishing intensity, which is considered within the range of natural variability as a very small area of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with the presence of vessel and towed equipment during Geophysical Activities should Project Area Tiebacks occur, are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 1 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the presence of vessels during Supporting Surveys include ongoing communications with marine users including (E, F, G, H, K, L) information and compensation for damages caused by the Project (I).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with the presence of the drilling installation during Drilling Activities in consideration of the residual effects predictions is not proposed.

13.4.5.2 Underwater Sound Emissions from Survey Equipment

The primary effects on Commercial Fisheries and Other Ocean Uses associated with the underwater sound emissions from survey equipment used during Supporting Surveys should Project Area Tiebacks be undertaken are:

- Change in abundance, distribution and/or quality of marine resources, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Change in Abundance, Distribution and/or Quality of Marine Resources)

Change in Abundance, Distribution and Quality of Marine Resources is a potential effect associated with underwater sound emissions from geophysical survey equipment should Project Area Tiebacks be undertaken.

As noted in Section 13.3.5.2, underwater sound emissions from geophysical survey equipment has the potential to affect fish behaviour and avoidance, and therefore has the potential to indirectly affect commercial fishing activity. Fish avoidance behaviours could reduce catch rates of fish areas where geophysical surveys are undertaken, therefore resulting in lower economic returns for fishers. Fish avoidance may also affect the results of fisheries science surveys if in the area at the same time. While interaction with Commercial Fisheries and Other Ocean Uses associated with geophysical activities in the Core BdN Development is unlikely due to limited to no fishing activity, there is potential for interaction in parts of the Project area where fishing intensity is higher (i.e., the west and north-west areas of the Project Area). As discussed in Section 13.3.5.2, studies have shown fish moving away from underwater sound emissions with resulting decreases in catches for short periods. For more sessile fish species, such as crab, a recent study concluded that if effects on crab harvests exists, the effects are less than natural variation (Morris et at 2018).

For areas of the Project area where fishing intensity is higher, changes in fish behaviour associated with underwater sound emissions are likely. However, while there may be behavioural response of fish from geophysical surveys the indirect effects to Commercial Fisheries and Other Ocean Uses will be low due to the transient, localized, and short-term nature of the surveys. Harvesters and science survey managers will be informed of survey locations in advance; other mitigation measures to further reduce effects of underwater sound on marine fish are presented in Section 9.1.5.2.

Change in Abundance, Distribution and/or Quality of Marine Resources associated with underwater sound emissions should Project Area Tieback be undertaken is predicted to be adverse, as described above. Behavioural effects would be short-term as surveys will be undertaken within a two- to four-week timeframe, and reversible once the survey is complete. Based on sound modelling, the geographic extent of the behavioural effects would between 1,000 km² and 10,000 km² of the location of underwater sound source within the Core BdN Development Area (See Section 9.3.5.3). The effect would be continuous while the survey is active. The magnitude of the effect is low. Underwater sound emissions may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses, it is considered within the range of natural variability as a very small area of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above. Mitigations to reduce effects are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Change in Abundance, Distribution and Quality of Marine Resources associated with underwater sound emissions from survey equipment used during Geophysical Activities should Project Area Tieback occur are predicted to be adverse, low in magnitude, with a geographic extent less between 1,000 km² and 10,000 km², of short-term duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with the Supporting Surveys include ongoing communications with marine users including (E, F, G, H, K, L)

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with Supporting Surveys in consideration of the residual effects predictions is not proposed.

13.4.6 Decommissioning

At end of field-life, which will either be at the end of the Core BdN Development or at the end of Project life, should Project Area Tiebacks be undertaken, the Project will be decommissioned in accordance with regulatory requirements in place at the time of decommissioning. Section 13.3.6 provides an effects assessment of decommissioning activities on Commercial Fisheries and Other Ocean Users, which indicates that the primary interaction is associated with the decommissioning of subsea infrastructure and well decommissioning and would be the same for decommissioning activities in the Project Area. Interactions and effects associated with decommissioning of the FPSO would be localized to the Core BdN Development Area and would not change from that discussed in Section 13.3.6. Therefore, the focus of the effects assessment of decommissioning on Commercial Fisheries and Other Ocean Uses will be on decommissioning of subsea infrastructure and well decommissioning.

13.4.6.1 Decommissioning of Subsea Infrastructure in the Project Area

The primary effects on Commercial Fisheries and Other Ocean Uses associated with decommissioning of subsea infrastructure are:

- Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses

- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage Caused by the Project)

Direct Interference Caused by the Project is a potential effect associated with Decommissioning of Subsea Infrastructure.

As noted above, interactions with fish harvesters and marine users would be similar to those discussed for decommissioning for the Core BdN Development (Section 13.3.6.1) but occurring within the Project Area. However, should subsea infrastructure be decommissioned in areas of the Project Area where fishing intensity is higher (i.e., in the northwest and western areas of the Project area) the potential for interaction is higher than assessed for the Core BdN Development Area. Due to the presence to vessels engaged in decommissioning, fish harvesters and other marine users may need to avoid the area. Mitigations, such as communication with mariners, fish harvesters and regulatory agencies would continue to ensure they are aware of decommissioning activities at site. With the removal of subsea infrastructure, interactions and thereby direct interference with Commercial Fishers and Other Ocean Uses would no longer be likely, as the area would return to baseline conditions.

Should subsea infrastructure remain in place, all flowlines will be flushed to ensure no hydrocarbons remain. Depending on water depths of the Project area, the potential for interaction with bottom trawling activity will vary. At shallower water depths, and if fishing activities are greater, there is a greater potential for direct interference with bottom trawling activities. The footprint of subsea infrastructure, for tiebacks and Core BdN Development Activity represents less than 0.03 percent of available fishing areas within the LSA. Navigational Warnings and Notices to Mariners would be issued and the coordinates of any remaining subsea infrastructure will be provided to NAFO, One Ocean, FFAW-Unifor, DFO and regulatory agencies (for inclusion on marine navigational charts).

Direct Interference Caused by the Project associated with Decommissioning of Subsea Infrastructure is predicted to be adverse if subsea infrastructure remains in place or neutral if infrastructure is removed as it would be a return to baseline conditions. Effects would be long-term and occur once. The geographic extent would be 22 km², based on the footprint of subsea infrastructure in the Project and Core BdN Development Areas. The magnitude of the effect would be negligible in areas with little to no fishing activity or low in areas with higher fishing activity. Subsea decommissioning activities and the remaining seabed infrastructure may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses in areas of higher fishing intensity, however it is considered within the range of natural variability as a very small area of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference Caused by the Project associated with the Decommissioning of Subsea Infrastructure are predicted to be neutral to adverse, negligible to low in magnitude, with a geographic extent less than 100 km², long-term in duration and occurring once. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with Decommissioning of Subsea Infrastructure.

Should subsea infrastructure be removed at the time of decommissioning, potential interactions of subsea infrastructure and gear damage would be eliminated. However, should subsea infrastructure remain in place there is potential for fishing gear damage should bottom trawling occur in the area. The potential for this interaction would be greater if the infrastructure was in areas with higher fishing intensity, such as the northwest and western areas of the Project Area. Overall, subsea infrastructure is estimated to represent approximately 0.03 percent of available fishing areas within the LSA, therefore the potential for interaction would be low. Navigational Warnings and Notices to Mariners would be issued and the coordinates of any remaining subsea infrastructure will be provided to NAFO, One Ocean, FFAW-Unifor, DFO and regulatory agencies (for inclusion on marine navigational charts).

Damage Caused by the Project associated with Decommissioning of Subsea Infrastructure is predicted to be adverse if subsea infrastructure remains in place or neutral if infrastructure is removed, as it is a return to baseline conditions. Effects would be sporadic and permanent if subsea infrastructure remains in place, with damage occurring only if there is trawling in the area an gear is damaged. The geographic extent would be 22 km², based on the footprint of he subsea infrastructure. The magnitude of the effect would be negligible in areas with little to no fishing activity or low in areas with higher fishing activity. Damage from remaining seabed infrastructure may cause a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses in areas of higher fishing activity, however it is considered within the range of natural variability as a very small area of the LSA is affected, with no associated adverse effect on the overall distribution, intensity, function and/or value of the Commercial Fisheries or Other Ocean Uses. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Cause by the Project associated with the Decommissioning of Subsea Infrastructure should Project Area Tiebacks be undertaken are predicted to be adverse to neutral, negligible to low in magnitude, with a geographic extent less than 100 km², long-term and occurring sporadically. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with Decommissioning of Subsea Infrastructure include communications with marine users (E, F, G, K, L), and submission of a decommissioning plan to the C-NLOPB (M), and provision of coordinates of remaining subsea infrastructure to regulatory agencies for inclusion on nautical charts (N).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with Decommissioning of Subsea Infrastructure in consideration of the residual effects predictions is not proposed.

13.4.6.2 Well Decommissioning

The primary effects on Commercial Fisheries and Other Ocean Uses due to wellhead decommissioning are:

- Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)
- Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch and income for harvesters (Damage Caused by the Project)

Direct interference caused by the Project is a potential effect associated with Well Decommissioning.

As noted in Sections 2.6.7.2 and 13.3.6, water depths will determine method for wellhead decommissioning. In shallower waters, wellheads are typically removed via internal wellbore cutting from the drilling installation with no wellbore remaining above the seabed. Whereas in deeper water, an external cutting tool is used from an ROV-equipped vessel leaving a partial stub (approximately 0.85 m) above the seafloor, posing a potential hazard to bottom-trawling fishing activities. Therefore, the potential for interaction with bottom trawling commercial fisheries depends on water depths. In shallower areas of Project area, where fishing intensity is greater, there is likely low potential for interference with bottom trawling as there is nothing remaining on the seafloor after the wellhead is removed. In the deeper waters of the Project Area, where fishing intensity is lower the potential for interaction would be low even with a 0.85 m stub remaining. Fish harvesters will be notified of the location of decommissioned wells and the coordinates of decommissioned wells will be provided to regulatory agencies for inclusion on marine navigational charts.

Direct Interference Caused by the Project associated with the Decommissioning of Wells is predicted to be adverse, as note above and long-term in duration. Effects would be permanent due to the presence of the pipe stub above the seafloor. The geographic extent limited to the location of the wellheads at each well template location, therefore less than 1 km² per template location. The magnitude of the effect is negligible. While there is a potential for the decommissioning of wells to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Direct Interference Caused by the Project associated with Well Decommissioning are predicated to be adverse, negligible in magnitude, less than 1 km², long-term and occurring continuously. These predictions are made with a high level of confidence.

Damage Caused by the Project is a potential effect associated with Well Decommissioning.

As noted in Section 13.3.6.2, a pipe stub remaining above the seafloor may damage fishing gear, should trawling occur in the area of the decommissioned wells. However, based on available domestic and international harvesting data, there is limited bottom-trawl fisheries in most of the Project Area compared with other parts of the NRA. Given this, and the presence of the FCA in the deeper waters of the Project Area, there is a low potential for conflicts with bottom trawls. Fish harvesters will be notified of the location of decommissioned wells and the coordinates of decommissioned wells will be provided to regulatory agencies for inclusion on marine navigational charts.

Damage Caused by the Project associated with Well Decommissioning is predicted to be adverse, as described above and sporadic, occurring only if trawling is carried out in the area where remaining wellhead is above the seabed. The geographic extent limited to the location of the wellheads at each well template location, therefore less than 1 km² per template location. The magnitude of the effect is negligible. While there is a potential for the decommissioning of wells to interact with fishing activities and other ocean uses, there would be no change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses relative to baseline conditions, given the small area occupied by survey vessel and/or survey gear relative to available fishing areas in the LSA. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigations are noted above.

In summary, with the application of mitigation measures, the residual environmental effects of Damage Caused by the Project associated with Well Decommissioning are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², long-term and occurring sporadically. These predictions are made with a high level of confidence.

Mitigations to reduce potential effects to Commercial Fisheries and Other Ocean Uses associated with Well Decommissioning include communications with marine users (E, F, G, H, K, L), submission of a decommissioning plan to the C-NLOPB (M), and provision of coordinates of decommissioned wells to regulatory agencies for inclusion on nautical charts (N).

Follow-up Monitoring for the effects on Commercial Fisheries and Other Ocean Uses associated with Well Decommissioning in consideration of the residual effects predictions is not proposed.

13.5 Significance of Residual Environmental Effects

This section summarises the residual environmental effects of the Project on Commercial Fisheries and Other Ocean Uses and presents the determination of significance.

13.5.1 Ecosystem Component Linkages

The interconnections between the physical, biological and human environment have been considered in the EIS and are summarized in Table 13-6. Overall, the EIS is based on the interactions between project activities and select VC's using source-pathway-receptor relationships as addressed in Section 13.1. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not affect significance determinations, as the potential effects (via direct and indirect pathways) on Commercial Fisheries and Other Ocean Uses have been assessed.

Table 13.6 Ecosystem Linkages Commercial Fisheries and Other Ocean Uses

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Core BdN and Project Area Tiebacks - PA			
All Activities	• Presence of vessels • Anti-collision zones • Subsea infrastructure • Underwater sound emissions from Supporting Surveys	• Potential interference with fishing activity and fisheries science surveys (vessels in transit or towing mobile gear). • Potential for project vessel transits to damage fishing gear, including fixed fishing gear and gear used for benthic fisheries science surveys, and bottom trawling gear • Potential interference with other ship movements (e.g., freighters, tankers, cruise ships, other oil and gas exploration). • Loss of access to the area by fish harvesters and fisheries science surveys • Potential to indirectly affect commercial fishing activity and fisheries science surveys through changes in fish behavior and avoidance of certain areas.	Abundance, distribution and quality of marine fish in commercial fishing areas.

13.5.2 Residual Environmental Effects Summary

Although some fisheries activities (including science surveys) have a potential to be affected by Project activities depending on their location and timing in relation to fish harvesting, effects from Project activities will be negligible for the Core BdN Development Area and low should Project Area Tiebacks occur in the Project Area. Overall, effects will be localized to occur within the Core BdN Development Area or the Project Area, where domestic fishing activity has usually been lower than in adjacent areas within the LSA, affecting a very small portion of the available fishing grounds. For other marine operators, slight alterations of course to avoid Project activities will be possible. No known existing subsea infrastructure would be affected during any phase of Project activities. Other described mitigation measures, communications with fishers and other ocean users, will further mitigate potential effects on this VC.

With the Project's adherence to relevant standards and guidelines for waste management and emissions, as described in Chapter 9, it is not predicted that the significant biophysical effects will occur for fish or fish habitat, or that the quality or marketability of commercial harvests will be affected.

Tables 13.7 and 13.8 summarizes the environmental effects assessment for Core BdN Development and Project Area Tiebacks that comprise the Project being assessed under CEAA 2012.

Table 13.7 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Uses – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-Up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Offshore Construction and Installation										
Installation of Subsea Infrastructure (including establishment of safety zone)	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<10 km²	S	C	Y	H	C, D, E, F, G, H, I, K, L	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N	<10 km²	S	S	Y	H		
Hook-up and Commissioning										
Establishment of Anti-Collision zone	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<10 km²	L	C	Y	H	D, E, F, G, H, K, L	Not Proposed
PRODUCTION AND MAINTENANCE OPERATIONS										
FPSO and Subsea Infrastructure										
Presence	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<10 km²	L	C	Y	H	D, E, F, I, K, L	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N	<10 km²	L	S	Y	H		
DRILLING ACTIVITIES										
Drilling Installation										
Presence	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<1 km²	M	C	Y	H	D, E, F, G, H, K, L	Not Proposed
SUPPLY AND SERVICING										
Marine Vessels										
Presence	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N	<10 km²	S	S	Y	H	A, E, F, G, H, I, J, K	Not Proposed

Table 13.7 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Uses – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY											
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
SUPPORTING SURVEYS										
Presence of Vessels and Towed Equipment	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<1 km² and <1000 km²	S-L	C	Y	H	E, F, G, H, I, K, L	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N	<1 km²	S	S	Y	H		
Underwater Sound Emissions	Change in abundance, distribution and/or quality of marine resources, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Change in Abundance, Distribution and/or Quality of Marine Resources)	A	L	<1000 km² - <10,000 km²	S	C	Y	H	E, F, G, H, K, L	Not Proposed
DECOMMISSIONING										
Decommissioning of Subsea Infrastructure	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	N - A	N	<10 km²	L	O	N/A	H	E, F, G, K, L, M, N	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	N – A	N	<10 km²	L	S	N/A	H		
Well Decommissioning	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<1 km²	L	C	N/A	H	E, F, G, K, L, M, N	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N	<1 km²	L	S	N/A	H		

Evaluation of Significance

- Based on the overall nature and characteristics of the Project and the existing environment for this VC within the LSA, and with the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine Fish and Fish Habitat.
- Overall, Project-related activities may result in some localized, long-term interactions with fish and fish habitat in the Project Area and/or the LSA, the number of individuals and habitat areas that may be affected, and the short- long- term and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects and will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area.
- For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant residual adverse effects on marine fish species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

Table 13.7 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Uses – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-Up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		

KEY:

Nature / Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Table 13.8 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Uses – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-Up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING										
Offshore Construction and Installation										
Installation of Subsea Infrastructure (including establishment of safety zone)	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N - L	<100 km²	S	C	Y	H	C, D, E, F, G, H, I, K, L	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N - L	<100 km²	S	S	Y	H		
PRODUCTION AND MAINTENANCE OPERATIONS										
FPSO and Subsea Infrastructure										
Presence	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<10 km²	L	C	Y	H	D, E, F, I, K, L	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N - L	<100 km²	L	S	Y	H		

Table 13.8 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Uses – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY											
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Confidence**		
DRILLING ACTIVITIES										
Drilling Installation										
Presence	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N - L	<1 km²	M	C	Y	H	D, E, F, G, H, K, L	Not Proposed
SUPPLY AND SERVICING										
Marine Vessels										
Presence	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N	<10 km²	S	S	Y	H	A, E, F, G, H, I, J, K	Not Proposed
SUPPORTING SURVEYS										
Presence of Vessels and Towed Equipment	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N - L	<100 km²	S - L	C	Y	H	E, F, G, H, I, K, L	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N - L	<1 km²	S	C	Y	H		
Underwater Sound Emissions	Change in abundance, distribution and/or quality of marine resources, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Change in Abundance, Distribution and/or Quality of Marine Resources)	A	L	<1000 km² - <10,000 km²	S	C	Y	H	E, F, G, H, K, L	Not Proposed
DECOMMISSIONING										
Decommissioning of Subsea Infrastructure	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	N – A	N - L	<100 km²	L	O	N/A	H	E, F, G, K, L, M, N	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	N – A	N - L	<100 km²	L	S	N/A	H		
Well Decommissioning	Direct interference caused by Project activities with fish harvesting and other marine activities, resulting in a change in the distribution, intensity, function and/or value of Commercial Fisheries and Other Ocean Uses (Direct Interference)	A	N	<1 km²	L	C	N/A	H	E, F, G, K, L, M, N	Not Proposed
	Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters (Damage or Loss of Income)	A	N	<1 km²	L	S	N/A	H		

Table 13.8 Environmental Effects Assessment Summary: Commercial Fisheries and Other Ocean Uses – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors							Mitigations	Follow-Up Monitoring
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Confidence		

Evaluation of Significance

- Based on the overall nature and characteristics of the Project and the existing environment for this VC within the LSA, and with the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine Fish and Fish Habitat.
- Overall, Project-related activities may result in some localized, long-term interactions with fish and fish habitat in the Project Area and/or the LSA, the number of individuals and habitat areas that may be affected, and the short- long- term and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects and will not result in detectable decline in overall fish abundance or changes in the spatial and temporal distributions of fish populations within this area.
- For fish species at risk, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA. The Project will therefore not have implications for the overall abundance, distribution, or health of such species nor its eventual recovery. The Project is not predicted to result in significant residual adverse effects on marine fish species at risk.

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY:

Nature / Direction of Effect:
P Positive
A Adverse
N Neutral (or no-effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
- Less 1 km²
- Less than 10 km²
- Less than 100 km²
- Less than 1,000 km²
- Less than 10,000 km²
- Greater than 10,000 km²

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Frequency of Effect
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

13.5.3 Determination of Significance

In consideration of the present knowledge of Commercial Fisheries and Other Ocean Uses within the Project Area, and with the application of mitigation measures, it is predicted that the Project will not result in significant adverse effects on Commercial Fisheries and Other Ocean Uses.

This prediction has been made with a high level of confidence based on a good understanding of the relevant areas' fisheries, adjacent science surveys and other marine components and activities in the area, and the general effects that the many past oil and gas exploration and production projects in the Atlantic Canadian offshore have had on such activities. The primary mechanism of interaction that may have adverse effects on these VCs is the presence of the FPSO and/or drilling installation(s) and their associated anti-collision zones, the presence of subsea infrastructure, and vessel traffic. The establishment of anti-collision zones does not the create an economic loss to harvesters or other marine operators. While there will be a small decrease in the area available for harvesting, work activities within the Project Area will represent a very small geographical portion of the overall LSA and RSA. It is therefore not anticipated that the Project will cause a detectable reduction in the overall value of activities pursued by Commercial Fisheries and Other Ocean Uses or result in economic loss. Furthermore, it is not anticipated that the Project will cause a detectable reduction in the overall nature, intensity, location or timing of current marine-based activities within the LSA for a community or region.

13.6 Monitoring and Follow-up

As documented above, Equinor Canada has committed to a number of measures and ongoing processes to avoid or reduce the potential for adverse interactions with, and effects upon, Commercial Fisheries and Other Ocean Uses. These include ongoing communication and cooperation mechanisms throughout the operational life of the Project (Section 13.1.5.2) and the availability of a fisheries gear and vessel damage compensation program. These are intended to allow an ongoing discussion of Project-related activities and issues as they may arise during Project implementation, and cooperative and collaborative planning and implementation of required management measures throughout the life of the Project. Section 18.4.2 provides an overview of the objectives of a follow-up monitoring program.

Given the high level of confidence regarding the prediction of no significant adverse environmental effects on Commercial Fisheries and Other Ocean Uses from the Project, and the implementation of mitigation, follow-up monitoring is not proposed to be implemented for routine Project activities for this VC.

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14.0 INDIGENOUS PEOPLES: ENVIRONMENTAL EFFECTS ASSESSMENT

Indigenous Peoples was selected as a valued component (VC) in recognition of the cultural, social, and economic importance of marine life (fish, migratory birds and marine mammals) and harvesting to Indigenous peoples, the requirements of the Environmental Impact Statement (EIS) Guidelines (Appendix A), and in recognition of potential or established Aboriginal and treaty rights. The EIS Guidelines listed 41 Indigenous groups in Newfoundland and Labrador (NL), the Maritime provinces and Québec, and directed Equinor Canada to engage with each of these groups in order to identify and assess potential adverse effects of the Project's planned components and activities on:

- Asserted or established Aboriginal or treaty rights protected by section 35 of the *Constitution Act, 1982* (section 35 rights), in respect of the Crown's duty to consult and where appropriate accommodate Indigenous peoples
- The elements of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) paragraph 5(1)(c) - health and socioeconomic conditions, physical and cultural heritage, including any built heritage of historical, archaeological, paleontological or architectural significance, and current use of lands and resources for traditional purposes

This chapter assesses and evaluates the potential environmental effects of the Core Bay du Nord (BdN) Development and Project Area Tiebacks on this VC. A key focus of this analysis is on assessing and evaluating the potential for the Project, and the various changes to the environment that may be associated with it, to interact with and affect Indigenous communities and/or groups and their activities, with specific reference to each of the socio-cultural aspects identified in Section 5(1)(c) of CEAA 2012, as well as interactions with potential or established Indigenous rights.

The Indigenous Peoples VC relates to other components of the biophysical and socioeconomic environment, including other VCs considered in the EIS: Commercial Fisheries and Other Ocean Uses (Chapter 13), Marine Fish and Fish Habitat (Chapter 9), Marine and Migratory Birds (Chapter 10), and Marine Mammals and Sea Turtles VC (Chapter 11). These VCs are assessed separately, and the results are not repeated in this Chapter but rather inform this analysis.

Potential cumulative environmental effects from various projects and activities in the marine environment are presented in Chapter 15. The potential environmental effects of accidental events on VCs are evaluated and assessed in Chapter 16.

14.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

The following sections define the spatial and temporal context within which potential environmental effects on Indigenous Peoples are assessed. These have been established to direct and focus the environmental effects assessment for this VC.

14.1.1 Spatial Boundaries

Four spatial assessment boundaries have been defined for the environmental effects assessment of this VC. They reflect the Core BdN Development, the Project Area Tiebacks, and the varying ways in which the Project and VC may interact. The boundaries are informed by the nature, scale, timing and other characteristics of the Project and the existing environmental setting, and potential environmental interactions. These Study Areas are defined below and are shown in Figure 14-1.

Core BdN Development Area: The Core BdN Development Area encompasses the immediate area in which Project activities and components may occur and includes the area within which direct physical disturbances to the marine environment may occur. It occupies an offshore area of approximately 470 km², encompassing the planned location of the floating production, storage and offloading (FPSO) and supporting subsea infrastructure and activities, including the associated anti-collision and safety zones and potential areas of vessel movement during 4D seismic surveys. The actual seabed footprint of Project facilities within the Core BdN Development Area is approximately 7 km², representing approximately 1.5 percent of the entire Core BdN Development Area. See Section 2.5.4 for more information on the safety and anti-collision zones for the Project.

Project Area: The broader Project Area is where Project Area Tiebacks (as described in Section 2.6.6) may occur. While the Project Area is defined as an overall area that encompasses all activities for the duration of the Project, different components and activities may occupy smaller areas within this overall area, as described in Chapter 2. The Core BdN Development Area is located entirely within the Project Area. The Project Area is approximately 4,900 km². The footprint of the Core BdN Development subsea infrastructure is approximately 0.1 percent of the Project Area. If Project Area Tiebacks were to be undertaken, the footprint of potential new tiebacks represents less than 0.5 percent of the Project Area.

Local Study Area (LSA): The LSA encompasses the geographic area over which planned and routine Project-related environmental interactions may occur. It represents the predicted environmental zone of influence of the Project's planned components and activities, within which Project-related environmental changes to Indigenous Peoples may occur and can be assessed and evaluated. The LSA is therefore defined as Northwest Atlantic Fisheries Organization (NAFO) Unit Areas (UAs) 3Le, 3Li and 3Ma, the three UAs that overlap the Project Area and includes the vessel traffic route. In total, the Project Area represents approximately 6.5 percent of the LSA, which is approximately 75,000 km².

Regional Study Area (RSA): The Indigenous Peoples VC considers the location and overall geographic extent of the various Indigenous communities and their activities included within the scope of this VC, as well as the distribution and movements of the various marine-associated resources that are used for traditional purposes by these groups. Therefore, for this VC, the RSA includes an overall region of eastern Canada that generally encompasses each of the Indigenous communities and their activities throughout NL, the Maritime provinces and Québec.

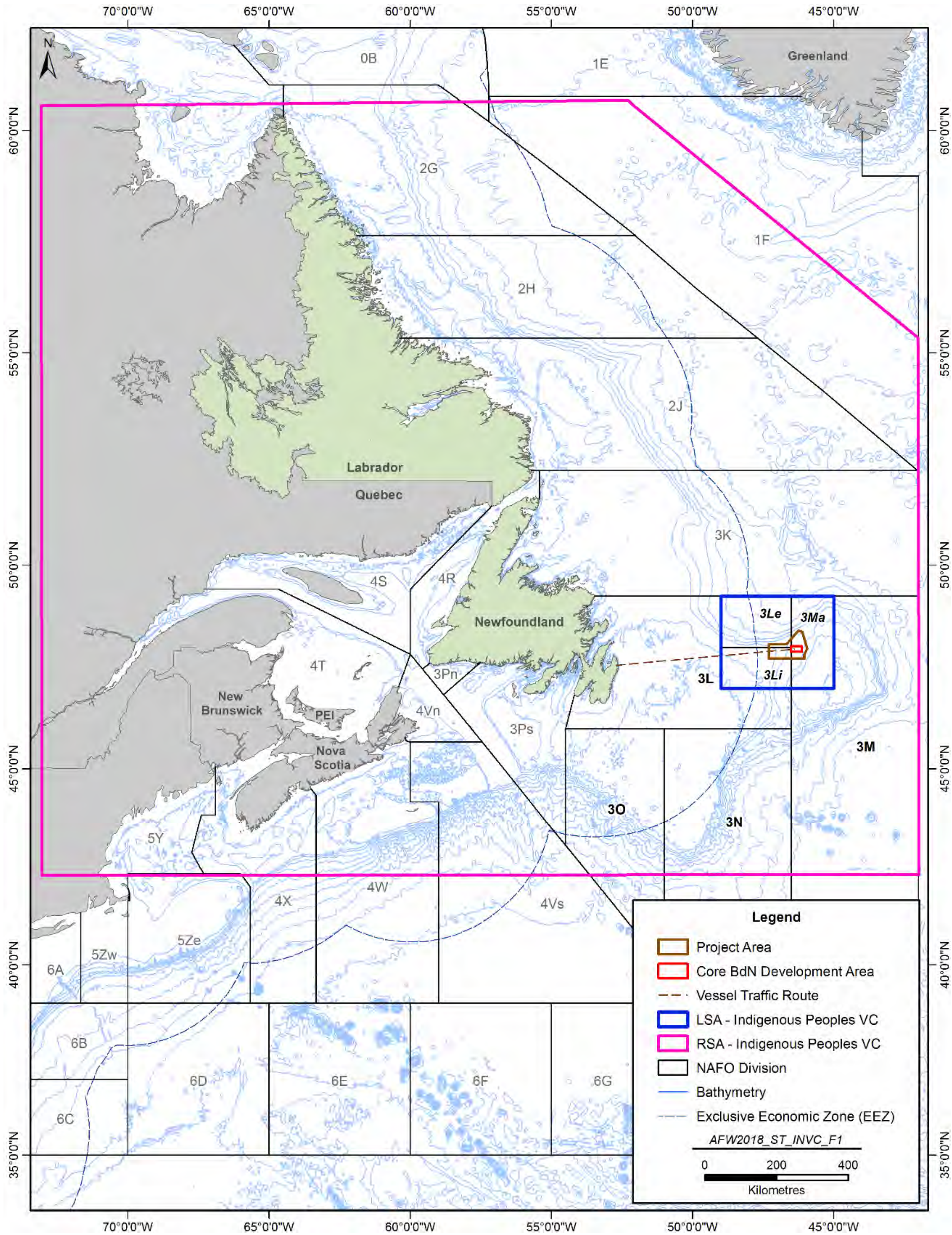

Figure 14-1 Environmental Assessment Study Areas: Indigenous Peoples

14.1.2 Temporal Boundaries

The temporal boundaries for the effects assessment encompass the frequency and duration of routine Project-related activities as well as the likely timing of any resulting environmental effects. The overall schedule for the Project is provided in Section 2.1.1, and the temporal boundaries of each Project Phase are provided in Table 14.1.

Table 14.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Core BdN Development Phases	
Offshore Construction and, Installation, and Hook-up and Commissioning (HUC)	• Site surveys commencing as early as 2021 • Offshore construction as early as 2023, but may occur later • Approximately 5 years; seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of year
Production and Maintenance Operations	• Commencement as early as 2026 • 12 to 20 years; year-round
Drilling Activities	• Commencement as early as 2024 • On average, drilling time is approximately 45-85 days per well (may be shorter for pilot wells and/or tiebacks) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2021 • Ongoing throughout life of Project; year-round
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed. • Approximately 2 to 4 years; seasonal or year-round
Project Area Tiebacks	*Extension of Project life to a maximum of 30 years*
Offshore Construction and Installation, and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to five tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but activities could occur year-round • May occur at any time over life of Project

Table 14.1 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Production and Maintenance Operations	• Continuation of activities from existing FPSO out to end of Project life • Year-round
Drilling Activities	• Total timeframe for drilling depends on number of wells required • On average, drilling time is approximately 45-85 days per well • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Year-round, when drilling occurs
Supply and Servicing	• Continuation of activities to end of Project life • Year-round
Supporting Surveys	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

14.1.3 Approach and Methods

The analysis and description of the potential environmental effects of the Project on this VC are based on consideration of the nature, scale and timing of the Project's planned components and activities (see Chapter 2), and the existing environment for this VC (see Section 7.3).

Potential Project-related issues have been identified through a variety of activities including Equinor Canada's ongoing engagement with Indigenous groups. As described in Chapter 3, Equinor Canada has engaged with the Indigenous groups listed in the EIS Guidelines (Appendix A) for more than two years, commencing with the Flemish Pass Exploration Drilling Program EIS (Statoil 2017). Equinor Canada has engaged with each of the identified Indigenous groups to provide information on the Project and associated regulatory processes and to seek input about their activities, any Indigenous knowledge, community issues and concerns regarding the Project and its potential interactions with Indigenous rights, interests and activities, for consideration and incorporation into the EIS.

Information respecting potential interactions has also been acquired through:

- A literature review
- A review of the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014a) and the Western Newfoundland SEA (Amec 2014b)
- Environmental assessments (EAs) of other offshore projects, both in NL and elsewhere in Atlantic Canada

- Information required by the Canadian Environmental Assessment Agency (the CEA Agency) arising from its technical review of the various drilling EAs (i.e., information requirements)
- Traditional knowledge studies prepared in the context of other projects, as well as a desktop Indigenous Knowledge Study (Appendix H) commissioned by Equinor Canada for this Project
- The results of three Project-specific workshops held in October 2018 (Appendix G)

Through Equinor Canada's engagement, in particular the Project-specific workshops referred to above, valuable feedback has been provided by Indigenous groups respecting both potential Project environmental effects and proposed mitigation measures and this feedback has been taken into account in the preparation of this EIS.

Through engagement, Indigenous groups have expressed concerns regarding the potential environmental effects of routine Project activities on fish, marine and migratory birds, and marine mammals and sea turtles that are harvested by Indigenous groups for either traditional or commercial purposes (see Section 7.3) or which are of cultural importance (see the desktop Indigenous Knowledge Study Appendix H).

The following summaries describe concerns expressed by Indigenous groups regarding marine and migratory species and the environment in interaction with the Project. More detailed information is included in Chapter 3.

- **Marine fish and fish habitat**: Potential effects of sound, pollution, seismic testing and light upon fish and fish habitat, population distribution and food sources. Support of directed research regarding Atlantic salmon migration through the Project Area. Potential effects of structures, sound, drilling wastes, and vessel traffic. Potential effects on benthic invertebrates (e.g., corals, sponges) and fish habitat. Potential effects of discharges (e.g., produced water and drilling muds) on pelagic species.
- **Marine and migratory birds**: Potential effects of increased traffic (e.g., sound, light and emissions) on marine and migratory birds. Potential effects of flaring activities. Potential light attraction and pollution resulting in bird mortality. Potential effects of sound, including continuous sounds, seismic testing, surveying and mapping on marine species.
- **Marine mammals and sea turtles**: Potential effects of increased traffic, sound, infrastructure, emissions and discharges on whales, dolphins and seals. Potential effects on marine mammals from vessel strikes.
- **Discharges to marine environment**: Potential effects of discharges (e.g., produced water and drilling muds) on pelagic species, marine and migratory birds; sedimentation effects on benthic invertebrates.
- **Seismic surveys**: Potential effects on marine life, including mammals, birds, fish and fish habitat; concerns about resulting changes in animal behavior.
- **Health, socioeconomic and cultural conditions**: Potential Project effects on Atlantic salmon and other species of importance due to sound, discharges, cumulative effects. Potential effects on commercial-communal fisheries in the Project Area and need to ensure that compensation guidelines take cultural values into consideration. Understanding of spiritual, cultural and social importance of Earth and natural resources to Indigenous people. Potential psycho-social effects.

- **Commercial-communal fisheries**: Potential effects on crab, sea cucumber (no fisheries within the Project Area and so not addressed here), shrimp, and migratory fish stocks; specific concern about discharge and increased traffic on Atlantic salmon populations.
- **Cumulative effects**: Potential increased pressure on marine environment and marine species due to additional projects.
- **Accidental events**: Information about oil spills and modelling, spill response procedures and protocols. Preparation for the possibility of oil spills at the Project site. Potential effects of oil spills on marine species and associated fishing activities. Potential effects of spills and blowouts and resulting contamination (either direct or through the food chain) of species of cultural significance to Indigenous Peoples. Potential economic effects of oil spills on coastal communities. Development of an oil spill communication plan with immediate contact with Indigenous groups in the case of an oil spill.

The desktop Indigenous Knowledge Study (Appendix H) has also provided general information (i.e., not specific to any Indigenous group, affiliation, region or province) relating to tangible and intangible effects on the health and wellbeing of Indigenous Peoples based on potential contamination of key species and / or limited access to land and resources resulting from offshore projects. Such potential environmental effects are also addressed in the EIS chapters that discuss the VCs for Marine Fish and Fish Habitat (Chapter 9), Marine and Migratory Birds (Chapter 10), Marine Mammals and Sea Turtles (Chapter 11), Commercial Fisheries and Other Ocean Uses (Chapter 13), and Accidental Events (Chapter 16).

14.1.4 Environmental Effect Significance Definitions

Significant residual adverse environmental effects are those that could cause a change in a VC that would alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this Project, a significant residual environmental effect on Indigenous Peoples is defined as one that causes one or more of the following:

- A decrease in employment and revenue from commercial-communal fishing caused by the Project such that there is a detectable adverse effect upon the economy or well-being of an Indigenous community for more than one year
- Destruction or disturbance of a structure, site or thing of historical, cultural, archaeological, paleontological, or architectural significance as a result of the Project, without the appropriate documentation or salvage and retrieval of the resource and the information it contains, and without prior approval from the affected Indigenous group or relevant regulatory authority
- Permanent loss of access to large portions of areas relied upon for traditional harvesting or loss of species harvested in a traditional territory for one or more seasons to the extent that traditional harvesting can no longer be conducted in a meaningful manner
- A reduction in the quality of ambient air, water, fish, wildlife, or other resources at concentrations that will result in human health risks, with an associated and detectable increase in the incidence of human (physical) health issues.

14.1.5 Potential Project-related Environmental Changes, Effects and Mitigation Measures

This section discusses the scope of the assessment, as well as potential environmental changes, interactions with Indigenous rights, interests and activities, and mitigation measures related to the Indigenous Peoples VC. Equinor Canada's ongoing engagement activities with the various Indigenous groups and other analyses has demonstrated the sociocultural and socioeconomic importance of marine habitat and marine life, including fish and fish habitat, marine mammals, and marine and migratory birds, and the marine ecosystem. Indigenous groups harvest marine resources for subsistence, cultural, spiritual, medicinal and economic purposes, and the potential for the Project to interact with these resources is the focus of this assessment. The environmental effects assessment of accidental events on this VC is presented in Chapter 16.

14.1.5.1 Scope of the VC Assessment

As indicated above, the EIS Guidelines require Equinor Canada to identify and assess potential adverse effects of the Project's planned components and activities on the following for the 41 identified Indigenous groups:

- Asserted or established Aboriginal or treaty rights protected by section 35 of the *Constitution Act, 1982* (Indigenous rights), in respect of the Crown's duty to consult and where appropriate accommodate Indigenous peoples
- The elements of CEAA 2012 paragraph 5(1)(c) - health and socioeconomic conditions, physical and cultural heritage, including any built heritage of historical, archaeological, paleontological or architectural significance, and current use of lands and resources for traditional purposes

Aboriginal or Treaty Rights

The various Indigenous groups listed in the EIS Guidelines (Appendix A) are located at a range of 640 km to 2,000 km from the Project and its associated activities. There is no overlap between the traditional territory of any of the 41 Indigenous groups and the Core BdN Development Area, the Project Area, or the LSA. It is Equinor Canada's understanding that none of the identified groups have asserted or established Indigenous rights to, in or near the lands and waters of the LSA, including the Core BdN Development Area and the Project Area. Additionally, none of the Indigenous groups has identified any current use of lands and resources for traditional purposes or other forms of traditional activities in the LSA. As a result, it was the CEA Agency's preliminary determination that there was a low likelihood of interaction of the Project between planned Project activities and asserted or established Aboriginal and treaty rights. The CEA Agency's preliminary determination did, however, indicate the potential (however unlikely) for Project impacts on asserted or established Aboriginal or treaty rights due to: 1) impacts upon harvesting resulting from potential exclusion from fishing areas; 2) effects of routine Project activities upon marine and migratory species of cultural or commercial importance (e.g., swordfish, Atlantic salmon and American eel); and 3) potential effects upon the conduct of harvesting activities within traditional territories.

Since the Project will be located in the eastern NL offshore, Equinor Canada acknowledges the potential for certain marine associated species of commercial or traditional importance to Indigenous groups to be present in or migrate through the Project Area and to be potentially affected by planned Project activities. Equinor Canada also acknowledges that direct interactions between the Project and marine-associated species of importance could potentially result in indirect impacts on Aboriginal or treaty rights. For example, direct impacts upon marine-associated species could, in turn, indirectly affect the exercise of the right to harvest marine species for food, social or ceremonial (FSC) purposes or pursuant to the terms of a treaty. The nature and scope of these Indigenous rights is described in Chapter 7. Since the current use of lands and resources for traditional purposes is based upon asserted or established Indigenous rights, the potential interaction between the Project and Indigenous rights will be assessed in the context of the current use of lands and resources for traditional purposes (see below).

Health and Socio-economic Conditions

Routine Project-related activities will occur in the marine environment at a range of approximately 640 km to 2,000 km from the listed Indigenous communities and their traditional territories. The geographic extent of potential effects resulting from routine Project activities (e.g., environmental emissions or discharges) will be localized and therefore, will not extend to Indigenous communities. As a result, no direct Project effects on the physical or social health and well-being and socioeconomic conditions of the relevant Indigenous groups are predicted. Since routine Project activities are not predicted to result in any actual or perceived contamination of country foods, a human health risk assessment is not required. The Project will also not place direct or indirect demands on community services and infrastructure used by Indigenous persons and / or their communities, nor will it result in other types of adverse social and economic effects such as interference with other commercial or recreational activities within traditional territories.

The potential exists for indirect Project effects upon the health, well-being and socioeconomic conditions resulting from effects on commercial-communal harvesting activities or the current use of lands and resources for traditional purposes. As discussed in Section 7.3, Indigenous groups in NL currently hold commercial-communal licences for a variety of species in NAFO Divisions 3L and 3M, portions of which may overlap the Project Area (see Table 7.18). As well, a number of Indigenous groups also currently hold commercial-communal fishing licences for Atlantic bluefin tuna and swordfish in NAFO Divisions 3L and 3M (see Figure 14-1 and Table 7.18). For many Indigenous groups, revenue from commercial-communal fisheries is an important source of funding for community services and programs.

The available 2011 to 2016 Fisheries and Oceans Canada (DFO) harvesting data (see Section 7.1.2) does not indicate any domestic commercial or commercial-communal fishing activity within the Core BdN Development Area and no Indigenous community or group has indicated that they actively fish in the area. While commercial fishing does take place within NAFO divisions overlapping the Project Area, levels of harvesting are generally low in the Project Area and concentrated in the western and northern portions. As available datasets do not distinguish between domestic commercial and commercial-communal fisheries, the extent of commercial-communal fishing activity in the Project Area is not known. However, during the course of engagement, no Indigenous group indicated any commercial-communal fishing activity in the Project Area, although reference was made to commercial-communal fishing in other areas of the Atlantic, including coastal waters near Indigenous communities. In addition, while licences may have been issued in NAFO divisions overlapping the Project Area, Indigenous groups may not execute all licenced fisheries, as certain species may be subject to moratoria, area closures or quota reductions. Through engagement, Indigenous groups have also indicated that commercial-communal licences for swordfish and bluefin tuna are currently inactive off Eastern Newfoundland and there are no recorded landings of either species in the Project Area between 2011 and 2016. Therefore, based on available information, at present there is limited potential for interactions between planned Project activities and commercial fishing activity, including commercial-communal fishing by Indigenous groups, in or near the Project Area. However, commercial-communal licences could be active in the future or the level of commercial-communal fishing could increase. Therefore, the potential for Project effects upon commercial-communal fisheries has been considered in the assessment.

Physical and Cultural Heritage, including any Built Heritage of Historical, Archaeological, Paleontological or Architectural Significance

Section 7.3 provides profiles of existing information for the Indigenous groups. Based on this information, there are no known physical or cultural sites, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance within the LSA. There are also no pathways of effects from routine Project activities to changes in structures, sites or things of historical, archaeological, paleontological or architectural significance in traditional territories due to the offshore location of the Project and localized extent of routine Project interactions.

Current Use of Lands and Resources for Traditional Purposes

As defined in the “Technical Guidance for Assessing the Current Use of Lands and Resources for Traditional Purposes under CEAA 2012” (CEA Agency 2015a) the current use of lands and resources for traditional purposes, as well as the exercise of treaty rights, is associated with an Aboriginal group's practices, traditions or customs. Traditional land and resource use is part of an Aboriginal group's distinctive culture and fundamental to their social organization and the sustainment of present and future generations. Traditional uses are often considered to refer to the practices, traditions and customs that define and distinguish the distinctive culture of an Indigenous community, and which were practiced prior to European contact. These “uses of lands and resources” can include, for example, hunting, fishing and gathering food for subsistence and ceremonial purposes, as well as associated time on and travel across the land, associated ceremonies and customs, cultural practices, and other tangible and intangible activities and values (CEA Agency 2015b). The term “current use of lands and resources” is also often expressed by Indigenous groups as being analogous to “aboriginal rights” or “treaty rights” (CEA Agency 2015b).

In the context of this EIS, the current use of lands and resources for traditional purposes (otherwise referred to as ‘traditional harvesting’) is defined as including activities and outcomes associated with the harvesting of fish, marine mammals and migratory birds in the traditional territories (asserted or established) of an Indigenous group for FSC or economic purposes pursuant to the exercise of an Indigenous right or under licence, including the right of Indigenous groups in the Maritimes and Gaspé region of Québec to harvest for a moderate livelihood pursuant to the Peace and Friendship Treaties of 1760 and 1761. While there is no known current use of the land or waters in the Core

BdN Development Area, Project Area or LSA for traditional purposes, some species that are traditionally harvested closer to Indigenous traditional territories have the potential to migrate through the LSA (see Section 6.1 and Section 7.3 for detailed information). These include species of marine fish, marine mammals, and marine and migratory birds. The potential for interaction between planned Project activities and marine-associated species of interest to Indigenous groups is low. Existing and available information indicates that only a very limited number of the migratory marine-associated species that are known to currently be used for traditional purposes or are of cultural significance (e.g., Atlantic salmon and American eel) have potential to be present in the Core BdN Development Area or Project Area (see Table 7.20).

14.1.5.2 Potential Environmental Changes and Effects

In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of project activities is based on those discharges/activities "with the greatest potential to have environmental effects." This is based on scientific literature, research studies, Indigenous knowledge, input from Indigenous groups and stakeholders, and professional experience of the EIS team. In consideration of the analysis set out in Section 14.1.5.1, there will be no interactions between Project activities and Physical and Cultural Heritage, including any Built Heritage of Historical, Archaeological, Paleontological or Architectural Significance. Similarly, there is no discernable potential for interactions between routine Project activities and Indigenous rights, except to the extent that the Project may potentially affect resources used for traditional purposes. As a result, the assessment of Project-related environmental effects on Indigenous Peoples is focused on the following potential environmental effects:

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

The effects assessment focusses on identified interactions. Where interactions are not identified in the table, there will be no discussion in the relevant effects analysis section.

Commercial-Communal Fisheries

As previously indicated, fishing enterprises associated with various Indigenous groups currently hold commercial-communal fishing licences in NAFO Unit Areas 3L and 3M and other fisheries management areas that overlap portions of the Core BdN Development Area and the Project Area (see Table 718). All five Indigenous groups in NL hold commercial-communal groundfish licences, and one group holds a licence for tuna, in 3L. In addition, the NL groups hold licences for other species (e.g., capelin, herring, mackerel, shrimp, and seal) in other fisheries management areas that overlap the Project Area. Fourteen Maritime groups hold licences for swordfish and/or Atlantic bluefin tuna in NAFO Unit Areas 3L and 3M. There was no recorded domestic commercial (including commercial-communal) fishing in the Core BdN Development Area between 2011 and 2016 and the low level of commercial fishing activity that occurs in the Project Area is concentrated in the western and northern portions, based on the available data.

Commercial-communal fishing activities that might take place in or near the Project Area do not represent traditional land and resource use. They occur under the authority of commercial licences issued by the federal government under the *Fisheries Act* and its associated *Aboriginal Communal Fisheries Licencing Regulation*, as well as other government policies and strategies designed to promote the involvement of Indigenous peoples and communities in commercial fisheries in Canada and to ensure appropriate management of fish stocks and resources. While the Indigenous commercial-communal fishery differs from the non-Indigenous commercial fishery in that licences are held in the name of the Indigenous group rather than an individual or corporate entity, in all material respects the potential interactions of the Project with the 'non-traditional' commercial-communal Indigenous fishery are the same as those that may be experienced by the non-Indigenous commercial fishery. Project components or activities that may result in restricted access to commercial-communal fishing grounds or changes to commercially harvested species, including swordfish or tuna populations, have the potential to (directly or indirectly) affect commercial-communal fisheries. Such potential interactions include changes to the health and/or distribution of licenced species, impacts on access to fishing grounds, changes in catch rates, damage to fishing gear. These potential interactions are summarized in this Chapter and discussed more fully in Chapter 13.

With specific reference to commercial-communal fishing for swordfish and tuna by Indigenous groups, while it was the CEA Agency's preliminary determination that there was a low likelihood of interaction between the Project under normal operations and Indigenous rights and activities, these commercial-communal fishing activities constituted the basis for a number of groups' identified interest in the Project. Consequently, the potential environmental effects on these two species and associated commercial fishing activities are given specific focus in the effects assessment for this VC.

Although swordfish comprise a relatively limited portion of the overall domestic commercial fisheries off eastern Newfoundland and elsewhere in Atlantic Canada, it is a relatively high value fishery overall. Like other large pelagic fisheries in the region, the fishery is focused primarily on the shelf break or in deeper waters to the south of the Project Area. DFO information shows that domestic swordfish harvesting is relatively low in the NL region compared to landings from Georges Bank and the Scotian Shelf in the Maritimes region. There was no reported domestic commercial or commercial-communal fishing activity for swordfish or tuna within or near the Project Area between 2011 and 2016, based on the DFO datasets. The domestic swordfish/tuna harvest is conducted mainly along the shelf edge and slope in NAFO Divisions 4XWV3PON (and primarily in NAFO 4X), between Georges Bank in the west to the Tail of the Grand Banks in the east (an area ranging from 400 km to 1,260 km from the Project Area).

Environmental effects on health and distribution of swordfish and tuna populations have been assessed as part of the Marine Fish and Fish Habitat VC. As described in Chapter 9, swordfish and other pelagic fishes have been known to be attracted to marine structures, creating the potential for individual swordfish to be exposed to the emissions (sound, light) and discharges associated with Project activities. However, swordfish is a highly mobile species that is likely able to avoid any anthropogenic effects associated with drilling installations, the FPSO and associated vessels. Based on known hearing capabilities of other pelagic fishes, swordfish may be attracted to low frequency sounds that are typical of offshore operations, but any high intensity sounds will likely cause movement away from the area. Since the overall distribution and migration pattern of swordfish includes most of the North Atlantic basin, the species' seasonal distribution in Canadian waters (movement from the Scotian Shelf to the Grand Banks in mid- to late summer) combined with their non-schooling behavior also reduces any potential population environmental effects from the Project. Spawning habitats for swordfish are also distant from the Project Area, occurring mainly in the Gulf of Mexico, Florida, the Caribbean and possibly off South America. The extreme distance of swordfish spawning grounds from the Project Area reduces potential interactions with important habitats and critical life stages that have less capability of avoidance.

Known tuna distribution in Canadian waters is based on commercial fisheries that have captured individuals in continental shelf waters of the Gulf of St. Lawrence, the Scotian Shelf, and the Grand Banks (Chapter 9). Atlantic bluefin tuna would have a seasonal / intermittent presence in the Project Area, migrating through the area in summer in search of food. The closest tuna spawning areas to the Project Area are open ocean areas east of the mid-Atlantic states of the United States (conservatively estimated to be at least 500 km and more likely over 1,000 km from the Project Area), at a distance that limits any potential effects on early life history stages. While bluefin tuna may form schools of less than 50 individuals, they are highly mobile, which further limits potential for interactions with Project activities.

With respect to potential Project effects on Indigenous swordfish/tuna licence holders, the interactions that might cause a change in commercial-communal harvesting activities are the same as those which would be experienced by commercial fishers. Such potential interactions include changes to the health and/or distribution of licenced species (discussed in Chapter 9), impacts on access to fishing grounds, changes in catch rates, and damage to fishing gear, with potential consequential effects upon socioeconomic conditions. These potential interactions are summarized in this Chapter and discussed more fully in Chapter 13.

Current Use of Lands and Resources for Traditional Purposes

This VC assessment also considers potential indirect effects on land and resource use activities, including whether and how Project-related changes in and effects on the biophysical environment off eastern Newfoundland (within the LSA) may affect resources that are used by Indigenous groups, including as a result of the migration and movement patterns of marine-associated species that are known to be used for traditional purposes. Through ongoing engagement, research contained in the desktop Indigenous Knowledge Study (Appendix H) and a review of publicly available information, Equinor Canada is aware that Indigenous groups have identified certain migratory marine-associated species of interest which are important for traditional purposes. Tables 7.19 and 7.20 list these species and indicate the likelihood of their occurrence in the Project Area. Only a limited number of these species have the potential to pass through the Project Area, of which the most important, based on the results of Indigenous engagement and consistent with the CEA Agency's preliminary determination of potential impacts on Indigenous rights and interests, are Atlantic salmon and American eel.

As described in Section 6.1.9, Atlantic salmon and American eel have the potential to migrate through the Project Area/LSA. Given the available data, there is likely low interaction with spring migration of adult salmon within and near the Project Area for the insular Newfoundland populations, Gulf of St. Lawrence populations, and eastern-southern Nova Scotia and Outer Bay of Fundy Populations. Post-smolt and adult salmon from Labrador and Nunavik Populations generally feed and overwinter in the Labrador Sea, therefore interaction of these populations with the Project Area would be considered negligible. Overwintering habitat for the Inner Bay of Fundy Population is suggested to be off the Scotian shelf or the southern portion of the Gulf of Maine, therefore interaction with the Project Area does not occur. American eel would have occasional presence in the Project Area, as adults migrate from coastal areas to the Sargasso Sea, but as migrations of adults and larvae generally follow continental shelf areas, the occurrence of American eel in the Project Area is unlikely (refer to Section 9.2 for additional information).

With respect to marine mammals and sea turtles, several Indigenous groups have also indicated participation in an annual subsistence seal harvest. Based on annual migration patterns, it is also possible that harp and hooded seal harvested for subsistence purposes elsewhere in the RSA could be present in the Project Area (see Table 7.20), although the likelihood is low. During engagement, certain Indigenous groups also identified the right whale and sea turtles as species of cultural importance, although again the likelihood of their occurrence in the Project area is low.

Indigenous groups have also indicated that migratory bird species are used for traditional land and resource activities. Indigenous groups have identified Canada goose, duck (black, eider, harlequin, long-tailed, sea), loon, merganser, murre, northern pintail, ptarmigan (Grouse), scoter (black, surf, white-winged) and teal as important bird species (see Table 7.19). The presence and distribution of these species in the RSA varies considerably. At approximately 500 km offshore, the Project Area is outside of the reported foraging range of most species breeding at the major seabird colonies in coastal Newfoundland, except for Leach’s storm-petrel, which has not been identified as harvested by any of the Indigenous groups.

The biophysical interactions between Project activities and Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles are discussed in Chapters 9, 10 and 11, respectively. The potential environmental changes and effects and the associated parameters used for the assessment of the identified environmental effects are provided in Table 14.2. Although there is no known current use of lands and resources for traditional purposes 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.

The identification of potential effects recognizes the multiple purposes and cultural importance of harvesting these marine resources, through both traditional land and resource use and the commercial-communal fisheries, and how participation in such activities may affect the health, social and economic well-being of Indigenous persons and communities. These potential interactions and effects have been brought forward into the following sections for further analysis.

Table 14.2 Potential Project-Related Environmental Changes and Potential Effects: Indigenous Peoples

Potential Environmental Effect	Potential Environmental Changes
Change in Commercial-Communal Fisheries	• Direct or indirect loss in availability of commercial-communal fisheries resources arising from Project activities
Change in Current Use of Lands and Resources for Traditional Purposes	• Direct or indirect loss in availability of fish and other marine- associated resources (migratory birds and marine mammals), which are traditionally harvested, arising from Project activities

The environmental effects assessment for this VC is on the key potential issues and interactions identified above, with a defined series of associated parameters that represent relevant aspects of the VC to which project-related changes could possibly be detected (although these are primarily used as key concepts and considerations upon which to focus the effects assessment, rather than to generate quantitative effects predictions).

An overview of potential interactions between the Project's planned components and activities and Indigenous Peoples, and specifically the potential to result in environmental changes and eventual detectable effects to the various aspects of this VC, is presented in Table 14.3. The effects assessment focuses only on the identified interactions.

Table 14.3 Potential Project-VC Interactions and Associated Effects: Indigenous Peoples

Project Component / Activity	Potential Environmental Effects		Mitigations
	Change in Commercial-Communal Fisheries	Change in Current Use of Lands and Resources for Traditional Purposes	
CORE BdN DEVELOPMENT ACTIVITIES			
OFFSHORE CONSTRUCTION AND INSTALLATION, AND HOOK-UP AND COMMISSIONING			
Offshore Construction and Installation and HUC			
Presence of Vessels			
• Lighting		•	
• Sound		•	
• Marine Discharges		•	B, C, D
• Installation of Subsea Infrastructure (including potential protection)	•		H, I, J, L, N, O
Hook-up and Commissioning			
• Anti-Collision Zone(s)	•		I, J, N, O
• Marine Discharges		•	A, D, E

Table 14.3 Potential Project-VC Interactions and Associated Effects: Indigenous Peoples

Project Component / Activity	Potential Environmental Effects		Mitigations
	Change in Commercial-Communal Fisheries	Change in Current Use of Lands and Resources for Traditional Purposes	
PRODUCTION AND MAINTENANCE OPERATIONS			
Presence of FPSO and Subsea Infrastructure			
• Lighting		•	
• Sound		•	
• Anti-Collision Zone(s)	•		I, J, N, O
• Presence of Subsea Infrastructure			I, J, N, O, L
Waste Management - Marine Discharges and Emissions			
• Produced Water		•	A, E
• Marine Waste Discharges		•	A, B, C, D, E
• Non-routine Flaring		•	
DRILLING ACTIVITIES			
Presence of Drilling Installation			
• Lighting		•	
• Sound		•	
• Anti-Collision Zone(s)	•		I, J, N, O
Waste Management - Marine Discharges and Emissions			
• Drill Cuttings		•	A, E
• Marine Waste Discharges		•	A, B, C, D, E
• Flaring during formation flow testing		•	
SUPPLY AND SERVICING			
Marine Vessels			
• Presence	•	•	F, J, L, N
• Lighting		•	
• Sound		•	
Aircraft (helicopters)			
• Sound		•	F
SUPPORTING SURVEYS			
• Presence of Vessels and Towed Equipment	•	•	J, L, N, O
• Lighting		•	

Table 14.3 Potential Project-VC Interactions and Associated Effects: Indigenous Peoples

Project Component / Activity	Potential Environmental Effects: Change in Commercial-Communal Fisheries	Potential Environmental Effects: Change in Current Use of Lands and Resources for Traditional Purposes	Mitigations
• Underwater Sound Emissions from Vessels		●	
• Underwater Sound Emissions from Geophysical Survey Equipment	●	●	
DECOMMISSIONING			
• Decommissioning of FPSO	●	●	A, B; C, D, E, J, N, O, P, Q, S
• Decommissioning of Subsea Infrastructure	●	●	A, E, J, N, O, P
• Well Decommissioning	●	●	A, E, J, N, O, P, R, S
PROJECT AREA TIEBACKS			
Offshore Construction and Installation, and HUC	●	●	A, B, C, D, E, H, I, J, L, N, O
Production and Maintenance Operations	●	●	A, B, C, D, E, I, J, N, O, L
Drilling Activities	●	●	A, B, C, D, E, I, J, N, O
Supply and Servicing	●	●	F, J, L, N
Supporting Surveys	●	●	J, L, N, O
Decommissioning	●	●	A, B; C, D, E, J, N, O, P, Q, R, S

14.1.5.3 Summary of Mitigation Measures

The following sections provide an assessment and evaluation of the potential effects of the Project on Indigenous Peoples. Mitigation measures identified for the Marine Fish and Fish Habitat (Chapter 9), Marine and Migratory Birds VC (Chapter 10), Marine Mammals and Sea Turtles VC (Chapter 11), and Commercial Fisheries and Other Ocean Uses VC (Chapter 13) also apply to this VC. Mitigation measures, as listed below, are identified and considered in an integrated manner within and throughout the environmental effects analysis that follows, as applicable. The environmental effects assessment for accidental events for VCs is presented separately in Chapter 16.

A. In consideration of the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010) and regulatory discharge limits, for discharges associated with the Project, the use of best treatment practices that are commercially available and technically feasible will be implemented.
B. Appropriate procedures will be implemented for the handling, storage, transportation, and onshore disposal of solid and hazardous waste
C. Sewage and grey water will be treated in consideration of the OWTG and in accordance with Canadian and international regulatory requirements (e.g., IMO).
D. Marine discharges (e.g., bilge water) are treated in accordance with MARPOL and Canadian requirements prior to discharge
E. The selection and screening of chemicals to be discharged, will be undertaken in consideration of the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG) (NEB et al. 2009) and Equinor Canada's chemical selection and screening processes.
F. Common traffic routes for vessels and helicopters will be used where possible and practicable
G. The use of obstruction lights, navigation lights, and foghorns on board the FPSO and drilling installation(s) and offshore supply vessels
H. Equinor Canada is evaluating the need for subsea infrastructure protection. In determining the need for protection measures, the level and types of historical fishing effort in the Project and Core BdN Development Area will be considered. Options for trawl protection will be in consideration of Equinor's global experience.
I. Equinor Canada will provide appropriate regulatory authorities the coordinates of the safety zone and/and or anti-collision zone for addition to marine navigational charts
J. Ongoing communication with fishers through One Ocean, Fish, Food an Allied Workers Union (FFAW-Unifor) and seafood producers regarding planned Project activities, including notification of coordinates of safety and/or anti-collision zones.
K. Ongoing communications with the NAFO Secretariat, through DFO as the Canadian representative, regarding planned Project activities, including timely communication of the anti-collision and/or safety zones
L. Develop and implement a compensation program which will be developed in consideration of the C-NLOPB Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (C-NLOPB 2017) and will be aligned with the Best Practices Document for Compensation Processes and Procedures that One Ocean is currently preparing.

M. In consideration with the One Ocean Risk Management Matrix Guidelines (One Ocean n.d.(a)), the need for a Fisheries Liaison Officer (FLO) and/or fisheries guide vessels during drilling installation movement from a NL port to its offshore location will be determined in consideration of the guidelines.
N. Equinor Canada will implement a standard marine communication protocol to promote safe practices between commercial fishing enterprises, other marine users and Project operations. The protocol will be in accordance with the One Ocean Protocols for Communication with Oil Installations on the Grand Banks (One Ocean n.d.(b)), which outlines communication requirements upon approach to the safety zone.
O. Issuance of Navigational Warnings and Notices to Mariners (where appropriate) regarding planned Project activities.
P. A decommissioning plan will be developed and submitted to the C-NLOPB for review and acceptance. The plan will be made in consideration of regulatory requirements, engagement with Indigenous groups, commercial fisheries and other stakeholders and likely effects on the environment.
Q. At the time of decommissioning, surface-related infrastructure (e.g., FPSO, turret, anchor lines) will be removed.
R. At the time of decommissioning a well, the well will be inspected in accordance with applicable regulatory requirements
S. Upon final decommissioning, if applicable, the communication through Notices to Mariners and DFO for inclusion on nautical charts, of the locations of subsea infrastructure that may be left in the Project Area.

14.2 Core BdN Development

The Core BdN Development includes the following six broad phases / categories of activities (Table 14.1):

- Production and maintenance operations
- Drilling activities
- Supply and servicing
- Supporting surveys
- Decommissioning

The assessment in the following sections is based on these activities and associated interactions.

Some or all of these activities may also be part of Project Area Tiebacks which may occur in the larger Project Area; their interactions and potential environmental effects are discussed in Section 14.3.

14.2.1 Offshore Construction and Installation, Hook-up and Commissioning

As noted previously, there is no recorded domestic commercial fishing, including commercial-communal fishing activity, currently conducted in the Core BdN Development Area based on the available DFO data. Given the limited presence of licenced commercial species in the Project Area and the corresponding low level of commercial fishing activity (such activity being concentrated in the western and northern portions of the Project Area), there is extremely limited potential for interactions between planned Project activities and fishing activity by Indigenous commercial-communal fishing enterprises. As identified in Table 14.2, if fishing were to occur, the only interactions would be potential gear interference associated with subsea infrastructure on the seabed and exclusion from fishing within the anti-collision zone.

As there is no current use of lands and resources for traditional purposes in the Core BdN Development Area, there will be no direct effects on traditional uses associated with either the anti-collision zone or the presence of subsea infrastructure. However, construction and installation, and HUC activities may indirectly affect traditional harvesting through the interaction of lighting, sound, and other emissions and migratory marine-associated species (marine fish, marine and migratory birds, and marine mammals), which may pass through the through the Project Area before moving to areas where traditional harvesting occurs.

14.2.1.1 Presence of Vessels

Lighting, Sound and Discharges

Chapter 13 indicates that lighting, sound, discharges and air emissions associated with the presence of vessels will not interact with commercial fishing. Given this information and the fact that no known commercial-communal fishing is currently conducted in the Core BdN Development Area, lighting, sound and discharges associated with construction and installation, and HUC activities will not result in interactions with commercial-communal fishing.

No traditional harvesting takes place in the LSA. There is limited potential for marine-associated fish species known to be used by Indigenous groups for traditional purposes to occur in the Project Area before moving to areas of traditional harvesting (see Table 7.19) and thus to be potentially affected by planned offshore construction and installation, and HUC activities. The potential exists for interaction with migratory fish species as a result of lighting, sound and other discharges. The biophysical and behavioural effects of such interactions are presented in Chapter 9.

The assessment of Project-related effects upon Marine Fish and Fish Habitat has determined that while Project-related sound, lighting and discharges have the potential to interact with such migratory species, behavioural effects and disturbances (if they occur at all) will be short-term and localized. As Chapter 9 determined that the residual effects on the Marine Fish and Fish Habitat VC are not likely to be significant and given the distance of the Project from Indigenous communities, there should be no effects on the harvesting of marine fish for traditional purposes.

Potential environmental effects of Project activities on Marine and Migratory Birds, including migratory birds potentially harvested for traditional purposes within the RSA, are discussed in Chapter 10. While artificial lighting has the potential to result in strandings, collisions, and increased opportunities for predation, as most migrating landbirds tend to fly closer to land (Weir 1976; Blomqvist and Peterz 1984) it is unlikely that large numbers of birds will be affected. There may be a slight increase in mortality / injury levels due to collisions, disorientation, and potential predation, but the mortality rate is anticipated to be low as most stranded birds encountered on platforms and vessels are released successfully. As described in Chapter 10, stranding data from Equinor Canada exploration activities in the Flemish Pass, including the Project Area, were collected over 1,755 days from 2008 to 2016. Most of these strandings occurred from June through August. Of the total 282 birds that were recovered, 252 were released alive. Some localized and short-term behavioral effects (change in presence and abundance) are also likely to occur, with some species displaced and others attracted by lighting and created foraging opportunities. The localized, transient, and short-term nature of these disturbances at one location and time during the Project considerably reduces the potential for adverse environmental effects upon Marine and Migratory Birds (individuals or populations). As Chapter 10 determined that the residual effects on the Marine and Migratory Birds VC are not likely to be significant and given the distance of the Project from Indigenous communities, there should be no effects on the harvesting of marine and migratory birds for traditional purposes.

The potential effects of offshore construction and installation, and HUC activities (presence of vessels and sound generated during subsea infrastructure installation) on marine mammals (including those of cultural importance to Indigenous groups) are discussed in Chapter 11. Given the localized, temporary and short-term nature of disturbances, any adverse residual environmental effects on Marine Mammals and Sea Turtles are predicted to be not significant. Therefore, taking into account the distance of the Project Area from Indigenous communities, no effects on the harvesting of marine mammals for traditional purposes are predicted.

As described in Chapters 9, 10, and 11, given the distance between the Project and traditional Indigenous harvesting areas (a range of approximately 640 km to 2,000 km from the Project), the localized and short-term nature of effects from this phase of Project activities and the limited likelihood of marine-associated traditionally harvested species occurring in or migrating through the Project Area, there is no potential for direct interaction between offshore construction and installation, and HUC activities and the current use of lands and resources for traditional purposes. With the application of mitigation measures, any potential effects on marine-associated species harvested for traditional purposes will be minimized. Consequently, construction, installation and HUC activities are not likely to result in residual adverse effects on the availability, sufficiency or quality of marine-associated resources to a manner or degree that would alter the overall nature, frequency, location, timing, quality or cultural value of traditional uses or activities or otherwise adversely affect health, well-being or socioeconomic conditions of Indigenous groups.

14.2.1.2 Installation of Subsea Infrastructure (including Potential Protection)

Subsea infrastructure will be demarcated by a safety zone, pursuant to the *Offshore Petroleum Drilling and Production Regulations* (O.C. 2009-386). As defined in Section 2.5.4, the safety zone does not prohibit entry by other ocean users; it is a zone in which the operator (Equinor Canada) has a duty to take reasonable measures to warn persons who are in charge of vessels and aircraft of the safety zone boundaries, the facilities within the safety zone and any related potential hazards (e.g., the presence of subsea infrastructure). The presence of subsea infrastructure has the potential to interfere with fishing activity (through, for example, gear damage). However, based on historical catch data, there is currently no evidence of Indigenous commercial-communal fishing within Core BdN Development Area and it is anticipated that fishing will continue to be very low. As a result, the likelihood of interaction between fishing activity and subsea infrastructure is negligible. The potential for gear or vessel damage will also be reduced with notification of the safety zone.

14.2.1.3 Anti-Collison Zone(s)

An anti-collision zone will be established once the FPSO (8.5 km²) and/or when the drilling installation(s) (1 km²) is on site. The anti-collision zone will represent less than 2 percent of the Core BdN Development Area, less than 0.2 percent of the Project Area and approximately 0.01 percent of the LSA. Per Canadian and international regulations, other marine traffic is not permitted to enter the anti-collision zone(s). Table 14.4 provides the size of the various areas (e.g., Core BdN Development Area, Project Area) and zones in relation to the LSA. The potential interaction between the establishment of an anti-collision zone(s) and commercial-communal fisheries relates to loss of access to fishing grounds by commercial-communal fishers. However, based on the small size and localized nature of the anti-collision zone and the absence of recorded domestic harvesting in the Core BdN Development Area, the activities associated with this phase are anticipated to cause little or no displacement of commercial harvesters from currently active fishing areas. Interference with the routing of fishing vessels around the anti-collision zone(s) will be minimal as alternative routes are possible when transiting through the Flemish Pass, especially since the anti-collision zones will be known to harvesters and locations can be considered during trip planning. Communications regarding the safety and anti-collision zones will be distributed via the Canadian Coast Guard Navigational Warnings and Notices to Mariners.

Table 14.4 Size of the Various Areas and Zones in Relation to the LSA

Area/Zone	Size (approximate)	Purpose	Percentage of LSA (approximate)
Project Footprint	7 km²	Physical area occupied by subsea infrastructure	0.01 percent
Anti-collision zones	8.5 km² (FPSO) 1 km² (drilling installation)	Per Transport Canada regulations, to protect safety of installations	0.01 percent
Safety zone	30 km²	Per Production and Drilling Regulations; demarcation of subsea infrastructure	0.04 percent
Core BdN Development Area	470 km²	Area where Core BdN Development activities will occur	0.65 percent
Project Area	4,900 km²	Area where Project Area Tiebacks may occur; includes Core BdN Development Area	6.5 percent

14.2.1.4 Summary of Environmental Effects

In summary, while no commercial-communal fishing activity is currently recorded for the Core BdN Development Area, were such fishing to occur in future, the residual environmental effects on commercial-communal fisheries resulting from Offshore Construction and Installation and HUC would be the same as those that have been predicted for Commercial Fisheries and Other Ocean Uses in Chapter 13. With the application of mitigation measures, residual effects on commercial-communal fisheries are predicted to be adverse, negligible in magnitude because there is no known commercial-communal fishing in the Core BdN Development Area and the footprint of the subsea infrastructure and/or anti-collisions zone represents a very small percentage of available fishing areas with the LSA. The geographic extent is approximately 8.5 km² associated with footprint of the subsea infrastructure and FPSO anti-collision zone, of long-term duration associated with the anti-collision zone for the FPSO, occurring continuously during this phase, and reversible. These predictions are made with a high level of confidence based on historical fishing data and the experience and professional judgement of the EIS Team. Ongoing communications regarding Project activities will reduce interactions and overall effects.

In summary, with the application of mitigation measures, the residual environmental effects on commercial-communal fisheries resulting from Offshore Construction and Installation and HUC are predicted to be negligible in magnitude, with a geographic extent less than 10 km², long-term in duration, occurring continuously and reversible. This prediction is made with a high level of confidence.

Indigenous communities are located at a range of approximately 640 km to 2,000 km from the Project Area and there is no current use of lands and resources for traditional purposes in the LSA. While marine species of importance to Indigenous groups may migrate through Core BdN Development Area, as discussed in Chapters 9, 10 and 11, activities associated with offshore construction and installation, and HUC are not expected to result in significant residual adverse effects upon such species (at either the individual or population level). Consequently, this phase of the Project is not likely to result in residual adverse effects on the availability or quality of such marine resources to a manner or degree that would alter the overall nature, frequency, location, timing, quality or cultural value of traditional uses or activities or otherwise adversely affect health, well-being or socioeconomic conditions of Indigenous groups. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Indigenous Peoples associated with the Offshore Construction and Installation and HUC activities include communication of ongoing activities, including the provision of anti-collision zone coordinates, to all marine users and regulatory agencies. (I, J, K, N, O), consideration of need for protection for subsea infrastructure (H); compensation program for damage from Project Activities (L).

Follow-up Monitoring for the effects on Indigenous Peoples associated with Offshore Construction and Installation and HUC Activities in consideration of the residual effects predictions is not proposed.

14.2.2 Production and Maintenance Operations

Activities associated with production and maintenance operations are described in Section 2.6.3. The primary interactions during production and maintenance operations with commercial-communal fisheries are the presence of the FPSO and subsea infrastructure and the anti-collision zone. Interactions associated with the presence of subsea infrastructure are the same as those addressed in Section 14.2.1.2.

Production and maintenance operations may also lead to changes in the abundance, location and/or quality of marine resources due to interactions (e.g., underwater sound emissions, marine discharges), which may in turn affect their use by fishers. However, it was concluded in Chapter 9 that there would be no significant residual adverse effects on Marine Fish and Fish Habitat associated with underwater sound emission or marine discharges and therefore, no indirect effects on the nature, quality and/or economic value of one or more of the marine activities that use or depend upon fish species. Considering the marketability / saleability of fish from the general area (the Project Area or the LSA), resulting specifically from market perceptions that would affect price and reduce economic returns, this has not been recorded in relation to other production facilities and operations in the NL region and is anticipated to be similar for Project operations

With respect to the current use of lands and resources for traditional purposes, due to the distance of the Project Area from Indigenous communities and as there is no current use of lands and resources for traditional purposes in the Core BdN Development Area, there will be no direct effects on traditional uses associated with the establishment of the anti-collision zone and subsea infrastructure. Potential effects relate to interactions between migratory marine species and light, sound, discharges and emissions, which could affect the presence, abundance, distribution, or quality of these resources and their availability and sufficiency for traditional activities.

14.2.2.1 Presence of FPSO and Subsea Infrastructure

Lighting and Underwater Sound

With respect to the current use of lands and resources for traditional purposes, potential interactions from production and maintenance activities regarding lighting and underwater sound emissions and migratory marine species traditionally used or harvested by Indigenous Peoples would be the same as those discussed in Section 14.2.1.1. There would be no residual effects on migratory marine species at the individual or population level from lighting and sound. Since there is no current use of lands and resources for traditional purposes in the Core BdN Development Area and since no significant adverse effects on migratory marine-associated species from light and sound emissions are predicted, there will be no effects on the current use of lands and resources for traditional purposes resulting from the presence of the FPSO or subsea infrastructure.

Anti-Collison Zone(s)

The establishment of the anti-collision zone and its potential effects upon commercial-communal fishing is assessed in Section 14.2.1.3 and the conclusions reached in that section are equally applicable to production and maintenance operations.

The anti-collision zone(s) is not anticipated to result in an interaction with commercial-communal fishing. With specific reference to the commercial-communal swordfish and tuna harvest as these take place outside the Project Area no potential for interactions between production and maintenance operations and Indigenous or non-Indigenous commercial fishers resulting from the presence of the FPSO and the associated anti-collision zones is predicted. If commercial swordfish / tuna harvesting is undertaken in the Project Area in the future, while the anti-collision zone(s), may temporarily reduce access to fishing grounds, any such disturbances will be localized, short-term, and reversible. Commercial harvesting activity is limited in the Project Area overall and alternative fishing areas are available. In view of the localized and temporary nature of potential disruptions, and with the implementation of mitigation measures, the Project is not predicted to result in significant residual effects on these fisheries. Consequently, no significant residual effects are anticipated for any future commercial-communal fishing activity. Thus, there will be no indirect adverse effects upon the economy or well-being of an Indigenous community associated with this commercial-communal activity.

14.2.2.2 Waste Management - Marine Discharges

Production and maintenance operations will result in marine discharges which are discussed in Section 2.8. Disturbances to fish species from discharges and emissions will be localized at any one location. It is therefore unlikely that marine resources will be affected by discharges and emissions from the FPSO in a manner and to a degree that would translate into effects on the overall availability or quality of a marine resource, and thus, on the overall nature, intensity, or economic value of commercial-communal fishing. It was concluded in Chapter 9, that as there is no interaction associated with these discharges and emissions on marine fish species, there is no interaction with commercial-communal fisheries.

With respect to the current use of lands and resources for traditional purposes, no traditional harvesting activities take place within the LSA. Chapters 9, 10, and 11 determined that discharges and emissions from the FPSO are not likely to result in significant adverse effects on marine species, including those of interest for traditional harvesting. The distance between the Project and traditional Indigenous harvesting areas ranges from approximately 640 km to 2,000 km. Given the distance from Indigenous communities and the limited likelihood of traditionally harvested marine-associated species occurring in or migrating through the Project Area, there is negligible potential for interaction between production and maintenance operations and the current use of lands and resources for traditional purposes. With the application of mitigation measures, potential effects on species harvested for traditional purposes will be reduced and there will be no residual effects on the availability or quality of such resources to a manner or degree that would alter the overall nature, frequency, location, timing, quality or cultural value of traditional uses or activities or otherwise affect health, well-being or socio-economic conditions.

14.2.2.3 Summary of Environmental Effects

In summary, no commercial-communal fishing activity is currently recorded for the Core BdN Development Area. Were such fishing to occur in the future, any residual effects on commercial-communal fisheries resulting from production and maintenance are the same as have been predicted for commercial operations in Chapter 13 and are not likely to be significant. With the application of mitigation measures, residual effects on commercial-communal fisheries are predicted to be adverse, negligible in magnitude because there is no known commercial-communal fishing in the Core BdN Development Area and the footprint of the subsea infrastructure and/or anti-collisions zone represents a very small percentage of available fishing areas with the LSA. The geographic extent is approximately 8.5 km² associated with footprint of the subsea infrastructure and FPSO anti-collision zone, of long-term duration associated with the anti-collision zone for the FPSO, occurring continuously during this phase, and reversible These predictions are made with a high level of confidence based on historical fishing data and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual environmental effects on commercial-communal fisheries resulting from Offshore Construction and Installation and HUC are predicted to be negligible in magnitude, with a geographic extent less than 10 km^2, long-term in duration, occurring continuously and reversible. This prediction is made with a high level of confidence.

Indigenous communities are located within a range of approximately 640 km to 2,000 km from the Project Area and there is no current use of lands and resources for traditional purposes in the LSA. While marine species of cultural importance to Indigenous groups may migrate through the Core BdN Development Area, activities associated with production and maintenance operations are not expected to result in significant residual adverse effects upon such species at the population level. Therefore, production and maintenance operations are not anticipated to have adverse effects on the presence, abundance, distribution or quality of resources that are currently used for traditional purposes. As a result, it is predicted there will be no effects upon the overall nature, frequency, location, timing, quality or cultural value of traditional uses or activities or upon any associated health, well-being or socio-economic conditions. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Indigenous Peoples associated with the Production and Maintenance Operations include communication of ongoing activities, including the provision of anti-collision zone coordinates, to all marine users and regulatory agencies. (I, J, K, N, O) compensation program for damage from Project Activities (L), management and treatment of wastes and discharges (A, B, C, D, E).

Follow-up Monitoring for the effects on Indigenous Peoples associated with Production and Maintenance Operations in consideration of the residual effects predictions is not proposed.

14.2.3 Drilling Activities

As described in Section 2.6.2, the Core BdN Development may involve the drilling of up to 40 wells over a period of three to five years. Wells will either be drilled using well templates (multiple wells drilled in one location) or at individual well locations (satellite wells). Drilling may be carried out by one or more drilling installations, which may operate concurrently. Refer to Section 2.6.2 for a description of drilling activities.

14.2.3.1 Presence of Drilling Installation

As identified in Table 14.2 and discussed in Chapter 13, primary interactions from drilling activities with commercial-communal fisheries are the presence of the drilling installation(s) and the associated anti-collision zone (approximately 1 km^2 in area) where marine uses, including fishing and other activities, are prohibited. It is anticipated that the drilling installation could be at any one location for a period of up to two years.

Since there is no current use of lands and resources for traditional purposes in the Core BdN Development Area or the Project Area, the presence of the drilling installation(s) and associated anti-collision zone will have no direct effects on traditional harvesting by Indigenous peoples. However, the potential exists for interactions between migratory marine species and light, sound and waste discharges, which could affect the presence, abundance, distribution, or quality of these resources and their availability for traditional activities, as discussed below.

Lighting and Sound

Chapter 13 concluded that there is no interaction between sound and lighting associated with drilling and commercial fishing activities. As the potential effects of lighting and sound on Marine Fish and Fish Habitat were assessed in Chapter 9 as not significant, there would be no effects on the nature, quality and/or economic value of species harvested in commercial-communal fishing activities.

Potential interactions between lighting and sound emissions and migratory marine species which are traditionally used or harvested by Indigenous Peoples would be the same as those discussed in Section 14.2.1.1. It is predicted that there would be no significant residual adverse effects on migratory marine species at the individual or population level from lighting and sound. Since there is no current use of lands and resources for traditional purposes in the Core BdN Development Area and since no significant adverse effects on migratory marine-associated species from light and sound emissions are predicted, there will be no effects on the current use of lands and resources for traditional purposes resulting from the presence of the drilling installation.

Anti-Collison Zone(s)

Drilling activities will be carried out in the Core BdN Development Area. The 1 km² anti-collision zone(s) established for a drilling installation will be in place for as long as the drilling installation is on site. Interactions associated with the anti-collision zone and commercial fishing, including commercial-communal fishing, will be similar to those addressed above (Sections14.2.1.3 and Section 14.2.2.1), but with a smaller zone(s). Navigational Warnings will communicate the location of drilling installation(s). The operation of drilling installations will occur for a shorter duration (up to two years per well template location) than the FPSO, with the potential for drilling and production and maintenance operations to overlap. There will be no additional types of interactions or effects on commercial-communal fishing, if any, beyond those assessed above in Sections 14.2.1.3 and 14.2.2.1.

14.2.3.2 Waste Management – Marine Discharges and Emissions

Drilling activities will generate marine discharges and emissions (e.g., bilge, deck drainage, sewage and food waste). Chapter 13 indicates that lighting, sound, discharges and air emissions associated with drilling operations will not interact with commercial fishing. Given this information and the fact that no commercial-communal fishing is currently conducted in the Core BdN Development Area, lighting sound and discharges associated with drilling activities will not result in interactions with commercial-communal fishing activity. It was concluded in Chapter 9 that there is no significant residual adverse affect from these emissions on marine fish species. It is therefore highly unlikely that commercially-harvested marine resources will be affected due to discharges and emissions from drilling activities in a manner and to a degree that would then translate into effects on their overall availability or quality, and thus, on the overall nature, intensity, or economic value of commercial harvesting activity.

With respect to the current use of lands and resources for traditional purposes, drilling activities have the potential to interact with Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles through marine discharges and emissions. Biophysical effects upon these marine-associated resources could potentially translate into indirect effects upon the current use of lands and resources for traditional purposes by Indigenous peoples. The potential effects of drilling activities upon marine-associated species have been identified and assessed in Chapters 9, 10 and 11, respectively and no significant adverse residual effects on marine-associated species were predicted. Thus, no effects upon the traditional harvesting of such species are predicted

During the course of engagement, specific questions were raised by some Indigenous groups with respect to the potential effects of drilling muds and cuttings upon Marine Fish and Fish Habitat and Marine Mammals and Sea Turtles, including with respect to prey species and related indirect effects on the current use of lands and resources for traditional purposes. Drill cuttings have been modelled by Equinor Canada (see Appendix I) and the interaction of drill cuttings with Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles has been the subject of comprehensive consideration (see Chapters 9, 10 and 11 respectively). As a result of this assessment it has been concluded that the effects will be localized and temporary and are not expected to result in any measurable change in the health of marine mammals and sea turtles, marine and migratory birds or marine fish or prey species of any of these marine-associated resources.

Given the distance between the Project and traditional Indigenous harvesting areas (a range of approximately 640 km to 2,000 km from the Project), the localized nature of effects from this phase of Project activities, the absence of significant residual adverse effects upon Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles, and the limited likelihood of traditionally harvested marine-associated species occurring in or migrating through the Project Area, the effects of drilling activities will not translate into any decrease in the availability, sufficiency or quality of marine-associated resources that are currently used for traditional purposes by Indigenous groups. As a result, there will be no effects upon the overall nature, frequency, location, timing, quality or cultural value of traditional uses or activities and no effects upon health, well-being or socio-economic conditions

14.2.3.3 Summary of Environmental Effects

In summary, while no commercial-communal fishing activity is currently recorded for the Core BdN Development Area, were such fishing to occur, the residual environmental effects on commercial-communal fisheries resulting from drilling activities would be the same as those predicted for commercial fisheries generally in Chapter 13. With the application of mitigation measures, the residual effects are predicted to be adverse and short-term, as drilling would occur for up to two years per well template location. The magnitude of effect would be negligible as the area of the drilling anti-collisions zone represents a very small percentage of available fish harvesting areas in the LSA (including the consideration of the FPSO anti-collision zone). The geographic extent is less than 1 km². Effects would be continuous during drilling and reversible once the drilling location leaves the area.

In summary, with the application of mitigation measures, the residual effects on commercial-communal fisheries resulting from drilling activities are predicted to be adverse, negligible in magnitude, with a geographic extent less than 1 km², medium term in duration, occurring continuously, and reversible. This prediction is made with a high level of confidence.

Indigenous communities are located a range of approximately 640 km to 2,000 km from the Project Area and there is no current use of lands and resources for traditional purposes in the LSA. As noted above, given the localized and short-term nature of drilling activities and the absence of any significant residual adverse effects on marine-associated species resulting from such activities, there are no predicted effects on the current use of lands and resources for traditional purposes, including any associated health or socioeconomic conditions. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Indigenous Peoples associated with Drilling Activities include communication of ongoing activities, including the provision of anti-collision zone coordinates, to all marine users and regulatory agencies. (I, J, K, N, O), management and treatment of wastes and discharges (A, B, C, D, E).

Follow-up Monitoring for the effects on Indigenous Peoples associated with Drilling Activities in consideration of the residual effects predictions is not proposed.

14.2.4 Supply and Servicing

The Project will involve marine vessel, including shuttle tankers, and aircraft use, including supply and support vessels to, from and within the Core BdN Development Area and Project Area year-round throughout the Project duration.

As identified in Table 14.2, interactions between supply and servicing activities and this VC relate to the presence of vessels and associated sound, lighting, and discharges while a vessel is in transit within the vessel traffic route, or within the Core BdN Development Area. Vessel movements occurring exclusively within the anti-collision zone are not considered here as there is no potential for interactions with this VC.

Vessels during each Project phase will generate typical marine vessel sound and marine discharges, including wastewater, solid waste and domestic (food) waste. As considered in Sections 9.2 and 9.3, and with identified mitigation measures in place, these discharges will not interact with commercial-communal fisheries. Therefore, the discussion of marine vessels is focused on interactions with commercial-communal fisheries that may occur along the vessel traffic route.

With respect to the current use of lands and resources for traditional purposes, potential effects relate to interactions between migratory fish, birds, and mammals and light and sound from Project-related vessels and aircraft which could affect the presence, abundance or quality of marine resources and their availability for traditional harvesting activities. In addition, the presence of supply vessels may result in injury to or mortality of marine mammals, which may be of importance for traditional harvesting.

14.2.4.1 Marine Vessels

Presence of Vessels

While current data does not distinguish between domestic commercial and commercial-communal fishing, certain Indigenous groups hold commercial-communal licences for various species (i.e., NL Indigenous groups hold licences for capelin, groundfish, herring, mackerel, seals, and shrimp) in harvesting areas that may intersect the vessel traffic route. Thus, vessels transiting to and from the Core BdN Development Area have the potential to interact with fishing activity and damage fishing gear or vessels used by commercial-communal harvesters. Any potential interactions between marine supply and servicing vessels and commercial-communal harvesters would be almost exclusively limited to the Project vessel traffic route. Refer to Section 2.6 for an overview of estimated vessel transits per month. Fixed gear such as gillnets may be in use along or near the vessel traffic route, typically within 50 km of St. John's. There is less potential for interacting with swordfish or tuna longlines as these are typically used in deeper waters off the shelf. Based on historical evidence, damage to other vessels is highly unlikely; no incidents have been reported between a supply vessel and a fishing boat or other vessel (C-NLOPB 2018). The implementation of standard marine industry measures and operation of vessels will reduce the likelihood of this occurrence.

Ongoing coordination and communication between Equinor Canada and the fishing industry (e.g., the FFAW-Unifor, One Ocean), will also reduce the potential for effects between Project-related vessel traffic and commercial fishers. These mitigations would apply equally to commercial-communal fisheries. Should gear damage occur, mitigation will compensate for losses.

Lighting and Sound

Chapter 13 has determined that no interactions are anticipated between lighting and sound from marine vessels and commercial-communal fishing.

With respect to the current use of lands and resources for traditional purposes, while no traditional harvesting takes place within the LSA, the presence of marine vessels may result in some level of attraction, avoidance or other behavioural responses by fish and invertebrates due to light and sound emissions (Røstad et al. 2006; De Robertis and Handegard 2013). In addition, in the Core BdN Development Area, support vessels may maintain their location through dynamic positioning which will introduce underwater sound. However, marine fish will likely not be disturbed by Project-related vessel activity given its transitory nature and short-term presence at any one location. Use of planned and proposed mitigation measures will avoid or reduce any such adverse interactions with these species. Chapters 9 and 10 concluded that with the implementation of applicable mitigations, lighting and sound from Project supply vessels are not likely to result in significant residual adverse effects on Marine Fish and Fish Habitat or Marine and Migratory Birds.

Key issues for marine mammals and sea turtles are generally limited to the effects (i.e., hearing impairment, injury, masking, behavioural responses) of underwater sound and to the potential for a vessel to strike a marine mammal and / or sea turtle resulting in injury or mortality. These potential interactions are discussed in Sections 11.2 and 11.3. Although there are no known concentration areas for marine mammals along the vessel traffic route to the Project Area, it is possible that groups of foraging marine mammals may be encountered during summer months, in particular. Since 2002, there have been two reports of supply vessels potentially striking a whale at night on the Grand Banks. However, as the whales were not subsequently sighted, the incidents were not fully confirmed, and such ship strikes are considered rare (Lawson, J., pers. comm., June 2018). Sea turtles are considered rare along the vessel traffic route and in the Project Area. Chapter 11 concluded that with the implementation of applicable mitigations, the Project is not likely to result in significant residual adverse effects on Marine Mammals and Sea Turtles.

14.2.4.2 Aircraft (Helicopters)

Sound

In addition to vessel traffic, the Project will require helicopter use within the Project Area year-round for the duration of the Project. Helicopters will be used for crew transfers and other purposes as required. Interactions between commercial-communal fishing or Marine Fish and Fish Habitat and helicopter use are not anticipated. Thus, no effects upon commercial-communal harvesting are predicted.

With respect to the current use of lands and resources for traditional purposes, while there is traditional harvesting in the LSA, aircraft use has the potential to result in disturbances to marine and migratory birds and marine mammals and sea turtles. There is potential for disturbance effects of aircraft overflights (e.g., from sound) on marine birds and mammals harvested for traditional purposes. The interactions and potential effects are described in detail in Chapters 10 and 11, which both concluded that Project-related aircraft activities are not anticipated to result in significant residual adverse effects on marine species. Aircraft transits are localized, short-term, and mobile (transitory) in nature, and because generally in keeping with the overall traffic that has occurred throughout the region for years.

With the application of mitigation measures, potential effects on marine or migratory bird species and marine mammals harvested for traditional purposes will be minimized and there will be no adverse effect on the availability or quality of such resources to a manner or degree that would alter the overall nature, frequency, location, timing, quality or value of traditional uses or activities or otherwise adversely affect health, well-being or socio-economic conditions.

14.2.4.3 Summary of Environmental Effects

In summary, while no commercial-communal fishing activities are currently recorded for the Core BdN Development Area, were such fishing to occur in the future, the residual environmental effects on commercial-communal fisheries resulting from supply and servicing would be the same as those that are discussed in Chapter 13. With the application of mitigation measures, the residual effects are predicted to be adverse and occurring sporadically, as effects would only occur if fishing activity is in the vessel traffic route at the same time as support vessels are transiting. The magnitude of effect would be negligible. The magnitude of the effect is negligible because there is no known commercial-communal fishing in the area and there is available fish harvesting areas within the larger LSA. The geographic extent would be approximately 10 km² as the potential for interaction to occur would be along the supply vessels' path in the vessel in the vessel traffic corridor. with a geographic extent confined to the vessel traffic route. The duration of effect would be short-term as it would only occur when vessels are transiting. These predictions are made with a high level of confidence based on historical fishing activity and the experience and professional judgement of the EIS Team. Mitigation measures are noted above.

In summary, with the application of mitigation measures, the residual effects on commercial-communal fisheries resulting from Supply and Servicing are predicted to be negligible in magnitude, with a geographic extent less than 10 km², short-term in duration, occurring sporadically, and reversible. This prediction is made with a high level of confidence.

Indigenous communities are located a range of approximately 640 km to 2,000 km from the Project Area and there is no current use of lands and resources for traditional purposes in the LSA. As noted above, the potential for interaction between Project-related supply and servicing and marine-associated species harvested for traditional purposes or cultural value is considered to be negligible, given the short-term, localized and mobile nature of these activities. As discussed in Chapters 9 to 11, no significant adverse effects on Marine Fish and Fish Habitat, Marine and Migratory Birds, and Marine Mammals and Sea Turtles were predicted as a result of supply and servicing. As a result, there are no predicted effects on the current use of lands and resources for traditional purposes, including any associated health, socioeconomic and cultural conditions. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Indigenous Peoples associated with Supply and Servicing include communication of ongoing activities to all marine users and regulatory agencies. (I, J, N, O), management and treatment of wastes and discharges (B, C, D); use of a common traffic corridor (F).

Follow-up Monitoring for the effects on Indigenous Peoples associated with Supply and Servicing in consideration of the residual effects predictions is not proposed.

14.2.5 Supporting Surveys

Supporting surveys associated with the Project are described in Section 2.6.6, and may include geophysical activities, environmental, geotechnical, geological and ROV / AUV surveys.

Project-related surveys will be focused within the Core BdN Development Area and will be of short-term in duration (e.g., weeks to months) and may take place at any time of the year throughout the life of the Project. Project-related surveys have the potential to interact with commercial-communal fishing through direct interference, damage to fishing gear, vessels, and equipment, and a change in abundance, distribution, and quality of marine resources resulting from sound emissions.

Since there is no current use of lands and resources for traditional purposes in the Core BdN Development Area or the Project Area, the conduct of supporting surveys and associated activities will have no direct effects on traditional harvesting or other activities in traditional territories by Indigenous peoples. However, the potential exists for interactions between migratory marine species and light and sound emissions which could affect the presence, abundance, distribution, or quality of these resources and their availability and sufficiency for traditional uses or activities. In addition, the possibility exists for injury to or mortality of marine mammals resulting from vessel strikes.

14.2.5.1 Presence of Vessels and Towed Equipment

As described in Section 2.6.6, two options are under consideration for 4D seismic surveys for the Project. Permanent reservoir monitoring would involve installation of ocean bottom cables (OBC) or ocean bottom nodes (OBN) on the seafloor, which would remain in place for the life of the Core BdN Development. The second option involves temporary installation of OBN or the use of towed seismic streamers (conventional seismic). Permanent reservoir monitoring seismic surveys are estimated to take approximately two weeks to complete and could be carried out twice per year. Conventional seismic surveys could be between two and four weeks and occur once per year in early Project life, with reduced frequency in later years. Timing and duration of surveys are estimated and will be finalized during Project design.

While towed equipment has the potential to interact with fixed fishing gear, there is no recorded commercial fishing activity in the Core BdN Development Area and therefore there is no potential for gear entanglement with towed equipment. Thus, there is currently no potential for interference with fishing gear by Project-related seismic surveys. In addition, any future commercial-communal swordfish or tuna fisheries that may occur in the Core BdN Development Area would likely use towed fishing gear such as longlines.

For permanent reservoir monitoring, the OBC or OBN would be installed on the seafloor and may interfere with fishing activity. The area occupied by the OBC/OBN is estimated to be approximately 135 km^2 and their location will be communicated to marine users.

Interactions associated with vessels engaged in Supporting Surveys would be the same as those assessed under supply and servicing (Section 14.2.4) regarding vessel presence, lighting and sound. While most survey activities will be within the Core BdN Development Area, some survey activity could occur in the Project Area and LSA (e.g., environmental surveys), though these would not be expected to interact with commercial-communal fishing. Mitigation measures such as communication with fishers and Navigational Warnings would reduce potential interactions with commercial-communal fisheries.

While Project-related vessel traffic has the potential to result in mortality or injury of Marine Mammals and Sea Turtles due to vessel strikes or contact with towed gear, given that vessels engaged in geophysical surveys travel at slower speeds than other vessels in transit, the potential for ship strikes or gear entanglement is very low.

14.2.5.2 Lighting

Chapter 13 states that lighting from support surveys will not interact with commercial fishing activities so no direct effects on commercial-communal fishing are predicted. The potential interaction of lighting on Marine Fish and Fish Habitat is assessed in Chapter 9. As there will be no predicted significant residual adverse environmental effects on Marine Fish and Fish Habitat, therefore, there will be no effect on the nature, quality and/or economic value of commercially-harvested species.

Potential interactions between vessel lighting and migratory marine species that are traditionally harvested by Indigenous peoples would be the same as those discussed in Section 14.2.1. No significant residual adverse effects are anticipated on migratory marine species at the individual or population level from lighting. Since there is no current use of lands and resources for traditional purposes in the Core BdN Development Area and since no significant adverse environmental effects on migratory marine-associated species from light emissions are predicted, there will be no effects on the current use of lands and resources for traditional purposes resulting from lighting associated with geophysical surveys.

14.2.5.3 Sound

The effects of underwater noise associated with Project-related surveys, such underwater sound from equipment used in geophysical activities, has the potential to indirectly affect commercial fishing activity through changes in fish behavior and avoidance of certain areas. Chapter 13 determined that while there may be behavioural response of fish to sound from geophysical surveys, indirect effects on commercial fisheries, including any indirect effects on catch rates and economic returns, are expected to be not significant. Note that underwater sound emitted during a 3D/4D seismic survey represents the worst-case scenario with respect to exposure of invertebrates and fishes to underwater sound. Sections 9.3.5.4 provides a comprehensive discussion of the interactions between fish species and underwater sound associated with Project-related surveys. It was concluded that fish would likely move away from the source during ramp-up or vessel approach to avoid sound disturbances. Overall, while there may be a behavioural response of fish to sound from geophysical surveys, the indirect effects on the commercial-communal fishery are unlikely due to the transient, localized, and short-term nature of the surveys. Mitigation measures to further reduce effects of underwater noise on marine fish are presented in Section 9.1.5.2.

With respect to the current use of lands and resources for traditional purposes, while there is some potential for interaction between supporting surveys and marine species, harvested in traditional territories that may migrate through the Project Area, fish species, including those harvested for traditional purposes, are likely to move away from an area due to the presence of underwater sound. As discussed, mitigations such as dispersion from the source during array ramp-up or vessel approach are anticipated to be successful at avoiding harm to fish species. Therefore, any such residual effects are determined to be not significant (Chapter 9). With respect to marine and migratory birds, there is little or no evidence that marine birds are adversely affected by marine surveys, particularly underwater sound (Chapter 10).

Interactions between Supporting Surveys and marine mammals and sea turtles were discussed in Chapter 11 and a sound modelling report has been produced (see Appendix D). Interactions may manifest in behavioural responses, masking and potential auditory and non-auditory impairments. The results of sound modelling concluded that it was unlikely that marine mammals in shelf waters would be affected by seismic surveys in the Project Area. Surveys may result in localized avoidance and short-term (not extending beyond the duration of the seismic survey) behavioural responses by marine mammals and sea turtles (which are considered unlikely in the Project Area). Any masking effects are also considered to be relatively short-term and are not predicted to extend beyond the duration of the seismic survey.

With respect to auditory impairment, the implementation of mitigation measures (e.g., ramp-up, delay in ramp-up if a marine mammal or sea turtle is detected within 500 m of the source array or shut down if an endangered or threatened marine mammal or sea turtle is detected within 500 m of the air source array), it is unlikely that seismic surveys will cause auditory injuries to marine mammals or sea turtles. Marine mammals (e.g., most baleen whales, some odontocetes, and some pinnipeds, as well as sea turtles) are highly mobile and show avoidance behaviour when exposed to such sound. Given the brief duration of exposure of any given mammal to underwater sound and the implementation of mitigation measures, the probability of exposure of marine mammals and sea-turtles to sounds strong enough to cause non-auditory physical effects are considered unlikely.

14.2.5.4 Summary of Environmental Effects

In summary, while no commercial-communal fishing activity is currently recorded for the Core BdN Development Area, were such fishing to occur in the future, residual effects on commercial-communal fisheries resulting from supporting surveys would be the same as those that have been predicted for Commercial Fisheries and Other Ocean Uses. With the application of mitigation measures, such effects are predicted to be adverse and reversible. The magnitude of predicted effects would be negligible as there is little fishing in the area and the area of geophysical surveys or other supporting surveys represents a very small percentage of the overall available fish harvesting areas within the LSA. Effects would be continuous while surveys were being carried out and short-term, as surveys are expected to be carried out within two to four weeks. The geographic extent would be between 100 km² and 1000 km², depending if permanent reservoir monitoring is chosen versus towed hydrophones (for geophysical surveys). These predictions are made with a high level of confidence based on historical fishing data and the experience and professional judgement of the EIS Team.

In summary, with the application of mitigation measures, the residual effects on commercial-communal fisheries resulting from Supporting Surveys are predicted to be negligible in magnitude, with a geographic extent less between 100 km² to 1,000 km², short-term in duration, occurring continuously, and reversible. This prediction is made with a high level of confidence. These predictions are made with a high level of confidence.

Indigenous communities are located within a range of approximately 640 km to 2,000 km from the Project Area and there is no current use of lands and resources for traditional purposes in the LSA. Given the low likelihood of the occurrence of traditionally-harvested or culturally important marine-associated resources either within or passing through the Core BdN Development Area and the absence of any significant residual adverse effects upon such marine-associated species (due to the localized and short-term nature of the activities and the implementation of mitigation measures), it is predicted that activities associated with supporting surveys are not expected to result in any effects upon the current use of lands and resources for traditional purposes, including any associated health, socioeconomic and cultural conditions. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Indigenous Peoples associated with Supporting Surveys include communication of ongoing activities (I, J, N, O), management and treatment of wastes and discharges (B, C, D); compensation program for damage from Project Activities (L).

Follow-up Monitoring for the effects on Indigenous Peoples associated with Supporting Surveys in consideration of the residual effects predictions is not proposed.

14.2.6 Decommissioning

As described in Section 2.6.7, at end of field-life the Project, either at the end of the Core BdN Development or the end of Project life should Project Area Tiebacks be undertaken, will be decommissioning in accordance with regulatory requirements in place at the time of decommissioning. A decommissioning plan will be submitted to the C-NLOPB for review and acceptance. Depending on the activity undertaken, decommissioning may occur seasonally or at any time of the year. It is anticipated that decommissioning will be carried out over multiple seasons, similar to Offshore Construction and Installation (Section 9.3.1) and be completed within a two to four-year timeframe. Decommissioning of the FPSO may occur at any time of the year.

As a base case, the FPSO will be decommissioned and removed from the Project location. It is likely that the FPSO will be decommissioned and removed from site in the initial phases of decommissioning. As noted above, vessels may be engaged to support decommissioning of the FPSO. All floating equipment (turret, mooring lines) will be removed. Subsea infrastructure, including flowlines and well templates may be removed or left in place. As noted in Section 2.6.7, these options will be further examined at the time of decommissioning.

Wells will be abandoned in accordance with regulatory requirements and as described in Section 2.6.7.2. Depending on water depth, the wellhead will either be removed during decommissioning or left in place. Well decommissioning may be carried out with a drilling installation (internal cutting of the well casing), which typically occurs at shallower water depths, or in deeper waters via a vessel and ROV-equipped with a mechanical cutter (external cutting of wellhead). Explosives will not be used to remove wellheads.

Activities associated with decommissioning are the same as described and the above sections, including vessels engaged in decommissioning activities, supply and servicing, helicopter supply and servicing, ROV / AUV surveys. Marine vessel and aircraft support activity levels during decommissioning would likely be similar to the construction and installation phase of the Project. Environmental, geotechnical, and/or geological surveys may be required during decommissioning.

During decommissioning, Project-related vessel traffic will be the main source of potential interactions with any commercial-communal fishing that may occur in the Project Area. Potential effects on commercial-communal fisheries would the same as those assessed under supply and servicing. The anti-collision zone will remain in place until the FPSO leaves the area. Thus, potential interference with commercial-communal fishing activity will be the same as addressed under Section 14.2.2 and will cease once the FPSO is removed from site.

Additional vessel transits through the LSA to and from shore as well as additional traffic within the Core BdN Development Area associated with decommissioning are anticipated to be minor. All vessel traffic-related mitigations will be enforced as described above for other components. No additional interactions with commercial-communal fishing activities are expected with decommissioning.

Potential effects from discharges and emissions related to decommissioning on Marine Fish and Fish Habitat are discussed and assessed in Section 9.2.6, where it was determined that they are not likely to have significant residual adverse effects on species such as those harvested for commercial or traditional purposes. During subsea infrastructure decommissioning activities, potential interactions, mitigation and residual effects would be the same as during the construction and installation and/or supply and servicing phases.

With respect to the current use of lands and resources for traditional purposes, based on analysis prepared for the biophysical VCs (Chapters 9 to 11), while species harvested for traditional purposes or of cultural importance may migrate through the Core BdN Development Area, it is unlikely that they will be affected by decommissioning activities. The likelihood that marine-associated species of traditional importance would be present in the Project Area is low. There is negligible potential for the biophysical effects of decommissioning to have an adverse effect on the presence, abundance, distribution, or quality of these resources, and thus, their overall availability for use by Indigenous groups within their traditional harvesting areas. There will also be no potential for such biophysical effects on an individual member of a species (should they occur) to translate into a decrease in the overall nature, frequency, location, timing, quality or cultural value of traditional uses or activities or to otherwise adversely affect health, well-being or socio-economic conditions.

14.2.6.1 Summary of Environmental Effects

In summary, while no commercial-communal fishing activity is currently recorded for the Core BdN Development Area, were such fishing to occur in future, the residual environmental effects on commercial-communal fisheries resulting from decommissioning would be the same as those that have been predicted for Commercial Fisheries and Other Ocean Users in Chapter 13. Effects associated with decommissioning would be neutral if subsea infrastructure were removed, as it is a return to baseline conditions, to adverse if it remained in place. Effects would be sporadic and long-term if subsea infrastructure remains in place, occurring only if there is bottom trawling in the in the area, to no interactions if subsea infrastructure was removed. The geographic extent would be 7 km², based on the footprint of he subsea infrastructure. The magnitude of the effect is negligible as there is little fishing in the area and the area that could be occupied by subsea infrastructure if it remained in place represents a very small area in relation to fishing areas available in the larger LSA. These predictions are made with a high level of confidence based on historic fishing data and the experience and professional judgement of the EIS Team. Mitigations would be the same as those discussed in Section 13.3.6.

In summary, with the application of mitigation measures, the residual effects on commercial-communal fisheries resulting from Decommissioning are predicted to be adverse, negligible in magnitude, with a geographic extent less than 10 km², long-term in duration, occurring sporadically. These predictions are made with a high level of confidence.

Indigenous communities are located a range of approximately 640 km to 2,000 km from the Project Area and there is no current use of lands and resources for traditional purposes in the LSA. While marine species of cultural importance to Indigenous groups may migrate through the Core BdN Development Area, activities associated with decommissioning are not expected to result in significant residual adverse effects upon such species. As a result, activities associated with decommissioning are not expected to result in effects upon the current use of lands and resources for traditional purposes, including any associated health, socioeconomic and cultural conditions. This prediction is made with a high level of confidence.

Mitigations to reduce potential effects to Indigenous Peoples associated with Decommissioning include submission of a decommissioning plan to the C-NLOPB (P); communication of ongoing activities (J, N, O), management and treatment of wastes and discharges (A, B, C, D, E); provision of coordinates of remaining subsea infrastructure to regulatory agencies for inclusion on nautical charts (S).

Follow-up Monitoring for the effects on Indigenous Peoples associated with Supporting Surveys in consideration of the residual effects predictions is not proposed.

14.3 Project Area Tiebacks

Over the life of the Project, Equinor Canada may choose to undertake additional exploration activities (e.g., exploration, appraisal, delineation drilling, 2D, 3D/4D seismic) to search for and possibly develop economically recoverable reserves. Should additional economically and technically recoverable reserves be discovered within the Project Area, they could be processed on the FPSO through the installation of additional subsea well templates and flowlines (as described in Section 2.6.7). Between one and five subsea developments could be tied-back to the FPSO and may include the drilling of up to 20 additional wells. Activities associated with Project Area Tiebacks would be the same as those described in Section 2.6.7 and summarized below

- Installation of subsea tieack(s) (well templates and flowlines)
- Continuation of production and maintenance operations from the existing FPSO
- Drilling activities associated with the drilling of up to 20 additional wells (total) in well templates
- Continuation of supply and servicing
- Additional supporting surveys, if required
- Decommissioning

The Core BdN Development has a field life of 12 to 20 years. Should Project Area Tiebacks occur, the field life of the Project may be extended, and maximum daily potential production rates would remain the same. Tiebacks to the FPSO may be feasible up to a distance of approximately 40 km from the FPSO location and/or a well template location. Figure 14-2 illustrates examples of tieback layouts that could occur, should Project Area Tiebacks be undertaken. For the purposes of the EA, it is assumed that the timeframe for Project Area Tiebacks would the same as those listed for the Core BdN Development. For instance, it is assumed that offshore construction and installation and HUC activities would occur over several seasons; production and maintenance operations, supply and servicing and supporting surveys would continue until 30-year end of Project life (an additional

10 to 18 years). All mitigation measures implemented for the Core BdN Development would also be applied to Project Area Tiebacks (see Section 14.1.5.2).

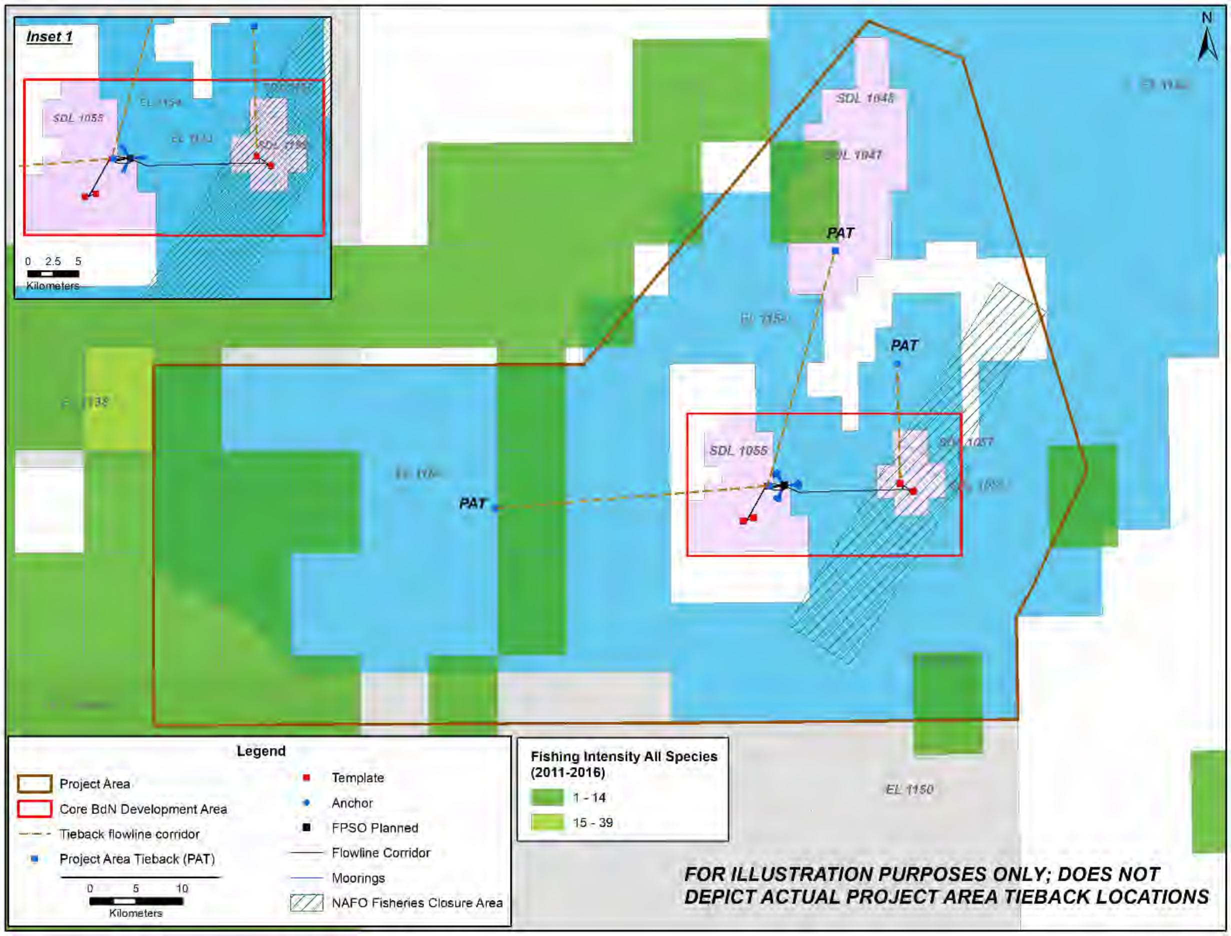

Figure 14-2 Illustration of Examples of Project Area Tiebacks

The activities during the Project Area Tiebacks phase would be the same as those assessed for the Core BdN Development Area. The primary differences between the Project Area Tiebacks and the Core BdN Development Area are the longer life span of Project activities, and the potential increase in spatial layout. Should Project Area Tiebacks activities occur in areas with higher fishing intensity, there is potential for an increased level of interaction with commercial and commercial-communal fisheries (see Section 13.4). As the specific locations of future installations and activities are not known, for the purpose of this assessment the following discussion assumes that operations and infrastructure in the Project Area will be located in and/or pass through areas that could potentially be used for commercial-communal harvesting in the future, thereby considering a potential "worst-case" situation with respect to locations for interactions. No commercial-communal fishing is currently known to occur within the Core BdN Development Area and the current level of commercial-communal harvesting in the Project Area is also unknown. However, it is assumed for the purposes of assessment that there may be future commercial-communal fisheries active in portions of the Project Area. The primary interactions with commercial-communal fisheries associated with Project

Area Tiebacks activity are the same as those for Core BdN Development: (1) potential for gear damage and (2) loss of access to fishing grounds due to the establishment of anti-collision zones. The following effects assessment of Project Area Tiebacks on commercial-communal fishing is therefore focused on these potential interactions.

Potential Project Effects – Commercial-Communal Fishing

With the installation of subsea infrastructure for potential tiebacks to the FPSO at distances up to 40 km, the spatial area occupied by subsea infrastructure would be increased with potential for interference causing gear damage. Subsea infrastructure located in areas of fish trawling activity would be designed with trawl protection based on international best practices and Equinor Canada's experience in the Norwegian Continental Shelf. The area that could be occupied by additional subsea infrastructure would represent a very small percentage of the available fishing areas in the LSA. As with the Core BdN Development, a safety zone demarcating the area occupied by subsea infrastructure will be established and will be communicated to marine users.

The anti-collision zone established around a drilling installation is temporary and localized to the drilling location. As described above, it will be approximately 1 km² and would represent an extremely small portion of available fishing areas in the LSA which is not expected to affect overall fishing success. Furthermore, subsea infrastructure for Project Area Tiebacks could have a seabed footprint up to 15 km² (or less than 0.02 percent of the LSA). However, due to the potential increase in fishing activity in the northern and western portions of the Project Area, the magnitude effect would likely be greater compared to Core BdN Development. Assuming there will be some level of commercial-communal fishing, the residual environmental effects on commercial-communal fisheries resulting from Project Area Tiebacks would be the same as those experienced by commercial fisheries.

In summary, with the application of mitigation measures, potential residual effects from Project Area Tiebacks on commercial-communal fisheries are predicted to be adverse, negligible to low in magnitude, with a geographic extent less than 100 km², long-term in duration, occurring continuously, and reversible. These predictions are made with a high level of confidence.

Potential Project Effects – Current Use of Land and Resources for Traditional Purposes

Given the distance between the Project and traditional Indigenous harvesting areas (a range of approximately 640 km to 2,000 km from the Project), the localized nature of effects from this phase of Project activities, the absence of significant residual adverse effects upon Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles, and the limited likelihood of traditionally harvested marine-associated species occurring in or migrating through the Project Area, the effects of drilling activities will not translate into any decrease in the availability, sufficiency or quality of marine-associated resources that are currently used for traditional purposes by Indigenous groups. As a result, there will be no effects on the overall nature, frequency, location, timing, quality or cultural value of traditional uses or activities and no adverse effects on health, well-being and socio-economic conditions of Indigenous groups.

14.4 Significance of Residual Environmental Effects

This section summarizes the residual effects of the Project as a whole on the Indigenous Peoples VC and presents the determination of significance.

14.4.1 Ecosystem Component Linkages

The interconnections between the physical, biological, and human environment have been considered in the EIS and are summarized in Table 14.5. Overall, the EIS is based on the interactions between project activities and select VC's using source-pathway-receptor relationships as addressed in Section 14.1. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not affect significance determinations, as the potential effects (via direct and indirect pathways) on Indigenous peoples have been assessed.

Table 14.5 Ecosystem Linkages Indigenous Peoples

Component / Activity	Interaction	Pathway	Ecosystem Linkages
Core BdN and Project Area Tiebacks - PA			
All Activities	• Presence of vessels • Anti-collision zones • Marine discharges • Subsea infrastructure	• Potential for marine-associated fish species known to be used by Indigenous groups for traditional purposes to occur in the Project Area before moving to areas of traditional harvesting. (effects are described in Chapter 9 – Marine Fish and Fish Habitat) • Potential effects of Project activities on Marine and Migratory Birds, including migratory birds potentially harvested for traditional purposes. (effects are described in Chapter 10 – Marine and Migratory Birds) • Potential effects on marine mammals, including those of cultural importance to Indigenous groups (effects are described in Chapter 11 – Marine Mammals and Sea Turtles). • Loss of access to fishing grounds by commercial-communal fishers.	Abundance, availability and quality of marine fish, marine and migratory birds and marine mammals and sea turtles in harvesting areas. Abundance, availability and quality of marine fish in commercial-communal harvesting areas.

14.4.2 Residual Environmental Effects Summary

Most Project-related activities will take place in an offshore marine environment, hundreds of kilometres from land and approximately 640 km to 2,000 km from Indigenous communities and their traditional territories. No Indigenous group has asserted or established Aboriginal or treaty rights in the Core BdN Development Area, the Project Area or the LSA. There are no documented instances of traditional harvesting within or near the Core BdN Development Area, Project Area or LSA and no current use of lands and resources for traditional purposes in any of these areas. There are no known sites of historical, archaeological, paleontological or architectural significance to Indigenous groups in the Core BdN Development Area, the Project Area or the LSA.

Various Indigenous groups hold commercial-communal licences for a variety of species, including swordfish and tuna, in NAFO Divisions 3L and 3M, portions of which overlap the Project Area. There is no recorded domestic commercial or commercial-communal harvesting in the Core BdN Development Area. Similarly, the level of domestic commercial harvesting in the Project Area is low and concentrated in the western and northern portions. The extent of commercial-communal fishing in the Project Area is not known as available datasets do not distinguish between Indigenous and non-Indigenous commercial harvesting and some fisheries data have been redacted based on protection of privacy requirements (see Section 7.1). However, no Indigenous group has indicated any commercial-communal fishing activity currently in the Project Area. Moreover, while some NL and Maritime Indigenous groups hold swordfish / tuna licences, there were no recorded landings of either swordfish or tuna in the Project Area between 2011 and 2016. Most harvesting of these species is undertaken well south of the Project Area and the range and migrations of both swordfish and tuna make it unlikely that there would be any interaction with planned Project activities. The potential Project effects on commercial-communal harvesting generally (including commercial-communal harvesting in the RSA outside the Project Area) have been discussed with Indigenous groups during engagement activities and no major concerns were expressed. If in future, commercial-communal harvesting occurs in the Core BdN Development Area or the Project Area, given the nature of the Project, including its limited and localized environmental disturbances, and associated mitigation measures (e.g., notification), any residual Project effects upon Indigenous commercial-communal fisheries with respect to either the licenced activity or commercially-harvested species would be the same as those experienced by non-Indigenous commercial fishers (see Chapter 13).

Given that routine Project-related activities will occur in the marine environment at a range of approximately 640 km to 2,000 km from the various Indigenous communities and their traditional territories, no direct effects on the physical or social health and well-being or economic conditions of Indigenous groups or communities are predicted. Routine Project activities are also not predicted to result in changes to the environment that would indirectly adversely affect the human health and well-being or socio-economic conditions of Indigenous groups or communities.

The identified Indigenous groups currently undertake traditional land and resource harvesting activities in their traditional territories which are generally near their communities. Potential adverse effects on marine-associated resources used by Indigenous groups for traditional purposes or otherwise are of cultural value are limited to possible effects on marine species that may migrate through the Flemish Pass prior to arriving in harvesting areas. The presence of such species in the Project Area is limited and the biological VC chapters (Chapters 9 to 11) respecting marine and migratory species have determined that the Project is not likely to result in significant residual adverse effects upon marine fish, marine or migratory birds, or marine mammals and sea turtles.

The various mitigation measures identified throughout this EIS will help avoid or reduce associated effects on these species. While it is not possible to determine with absolute certainty whether an individual of any species (in any life history stage) used by one or more of these Indigenous groups may be present in the Project Area before moving to an area that is the subject of traditional harvesting activity (particularly for juvenile stages of some species with extensive dispersion), the potential is extremely remote for any degree of connection between individuals within the Project Area and those harvested for traditional purposes. As a result, the Project is not anticipated to have an adverse effect on the availability or quality of resources that are currently used for traditional purposes, especially in a manner or to a degree that would alter the overall nature, frequency, location, timing, quality or cultural value of current land and resource use activities for traditional purposes. Therefore, no effects upon the current use of lands and resources for traditional purposes by Indigenous groups are predicted. Since no effects on the current use of lands and resources for traditional purposes are predicted, the Project will have no effects upon asserted or established Aboriginal or treaty rights.

Similarly, routine Project activities are not predicted to result in effects on the socioeconomic conditions of the various Indigenous communities. Given the location of Project activities and the distance from Indigenous communities, routine activities are not predicted to interact with on-land or near-shore Indigenous activities that contribute to the socioeconomic conditions and well-being of Indigenous communities. Since residual effects on Marine Fish and Fish Habitat, including species harvested for traditional purposes, are determined to be not significant, no associated potential effects to socioeconomic conditions such as employment and business activity and income, community revenue, community-based services and infrastructure, and availability of culturally important species in the Indigenous communities are predicted. With the application of mitigation measures and adherence to published and / or industry standards and best management practices, no effects from routine Project activities on Indigenous groups and their activities are predicted.

Tables 14.6 and 14.7 summarizes the environmental effects assessment for Core BdN Development and Project Area Tiebacks that comprise the Project.

14.4.3 Determination of Significance

It is predicted that, with the application of mitigation measures, the Project will not result in significant adverse effects on Indigenous Peoples.

As stated previously, there is no recorded domestic commercial or commercial-communal fishing currently in the Core BdN Development Area and overall levels of commercial fishing in the Project Area are low. If, in future, commercial-communal fishing occurs in this area, the primary mechanism of interaction that may have direct adverse effects on commercial-communal fisheries would be the presence of the FPSO, associated subsea infrastructure, drilling installation(s), the establishment of anti-collision zones, and vessel traffic. As discussed previously, given the localized nature of Project infrastructure and its small physical footprint, and the availability of alternative fishing grounds, even were commercial-communal fishing activities to occur in the Core BdN Development Area, the presence of Project components and associated anti-collision zones would not have any direct effect on the commercial-communal harvest (in terms of catch rates, employment and revenue) and no detectable effect on the economy or well-being of an Indigenous community.

Table 14.6 Environmental Effects Assessment Summary: Indigenous Peoples – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations (see Table 14.2 for list of mitigations)**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**		
CORE BdN DEVELOPMENT										
OFFSHORE CONSTRUCTION AND INSTALLATION, HOOK-UP AND COMMISSIONING										
Presence of Vessels										
Lighting	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Sound	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Marine Discharges	• Change in commercial-communal fisheries	No Interaction							B, C, D	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Installation of Subsea Infrastructure (including potential protection)	• Change in commercial-communal fisheries	A	N	< 10 km²	L	C	R	H	H, I, J, K, L, N, O	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Hook-up and Commissioning										
Anti-Collison Zone(s)	• Change in commercial-communal fisheries	A	N	< 10 km²	L	C	R	H	A, B, C, D, E, I, J, K, L, N, O	Not Proposed
Marine Discharges	• Change in commercial-communal fisheries	No Interaction							A, D, E	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
PRODUCTION AND MAINTENANCE OPERATIONS										
Presence of FPSO and Subsea Infrastructure										
Lighting	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Sound	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Anti-Collison Zone(s)	• Change in commercial-communal fisheries	A	N	< 10 km²	L	C	R	H	I, J, N, O	Not Proposed
Presence of Subsea Infrastructure	• Change in commercial-communal fisheries	A	N	< 10 km²	L	C	R	H	I, J, N, O, L	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		

Table 14.6 Environmental Effects Assessment Summary: Indigenous Peoples – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations (see Table 14.2 for list of mitigations)**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**		
Waste Management - Marine Discharges and Emissions										
Produced Water	• Change in commercial-communal fisheries	No Interaction							A, E	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Marine Waste Discharges	• Change in commercial-communal fisheries	No Interaction							A, B, C, D, E	N/A
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Non-routine Flaring	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
DRILLING ACTIVITIES										
Presence of Drilling Installation										
Lighting	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Sound	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Anti-Collison Zone(s)	• Change in commercial-communal fisheries	A	N	<1 km²	M	C	R	H	I, J, N, O	Not Proposed
Waste Management - Marine Discharges and Emissions										
Drill Cuttings	• Change in commercial-communal fisheries	No Interaction							A, E	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Marine Waste Discharges	• Change in commercial-communal	No Interaction							A, B, C, D, E	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Flaring during formation flow testing	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		

Table 14.6 Environmental Effects Assessment Summary: Indigenous Peoples – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations (see Table 14.2 for list of mitigations)**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**		
SUPPLY AND SERVICING										
Marine Vessels										
Presence	• Change in commercial-communal fisheries	A	N	<10 km²	S	S	R	H	B, C, D, F, I, J, N, O	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Sound	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Lighting	• Change in commercial-communal fisheries	No interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Aircraft (helicopters)										
Sound	• Change in commercial-communal fisheries	No Interaction							F	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
SUPPORTING SURVEYS										
Presence of Vessels and Towed Equipment	• Change in commercial-communal fisheries	A	N	<100 km² and <1000 km²	S	C	Y	H	B, C, D, I, J, L, N, O	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Lighting	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Underwater Sound Emissions from Vessels	• Change in commercial-communal fisheries	No Interaction							Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Underwater Sound Emissions from Geophysical Equipment	• Change in commercial-communal fisheries	A	N	<100 km² and <1000 km²	S	C	Y	H	Not Proposed	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		

Table 14.6 Environmental Effects Assessment Summary: Indigenous Peoples – Core BdN Development

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations (see Table 14.2 for list of mitigations)**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**		
DECOMMISSIONING										
Decommissioning of FPSO	• Change in commercial-communal fisheries	A	N	<10 km²	L	S	N/A	H	A, B; C, D, E, J, N, O, P, Q, S	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Decommissioning of Subsea Infrastructure	• Change in commercial-communal fisheries	A	N	<10 km²	L	S	N/A	H	A, E, J, N, O, P	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Well Decommissioning	• Change in commercial-communal fisheries	A	N	<10 km²	L	S	N/A	H	A, E, J, N, O, P, R, S	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		

Evaluation of Significance

- The Project will not result in significant residual adverse environmental effects on Indigenous Peoples.
- The Project will not cause a decrease in employment and revenue from commercial-communal fishing such that there is a detectable adverse effect upon the economy or well-being of an Indigenous community.
- The Project is not likely to have significant residual adverse effects on the availability or quality of resources that are currently used for traditional purposes by Indigenous groups in a manner and to a degree that would alter the nature, location, timing, intensity or cultural value of these activities
- The Project is not likely to result in any effects on current use of lands and resources for traditional purposes by Indigenous Peoples, including any associated health, socioeconomic and cultural conditions

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY

Nature / Direction of Effect:
P Positive
A Adverse
N Neutral (or no effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less than 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Frequency of Effect:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

Table 14.7 Environmental Effects Assessment Summary: Indigenous Peoples – Project Area Tiebacks

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY										
Project Component or Activity	**Potential Environmental Effects**	**Residual Environmental Effects Summary Descriptors**							**Mitigations (see Table 14.2 for list of mitigations)**	**Follow-Up Monitoring**
		Nature	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**		
Offshore Construction and Installation, and Hook-up and Commissioning	• Change in commercial-communal fisheries	A	N - L	<100 km²	S	C	Y	H	A, B, C, D, E, H, I, J, L, N, O	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Production and Maintenance Operations	• Change in commercial-communal fisheries	A	N	<10 km²	L	C	Y	H	A, B, C, D, E, I, J, N, O, L	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Drilling Activities	• Change in commercial-communal fisheries	A	N - L	<1 km²	S	C	Y	H	A, B, C, D, E, I, J, N, O	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Supply and Servicing	• Change in commercial-communal fisheries	A	N	<1 km²	S	S	Y	H	F, J, L, N	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Supporting Surveys	• Change in commercial-communal fisheries	A	N - L	<100 km² - <1000 km	L	C	Y	H	J, L, N, O	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		
Decommissioning	• Change in commercial-communal fisheries	A-N	N- L	< 100 km²	L	O	N/A	H	A, B; C, D, E, J, N, O, P, Q, R, S	Not Proposed
	• Change in current use of lands and resources for traditional purposes	N	N/A	N/A	N/A	N/A	N/A	H		

Evaluation of Significance

The Project will not result in significant residual adverse environmental effects on Indigenous Peoples.

The Project will not cause a decrease in employment and revenue from commercial-communal fishing such that there is a detectable adverse effect upon the economy or well-being of an Indigenous community.

The Project is not likely to have significant residual adverse effects on the availability or quality of resources that are currently used for traditional purposes by Indigenous groups in a manner and to a degree that would alter the nature, location, timing, intensity or cultural value of these activities

The Project is not likely to result in significant residual adverse effects on current use of lands and resources for traditional purposes by Indigenous Peoples, including any associated health, socioeconomic and cultural conditions

NOTE: The environmental effects assessment for accidental events is presented separately in Chapter 16.

KEY

Nature / Direction of Effect:
P Positive
A Adverse
N Neutral (or no effect)

Magnitude of Effect:
N Negligible
L Low
M Medium
H High

Geographic Extent of Effect:
Less than 1 km²
Less than 10 km²
Less than 100 km²
Less than 1,000 km²
Less than 10,000 km²
Greater than 10,000 km²

Duration:
S Short-term - less than 12 months (1 year)
M Medium-term - 1 to 5 years
L Long-term - more than 5 years

Frequency of Effect:
N Not likely to occur
O Occurs once
S Occurs sporadically
R Occurs on a regular basis
C Occurs continuously

Reversibility:
R Reversible (will recover to baseline)
I Irreversible (permanent)

Confidence Level in Predictions:
L Low level of confidence
M Moderate level of confidence
H High level of confidence

N/A Not Applicable

The environmental effects analysis indicates there is limited potential for marine-associated species that are known to be traditionally harvested by, or of cultural importance to, the identified Indigenous groups to occur in or pass through the Core BdN Development Area before moving to an area of traditional harvesting. The implementation of the mitigation measures outlined throughout this EIS will reduce direct potential effects on these resources and any associated effects upon their availability, quantity, quality or economic value for traditional activities. The Project is not anticipated to adversely alter the overall nature, frequency, location or timing of current use of lands and resource for traditional purposes by one or more Indigenous groups or result in any effects upon health and well-being or cultural or socioeconomic conditions. No effects upon the exercise of Aboriginal or treaty rights (asserted or established) are predicted.

14.5 Environmental Monitoring and Follow-up

The various environmental monitoring initiatives outlined earlier in relation to relevant components of the biophysical environment are indirectly applicable to this VC. Section 18.4.2 provides an overview of the objectives of a follow-up monitoring program. Given the high level of confidence regarding the prediction of no significant adverse environmental effects on Indigenous Peoples, and the implementation of mitigation measures, no follow-up is proposed to be implemented for routine Project activities.

Equinor Canada will, in accordance with its commitment to ongoing engagement with identified Indigenous groups throughout the EA process continue to review their inputs and perspectives as the planning and eventual implementation of the Project progresses. Equinor Canada will consider such input in its Project-related planning and decision-making as applicable and appropriate, including in the design of any monitoring and follow-up program in accordance with Section 9 of the EIS Guidelines (Appendix A).

14.6 References

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15.0 CUMULATIVE ENVIRONMENTAL EFFECTS

As required under Section 19(1) of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012), the Environmental Impact Statement (EIS) assesses and evaluates cumulative environmental effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out, as well as the significance of these potential effects. The cumulative environmental effects assessments for all valued components (VCs) are reported in separate subsections within this chapter and were completed in accordance with the approach and methods described below.

15.1 Approach and Methods

As noted in the EIS Guidelines (Section 7.6.3 in Appendix A), cumulative effects "*are those that are likely to result from the designated project in combination with other physical activities that have been or will be carried out. Cumulative effects may result if:*

- The implementation of the project may cause direct residual adverse effects on the VC, taking into account the application of technically and economically feasible mitigation measures, and
- The same VC may be affected by other past, present and future physical activities"

The approach and methods used in undertaking the cumulative effects assessment are based on the guidance provided in the following the Canadian Environmental Assessment Agency (CEA Agency) documents:

- Operational Policy Statement (OPS) entitled "Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012" (CEA Agency 2015)
- Interim Technical Guidance entitled "Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012" (CEA Agency 2018).

The cumulative environmental effects assessment considers the overall total effect on the VCs as a result of the Project's predicted residual environmental effects (as described in Chapters 9 to 14) and those of other relevant projects and activities.

15.1.1 Identification of Valued Components

The EIS Guidelines (Section 7.6.3 in Appendix A) also state that the cumulative effects assessment will "*identify and provide a rationale for the VCs that will constitute the focus of the cumulative effects assessment, focusing the cumulative effects assessment on the VCs most likely to be affected by the project and other project and activities*", while also noting that "*VCs that would not be affected by the project or would be affected positively by the project can, therefore, be omitted from the cumulative effects assessment*."

This cumulative effects assessment focusses on the same set of VCs as those considered in the Project-specific effects assessment, as these represent the components of the environment that may interact with and be adversely affected by the Project, and thus, on which the Project and its effects may contribute to cumulative effects within the spatial and temporal boundaries under consideration (see Section 15.1.2).

Table 15.1 lists the various environmental components specified in the EIS Guidelines (Section 7.6.3 in Appendix A) as requiring consideration in planning and completing the cumulative effects assessment and provides an indication how each of these are included in the cumulative effects assessment.

Table 15.1 Environmental Components Included in the Cumulative Effects Assessment

Components	Consideration / Inclusion in the Environmental Effects Assessment		
	Project Effects Assessment	Cumulative Effects Assessment	Overview / Rationale
Marine Fish and Fish Habitat, including salmon and other valued species; including marine plants	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.
Marine and Migratory Birds	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.
Marine Mammals and Sea Turtles	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.
Species at Risk (SAR)	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects. • Included in an integrated manner within each of the above listed biological components
Marine Plants			• The Marine Fish and Fish Habitat VC includes relevant fish species as well as plankton, algae, benthos and relevant components of their habitats (such as water and sediment), as well as marine plants given the clear interrelationships between these environmental components. • The consideration of marine plants within this VC is in keeping with current and standard environmental assessment (EA) practice, and provides for a more comprehensive, holistic approach while at the same time reducing unnecessary repetition. • Although as described in Chapter 9, the Project has little potential to adversely affect marine plants, this component is retained as part of the overall Marine Fish and Fish Habitat VC for completeness and as outlined above.
Special Areas	•	•	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects.

Table 15.1 Environmental Components Included in the Cumulative Effects Assessment

Components	Consideration / Inclusion in the Environmental Effects Assessment		
	Project Effects Assessment	**Cumulative Effects Assessment**	**Overview / Rationale**
Commercial Fisheries (including Human environment)	●	●	• Potential for residual (but not significant) environmental effects as a result of the Project, which may contribute to cumulative effects. This includes effects to fishers who may be operating under a commercial-communal licence on behalf of Indigenous communities.
Indigenous Peoples (includes Human Environment)	●	●	• Although, as described in Chapter 14, there are no significant residual effects on Indigenous Peoples, this VC is considered in the cumulative effects assessment to systematically examine whether there is potential for interactions associated with other projects and activities, in conjunction with the Project, to result in cumulative effects on Indigenous Peoples. • Potential cumulative effects were identified as an item of concern to some Indigenous groups during engagement (see Chapter 3).
Air Quality and Greenhouse Gases (GHGs)			• Not a separate VC for the Project-specific environmental effects assessment or the cumulative effects assessment. • These aspects of the atmospheric environment are addressed as part of the overall discussion of potential Project-related environmental emissions in Section 2.8.1 and Chapter 8. • This includes a description of the anticipated types and levels of Project-related air emissions and their contribution to regional ambient air quality and greenhouse gas (GHG) levels, as well as results from air emissions and dispersion modelling (Appendix K). • By considering their accumulation with other emissions sources, the analysis of Project-specific air emissions is therefore inherently an analysis of potential cumulative effects. • Air dispersion modelling indicates that the predicted ground-level concentrations, for each operational scenario considered, are below the respective NL Air Pollution Control Regulations. • Air dispersion modelling results indicate that the overall maximum predicted concentrations above the Canadian Ambient Air Quality Standards, for each operational scenario considered, occur approximately 500 m to 1,700 m from the floating production, storage and offloading (FPSO) and/or drilling installation.

Table 15.1 Environmental Components Included in the Cumulative Effects Assessment

Components	Consideration / Inclusion in the Environmental Effects Assessment		
	Project Effects Assessment	Cumulative Effects Assessment	Overview / Rationale
			• GHG emissions represent less than 2.4 percent of NLs emissions and less than 0.04 percent of Canada's emissions reported by Environment and Climate Change Canada (ECCC) in 2016, which is the latest year for which reports are available. • The Project-related emissions calculations, as presented previously in Section 2.8.1 and Chapter 8, do have the potential to cumulatively interact with the emissions from other marine vessel traffic in the area and the operation of existing and planned offshore operations in the Jeanne d'Arc Basin. However, due to the distances of these sources with respect to the Project, an interaction with the potential to result in a detectable effect is very unlikely. This is supported by results presented in the 2013 Environmental Studies Research Fund (ESRF) Air Emissions Study – Effects of Offshore Oil and Gas Production on Air Quality in Canada's East Coast Offshore Areas (Stantec 2013), which concluded that air emission concentrations (in this case NOX) generally meet onshore ambient air quality regulations within 500 m of the emitting platform.
Human Environment			• Relevant aspects of the human environment that have the potential to be affected by the Project (such as Commercial Fisheries and Other Ocean Uses) and/or are required to be considered in the EIS under relevant provisions of CEAA 2012 (such as, for Indigenous Peoples, those factors required under Section 5(1)(c) of CEAA 2012) are part of the other socioeconomic VCs identified above.

No other components of the biophysical or socioeconomic environments have been identified by Equinor Canada, Indigenous groups, or stakeholders as having the potential to be affected by the Project in such a way that would necessitate or justify their inclusion in the cumulative effects assessment presented in this EIS.

15.1.2 Spatial and Temporal Boundaries

The EIS Guidelines (Section 7.6.3 in Appendix A) state that the EIS will "*identify and justify the spatial and temporal boundaries for the cumulative effect assessment for each VC selected*". The EIS Guidelines also state that "*the boundaries for the cumulative effects assessments will generally be different for each VC considered*", noting that "*these cumulative effects boundaries will also generally be larger than the boundaries for the corresponding project effects*."

The CEA Agency's interim technical guidance document titled *Assessing Cumulative Environmental Effects under CEAA 2012* (CEA Agency 2018) suggests various methods to determine spatial boundaries for a cumulative effects assessment, including activity-centered spatial boundaries that are determined based on the distribution of physical activities in the vicinity of the project. The technical guidance document notes that this approach may be useful if the project is located in a remote area with few interacting physical activities, as is the case for this Project.

The specific spatial and temporal boundaries that are presented for each VC in the respective VC analysis chapter (Chapters 9 to 14) have also been applied to the assessment of cumulative environmental effects for each VC, including the Core Bay du Nord (BdN) Development Area, Project Area, Local Study Areas (LSAs), and Regional Study Area (RSA). These boundaries were defined to incorporate:

- The likely geographic and temporal zones of influence of the Project and its environmental effects
- The overall geographic extents and distribution patterns of the various biota and human activities that comprise the VCs under consideration and which may therefore be affected by the Project and its environmental effects
- The other projects and activities and associated environmental effects that may affect the same individuals or populations as those affected by the Project (whether these occur within or outside the RSA itself)

Specific spatial assessment boundaries (i.e., LSAs) were established for each VC in Chapters 9 to 14 based on the potential extent of Project-related effects on the VC. The RSA includes each of these VC-specific LSAs within its boundaries and also encompasses other physical activities outside the Project Area and/or LSAs that have potential to interact cumulatively with the Project. The RSA therefore takes into account the overlapping environmental effects from the Project and other physical activities on each VC within their respective LSAs. The RSA also considers and incorporates the distributions and movements of the various VCs that may be affected by the Project over the time periods and durations in which the VCs may also be affected by other projects and activities occurring within these areas and ranges. The RSA was delineated to accommodate the relatively large area that could be affected in the extremely unlikely event of an accidental release from a subsurface blowout. The RSA for Indigenous Peoples includes an overall region of eastern Canada that generally encompasses each of the Indigenous communities and their activities throughout Newfoundland and Labrador (NL), the Maritime provinces (Nova Scotia [NS], New Brunswick [NB] and Prince Edward Island [PEI]), and Québec.

The cumulative environmental effects assessment takes a conservative approach in regard to the temporal scope of the Project. The assessment considers the possibility for cumulative environmental effects over the total potential life of the Project, which includes the Core BdN Development and Potential Future Development, for a total of up to 30 years.

A key consideration in assessing the potential for, and the nature and characteristics of, cumulative effects resulting from the Project in combination with other projects and activities relates to the spatial and temporal distributions of these other projects and activities and their associated environmental disturbances. This includes the potential for the environmental zone of influence of the Project to overlap or otherwise interact with those of one or more of these other projects and activities. Where information is available on the overall spatial and temporal characteristics of other projects and activities, it is presented and considered in the cumulative effects assessment (see, for example, Tables 15.2 and 15.3). Further available information on the known and likely effects of other projects and activities (and especially, their spatial and temporal characteristics) is also presented in the VC-specific sections and tables in this chapter.

15.1.3 Sources of Potential Cumulative Effects

The EIS Guidelines (Section 7.6.3 in Appendix A) state that the cumulative effects assessment should "*specify other projects or activities that have been or that are likely to be carried out that could cause effects on each selected VC within the boundaries defined, and whose effects would act in combination with the residual effects of the project*".

As stated in the OPS, "Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012*" (CEA Agency 2015), the following criteria should be used to determine which future projects to include in the cumulative effects assessment:

> *A cumulative environmental effects assessment of a designated project must include future physical activities that are certain and should generally include physical activities that are reasonably foreseeable.*
>
> *These concepts are defined as follows:*
>
> - *Certain: 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.*
> - *Reasonably Foreseeable: 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.*

Table 15.2 lists ongoing and future (i.e., certain, and reasonably foreseeable) projects in the RSA that are considered in this cumulative effects assessment. The projects and activities outlined in Table 15.2 include those that align with the temporal scope of the Project (i.e., starting in 2020). Projects whose temporal scope expires in 2019 are not included in the cumulative effects assessment. Based on the conclusions of the EAs completed for these projects / activities, they are not likely to result in significant adverse environmental effects, however, they may overlap spatially and temporally with the Project. Table 15.2 is inclusive of all of the projects listed on the CEA Agency Registry website and the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) Project-based Environmental Assessment website as of January 15, 2019 that meet the above criteria and therefore have potential to interact cumulatively with the Project.

Table 15.2 Ongoing and Future Projects Considered in this Cumulative Effects Assessment

Proponent	Project Name	Approximate Distance from Project Area (Southwest Corner)	Approximate Distances from Core BdN Development Area (FPSO Location)	Temporal Boundaries
Offshore Petroleum Production Projects				
Hibernia Management and Development Company Ltd. (HMDC)	Hibernia	157 km	226 km	1997 to 2040
Suncor Energy Inc. (Suncor)	Terra Nova	166 km	229 km	2002 to 2029[1]
Husky Energy Inc. (Husky Energy)	White Rose and Extension Project	118 km	180 km	2005 to 2042
ExxonMobil Canada Properties (EMCP)	Hebron	160 km	225 km	2017 to 2042
Geophysical Survey Programs				
Husky Energy	Jeanne d'Arc Basin / Flemish Pass Regional Seismic Program	108 km	168 km	2012 to 2020
HMDC	2D / 3D / 4D Seismic Projects for the Hibernia Oil and Gas Production Field	157 km	226 km	2013 to remaining life of field
Suncor	Eastern Newfoundland Offshore Area 2D / 3D / 4D Seismic Program	13 km	86 km	2014 to 2024
ExxonMobil Canada Ltd. (ExxonMobil)	Eastern Newfoundland Offshore Geophysical, Geochemical, Environmental and Geotechnical Program	51 km	103 km	2015 to 2024
MG3	Geochemical Data Acquisition and Seabed Sampling for Basin Modelling in Labrador Offshore	979 km	988 km	2015 to 2024
WesternGeco Canada	Eastern Newfoundland Offshore Seismic Program	205 km	164 km	2015 to 2024
WesternGeco Canada	Southeastern Newfoundland Offshore Seismic Program	502 km	558 km	2015 to 2024
Polarcus UK Ltd.	Eastern Newfoundland Offshore 2D, 3D, and 4D Seismic Program	108 km	119 km	2016 to 2022

Table 15.2 Ongoing and Future Projects Considered in this Cumulative Effects Assessment

Proponent	Project Name	Approximate Distance from Project Area (Southwest Corner)	Approximate Distances from Core BdN Development Area (FPSO Location)	Temporal Boundaries
CGG Services (Canada) Inc.	Newfoundland Offshore 2D, 3D, and 4D Seismic Program	144 km	213 km	2016 to 2025
Seitel Canada Ltd.	East Coast Offshore 2D, 3D, and 4D Seismic Program	294 km	323 km	2016 to 2025
Fugro Geosurveys	Offshore Seafloor and Seep Sampling Program	148 km	185 km	2017 to 2027
Chevron Canada Limited (Chevron)	Capelin 3D Seismic Survey of EL 1138 Offshore NL	55 km	75 km	2018 to 2021
Multiklient Invest AS (MKI)	Newfoundland Offshore Seismic Program	230 km	285 km	2018 to 2023
MKI	Labrador Offshore Seismic Program	339 km	372 km	2018 to 2023
Nexen Energy ULC (Nexen)	Eastern Newfoundland Offshore Geophysical, Geochemical, Environmental and Geotechnical Program	43 km	96 km	2018 to 2027
Exploration Drilling Programs				
Husky Energy	Delineation / Exploration Drilling Program for Jeanne d'Arc Basin Area	115 km	178 km	2008 to 2020
Husky Energy	Husky Energy Exploration Drilling Project	131 km	203 km	2018 to 2025
Nexen	Flemish Pass Exploration Drilling Project	66 km	49 km	2018 to 2028
Equinor Canada	Flemish Pass Exploration Drilling Program	intersect	intersect	2018 to 2028
ExxonMobil	Southeastern Newfoundland Offshore Exploration Drilling Program	247 km	294 km	2020 to 2029
ExxonMobil	Eastern Newfoundland Offshore Exploration Drilling Program	130 km	186 km	2018 to 2030

Table 15.2 Ongoing and Future Projects Considered in this Cumulative Effects Assessment

Proponent	Project Name	Approximate Distance from Project Area (Southwest Corner)	Approximate Distances from Core BdN Development Area (FPSO Location)	Temporal Boundaries
BP Canada Energy Group ULC	Orphan Basin Exploration Drilling Program	254 km	260 km	2017 to 2026
Chevron Canada Limited (Chevron)	West Flemish Pass Exploration Drilling Project	57 km	80 km	2021 to 2030
Sources: CEA Agency 2019; C-NLOPB 2019a. [1] Terra Nova project current approval expires in 2019. Representatives of Suncor have indicated that applications will be made to extend the life of the Project for an additional 10 years (Campbell 2018)				

Table 15.3 provides an overview of the ongoing and future projects listed in Table 15.2 as well as other past, present, and future physical activities that have been or are being carried out in the RSA and have potential to interact cumulatively with the Project. Where the particular locations and/or geographic extents of these other projects and activities at present and/or within the temporal duration of the Project are defined and known, this information is summarized on Figure 15-1, which includes distances from the Core BdN Development Area and the Project Area.

Table 15.3 Overview of Past, Present, and Future Projects and Other Physical Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview
Hibernia	• Discovered in 1979, Hibernia is located approximately 315 km east-southeast of St. John's, NL. • The development phase of the Hibernia project commenced in late 1990 and continued until the mating of the gravity-based structure (GBS) and its topsides at Bull Arm, NL in 1997, after which the platform was towed to and installed at its site on the Grand Banks in June of that year. • With estimated recoverable reserves of approximately 1.4 billion barrels, commercial production from Hibernia commenced in November 1997 and is ongoing. • Components on the Hibernia project include the original Hibernia Platform and the subsequently developed Hibernia Southern Extension excavated drill centre. • Production from the Hibernia South Extension commenced in 2011.
Terra Nova	• Discovered in 1984 and declared a significant discovery in 1985, Terra Nova has reserve estimates of approximately 500 million barrels of recoverable oil. It is located approximately 350 km southeast of St. John's and 35 km southeast of Hibernia. • Components of the Terra Nova project include an FPSO and multiple drill centres; wells are drilled within these drill centres using a semisubmersible drilling platform. • Production from the Terra Nova FPSO began in January 2002.

Table 15.3 Overview of Past, Present, and Future Projects and Other Physical Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview
White Rose and Extension Project	• Discovered in 1984, a significant discovery license (SDL) for White Rose was issued in January 2004. • White Rose is located approximately 350 km east-southeast of St. John's, and approximately 50 km from the Hibernia and Terra Nova fields. • Components of the White Rose project include a FPSO and five excavated drill centres. • White Rose and its satellite extensions are operated using an FPSO, and first oil was produced in November 2005 followed by the North Amethyst expansion in May 2010. • The West White Rose extension will access further resources to the west of the field, using a fixed drilling installation tied back to the existing FPSO. First oil is expected in 2022 (Husky Energy n.d.).
Hebron	• First discovered in 1980, Hebron is estimated to contain more than 700 million barrels of recoverable resources. • Components of the Hebron project include a drilling and production platform (a GBS similar to but smaller than the Hibernia GBS). • The Hebron platform was towed to field in June 2017. The Hebron project is designed for an oil production rate of 150,000 barrels of oil per day. • The Hebron project produced first oil on November 27, 2017 (ExxonMobil 2017).
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Offshore geophysical survey programs are often planned and conducted to get an overall understanding of regional geology and hydrocarbon potential, and to help identify sites or zones that may warrant further investigation, such as through eventual exploration drilling activities (see below). • These may include 2D and 3D geophysical data acquisition, as well as associated environmental and geotechnical / geological surveys. • While exploration projects and activities are typically proposed and approved through the EA process as multi-year programs that can cover large offshore areas, the type and level of activity conducted each year can also vary and is usually a smaller than the overall spatial scope assessed. Over the period 2014 to 2017, approximately 1.8 million km of geophysical survey data (including 2D, 3D, side-scan sonar, multibeam, subbottom profiling, gravity and magnetic data, and controlled-source electromagnetic data) was collected in the eastern NL offshore region and approximately 160,000 km of geophysical survey data was collected in the Jeanne d'Arc Basin (C-NLOPB 2018). There are a number of offshore geophysical programs off the eastern NL offshore area that were in progress, being subject to EA review or recently approved as of the time of EIS writing (see *http://www.cnlopb.ca/assessments*) and are listed in Table 15.2 • It is likely that geophysical and other exploration activities will extend throughout the temporal duration of this Project.

Table 15.3 Overview of Past, Present, and Future Projects and Other Physical Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview
Offshore Petroleum Exploration – Drilling	• The eastern NL offshore area is subject to ongoing and planned future exploration drilling programs which were in progress, subject to EA review, or recently approved as of the time of writing (see http://www.cnlopb.ca/assessments) and are listed in Table 15.2. • As of January 3, 2019, a total of 470 wells have been drilled in the Canada-NL Offshore Area, including 171 exploration wells, 57 delineation wells, and 242 development wells (C-NLOPB 2019b). • Over the three-year period of 2016 to 2018, seven wells were drilled (or re-entered) in the eastern NL and Jeanne d'Arc Basin C-NLOPB land tenure areas, including four exploration / delineation wells (C-NLOPB 2019b). • It is likely that exploration drilling programs will extend throughout the temporal duration of this Project. • 16 wells, including side tracks, were drilled by Equinor Canada in the Project Area; 11 of these wells were drilled in the Core BdN Development Area. • Multibeam echo sounder and side scan data collected in 2018 in the Core BdN Development Area provide an estimate of anomalies on the seabed which resembles cuttings deposition for four well-sites surveyed in 2018; these anomalies (at greater than 15 cm resolution) are estimated to range from 80 m to 350 from a well site. Sampling was not undertaken to determine if these anomalies were drill cuttings. • Exploration drilling could be carried out on exploration licences within the BdN Project Area held by Equinor Canada (i.e., EL 1143, EL 1154, EL 1156)
Fishing Activity	• Commercial fisheries by domestic and foreign harvesters within western areas of the RSA are extensive and diverse, with less harvesting in the Project Area, as described in Chapter 7 of this EIS. • Fisheries science studies (domestic and foreign) occur in the RSA, several annually, but for limited times. • Indigenous groups hold commercial-communal fishing licences for swordfish and tuna in Northwest Atlantic Fisheries Organization (NAFO) 3L and 3M. Currently, no commercial-communal fishing occurs in these areas, but the licences could be active in the future. • Fishing activity will extend throughout the temporal duration of this Project.
Other Marine Vessel Traffic	• This includes tanker traffic and supply vessels associated with the existing offshore oil developments, as well as cargo ships, cruise ships, other commercial and recreational vessels, naval vessels (Department of National Defence [DND]), and Fisheries and Oceans Canada (DFO) research survey vessels (see Chapter 7). Fishing vessel traffic is included within the scope of "fishing activity" above. • Other marine vessel traffic activity will extend throughout the temporal duration of this Project.

Table 15.3 Overview of Past, Present, and Future Projects and Other Physical Activities Considered in the Cumulative Effects Assessment

Project / Activity	Overview
Other Harvesting Activity	• Wildlife populations of fish, birds and seals off NL are subject to harvesting activities. • Although non-commercial wildlife harvesting activity does not occur in the Project Area, Project activities may affect, fish, bird and seal populations that occur in and/or migrate through the Project Area. • Indigenous groups conduct traditional harvesting activities, including food, social and ceremonial (FSC), throughout the RSA, but no such harvesting is known to occur in the Project Area. • Harvesting activities will occur throughout the temporal duration of this Project.

An operating licence is required for all petroleum-related activities in the NL offshore area, including geophysical activities, exploration drilling, and production drilling. Operating licences are valid for a maximum period of one year and expire on March 31st of each year. C-NLOPB's Annual Reports for the past five fiscal years (April 1st to March 31st) indicate that the following number of operating licences were issued (C-NLOPB n.d): 19 in 2013-2014, 21 in 2014-2015, 20 in 2015-2016, 20 in 2016-2017, and 17 2017-2018 (C-NLOPB n.d.). Based on the maximum number of operating licences issued annually during this period, it is conservatively assumed for the purposes of this cumulative effects assessment that 21 other petroleum-related projects and/or activities (potentially including geophysical surveys and/or drilling for exploration and/or production purposes) may be carried out in the RSA during any given year within the temporal boundaries of the Project.

15.1.4 Assessing Cumulative Effects

The cumulative effects assessment considers the predicted residual environmental effects of the Project and their potential accumulation and interaction in space and time with those of other past, ongoing, and future projects and activities. Section 7.6.3 of the EIS Guidelines (Appendix A) specify that the EIS will "*assess the cumulative effects on each VC selected by comparing the future scenario with the project and without the project. Effects of past activities (activities that have been carried out) will be used to contextualize the current state of the VC*."

Past and ongoing projects and activities and their environmental effects are reflected in the existing baseline environmental conditions for each VC, as described in Chapters 5 to 7 of this EIS. The current condition of the VC as a result of natural and anthropogenic factors, and its overall sensitivity or resiliency to further disturbance or change, has been considered in a fully integrated manner throughout the environmental effects assessments. The cumulative effects assessment considers how this existing environmental condition may be changed by the Project, and then, whether and how the effects of other ongoing and future projects and activities that have a high degree of certainty (i.e., will be executed or carried out) would affect the same VCs through direct overlap in space and time and/or by affecting the same individuals or populations. This includes predicting the likely nature and degree of the potential effects of this Project on the VC, as well as potential effects resulting from other, multiple sources of future environmental interactions, as described below.

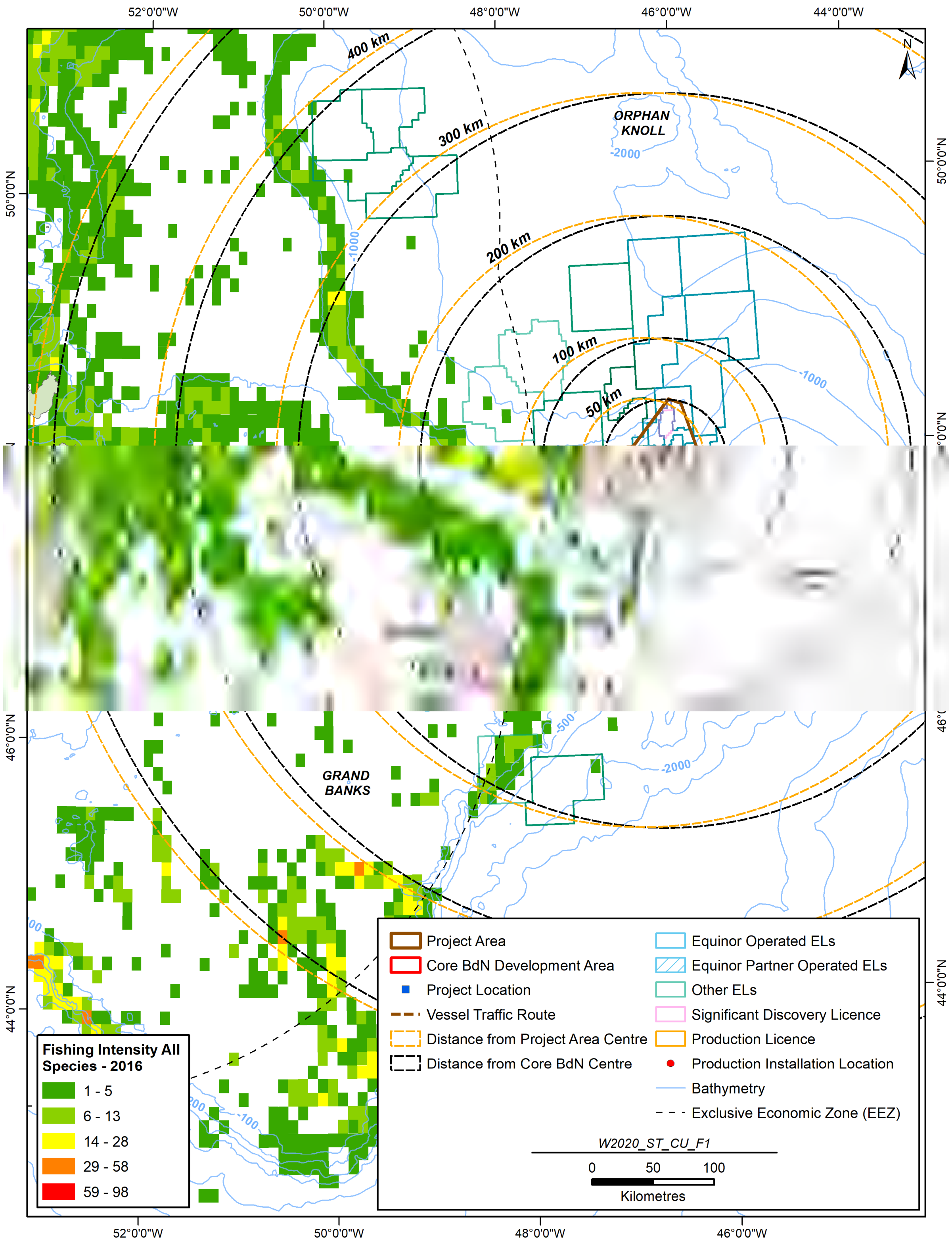

Figure 15-1 Other Project Activities Considered in the Cumulative Effects Assessment – Distances from Core BdN Development Area and Project Area

The cumulative effects assessment summarizes and considers whether and how this existing, pre-Project environmental condition may be changed by the introduction of the Project and its potential residual (with mitigation) environmental effect, as determined and described in the preceding Project-specific environmental effects assessment (Chapters 9 to 14).

Other future projects and activities that may affect the same VCs are considered (Tables 15.2 and 15.4). These comprise certain or reasonably foreseeable future physical activities that may affect the same VCs as the Project, and whose effects on the VC would likely overlap in space and time with those of the Project and/or would affect the same individuals, populations, or communities as the Project. The cumulative effects assessment therefore focusses on determining and considering the likely nature and spatial and temporal characteristics of the residual environmental effects of the Project, of the affected environmental components and systems, and the environmental effects of other relevant projects and activities within these areas and time periods.

Table 15.4 Potential Interactions with Other Projects and Activities Considered in the Cumulative Effects Assessment

Project / Activity	VCs Potentially Affected					
	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Commercial Fisheries and Other Ocean Uses	Indigenous Peoples
Hibernia	●	●	●	●	●	●
Terra Nova	●	●	●	●	●	●
White Rose and Extension Project	●	●	●	●	●	●
Hebron	●	●	●	●	●	●
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	●	●	●	●	●	●
Offshore Petroleum Exploration – Drilling	●	●	●	●	●	●
Fishing Activity	●	●	●	●		●
Other Marine Vessel Traffic	●	●	●	●	●	●
Other Harvesting Activity	●	●	●		●	●

In cases where predicted residual adverse environmental effects of the Project on the VC have potential to accumulate or interact with those of one or more other projects or activities (regardless of the significance of the individual residual adverse effects potentially associated with the Project and the other projects and activities), the potential cumulative effects of the Project in combination with these other activities are assessed and evaluated. The potential implications for the VC resulting from multiple sources and types of environmental change are considered, including the likely future condition of the environment both with and without the Project. Analytical methods and assumptions used in the VC specific cumulative effects assessments are defined and described. Where available and applicable, the assessment uses relevant scientific, engineering, community, stakeholder, and Indigenous knowledge and perspectives.

The cumulative effects assessment recognizes that there is limited potential for the direct "footprint" or environmental zones of influence of many Project-related disturbances or effects to accumulate with those of other projects and activities. However, the widespread and often migratory nature of some marine-associated species and/or human activities causes the potential for individuals / populations and activities to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur. At the same time, many (especially benthic invertebrate) species are relatively immobile or sessile, which limits the potential for interactions with multiple projects and disturbances. Mobile fish, birds, marine mammals, and sea turtle species that have higher potential to interact with multiple projects also have higher capability for avoidance of potential effects. Therefore, the typical movement patterns and ranges of many marine species, coupled with the availability of alternative habitats, and/or localized extents of Project-related disturbances (e.g., flaring events, seismic surveys), and remote location of the Project limits the potential for cumulative effects to occur. However, there may be potential for displacement from key habitats or disruption during key activities over extended areas or periods, such that these species may be (cumulatively) affected in a manner that may cause negative and detectable effects at a population or regional level.

15.1.5 Mitigation Measures

The cumulative effects assessment includes the identification and consideration of technically and economically feasible mitigation measures that Equinor Canada will implement to avoid or reduce potential environmental (including cumulative) effects.

The mitigation measures outlined in Chapters 9 to 14 are intended to avoid or reduce the potential effects and cumulative effects of the Project and are considered in the analysis of cumulative effects. Where relevant, the assessment also identifies and considers additional mitigation that may be required and only applicable to cumulative effects, as well as other relevant mitigation that may be the responsibility of parties other than Equinor Canada or its contractors, as applicable and as required in the EIS Guidelines.

Information on other projects and activities and their known or likely environmental effects and planned mitigation measures has been obtained through existing and publicly available information sources. Standard mitigation measures from the regional strategic environmental assessment (Amec 2014) are incorporated into the VC-specific sections below, however, it is noted that some projects / activities may have identified project-specific mitigation measures in their respective EAs. The cumulative effects assessment considers the nature, location, and timing of these other projects and their environmental effects in relation to the Project, as well as environmental protection measures that are known and/or required to be implemented in relation to them, including those required under applicable legislation, regulations, and other requirements. The assessments of cumulative effects presented here are therefore not based on information or assumptions regarding mitigation measures by other proponents that would require discussions with, and confirmation by, other parties.

15.1.6 Determination of Significance

The significance of predicted residual cumulative environmental effects is evaluated, using the same VC-specific significance definitions as those used in the Project-specific effects assessments (refer to Chapters 9 to 14).

15.1.7 Follow-up

The cumulative effects assessment concludes with the identification and discussion of environmental follow-up programs that may be required "*to verify the accuracy of the assessment or to dispel any uncertainty concerning the effectiveness of mitigation measures for certain cumulative effects*" (EIS Guidelines, Section 7.6.3 in Appendix A). This includes considering whether follow-up specific to cumulative effects may be necessary or appropriate, as well as the relevance of follow-up identified as part of the Project-specific environmental effects assessment (Section 15.9) to cumulative environmental effects.

15.2 Marine Fish and Fish Habitat (including Species at Risk)

15.2.1 Past and Ongoing Effects (Baseline)

Marine Fish and Fish Habitat in the Project Area, LSA, and RSA have been and are being affected by a variety of natural and anthropogenic influences. These include past and ongoing fishing activity, offshore petroleum exploration and production activities, general vessel traffic, and other human activities (both planned and routine, as well as illegal activities and accidental events), as well as the effects of climate change and other natural oceanographic processes (Amec 2014; Cordes et al 2016). These activities may have influences on the presence, distribution, and abundance of fish and invertebrate species, as well as the overall size and health of fish populations.

The Marine Fish and Fish Habitat VC includes fish and invertebrate species along with associated life stages, and the habitats (nursery, rearing, spawning, migration, foraging) upon which they depend. These include commercially and/or ecologically important species that are considered secure, as well as those listed as species at risk (SAR). Overfishing and extreme climate conditions have collectively contributed to the collapse of the Atlantic cod and other groundfish stocks in the North Atlantic in the early 1990s (Kulka 2011; Christensen et al. 2014; Nogueira et al. 2017), which coincided with an increase in prey species, including snow crab and shrimp, on the Grand Banks and Flemish Cap. Recently, these prey species have, in turn, declined in response to the recovering groundfish stocks and other factors (Nogueira et al. 2015, 2017). Commercial fishing efforts continue to influence commercial and non-commercial (as bycatch and through trophic interactions) species populations in the Northwest Atlantic (Edinger et al 2007; Clark et al 2016; Nogueira et al 2017). Such activities have also affected corals and sponges, which are sensitive, habitat-forming species that are distributed primarily on the slopes of the Grand Banks and Flemish Cap (Edinger et al 2007; Clark et al. 2016; Guijarro et al. 2016; Ragnarsson et al. 2017; Miles 2018). On the Flemish Cap, for example, fish species density has been declining across depth assemblages since the mid to late-2000s (Nogueira et al. 2017) as a result of modifications in fishing pressure and the effects of climate change. Oceanographic variability through the Atlantic multidecadal oscillation also has implications for trophic levels, resulting in increased plankton and fish productivity during warm periods and the reverse in cold conditions (Drinkwater et al. 2014).

The effects of previous activities and natural environmental influences are reflected in the existing baseline environmental conditions for this VC, as described in Section 6.1. This includes considering the current condition (e.g., health or quality) of potentially affected fish and invertebrate populations and their habitats, and their potential resiliency or sensitivity to further environmental change as a result of the Project.

15.2.2 Potential Project-Related Contributions to Cumulative Effects

As described in Chapter 9, the Project may affect Marine Fish and Fish Habitat, including possible injury, mortality, behavioural effects due to underwater sound or other disturbances in the marine environment, effects to benthic communities through the alteration of marine habitats, and effects on habitats and food resources related to discharges, and other disturbances in the marine environment.

The Project will interact with Marine Fish and Fish Habitat within and adjacent to the Project Area, although as described in Chapter 9, it will entail a relatively localized, short- to long-term environmental disturbance at any one location. The primary mechanisms of interaction that may have effects on this VC include lighting, sound, and marine discharges associated with the Project, including those that may result in direct interaction with and effects on the seabed and sensitive benthic organisms or habitats. Marine discharges will be treated prior to release in consideration of the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010) and in accordance with regulatory requirements, reducing associated effects on the environment. There would be short-term disturbance to fish habitats during construction and installation, and hook-up and commissioning (HUC) activities, that would potentially result in the injury or mortality of marine fish and invertebrates within the footprint of the subsea infrastructure. In areas of the Project Area where bottom trawling has occurred, or continues to occur, fish habitat in these areas is likely affected. There may also be short-term and localized suspended natural sediments associated with placement of structures on fine mud substrates the installation of subsea infrastructure would add colonizing substrate to a habitat limited area. However, as described in Sections 9.3.1.3 and 9.3.2.2, addition of subsea infrastructure over the life of the Project would likely increase habitat complexity supporting sessile invertebrates (e.g., hard structures for colonization) and mobile invertebrate and fish species (e.g., shelter, food subsidies). The installation of subsea infrastructure would add colonizing substrate to a habitat limited area. Modelling of released drilling muds and cuttings and produced water has also indicated that they would be relatively localized to the well site (within 200 m) and FPSO (within 100 m), respectively, reducing the area of potential effect. Sound modelling indicated that geophysical activities including seismic surveys, may elicit behavioral responses and fish and invertebrates 50 km from the source. However, the potential effect from these surveys would be transient and short-term in nature (e.g. weeks), limiting effects on any single location. Planned Project activities likewise represent localized environmental disturbances, though of long-term duration over the life of the Project. These potential effects are addressed through standard mitigation measures and are not anticipated to adversely affect this VC.

As with secure species, planned mitigation measures will be used to avoid or reduce such adverse interactions. Therefore, it is not predicted that there will be any significant residual adverse environmental effects on SAR. Of SAR that have been assessed, proposed critical habitat has only been delineated for northern and spotted wolffish and is located on the edge of the Grand Banks and Labrador Shelf that is northeast of the Project Area (DFO 2018a). Although the presence of Project-related supply and servicing vessels may result in some degree of attraction, avoidance or other behavioural responses by individual fish, marine fish (including northern and spotted wolffish and other SAR) will not be disturbed by this vessel activity due to its transitory nature and short-term presence at any particular location. The proposed wolffish recovery strategy indicates that oil and gas exploration and production may have potential environmental effects on wolffish associated with operational discharges, however it notes that any potential effects would be highly localized and insignificant at the population level (DFO 2018a). In consideration of the high aggregations of wolffish species outside the Project Area, and the implementation of planned mitigation measures, the Project is not anticipated to have implications for the overall abundance, distribution, or health of wolffish species nor their eventual recovery. The Project is not predicted to result in significant residual adverse effects on marine fish SAR and therefore will not have implications for the overall abundance, distribution, or health of these species nor its eventual recovery.

As described in Chapter 9, based on the nature and characteristics of the Project and the existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine Fish and Fish Habitat.

15.2.3 Other Projects and Activities and Their Effects

Other ongoing and likely future projects and activities that may affect Marine Fish and Fish Habitat within the Project Area and RSA, as described in Table 15.5, includes other petroleum resource developments, geophysical activities, exploration drilling, fishing activity, and vessel traffic. Details on other projects and activities are described in Section 15.1.3. The migratory nature of some fish species may increase the potential for individuals and populations to interact with multiple perturbations, and therefore for cumulative effects to occur. As indicated, the environmental zone of influence of each project and activity in the region is typically localized and not likely to have an overall ecological or population level effect.

There are four operational oil producing facilities (i.e. Hibernia, Terra Nova, White Rose and Hebron) located offshore NL. Potential cumulative effects on Marine Fish and Fish Habitat are associated with emissions and discharges from the developments. While each of these production projects represents long-term operations in the offshore area and have associated environmental emissions and interactions related to this VC, these projects and their environmental zones of influence are for the most part, localized to the respective production operations and quite far removed from the predicted Project-related zones of influence (see Table 15.2 and 15.5). Geophysical activities including seismic surveys have potential injury and behavioural effects on marine fish as described in Chapter 9. Survey areas are often geographically extensive with potential for spatial overlap among programs. However, geophysical surveys are generally irregular in timing and operating for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence.

Drilling activities have potential effects on Marine Fish and Fish Habitat from burial, smothering, and ingestion from suspended particles and sedimentation as described in Chapter 9. As described in EAs for exploration drilling programs, exploratory drilling is generally short-term with drill cuttings dispersion mainly localized to within 1 km from the wellhead (Nexen 2018, Statoil 2017). Previous exploration drilling in the Project area may contribute to cumulative interactions on fish habitat in combination with proposed Project related interactions (e.g., installation of subsea infrastructure and modelled drill cuttings deposition). However, given the localized nature Project interactions with the benthic environment and the localized nature of previous drilling interactions, and the implementation of mitigation measures, cumulative interactions are similarly anticipated to be localized and unlikely to result in significant adverse cumulative environmental effects.

The commercial fishing industry will continue to be a key influence as described in Section 7.1, resulting in fish catches (mortality) and habitat disturbance through current and future fishing activities, practices, and management processes. Fish harvesting typically occurs where the targeted species have been harvested in the past and are therefore known to occur, which tends to make historical harvesting locations fairly consistent from year to year. The occurrence of a particular commercial fish species is primarily influenced by the availability of supporting habitat, including the presence of prey (food) species. Harvesting in the RSA is concentrated in the April to August period for domestic and foreign harvest. Some fisheries in the RSA (such as shrimp and several groundfish fisheries) are open year-round until quotas are taken, while others (e.g. snow crab) have a fairly well-defined and relatively shorter open season, usually within the April to July period in the RSA. It is considered likely that there will be some degree of overlap between fishing activities and the environmental zone of influence of this Project over its duration

Offshore petroleum exploration and development activities from other operators have associated vessel traffic. These vessel operations and vessel movements associated with fishing vessels, cargo transport, and other marine activities will continue to occur throughout the region (Section 7.2.2) over the life of the Project. Marine vessel traffic occurs throughout the Grand Banks with concentrated vessel traffic nearshore and towards the existing producing projects (Marine Vessel Traffic 2018). While there appear to be areas of concentrated vessel traffic in the Flemish Pass, it does not originate from NL shores (Marine Vessel Traffic 2018).

Table 15.5 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia	• Change in habitat availability and quality • Change in food availability and quality • Change in fish and invertebrate mortality, injury and health • Change in fish and invertebrate presence and abundance (behavioural effects)	The following is an overview of key results from the Hibernia 2014 Environmental Effects Monitoring (EEM) program (HMDC 2017): • Sediment chemistry testing has shown barium levels from drill cuttings not significantly different from total barium baseline (1994) concentrations up to 1 km from platform, with the highest levels of barium found approximately 250 m from the Hibernia platform and HSE. Barium for majority of sampling stations within 3 km were low (0 mg/kg to 299 mg/kg). • Toxic responses using Microtox and amphipod survival assays were observed as far as 6 km away from the Hibernia platform. For the HSE, the farthest amphipod survival tests indicative of toxicity occurred at a distance of 1 km, and significant near-field effects on sediment parameters were also noted within 1 km. • Fuel range hydrocarbons were detected in sediments out to 1 km from the Hibernia platform and HSE. • The water sampling program confirmed the levels of many analytes are elevated in surface samples collected nearest to the discharge point. However, this effect was found to be very localized (<50 m) with fast decreasing contaminant concentrations away from the point of discharge. • Fuel range hydrocarbons and lube range hydrocarbons were present in all livers of American plaice collected from the Hibernia platform and HSE areas, as well as in almost all livers from fish collected in the reference areas located 16 km away from the Hibernia platform on the north and west radii. Overall the results indicate that the hydrocarbon levels in fish livers are similar for American plaice from the reference area when compared to fish livers from the Hibernia platform area. However, liver tissue from the HSE area had a significantly higher level of fuel range hydrocarbons compared to reference area samples in 2014. • The results of the fish health survey carried out in 2014 indicated that the overall health of American plaice is similar in the Hibernia platform area, HSE area, and the more distant reference areas.

Table 15.5 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Terra Nova	• Change in habitat availability and quality • Change in food availability and quality • Change in fish and invertebrate mortality, injury, health • Change in fish and invertebrate presence and abundance (behavioural effects)	The following is an overview of key results from the Terra Nova 2014 EEM program (Suncor 2017): • Concentrations of barium decreased to background levels within approximately 3 km from drill centres; concentrations of >C10-C21 hydrocarbons decreased to levels near the laboratory detection limit (0.3 mg/kg) within approximately 4.5 km from drill centres. Higher sulphides and lower redox occurred at a few stations within 1 km to 2 km of drill centres. • There was little to no evidence of project-related sediment toxicity, as measured using Microtox and amphipod survival assay. However, there was evidence of project effects on in-situ benthic invertebrates near drill centres, with abundances of some taxa increasing and abundances of other taxa decreasing near drill centres and at higher barium and >C10-C21 hydrocarbon concentrations. Effects on the most affected taxa were apparent within 1 to 2 km of drill centres. • Analyses of water samples indicated that seawater physical and chemical characteristics at EEM study area stations and reference area stations, located approximately 20 km southeast and southwest of the Terra Nova site, were similar. • Iceland scallop resources were not tainted and there was no evidence of muscle tissue contamination in 2014. No contamination or tainting was noted for American plaice and American plaice health, as measured through a combination of health indicators, was similar between the Terra Nova EEM study area and the more distant reference areas.
White Rose and Extension Project	• Change in habitat availability and quality • Change in food availability and quality • Change in fish and invertebrate mortality, injury, health • Change in fish and invertebrate presence and abundance (behavioural effects)	The following is an overview of key results from the White Rose 2014 EEM program (Husky Energy 2017): • Analysis of sediment physical and chemical characteristics showed that concentrations of drill mud hydrocarbons and barium were elevated near active drill centres and concentrations decreased with distance from drill centres, as expected. The estimated distance over which hydrocarbons concentrations in sediment were correlated with distance from active drill centres (i.e., the threshold distance) extended to an average 5.8 km in 2014. The distance over which barium concentrations were correlated with distance from active drill centres extended to an average of 1 km.

Table 15.5 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
		• In 2014, project effects on sediment lead concentrations were noted, but threshold distances for lead have consistently decreased from a maximum 1.5 km in 2006 to a minimum 0.6 km in 2014; unchanged from 2012. For the first time, project effects on sediment fines concentrations were noted in 2014, with an estimated threshold distance of 0.7 km from the nearest active drill centre. • Three sediment samples, collected from stations located at distances of 1.5 km and 2.2 km from the nearest drill centres, as well as from a reference station located 22 km from the nearest drill centre, were toxic to bacterial luminescence. • For amphipod toxicity testing of sediment, amphipod survival was greater than 80 percent for all but two samples. The sampling stations where survival was less than 80 percent were located at distances of 1.1 km (64 percent survival) and of 5.6 km (76 percent survival) from the nearest drill centres. • There was no evidence of project effects on water quality. • Analyses of fish tissue chemistry, taste and fish health characteristics for American plaice and snow crab collected within 4 km of drill centres revealed no compelling evidence of effects of project activities on commercial fish.
Hebron	• Change in habitat availability and quality • Change in food availability and quality • Change in fish and invertebrate mortality, injury, health • Change in fish and invertebrate presence and abundance (behavioural effects)	• Components for Hebron include a drilling and production platform. • It is estimated that water based muds (WBM) based drill cuttings deposition would be 12.8 km^2 total around the Hebron platform and drilling installations (ExxonMobil 2011). • Disposal of synthetic based muds (SBM) drill cuttings will be by reinjection into wells, with some disposal of treated SBM drill cuttings into the environment (ExxonMobil 2011). • Preliminary produced water dispersion modelling was conducted in support of the EA for the Hebron project. At a modelled produced water discharge elevation of 35 m, the plume was predicted to reach the bottom. At a modelled discharge rate of 56,000 m^3/d, a dilution factor of 300 was predicted to be reached within a horizontal distance ranging from 74 m to 676 m (Amec 2010, in ExxonMobil 2011).

Table 15.5 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Change in habitat availability and quality • Change in food availability and quality • Change in fish and invertebrate mortality, injury, health • Change in fish and invertebrate presence and abundance (behavioural effects)	• These types of offshore exploration activities have been widely carried out off eastern NL and elsewhere, typically use relatively standard equipment and techniques, and are subject to general environmental protection requirements and mitigation measures that are based in regulation and other guidelines. • Project-specific EAs for these projects in the Canada-NL Offshore Area therefore typically conclude that with the implementation of these mitigation measures, they are not likely to result in significant adverse environmental effects (see *http://www.cnlopb.ca/assessments*). • Although the often-extensive survey areas covered by some types of offshore geophysical surveys can increase the potential for spatial interactions between their potential effects and those of other activities in the marine environment, most geophysical survey activities operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence.
Offshore Petroleum Exploration – Drilling	• Change in habitat availability and quality • Change in food availability and quality • Change in fish and invertebrate mortality, injury, health • Change in fish and invertebrate presence and abundance (behavioural effects)	• As noted above, these types of offshore exploration activities have been widely carried out off eastern NL and elsewhere, typically use relatively standard equipment and techniques, and are subject to general environmental protection requirements and mitigation measures that are based in regulation and other guidelines. • EAs for these programs in the Canada-NL Offshore Area therefore typically conclude that with the implementation of these mitigation measures, they are not likely to result in significant adverse environmental effects (see *http://www.cnlopb.ca/assessments*). • Drilling and other types of exploration activities are typically relatively short-term and localized activities. This can reduce the potential for individuals and populations to be affected simultaneously and repeatedly by multiple projects and activities

Table 15.5 Marine Fish and Fish Habitat: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Fishing Activity	• Change in habitat availability and quality • Change in food availability and quality • Change in fish and invertebrate mortality, injury, health • Change in fish and invertebrate presence and abundance (behavioural effects)	• Commercial fishing activity in the region is extensive and diverse, involving a variety of participants, species, gear types, and occurring year-round. • Fish habitat in the Project Area is likely affected by bottom-trawling activities. • The level of commercial fishing effort in the Project Area is relatively low and is primarily concentrated in the north western portion of the Project Area.
Marine Vessel Traffic	• Change in habitat availability and quality • Change in fish and invertebrate mortality, injury, health • Change in fish and invertebrate presence and abundance (behavioural effects)	• Vessels are highly transitory, reducing potential effects in any location and time.
Other Harvesting Activity	• N/A	• N/A

15.2.4 Potential Cumulative Environmental Effects

The Project has the potential to interact with Marine Fish and Fish Habitat within and adjacent to the Core BdN Development Area and Project Area, including the introduction of emissions (e.g., underwater sound and vibrations, light), discharges (e.g., produced water, drill cuttings, chemicals, other wastes), presence of infrastructure (including subsea) and direct interactions with the benthic environment. Due to the number of interactions taken into consideration for Marine Fish and Fish Habitat, the following discussion is separated by project and activity.

Project and Marine Fish and Fish Habitat associated mitigations that reduce the magnitude, duration, or potential area of effect of Project activities as described in Section 9.1.5.2, will reduce the potential for overlapping effects.

Offshore Petroleum Production Projects

There are four existing petroleum production projects in the RSA (i.e., Hibernia, White Rose, Terra Nova, and Hebron), each of which have and will contribute somewhat to environmental effects on Marine Fish and Fish Habitat. The ongoing EEM programs for these projects have, however, generally demonstrated a localized (<10 km) geographic extent for the project-induced changes on fish habitat. It is also expected that Hebron, located near Terra Nova, will have a similar zone of influence (see Table 15.5).

As mentioned above, the predicted zones of influence associated with the Project for seismic sound, produced water and drill cuttings are predicted to be 50 km, 100 m and 200 m, respectively. For this analysis, the maximum zone of influence of 50 km is used. Taking into consideration that the other offshore petroleum production projects have demonstrated a localized extent of less than 10 km, and the distance of these projects from the Project Area (i.e. 118 km to 166 km), it is not anticipated that effects will overlap spatially. However, the migratory nature of some fish species may increase the potential for individuals and populations to be affected by multiple producing projects. Most key fish species in the Project Area (see Section 6.1) are part of middle to deep slope assemblages that have preferred depth distributions that are deeper than current producing projects on the Grand Bank Shelf, limiting potential cumulative effects on these species. Atlantic salmon and American eels have low potential to interact with the Project Area as detailed in Section 15.2.5 based on migration routes and overwintering areas, limiting potential for cumulative effects among this Project and other offshore petroleum production projects. Water depths at Hibernia, Hebron, Terra Nova, and White Rose Developments are 80 m and 120 m and the preferred depth range for roundnose and roughhead grenadiers are 400 m to 1,200 m (2007a, 2008). Lanternfish undergo diel vertical migrations where they occupy near surface waters at night (Halliday 1970), however their range is limited to slope waters with few observations on the Grand Bank Shelf (see Section 6.1.9). Greenland halibut is a key species in the Project Area with high migratory capabilities. Greenland halibut undergo long distance spawning migrations towards the Davis Strait (Bowering 1984; Junquera and Zamarro 1994). As they have very limited distribution on the Grand Banks shelf and are generally distributed in deep waters (<2,000 m) it is unlikely this species will migrate between producing projects. Many benthic invertebrate species are relatively immobile or sessile, which limits the potential for cumulative interactions with multiple producing projects and disturbances.

Geophysical and Other Exploration Activities

Due to the wide extent of geophysical survey activities, they have potential for overlapping and cumulative effects with Project activities. Geophysical surveys within the Project Area, particularly 3D/4D seismic surveys, will likely cause behavioural effects on fishes with swim bladders used in hearing, as well as species with sensitivities to particle displacement in the water column.

Based on the sound modelling conducted (see Appendix D), available scientific literature, and the selection of 160 dB re 1 µPa (0-p) as the received SPL threshold for behavioural effects of fishes, behavioural effects on fishes could extend as far as 50 km from the seismic air source array. The 50 km distance would only apply to certain pelagic fish species that use their swim bladders to detect underwater sound and are highly sensitive to sound pressure. Since there is considerable variability in hearing sensitivity both within and between fish species, there would likely be different reactions from fishes occurring within 50 km of the seismic source. Although there could be distributional shifts in fish species due to exposure to sound from seismic activities, the overall behavioural effects would be temporary. All fishes would not leave the area defined by the 50 km radius.

While geophysical surveys are short-term in nature, concurrent seismic programs have occurred several times in Atlantic Canada. It is standard practice in the industry that seismic operators communicate with each other to provide spatial and/or temporal separation of operations which will mitigate against cumulative effects of geophysical surveys.

Exploration Drilling

The environmental effects of exploration drilling activities are localized and short-term, which result in a temporary environmental disturbance at a given location and time (Nexen 2018, Statoil 2017). Drill cuttings modelling for recent exploration drilling programs at similar depths (1,100 to 1,200 m) have indicated that aggregations of drill cuttings are generally localized to within 1 km from the wellhead and similar extents for drilling in shallower waters (350 m, Statoil 2017). Drill cuttings modelling for the Project indicated that drill cuttings would be mainly localized to within 200 m from the wellhead. In general, released cuttings beyond a few kilometres from the wellhead for all these projects are predicted to be patchy in nature. Drill cuttings predicted to drift beyond the model area (>23 km) are highly dispersed and therefore would likely result in low accumulations further limiting potential cumulative effects among projects (Nexen 2018, Statoil 2017, see Section 9.3.2.4). As indicated on Figure 2-1, there are several ELs within or adjacent to the Project Area. If concurrent drilling activities were occurring between the Project and an exploration drilling program, there would be a minimum separation distance of 500 m for each installation, due to safety zone requirements, and therefore an overall separation distance of 1 km. Based on drill cuttings modelling completed for the Project, cuttings are predicted to be within 200 m from the wellhead, and therefore likely confined within the safety zone. Spatial overlap of drill cuttings deposition is not predicted.

Sound from a drillship is predicted to be localized limiting overlap with other activities. Sound modelling of a drillship for the Project indicated that sound levels would be <160 re 1 $\mu Pa_{(rms)}$. The maximum horizontal distance to 160 re 1 $\mu Pa_{(rms)}$ was limited to within 40 m from the drilling installation. Furthermore, the predicted levels are below minimum measured received sound pressure levels (SPLs) that elicit overt behavioural responses in fish (178 dB re 1 $\mu Pa_{(0\text{-}p)}$ and 161 dB re 1 $\mu Pa_{(rms)}$), therefore it is unlikely that fish would remain in the immediate area long enough to be affected. Beyond 1 km from the Project estimated maximum sound levels would be less than 140 dB re 1 µPa SPL and decrease with distance from the sound source. As indicated on Figure 2-1, there are several ELs within or adjacent to the Project Area. If concurrent drilling activities were occurring between the Project and an exploration drilling program, there would be a minimum separation distance of 500 m for each installation, due to safety zone requirements, and therefore an overall separation distance of 1 km. Based on sound modelling completed for the Project, sound from a drillship was limited to within 40 m, and therefore within the safety zone. Spatial overlap of sound from drilling installations is not predicted.

Lighting from the drilling installation may potentially attract marine fish species. However, the potential effects of lighting on Marine Fish and Fish Habitat from the drilling installation are predicted to be highly localized with limited potential for overlap with other activities.

Although the majority of potential effects are localized with limited potential for spatial overlap, the migratory nature of some fish species may increase the potential for individuals and populations to be affected by multiple perturbations. However, the short-term nature of exploratory drilling programs (i.e., 35 to 65 days per well) limits cumulative interaction among multiple projects (Nexen 2018, Statoil 2017).

Fishing Activity

Commercial fishing activities and associated effects may potentially interact in space and time with those of planned Project activities within the Project Area. Special Areas within the Core BdN Development Area are closed to bottom-contact fishing reducing cumulative effects among Project and fishing activities. Although commercial fishing activity may occur anywhere in the Project Area; domestic commercial fishing activity within the Project Area from 2011 to 2016 was primarily concentrated in the western portion of the Project Area (refer to Figure 7-10). Available geospatial data on commercial fisheries using mobile fishing gear from 2011 to 2016 (Section 7.2.4) shows that these fisheries have similarly been concentrated primarily in the western portion of the Project Area during recent years, but also occurred in several locations along the perimeter of the Project Area in 2013 and 2014 (refer to Figure 7-14). The intensity of fishing effort within the Project Area is low (ranging from 0 to 14 fishing data records per DFO grid cell for the period of 2011 to 2016). Indigenous groups hold commercial-communal fishing licences for swordfish and tuna in NAFO 3L and 3M. Currently, no commercial-communal fishing occurs in these areas, but the licences could be active in the future. Swordfish and tuna are highly mobile species that are likely able to avoid any anthropogenic effects associated with the Project, limiting cumulative effects with potential commercial-communal fishing. The distance between the Project Area and other areas where higher intensities of commercial fishing activities occur, and the planned mitigations measures will reduce the potential for cumulative effects on Marine Fish and Fish Habitat from the residual effects of the Project in combination with the residual effects of commercial fisheries.

Marine Vessel Traffic

Vessel traffic for supply and servicing of the Project is estimated to be a maximum of 16 transits per month when more than one activity is occurring (e.g., HUC and drilling, or drilling and production) and will reduce to approximately four to eight per month during production. Offshore petroleum exploration and development activities have associated vessel traffic, and there are vessel movements associated with fishing vessels, cargo transport, and other marine activities that will continue to occur throughout the region (Section 7.2.3). Concentrated areas of vessel traffic on the Grand Bank are generally associated with supply and servicing with the existing production facilities. As Project activities are distant, from existing production facilities, with the closest operating installation approximately 118 km from the Project Area it is anticipated that there will be little overlap with concentrated areas of vessel traffic. Minimum safe working distances between vessels will also limit interaction among activities.

While there will likely be overlap in vessel traffic, the overall potential effects are transient in nature. Generally, effects caused by exposure to vessel sound are temporary and generally limited to the duration of the sound emissions and perhaps for a short time post-exposure (Popper and Hastings 2009).

Potential cumulative effects associated with the introduction of invasive species from Project and non-Project vessels carrying ballast water will be mitigated through compliance with the *Canada Shipping Act, 2001* and the associated *Ballast Water Control and Management Regulations*, which apply to Canadian vessels everywhere, as well as foreign vessels operating in waters under Canadian jurisdiction. With the implementation of standard mitigation measures, which are anticipated to be in place for other projects and activities as well, routine operational discharges are not expected to result in a measurable change in health for marine fish, either individually or cumulatively.

Other Harvesting Activity

The recreational groundfish (i.e., Atlantic cod, winter flounder) fishery occurs in 3KL within the RSA during the summer to early fall using angling gear or handlines. These harvests are primarily in inshore waters with limited spatial overlap with the Project area or vessel traffic route. As coastal groundfish are unlikely to migrate through the depths of the Project Area (COSEWIC 2010a; Decelles et al. 2010) and effects from supply and servicing vessels are transient in nature, cumulative effects on fish would be limited. Furthermore, retention of northern and spotted wolffish, and shark species is prohibited, limiting effects on these SAR. Indigenous groups conduct traditional harvesting activities throughout the RSA, but no such harvesting is known to occur in the LSA, Project Area or Core BdN Development Area. Furthermore, the low potential for interaction of fished migratory species (i.e., American eel and Atlantic salmon) and Project Activities as detailed in Section 15.2.5 limits cumulative effects on these species.

15.2.5 Species at Risk

As described in Section 6.1.9, there are 23 species with conservation designations that may occur within the Project Area; however, only five are listed under provincial and federal legislation (i.e., *Endangered Species Act* (ESA) or *Species at Risk Act* (SARA). Further species information is presented based on SAR designation (e.g. wolffish species, white shark), indigenous importance (e.g., Atlantic salmon, American eel), range overlap with the Project Area (e.g., Atlantic cod, white hake, thorny skate, grenadier species, redfish species, shark species, and Atlantic bluefin tuna), or a combination of these reasons as was discussed in Section 6.1.9. As with secure fish species, SAR may interact with Project activities based on occupation of various habitats at different life history stages. However, as detailed above in Section 15.2.2, many of the offshore activities and associated disturbances that will occur as a result of this Project will be relatively localized at a specific location, or transient, though of a long-term nature. It is not predicted that routine Project activities will exacerbate any main potential threats to SAR to prevent their recovery as detailed in the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessments, recovery plans, management plans and action plans.

For Atlantic cod, white hake, grenadier species, redfish species, wolffish species, and thorny skate, fishing effort has been identified as the main factor affecting species abundance (COSEWIC 2007a, 2008, 2010a, 2010b, 2012e, 2013; Nogueira et al 2015). Population trends for these species vary depending on level of fishing effort and area. The Flemish Pass restricts passage of many groundfish species between the Grand Banks and the Flemish Cap (Pérez-Rodrigues et al. 2016). Studies from the Grand Bank shelf (NAFO area 3LNO) indicate that Atlantic cod have had a positive population growth rate from 2002-2013, but they have not reached historic population levels (Nogueira et al 2015). Similarly, Nogueira et al (2015) indicated that redfish species populations were increasing and have even increased their depth range to shallower waters. Over the same time period, sampled roughhead grenadiers have had an overall increase in mean length, suggesting there has been a decreasing impact of fishing over time (Nogueira et al 2015). Thorny skate declined from 1974-1995 but increased on the Grand Banks from 1996-2010. On the Flemish Cap, populations of Atlantic cod increased in the late 2000s but have declined in recent years. Redfish species increased in the early 2000s but have declined since the mid to late 2000s (Nogueira et al 2017). As grenadiers, and redfish are slow-growing and long-lived species, there is higher potential for cumulative effects over their lifetime.

The main threats to American eel are largely in freshwater systems including habitat degradation and fragmentation, food web changes, fisheries and chemical and biological contamination (COSEWIC 2012d; Chaput et al 2014). Changes and variations in oceanographic processes are considered the main threat to ocean survival of larvae (Knights 2003; COSEWIC 2012d; Chaput et al. 2014). Although seismic activities are suggested to result in localized stress and mortality of larval stages, Chaput et al. (2014) indicated that there is no indication that the larval densities at sea that may encounter seismic activities would result in effects on the population. Juvenile and adult American eel have also showed strong avoidance to lights but have some attraction to underwater sound (Hadderingh et al 1992; Patrick et al 1982, 2001). Overall, adult American eel avoidance would likely reduce potential interaction with Project activities. Young American eel larvae in marine environments also have limited avoidance capabilities as demonstrated by leptocephali net avoidance in the Sargasso Sea (Castonguay and McCleave 1987). Migrating adult American eels firstly use shallow waters along the continental shelf and edge and then travel in deep waters directly south towards the Sargasso Sea (Béguer-Pon et al. 2015, see Section 6.1.9.2). Therefore, it is unlikely that adult American eels may travel through the depths within the Project Area and that cumulative effects on this species are unlikely.

Threats to Atlantic salmon include climate change, habitat loss, fishing, and barriers to migration in freshwaters (COSEWIC 2010c; DFO 2016a). There have been broad-scale declines in marine survival; however, main drivers for this trend remain uncertain. Action plans and recovery strategies have been developed for the inner Bay of Fundy (iBoF) Atlantic salmon population (2016a) also identify aquaculture, ecological community shifts (i.e., food limitation, increased predation), environmental shifts (i.e., changing temperatures, altered migration routes), fisheries, and depressed population phenomena (i.e., lack of recruits to form effective schools) as threats to marine survival (DFO 2016a). As detailed in Section 9.4.5, each regional group based on the designatable units have their own migration routes and overwintering patterns in marine waters. Given the available data, there is likely low interaction with spring migration of adults within and near the Project Area for the insular Newfoundland populations, Gulf of St. Lawrence populations, and eastern-southern NS and Outer Bay of Fundy Populations. Post-smolt and adult salmon from Labrador and Nunavik Populations generally feed and overwinter in the Labrador Sea therefore interaction of these populations with the Project Area would be considered negligible. Overwintering habitat for the iBoF is suggested to be off the Scotian shelf or the southern portion of the Gulf of Maine, therefore interaction with the Project Area is also unlikely. The low potential for interaction, in combination with the highly mobile nature of the species, suggests that cumulative effects on this species are unlikely.

Wolffish abundance has declined since the 1980s but there has been an upward trend in abundance since the mid-1990s. Northern wolffish have shown the least recovery of the three species

(COSEWIC 2012a, 2012b, 2012c). Recovery strategies and action plans are available for northern and spotted wolfish and a recovery strategy is available for spotted wolfish (DFO 2018a). Proposed critical habitat for northern and spotted wolfish are primarily on the northeast shelf and slope of the Grand Banks outside of the Project Area. There are a number of potential threats to these species including fishing mortality, oil and gas exploration and production, seismic activities, and marine discharges. While recovery documents (DFO 2018a) note that oil and gas exploration and production are a potential threat to wolfish, the localized nature of activities limits potential effects. As eggs and adults generally reside on the seafloor, it is not predicted that seismic activity would have any direct physical impacts (DFO 2018a). However, there may be potential change behaviour when exposed to seismic sound as has been documented in other fish species. As wolfish are slow-growing and long-lived species, there is higher potential for cumulative effects over their lifetime. However, the localized nature of these activities limits potential effects from Project activities.

Pelagic species including basking shark, porbeagle, shortfin mako, white sharks, and bluefin tuna are seasonal migrants in Canadian waters. Bycatch mortality is one of the main threats to these pelagic species. These species migrate into North Atlantic waters for foraging opportunities or reproduction purposes. High mobility in these pelagic species indicates that they may interact with multiple projects, increasing their potential for cumulative effects. However, their highly transitory nature and sensory capabilities (Southwood et al. 2008) also suggests that they will likely be able to avoid areas of disturbance, reducing potential for project activity interactions and thereby reducing potential for cumulative effects.

Given that injury and mortality to fish species from fisheries are the primary threat to SAR in the RSA, and there is limited overlap between Project and fisheries activities, it is not predicted that there will be significant cumulative adverse effects on SAR. Areas on the Northern Grand Banks outside the Project Area have been proposed as critical habitat for both northern and spotted wolfish (DFO 2018a), however it is not predicted to be affected by the Project. Mitigation measures will also be applied based on industry standards, best management practices and best available techniques, that are economically and technically feasible, further limiting potential for cumulative effects on SAR over the life of the Project. This includes avoidance of critical habitat established in future action plans, management plans, and recovery strategies where a significant effect on habitat has been determined. Therefore, the Project is not predicted to contribute to potential cumulative effects on SAR.

15.2.6 Cumulative Effects Summary and Evaluation

Table 15.6 summarizes the results of the cumulative effects assessment for this VC. As discussed, the Project will not result in significant adverse cumulative environmental effects on Marine Fish and Fish Habitat (including SAR) in combination with other projects and activities that have been or will be carried out. The relative contribution of the residual effects of the Project to cumulative effects on this VC within the overall RSA is predicted to be low.

Table 15.6 Summary of Potential Cumulative Environmental Effects: Marine Fish and Fish Habitat

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and Ongoing Activities)	• Habitats in the RSA are used by fish and invertebrate species of commercial, cultural, ecological, and/or conservation importance, and support regionally important areas of biodiversity and marine productivity. • Fish presence and abundance for secure species and SAR affected by directed commercial fisheries and bycatch, as well as oceanographic conditions. • Fishing pressures along with oceanographic conditions continue to influence fish distribution and abundance in the Project Area and overall region. Overall, due to warming conditions, groundfish have been recovering on the Grand Banks with a decline in groundfish prey species.
Residual Environmental Effects of the Project	• The Project may result in residual changes in habitat availability and quality; food availability and quality; mortality, injury, or health (physical effects); and/or presence and abundance (behavioural effects) for Marine Fish and Fish Habitat, including secure species and SAR. With the application of mitigation measures, these potential residual adverse effects are predicted to be not significant and the Project is not expected to result in overall ecological or population-level effects on Marine Fish and Fish Habitat. • This prediction is made with a moderate to high level of confidence.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia	Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from ongoing EEM programs.
Terra Nova	Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from ongoing EEM programs.
White Rose and Extension Project	Operations are located well outside of the Project Area and LSA, with highly localized environmental effects as determined from ongoing EEM programs.
Hebron	Operations are located well outside of the Project Area and LSA. Based on its Comprehensive Study Report and other existing EEM programs, it is anticipated that Hebron will have localized environmental effects suggesting there is no potential for interaction.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	Some potential for interaction, although localized and short-term nature of these activities and their effects, along with planned and required separation measures and other mitigation measures, will reduce potential for interaction.
Offshore Petroleum Exploration – Drilling	Some potential for interaction, although localized and short-term nature of these activities and their effects, along with planned mitigation measures, will reduce potential for interaction.
Fishing Activity	Some potential for interaction, although these activities occur primarily in select parts of the Project Area only, mostly outside of the Core BdN Development Area. Safety zones around Project activities will limit the potential for overlapping and concurrent environmental effects, and thus, for cumulative effects on this VC.

Table 15.6 Summary of Potential Cumulative Environmental Effects: Marine Fish and Fish Habitat

Summary of Potential Cumulative Environmental Effects	
Other Marine Vessel Traffic	Some potential for interaction, although these activities and their effects are highly localized and transient
Other Harvesting Activity	These harvests are primarily in inshore waters with limited spatial overlap with the Project area or vessel traffic route. These activities and their effects are highly localized and transient.
Cumulative Effects Summary	Project components and activities are not likely to result in significant residual adverse cumulative environmental effects on Marine Fish and Fish Habitat in combination with other projects and activities that have been or will be carried out in the RSA.

15.3 Marine and Migratory Birds (including Species at Risk)

15.3.1 Past and Ongoing Effects (Baseline)

The waters off eastern NL, including the LSA, provide important feeding areas for many marine-associated bird species, some of which breed along the province's coastline. Although they do not regularly occur in the offshore environment, landbirds and shorebirds may pass through the RSA on a transient basis during spring and fall migration. The distribution, abundance, and health of Marine and Migratory Birds and their populations are often influenced by both natural phenomena such as weather, food availability, and oceanographic variation, as well as anthropogenic activities and their associated disturbances including harvesting, fishing, vessel traffic, offshore oil and gas production facilities, and pollution. Vessel movements associated with fishing activity and general marine traffic throughout the region, as well as previous offshore exploration and production activities, may also affect marine bird populations in the region. Fisheries bycatch and bird harvesting activity may also put pressure on some bird populations. In addition to these local disturbances, marine migratory bird species may also be affected by a variety of activities and associated effects within their, often extensive ranges, including harvesting, and pesticides.

In general, the populations of most marine-associated bird species occurring off eastern NL are considered secure overall (Section 6.2), although the number of nesting Leach's storm-petrel, for example, has declined in recent years (Wilhelm et al. 2015). That species is thought to be particularly vulnerable to the potential effects of offshore activities through attraction to artificial light sources resulting in collision and stranding. In addition, because they forage hundreds of kilometres from the nest site in the deep waters off the continental shelf during the breeding season (Hedd et al.2018), there may be risk of exposure to oil from spills and routine discharges of adults and of eggs through transfer from oiled adults' breast plumage (Morandin and O'Hara 2016).

Leach's storm-petrel, a species recently designated as Vulnerable by the International Union for Conservation of Nature (IUCN), is found in the offshore waters of eastern NL during the nesting season; unlike most seabirds nesting in eastern NL, breeding adults are known to forage within the LSA, hundreds of kilometres offshore (Hedd et al. 2018). Population sizes of the four of the seven major Atlantic Canadian colonies that have been monitored have decreased, the cause of which may be several factors including predation, ingestion of marine contaminants such as mercury, collisions and strandings due to attraction to lighted structures, and contact with hydrocarbons (BirdLife International 2018). A recent tracking study undertaken by Hedd et al. (2018) provides information regarding the foraging areas used by these seven colonies and presents the locations of these foraging areas with respect to existing production platforms off NL and NS. The core foraging areas of four of these colonies overlap with production facilities: Baccalieu Island, NL, Gull Island (Witless Bay), NL, Country Island, NS, and Bird Island, NS. However, the trend in colony size for three of the seven colonies is unknown. Although colony size is declining at Baccalieu, Gull and Country Islands, colony size at Middle Lawn, NL, is declining despite a core foraging area that does not include production facilities. Colony size trends at Bird Island and the remaining two NS colonies are unknown. As a result, the relationship between core foraging area overlap with production facilities and trend in colony size is uncertain. The core foraging areas for all seven of these Leach's storm-petrel colonies are extremely large, with foraging trips for birds from most colonies averaging more than 1,400 km per round trip and more than 500 km from the colonies (Hedd et al. 2018).

The effects of previous activities and natural environmental influences are reflected in the existing baseline environmental conditions for this VC, as described in Section 6.2. This includes a consideration of the current condition (e.g., health or quality) of potentially affected marine and migratory bird populations, and their potential resiliency or sensitivity to further environmental change as a result of the Project. Chapter 10 provides details on Project activities that may affect this VC.

15.3.2 Potential Project-Related Contributions to Cumulative Effects

As described in Chapter 10, potential interactions with, and effects on, Marine and Migratory Birds as a result of the Project relate primarily to possible attraction and/or disorientation of the birds around the FPSO, drilling installation and/or vessels due to artificial light sources. There may also be sensory disturbance or a change in risk of mortality or injury from lights, underwater sound, discharges, and vessel and aircraft traffic, as well as changes in the availability, distribution, and/or quality of food resources or habitats due to physical displacement because of vessel presence (e.g., disruption of foraging activities), disturbances, and/or Project-related waste discharges.

Although Project-related components, activities, and discharges may result in some localized, long-term interactions with marine-associated avifauna in parts of the LSA throughout the life of the Project, including bird attraction to offshore lighting and other components, the implementation of a systematic and documented protocol to recover and release stranded birds, as outlined in Chapter 10, will mitigate bird strandings resulting from artificial lighting. Consequently, as concluded in Chapter 10, the number of individuals that may be affected, and the temporary and reversible nature of these interactions, means that the Project will not have overall ecological or population-level effects, and particularly, will not result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within the RSA.

With regard to avifauna SAR, ivory gull and red-necked phalarope are the only such species designated by SARA or COSEWIC, and Leach's storm-petrel and black-legged kittiwake are the only IUCN-listed species that are likely to be found in the Project Area. During fall migration, there is some potential for peregrine falcons and nocturnally migrating landbird SAR to be present and to be attracted to the Project. However, the potential for interactions between individuals of these species and the Project is limited, and no identified critical habitat is present in the LSA or RSA. The Project will consequently not have an effect on the overall abundance, distribution, or health of such SAR nor its eventual recovery. The Project is therefore not likely to result in significant residual adverse effects on avian SAR.

As described in Chapter 10, based on the nature and characteristics of the Project, the existing environment for this VC within the LSA and RSA, and the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine and Migratory Birds.

15.3.3 Other Projects and Activities and Their Effects

Other ongoing and likely future projects and activities that may affect Marine and Migratory Birds within the Project Area and RSA (Table 15.7) include other offshore petroleum production projects, geophysical activities associated with exploration, exploration drilling, fishing activity, vessel traffic and harvesting. Details on other projects and activities are described in Section 15.1.3. The widespread and migratory nature of many marine bird species can also increase the potential for avifauna to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur.

As indicated, the environmental zone of influence of each project and activity in the region is typically localized (especially with regards to the effects of lights and other such disturbances), and small compared with the total amount of habitat available in the region.

Table 15.7 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia	• Change in habitat availability and quality • Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects) • Change in mortality / injury levels and health of individuals or populations	• Current or potential effects are similar to those that could be associated with the Project and are primarily associated with possible implications for mortality / injury levels and habitat availability / quality due to attraction of night-flying birds to artificial lighting (including flares) and exposure/attraction to emissions and discharges from platforms and vessels (Ellis et al. 2013). There are also potential disturbance effects from vessel and aircraft traffic. • Non-routine discharges may contribute to a change in mortality / injury levels, but these are not anticipated. • Sheening may contribute to a change in mortality/injury levels. • Routine discharges will be managed in consideration of the guidelines and in compliance with regulations. and are unlikely to cause measurable change in mortality / injury, presence and abundance or food
Terra Nova	• Change in habitat availability and quality • Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects) • Change in mortality / injury levels and health of individuals or populations	

Table 15.7 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
White Rose and Extension Project	• Change in habitat availability and quality • Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects) • Change in mortality / injury levels and health of individuals or populations	availability and quality. There may be a change in food availability due to discharges of organic waste. • Interactions with the VC are anticipated to be confined to within approximately 5 km (Poot et al. 2008) to 16 km (Rodríguez et al. 2014, 2015) of the source for lighting attraction effects. • Operational discharges and effects of vessel and aircraft traffic are more localized (Fraser et al. 2006; Rojek et al. 2007; Hoang 2013; Morandin and O'Hara 2016). • The majority of strandings reported by operators occur in September and October, corresponding with the departure of Leach's storm-petrel fledglings from the breeding colonies, and with fall landbird migration (LGL 2017a). • Poor visibility atmospheric conditions (fog, drizzle) are also associated with greater numbers of strandings.
Hebron	• Change in habitat availability and quality • Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects) • Change in mortality / injury levels and health of individuals or populations	
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Change in habitat availability and quality • Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects) • Change in mortality / injury levels and health of individuals or populations	• Effects from exploration survey programs are primarily associated with attraction to artificial lighting and operational discharges from vessels (Ellis et al. 2013). • Although the large survey areas covered by some types of offshore geophysical surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most survey activities operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. • Available research suggests these effects are therefore minor and short-term in duration for marine and migratory birds and their habitats (e.g., Davis et al. 1998; Material Management Service 2004; Dooling and Popper 2007). • There are potential disturbance effects from vessel and aircraft traffic. • Interactions with the VC are anticipated to be confined to within approximately 5 km (Poot et al. 2008) to 16 km (Rodríguez et al. 2014, 2015) of the source for lighting attraction effects. • Operational discharges and effects of vessel and aircraft traffic are more localized (Rojek et al. 2007; Hoang 2013).

Table 15.7 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Offshore Petroleum Exploration – Drilling	• Change in habitat availability and quality • Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects)	• Effects from exploration drilling are primarily associated with attraction to artificial lighting (including flares) and operational discharges from drilling installations and vessels (Ellis et al. 2013). • There are potential disturbance effects from vessel and aircraft traffic. • Interactions with the VC are anticipated to be confined to within approximately 5 km (Poot et al. 2008) to 16 km (Rodríguez et al. 2014, 2015) of the source for lighting attraction effects. • Operational discharges and effects of vessel and aircraft traffic are more localized (Rojek et al. 2007; Hoang 2013).
Fishing Activity	• Change in habitat availability and quality • Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects) • Change in mortality / injury levels and health of individuals or populations	• Entanglement in fishing gear, particularly gillnets and, to a lesser extent, longlines and bottom trawls, can cause changes in mortality and injury levels to seabirds (accidental bycatch). In NL, murres and shearwaters are the most commonly captured (Ellis et al. 2013). • The southwest slope of the Grand Bank in the RSA has seasonally high bycatch rates that are potentially of concern (Ellis et al. 2013), although common murre populations in southeastern Newfoundland have not shown signs of decrease (Robertson et al. 2004). • Vessel lighting, disturbance, and emissions / discharges from fishing vessels may cause a change in habitat quality; this change is again quite short-term and transient at any given location. • Bait and offal from fishing vessels cause change in food availability for marine birds, and this in turn may result in localized changes in presence and abundance of avifauna.
Other Marine Vessel Traffic	• Change in food availability and quality • Change in avifauna presence and abundance (behavioural effects) • Change in mortality / injury levels and health of individuals or populations	• Vessel and aircraft traffic may affect seabirds through lighting, discharges, and displacement / disturbance. • Vessels are highly transitory, reducing effects in a given location and time • Interactions with the VC are anticipated to be confined to within approximately 5 km (Poot et al. 2008) to 16 km (Rodríguez et al. 2014, 2015) of the source. • Vessel and aircraft traffic in proximity to coastal breeding colonies and IBAs has the greatest potential for negative effects on the VC.

Table 15.7 Marine and Migratory Birds: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Other Harvesting Activity	• Change in mortality / injury levels and health of individuals or populations	• Some types of marine birds (specifically, murres and waterfowl) can experience change in mortality / injury due to harvesting. • Although harvesting, including traditional Indigenous harvesting, is typically conducted in nearshore areas, some birds are highly mobile and individuals that occur in the RSA may also be at risk of mortality due to harvesting.

15.3.4 Potential Cumulative Environmental Effects

Potential interactions with, and effects on, Marine and Migratory Birds as a result of the Project and other projects and activities in the region relate primarily to attraction effects associated with artificial lighting. Section 10.3.2.2 provides a detailed summary of the existing and available literature on the potential effects of offshore lighting on marine-associated avifauna. Available studies on attraction of birds to offshore lighting from oil and gas facilities have demonstrated attraction distances of less than 2 km for gas flaring (Day et al. 2015) to 5 km for a production platform with full lighting (30 kilowatts [kW]) (Poot et al. 2008), although attraction from distances of greater than 5 km could not be discounted. A recent global positioning system (GPS) tracking study of Cory's shearwater on the Island of Tenerife found that birds fledging from colonies up to 16 km away from coastal lighting were attracted to and stranded at those lights, and fledgling short-tailed shearwaters in Australia have been found stranded at a plant 15 km from the nearest breeding colony, suggesting that attraction distances of anthropogenic light sources may be much more than 5 km (Rodríguez et al. 2014, 2015). As a reminder, the effects of Project artificial lighting will be mitigated through investigating lighting reduction options and avoiding flaring during routine operations.

These potential interactions may be particularly relevant to species like Leach's storm-petrel, which is vulnerable due to high potential for attraction to lights. Unlike other seabird species, which undertake comparatively short daily movements during the breeding season, individual Leach's storm-petrels, in their extremely long foraging trips, could potentially be exposed to more than one source of disturbance. Species with greater wintering site fidelity such as common murres nesting in the northwest Atlantic, whose wintering area is concentrated on the Grand Banks, may be more vulnerable than species with greater intercolonial and interannual diversity in wintering areas such as thick-billed murre (McFarlane Tranquilla et al. 2014). However, because the foraging and wintering grounds of marine bird species are so large, if there is an interaction between the Project and marine birds, the attraction and/or displacement effects due to the proposed Project and other ongoing projects will potentially disrupt only a small percentage of individuals. The effects are likely to be transient and temporary in nature without significant adverse cumulative effects on individuals or populations.

The potential for cumulative effects to occur within the Project Area would depend on the spatial and temporal interaction between the Project, other offshore production activities, other marine traffic, and commercial fishing activity that may occur throughout the RSA. The Project Area is currently subject to lower levels of anthropogenic activity (e.g., fishing and offshore petroleum production activities) and lower levels of artificial lighting than surrounding areas in the RSA. The current production projects (i.e., Hibernia, Terra Nova, White Rose, and Hebron) are located more than 118 km from the Project Area and, with the possible exception of vessel transits, environmental disturbances that are relevant to this VC resulting from Project activities (including light emissions that may attract and/or disorient night-flying birds) will not overlap with those of these current production projects. However, the presence in the Project Area of the FPSO, drilling installation(s) and supply, service, and survey vessels would be a new source of night lighting in a region that is currently relatively free of nocturnal artificial lighting, as indicated in a world atlas computed of artificial night sky brightness (Falchi et al. 2016), and is part of a foraging area for Leach's storm-petrel, a species prone to attraction to artificial lighting. The result may be the potential for additional individuals to interact with artificial lighting, or the same individuals to interact with multiple offshore petroleum production projects.

Waste discharges from the four existing petroleum production projects in the RSA (Hibernia, Terra Nova, White Rose and Hebron) may contribute to environmental effects on marine and migratory birds. As discussed in Section 10.3.2.3, surface sheening may occur during relatively calm water conditions. Experience with existing production facilities (Fraser et al. 2006; Morandin and O'Hara 2016) demonstrate a localized geographic extent of sheen formation. Similarly, zones of influences associated with other discharges, including food and sewage wastes, are localized to the installations. Given the distance between the Project and the other offshore petroleum production projects the interactions with sheening and other discharges are not anticipated to overlap spatially. However, the long-distance movements of some bird species have the potential for individuals and populations to be affected by multiple producing projects. The foraging trips of nesting Leach's storm-petrels between the Witless Bay nesting colony and foraging areas in Flemish Pass suggest the potential for effects from multiple producing projects. However, Leach's storm-petrel feeds primarily on prey species that are present in deeper waters, and therefore are not likely present in the relatively shallow waters surrounding the existing production facilities. While some black-legged kittiwakes and great black-backed gulls may pass through the zones of influence of multiple production installations during their spring and fall migration between coastal nesting colonies to and their offshore staging and wintering areas, the number of individuals likely exposed to all the producing operations is likely small, therefore population effects are unlikely. Cumulative effects associated with sheening and waste are therefore unlikely.

Potential interactions with marine birds as a result of other types of projects and activities in the RSA (i.e., projects and activities other than those associated with offshore petroleum production) will generally entail localized and short-term disturbances at any one location and time. This reduces the potential for individuals and populations to be affected repeatedly through multiple interactions with those projects and activities, as well as the potential for, and degree and duration of, overlap with the effects of this Project and other activities in the marine environment.

Harvesting pressure on birds that frequent the Project Area also has potential to contribute to cumulative effects, particularly in the case of murres, which are subject to the annual 'turr hunt' in Newfoundland. Waterfowl are more commonly found in coastal habitats and less prone to interaction with the Project.

The environmental effects of ongoing or planned exploration activities in the region will be localized and short-term in nature, including those resulting from offshore geophysical surveys, which result in a temporary and short-term environmental disturbance from lighting at a given location and time. Interactions with Marine and Migratory Birds are anticipated to be confined to within approximately 16 km (Poot et al. 2008; Rodríguez et al. 2014, 2015). Exploration drilling may only take place in accordance with an approved exploration licence (EL) issued by the C-NLOPB. Equinor Canada operates the majority of ELs in the Project Area, which decreases the possibility of other operators conducting simultaneous exploration drilling activities nearby. The relatively limited geographic zones of influence associated with residual effects of the Project and the relatively short-term nature of residual effects associated with geophysical surveys and exploration drilling, reduce the likelihood of potential spatial and temporal overlap of the residual effects of the Project and the residual effects of other projects and activities that may be taking place simultaneously or sequentially in the RSA.

Marine vessel traffic from fisheries, research surveys, and other activities is also common in the RSA, although transient in nature.

There will be regular interactions with Marine and Migratory Birds in the LSA, which could in turn affect Leach's storm-petrel nesting colonies during that time. This will increase the potential for individuals and populations to be affected through multiple interactions with the Project, and for species to be affected simultaneously or sequentially by the Project and other projects and activities. Mitigations to reduce potential attraction (e.g., investing lighting reduction options, no routine flaring) along with the implementation of other planned Project-related mitigation measures, will reduce the potential for and degree of associated cumulative effects on Marine and Migratory Birds.

15.3.5 Species at Risk

The Project is not anticipated to result in significant residual adverse effects on marine-associated avian SAR, and therefore, is not anticipated to contribute to cumulative effects on these species. There is no designated critical habitat for avian SAR within the Project Area, LSA, or RSA, and ivory gull, red-necked phalarope, Leach's storm-petrel, and black-legged kittiwake are the only such species that have the potential to be found in the area on a regular basis. Ivory gull is generally associated with pack ice, and as such, it is more likely to occur in the northern portion of the Project Area. Mitigation measures will prevent significant residual adverse effects on Leach' storm-petrel, and black-legged kittiwake is not known to be adversely affected by routine Project operations. During fall migration, there is some potential for peregrine falcons and nocturnally migrating landbird SAR to pass through, but the risk of interactions with this and other projects in the area is low.

15.3.6 Cumulative Effects Summary and Evaluation

Table 15.8 summarizes the results of the cumulative effects assessment for this VC. As discussed, the Project is not likely to result in significant adverse cumulative environmental effects on Marine and Migratory Birds (including SAR) in combination with other projects and activities that have been or will be carried out. This conclusion considers the uncertainty in the distance at which Leach's storm-petrel is attracted by artificial lighting, and the fact that the Project will be a new source of artificial lighting in an area that currently has low densities of transient light sources. The relative contribution of the residual effects of the Project to cumulative effects on this VC within the overall RSA is predicted to be low.

Table 15.8 Summary of Potential Cumulative Environmental Effects: Marine and Migratory Birds

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and Ongoing Activities)	• Offshore NL provides important habitat for tens of millions of marine and migratory birds. Several major seabird colonies are also found along the Newfoundland coastline, and species that do not breed in the area are drawn to the Grand Banks for foraging throughout the year. • In general, the populations of most marine-associated bird species occurring off eastern Newfoundland are considered secure overall, although one species, the Leach's storm-petrel, has seen declines in recent years.
Residual Environmental Effects of the Project	• The Project may result in residual changes in habitat availability and quality, food availability and quality, avifauna presence and abundance (behavioural effects) and/or morality / injury levels and health for Marine and Migratory Birds, including secure species and SAR. These potential residual effects are predicted to be not significant and the Project is not expected to result in overall ecological or population-level effects on Marine and Migratory Birds. • This prediction is made with a moderate to high level of confidence.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia	Operations are located well outside of the Project Area, with highly localized environmental effects.
Terra Nova	Operations are located well outside of the Project Area, with highly localized environmental effects.
White Rose and Extension Project	Operations are located well outside of the Project Area, with highly localized environmental effects.
Hebron	Operations are located well outside of the Project Area, with highly localized environmental effects.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	Some potential for interaction, although localized and short-term nature of these activities and their effects, along with required separation measures and other mitigation measures, will reduce potential for interaction.
Offshore Petroleum Exploration – Drilling	Some potential for interaction, although localized and short-term nature of these activities and their effects, and other mitigation measures, will reduce potential for interaction.

Table 15.8 Summary of Potential Cumulative Environmental Effects: Marine and Migratory Birds

Summary of Potential Cumulative Environmental Effects	
Fishing Activity	Some potential for interaction, although these transient activities occur in select parts of the Project Area only, primarily outside of the Core BdN Development Area. Vessel and aircraft traffic and associated discharges (including fish offal) and emissions could have cumulative effects on habitat quality and food availability, although these would be minor due to the spatially and temporally limited nature of these effects.
Other Marine Vessel Traffic	Some potential for interaction, although these activities and their effects are highly localized and transient. Vessel and aircraft traffic and associated emissions could have cumulative effects on habitat quality and food availability, but these would be minor due to the spatially and temporally limited nature of these effects.
Other Harvesting Activity	Harvesting pressure could potentially result in cumulative changes in mortality / injury to murres and, to a lesser extent, waterfowl.
Cumulative Effects Summary	Project components and activities are not likely to result in significant residual adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out in the RSA. This prediction is made with a moderate to high level of confidence.

15.4 Marine Mammals and Sea Turtles (including Species at Risk)

15.4.1 Past and Ongoing Effects (Baseline)

The key potential environmental effects of anthropogenic activities on Marine Mammals and Sea Turtles in the RSA include hearing impairment and auditory injury from exposure to underwater sound, injury or mortality from ship strikes and/or entanglement in fishing gear, as well as behavioural effects (key amongst these is avoidance with the potential to influence important life functions like foraging) in response to sound or the physical presence of vessels, the FPSO and drilling installation(s). Marine Mammals and Sea Turtles may also be affected (albeit to a lesser extent) by discharges from vessels, the FPSO and drilling installation(s) as well as effects on their prey.

As in other areas of the globe, marine activities in the RSA, including commercial fishing, general marine traffic, and oil and gas exploration and development, have resulted in increased background sound levels relative to naturally occurring oceanographic and biological sounds (Delarue et al. 2018; Maxner et al. 2018 in Appendix L). Naturally occurring sounds vary spatially and seasonally. For example, as described in Section 5.7.1, natural ambient sound levels in the eastern NL offshore area are elevated in winter primarily due to higher winds and sea states and at least in some locations vocalizing baleen whales. Acoustic measurements collected during the two-year ESRF soundscape study indicated that oil and gas activities in Jeanne d'Arc Basin and Newfoundland Slope waters (i.e., in and near the Project Area) contribute substantially to the soundscape. At an acoustic recorder located 17 km from Hibernia (in 110 m of water), minimum and maximum broadband sound levels were approximately 104 dB and 144 dB re 1 uPa, respectively, with predominantly low-frequency sound from support vessels and the platform contributing to these sound levels (Delarue et al. 2018). Underwater sound from seismic surveys greatly increase broadband sound levels in portions of the

RSA during summer and early fall. During 2014 and 2015, minimum and maximum broadband sound levels at Sackville Spur, were approximately 102.4 dB re 1 uPa and 165.8 dB re 1 uPa. Maximum broadband sound levels were primarily attributable to nearby seismic surveys. In all cases, the 10–100 Hz band contained the most energy. This is the frequency band associated with seismic surveys and large vessel shipping (Maxner et al. 2018 in Appendix L).

The effects of past and ongoing activities are in theory reflected in the existing environmental conditions for the Marine Mammal and Sea Turtle VC, as described in Section 6.3. This includes consideration of the current condition (health or quality) of potentially affected populations and their habitats, and thus, their potential resiliency or sensitivity to further environmental change as a result of the Project and/or other projects and activities within the RSA and likely beyond the RSA.

15.4.2 Potential Project-Related Contributions to Cumulative Effects

Potential interactions with, and effects on, Marine Mammals and Sea Turtles as a result of the Project relate to possible injury/mortality or disturbance from vessel movement, sound, and discharges. The primary pathways for potential residual effects on marine mammals are those associated with increases in underwater sound and vessel traffic that may result in change in mortality or injury or change in habitat quality or use (behavioural effects). While other potential pathways include change in prey availability or quality or change in health (contaminants) the focus of the cumulative effects discussion is on effects from sound.

As indicated in Chapter 11, the greatest potential for environmental effects on Marine Mammals and Sea Turtles is related to underwater sound from the seismic surveys and to a lesser extent operation of the FPSO and drilling installation(s). It is possible that marine mammals may exhibit localized and likely temporary avoidance of these activities. In the unlikely event that a sea turtle occurred in the Project Area, there could be localized avoidance of Project activities. The likelihood of a marine mammal and sea turtle incurring permanent hearing impairment (PTS) from exposure to air source pulses from geophysical surveys is low, given the implementation of mitigation measures in accordance with the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) (DFO 2007).

The risk of injury and mortality from ship strikes is considered quite low, particularly since support vessels will maintain a constant course and speed whenever possible.

As described in Chapter 11, based on the nature and characteristics of the Project and existing environment for this VC within the LSA and RSA, and with the planned implementation of mitigation, the Project is not likely to result in significant residual adverse effects on Marine Mammals and Sea Turtles.

15.4.3 Other Projects and Activities and Their Effects

On-going and potential future projects and activities which may affect Marine Mammals and Sea Turtles within the Project Area and RSA (Table 15.9) include fisheries, general vessel traffic, and ongoing and planned offshore oil and gas exploration and production activities. The potential for direct spatial and temporal overlap with the Project is also provided in Table 15.9. Also, relevant to the cumulative effects assessment is consideration of whether Marine Mammals and Sea Turtles may move amongst anthropogenic activities (and their sound fields), thereby experiencing cumulative effects. This is discussed further in Section 15.4.4.

Table 15.9 Marine Mammals and Sea Turtles: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia	• Change in injury levels (underwater sound) • Change in mortality / injury levels (ship strikes) • Change in habitat quality or use (behavioural effects) • Change in prey availability or quality • Change in health (contaminants)	• Production from Hibernia, Terra Nova, White Rose, and Hebron and associated supply vessel traffic occur year-round and are a continuous source of underwater sound contributing to elevated background sound levels. • Current or potential effects are similar to those that could be associated with this Project and are primarily associated with possible implications for mortality / injury levels and habitat availability or quality due to underwater sound and other emissions and discharges from platforms and vessels, as well as the risk of collision with vessels. There are also potential (albeit minor and temporary) disturbance effects from vessel and aircraft traffic. • Non-routine discharges (i.e., accidental release of oil) may contribute to a change in mortality/injury levels, but these releases are highly unlikely. • Routine discharges will be managed in consideration of the guidelines and in compliance with regulations and are unlikely to cause measurable change in marine mammal and sea turtle health. • Table 15.5 summarizes EEM results and EA predictions of relevance for Marine Fish and Fish Habitat. Many of these are also relevant with respect to the spatial boundaries of potential effects on habitat quality (i.e., water quality) and the quality and availability of prey for Marine Mammals and Sea Turtles.
Terra Nova		
White Rose and Extension Project		
Hebron		

Table 15.9 Marine Mammals and Sea Turtles: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Change in injury level (underwater sound) • Change in mortality or injury level (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in prey availability or quality • Change in health (contaminants)	• Geophysical surveys, including seismic surveys which produce impulsive sound, occur regularly in the RSA with most survey effort occurring during the June to October period. This overlaps with marine mammal and sea turtle presence in the RSA, including periods of foraging and migration. • Acoustic recordings within the RSA during summer have demonstrated that seismic surveys are a dominant sound source at distances over 100 km from acoustic recorders (see Section 5.6). • The key environmental effects of concern from offshore geophysical surveys are related to underwater sound. • Geophysical surveys which employ air source arrays (and to a much lesser extent other sound sources, e.g., multibeam echo-sounder [MBES], sidescan sonar [SSS]) have the potential to impair hearing (TTS, PTS). Available evidence indicates that hearing impairment is most likely to occur in close proximity to air source arrays (i.e., within several hundred metres). Based on previous studies, potential behavioural effects (i.e., avoidance) related to underwater sound are expected to occur at distances ranging from several hundred metres to several kilometres and for certain migrating species tens of kilometres. There is also potential for masking of sounds important to marine mammals, particularly baleen whales. • Air source sound from multiple concurrent seismic surveys in the RSA has the potential to contribute to cumulative effects. However, the nature and magnitude of these cumulative effects on Marine Mammals and Sea Turtles are not known with certainty. Potential effects are likely minimized by the minimum separation distance typically required between seismic surveys (i.e., 30 km; see LGL 2017a). • The slow survey speed of geophysical vessels (< 5 knots) greatly reduces the potential for vessel strikes.

Table 15.9 Marine Mammals and Sea Turtles: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Offshore Petroleum Exploration – Drilling	• Change in injury level (underwater sound) • Change in mortality or injury level (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in prey availability or quality • Change in health (contaminants)	• Underwater sound produced by drilling installations is continuous with relatively low source levels. • It is unlikely exploration drilling activities would affect marine mammal and sea turtle hearing. Potential behavioural effects (i.e., avoidance) related to underwater sound are expected to occur at distances ranging from several hundred metres to several kilometres. There is also potential for masking of sounds important to marine mammals, particularly baleen whales. • Drilling programs are typically short-term (i.e., months) and localized activities, which can reduce the potential for individuals and populations to be affected simultaneously and repeatedly by multiple projects and activities.
Fishing Activity	• Change in injury level (underwater sound) • Change in mortality or injury level (vessel strikes or entanglement in gear) • Change in habitat quality or use (behavioural effects) • Change in prey availability or quality • Change in health (contaminants)	• Commercial fishing activity occurs throughout the RSA with most effort during summer but with fishing year-round. • Entanglement in fishing gear, particularly gillnets and, to a lesser extent, longlines and bottom trawls, can cause changes in mortality and injury levels to Marine Mammals and Sea Turtles (accidental bycatch). • Acoustic disturbance and discharges from fishing vessels may cause a change in habitat quality; this change is considered short-term and transient at any given location. • The level of commercial fishing effort in the Project Area is relatively low and is primarily concentrated in the western portion of the Project Area.
Other Marine Vessel Traffic	• Change in injury levels (underwater sound) • Change in mortality or injury levels (vessel strikes) • Change in habitat quality or use (behavioural effects) • Change in health (contaminants)	• It is highly unlikely sound from vessels would affect marine mammal and sea turtle hearing. • There is some possibility that Marine Mammals and Sea Turtles directly in the path of a vessel may be struck by a vessel. The risk of lethal injury and mortality is higher for vessels transiting at speeds in excess of 14 knots. • Vessels are highly transitory, with limited potential for overlap of behavioural effects at a given location and time.

Table 15.9 Marine Mammals and Sea Turtles: Other Projects and Activities and their Potential Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Other Harvesting Activity	• Change in mortality / injury levels	• Seal harvesting, including Indigenous harvesting, is conducted in nearshore areas of the RSA and the populations which are harvested (harp, hooded seals) are considered abundant and well-managed.

15.4.4 Potential Cumulative Environmental Effects

As noted earlier, the key potential environmental effects of anthropogenic activities in the Project Area and RSA on Marine Mammals and Sea Turtles is change in habitat quality and use (behavioural effects) as well as change in mortality / injury levels and change in health (related to exposure to contaminants). The assessment below is organized by effect type to facilitate the ease of considering multiple anthropogenic activities on Marine Mammals and Sea Turtles.

15.4.4.1 Change in Injury / Mortality Levels

There are essentially two primary sources of anthropogenic activities in the RSA that may result in cumulative injury/mortality effects with the Project: vessel strikes and entanglement in fishing gear. Underwater sound from Project activities is not expected to result in marine mammal or sea turtle mortality (see Sections 11.3 to 11.5).

In their most recent five-year (2011 to 2015) baleen whale serious injury and mortality determinations, National Oceanic and Atmospheric Administration (NOAA) Fisheries reported an average of six large whale mortalities per year resulting from ship strikes along the east coast of North America, and another seven ship strikes in the region resulting in injury (either serious or non-serious) to the whale (Henry et al. 2017). The actual number of ship strike mortalities is likely much greater due to underreporting, the impossibility of recovering all carcasses, and the difficulty in determining cause of death in many cases. NOAA Fisheries reported that, on average, about 41 large whale mortalities per year during 2011 to 2015 had insufficient information to determine cause of death (Henry et al. 2017). It is uncertain how many marine mammals may be struck by vessels in the RSA. Since 2002, there have been two reports of supply vessels striking a whale at night on the Grand Banks; however, the whales were not re-sighted to allow confirmation of the incidents and such ship strikes are considered rare (Lawson, J., pers. comm., June 2018). While nearly all species of large whale have been involved in vessel strikes (Laist et al. 2001), of greatest concern is the North Atlantic right whale. However, this species is considered uncommon in the RSA and rare in the Project Area.

Based on the information and analysis summarized in Sections 11.3 to 11.5, it is unlikely that Project vessels transiting to and from the Project Area and within the Project Area will strike a marine mammal or a sea turtle. Overall, the risk of Marine Mammals and Sea Turtles incurring injury or experiencing mortality is considered low. This risk is further reduced for SAR given that the rare occurrence of these species, with perhaps the exception of fin whales. Given that the Project is not expected to result in mortality or injury to Marine Mammals and Sea Turtles, there is limited potential for this type of cumulative effect.

Along with vessel strikes, marine mammals are also at increased risk of mortality or injury due to entanglement in fishing gear. Entanglement in fishing gear (particularly longlines) has been identified as a primary threat for sea turtles, including the endangered leatherback and loggerhead sea turtles (COSEWIC 2010d, 2012g). Marine mammals are also at risk of entanglement in fishing gear; this is one of the leading causes of mortality for the North Atlantic right whale (COSEWIC 2013). Given that the Project is not expected to result in mortality or injury to Marine Mammals and Sea Turtles, there is limited potential for cumulative mortality effects.

Underwater sound from anthropogenic activities has the potential to elicit auditory injury (PTS) in Marine Mammals and Sea Turtles. As reviewed in Section 11.3, sound from vessels, the FPSO and drilling installations, are not expected to result in auditory injury or TTS in hearing. Of most concern, is exposure of Marine Mammals and Sea Turtles to strong impulsive sounds from air source arrays. Based on the information and analysis summarized in Section 11.3.5 and with the implementation of mitigation measures, it is unlikely that geophysical surveys conducted for the Project will result in injuries (PTS) for marine mammals or sea turtles. Most marine mammals would have to occur and remain within close range of the air source array, less than 40 m to approximately 160 m, to in theory incur auditory injury. Overall, the risk of Marine Mammals and Sea Turtles incurring hearing impairment (injury) is considered low. This risk is further reduced for SAR given the rare occurrence of these species, with the exception of fin whales (Schedule 1, Special Concern), in the Project Area.

It is probable that geophysical surveys occurring in the Project Area may occur at the same time as other geophysical surveys in the RSA and that marine mammals and possibly sea turtles will be exposed to underwater sound from multiple geophysical surveys. In recent years, there has been as many as three concurrent 3D seismic surveys in slope waters around the Project Area with a concurrent 2D seismic survey offshore Labrador (LGL 2017b). Based on available information and acoustic modelling undertaken for the Project, marine mammals would have to occur within 10s to 100s of metres of an air source array to potentially experience PTS. Adverse auditory effects on Marine Mammals and Sea Turtles, appear unlikely beyond a localized area from the sound source particularly since most marine mammals exhibit at least localized avoidance of an active seismic source. In addition, seismic programs will use mitigation measures such as ramp-ups, delayed start-ups, and shut-downs of the air source arrays as well as spatial separation between seismic surveys (typically a minimum of 30 km; LGL 2017b). Given that the Project is not expected to result in auditory injury to Marine Mammals and Sea Turtles, there is limited potential for this type of cumulative residual effect.

15.4.4.2 Change in Habitat Quality or Use (Behavioural Effects)

Marine Mammals and Sea Turtles within the RSA are routinely exposed to anthropogenic sound from vessel traffic, oil and gas activities, fishing activities and in nearshore areas, marine construction activities. The key question in this assessment is whether behavioural effects (i.e., changes in habitat quality and use) from Project activities will combine in an additive and/or synergistic way with behavioural effects resulting from other anthropogenic activities. As discussed in Section 11.3, behavioural reactions of marine mammals to sound can depend on many factors including species, state of maturity, experience, current activity, reproductive state, and time of day (e.g., Richardson et al. 1995; Ellison et al. 2012); this multitude of factors, along with data gaps, makes effects predictions difficult. If a marine mammal reacts to an underwater sound by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be biologically important to the individual, let alone the stock or population (e.g., New et al. 2013a). However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be serious (Lusseau and Bejder 2007; Weilgart 2007; New et al. 2013b; Nowacek et al. 2015; Forney et al. 2017). Similarly, if masking of sounds of interest to marine mammals occurs regularly and in areas of important habitat, this is of concern. Relative to marine mammals, there is limited information on the effects of underwater sound on sea turtles. Sea turtles are unlikely to experience cumulative effects to the same degree as marine mammals because they are considered rare in the Project Area.

As assessed in Section 11.3, sound from Project activities are not predicted to result in significant residual adverse effects on Marine Mammals and Sea Turtles. A review of available literature and results of acoustic modelling indicate that marine mammals may exhibit avoidance responses to continuous sound sources (i.e., drilling, FPSO, vessels) at distances ranging from 3.6 km to 34 km; this conservatively assumes a 120 dB re 1 μPa rms criterion for avoidance. For impulsive sound sources (i.e., seismic surveys, MBES), results of acoustic modelling indicate that marine mammals may exhibit avoidance at distances ranging from 135 m to 20.1 km, based on a 160 dB re 1μPa rms criterion. These criteria are intended to serve as a tool in effects assessment and marine mammal response will vary greatly depending on many factors (see above). Given that there will be several concurrent Project activities within the Core BdN Development Area year-round for 12 to 20 years (plus Potential Future Development activities in the larger Project Area for an additional 10 to 18 years), there is potential that some marine mammals may exhibit longer-term avoidance of the Sackville Spur area. However, most evidence of marine mammal response to long-term marine projects and/or anthropogenic activities is that they habituate to underwater sound in the area.

Marine mammals may exhibit localized and likely short-term avoidance of fishing vessels, transiting vessels, and existing production facilities in the Jeanne d'Arc Basin (see Section 11.3.4 for a review of marine mammal response to vessels). Continuous underwater sound and other environmental disturbances are generated by the production facilities and attending supply vessels at Hibernia, Terra Nova, Hebron, and White Rose. Transient sound is generated by associated shuttle tankers and supply vessels transiting to and from each of these production facilities. There will be limited potential for cumulative effects of the Project due to the separation distances between the Project Area and existing production facilities (i.e., >118 km). It is also unlikely that short-term and localized effects experienced by a marine mammal at Jeanne d'Arc production fields would lead to additive cumulative effects for that individual that may move to the Project Area. As discussed in Section 11.3.2.1 and 11.3.3.1, any displacement from production platforms (and drilling installations) is likely to be localized. Sea turtles are considered uncommon in Jeanne d'Arc Basin and rare in the Project Area.

There is some potential for cumulative effects from underwater sound from fishing vessels and Project activities. However, this potential is reduced because fishing activities mainly occurs in the western portion of the Project Area only, primarily outside of the Core BdN Development Area and the number of fishing vessels active in the area at a given time is limited. Anti-collision zones around the FPSO and drilling installation(s) where fishing vessels are not expected to occur will limit potential for overlap, and thus, additive or synergistic cumulative behavioural effects on this VC are unlikely. It is also unlikely that short-term and localized behavioural effects experienced by a marine mammal near a fishing vessel outside of the Project Area would lead to additive cumulative effects for that individual that may move to the Project Area.

The potential for cumulative behavioural effects from underwater sound from marine traffic and Project activities is reduced because the Project Area is distant from major shipping routes to North America as well as the primary shipping route into St. John's (see Figure 2 in Maxner et al 2018) and thus, additive or synergistic cumulative behavioural effects on marine mammals (and sea turtles) are unlikely. It is also unlikely that short-term and localized behavioural effects experienced by a marine mammal near a transiting vessel outside of the Project Area would lead to additive cumulative effects for that individual that may move to the Project Area.

Whereas the sounds generated by the Project FPSO, standby vessels (SBVs) and offshore supply vessels (OSVs), and offshore production facilities in the Jeanne d'Arc Basin are continuous and occur year-round for multiple years, sounds generated by exploratory drilling and geophysical surveys are considered relatively short-term in nature. However, geophysical surveys generate higher sound levels which are impulsive. As noted above, it is probable that geophysical surveys occurring in the Project Area may occur at the same time as other geophysical surveys in the RSA and that marine mammals and possibly sea turtles will be exposed to underwater sound from multiple geophysical surveys. In recent years, there has been as many as three concurrent 3D seismic surveys in slope waters around the Project Area with a concurrent 2D seismic survey offshore Labrador (LGL 2017b). It is uncertain how a marine mammal will respond to sound arriving from multiple sources and possibly from multiple directions. However, for seismic surveys in the Sackville Spur area, sound is not expected to propagate well to shelf waters (i.e., water depths 100 m to 300 m). Based on modelling of a representative air source array inside the Core BdN Development Area, sound levels in shelf waters (>150 km away) will reach values of 90 to 95 dB re 1μPa and the non-weighted SEL decreases to 130 to 135 dB re 1 $\mu Pa^2 s$ (Zykov 2018 in Appendix D). As such, whales in shelf waters are not predicted to experience behavioural effects from a seismic survey in the Project Area. Whales in the Sackville Spur and Flemish Pass area, which based on available data are thought to be primarily odontocetes and possibly fin whales, may exhibit avoidance responses. Concurrent seismic surveys typically maintain a minimum separation distance of 30 km but could be separated by hundreds of kilometres as was the case for seismic surveys in 2017 in the Flemish Pass area (LGL 2017b); this spatial separation should reduce the potential for additive and/or synergistic cumulative effects. There is uncertainty whether the Sackville Spur and/or adjacent Flemish Pass provides important marine mammal habitat. There is evidence to suggest that odontocetes and fin whales regularly occur there (Delarue et al. 2018).

As discussed in Section 11.3, Project activities are not expected to result in significant residual adverse effects related to masking of sound used by marine mammals. Multiple sound sources in and adjacent to the Project Area increase the potential for masking. However, the potential for masking of marine mammal calls and / or important environmental cues is considered limited from drilling installations, vessel traffic, and FPSOs given the relatively low source level and attenuation of sound to levels below measured ambient levels in the region (Delarue et al. 2018; Zykov 2018 in Appendix D). Masking effects of pulsed sounds (even from large arrays of air sources) on marine mammal calls and other natural sounds are generally expected to be limited, although there are few specific data on this (see Appendix 4 of LGL 2015). Due to the intermittent nature and low duty cycle of seismic pulses, marine mammals and sea turtles can emit (in the case of marine mammals) and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are considered infrequent. The degree to which reverberation will contribute to potential masking for marine mammals in and near the Project Area is uncertain. A desktop analysis of seismic reverberation at the southern end of Flemish Pass was undertaken for this Project (Maxner et al. 2018 in Appendix L). The analysis indicated that the listening space of mysticetes is substantially reduced for at least half of the inter-pulse period when the seismic vessel is within 15 km of a whale. In contrast, the analysis indicated that masking of odontocete clicks and whistles did not occur during the seismic survey. This suggests that at least for mysticetes in deep water near the Project Area, that masking of sounds may occur during seismic surveys—the implication of masking is uncertain; however, masking effects are likely minimized by the ability of some cetaceans to modify their vocal behaviour (change their calling rates, shift their peak frequencies) in response to anthropogenic sounds (e.g., Blackwell et al. 2015) and that marine mammals have mechanisms that enhance the detectability of signals in the presence of sound including spatial release, comodulation masking release, as well as the within valley (or “dip”) listening strategy (see Erbe et al. 2016 for a review).

15.4.4.3 Change in Health (Contaminants)

Marine Mammals and Sea Turtles may also be affected by discharges from vessels, the FPSO and drilling installations, as well as effects on their prey. As discussed in Section 11.3, changes in marine mammal and sea turtle health resulting from Project discharges were predicted to be negligible to low in magnitude. Vessels operating in the RSA typically remain at specified distances from active offshore exploration and production drilling and geophysical programs in the region. These separation distances along with adherence to OWTG (NEB et al. 2010) and/or MARPOL (as applicable) are expected to reduce the potential for cumulative effects between routine operational and waste discharges from the Project and non-Project sources. With the implementation of standard mitigation measures, routine discharges from vessels and offshore oil installations are not expected to result in a measurable change in health for Marine Mammals and Sea Turtles.

15.4.5 Species at Risk

Eleven of the marine mammals and sea turtle species that are known or expected to occur in the Project Area and/or RSA are listed as Endangered or of Special Concern under Schedule 1 of SARA, or identified as species of conservation concern by COSEWIC.

These SAR / SOCC include four listed mysticete species:

- The Atlantic population of blue whale is listed as Endangered under Schedule 1 of SARA; there may be fewer than 250 adult individuals, and recruitment appears to be low (COSEWIC 2002). Blue whales may be sensitive to large-scale climatic shifts that could alter prey abundance, in addition to localized threats such as vessel strikes, pollution, underwater sound, and interaction with fishing and whale-watching activities (COSEWIC 2002; DFO 2018b).
- The North Atlantic right whale population is listed as Endangered under Schedule 1 of SARA because of the relatively small size of the population and the prevalence of threats (COSEWIC 2013). The best estimate for the western North Atlantic population is 451 individuals (Pettis et al. 2017), but the population size has been declining since 2010 (Pace et al. 2017). In recent years, this is largely attributable to increased interaction with fishing equipment and the growing incidence of ships striking individuals offshore NS, particularly females of reproductive age (COSEWIC 2013). Other threats as identified in the Recovery Strategy (DFO 2014) and proposed Action Plan (DFO 2016b) for this species include exposure to contaminants, acoustic disturbances, vessel presence disturbances, and changes in prey availability and quality.
- The Eastern Canada-West Greenland population of bowhead whale remains listed as a species of Special Concern by COSEWIC, despite a recent rise in numbers to an estimated 6,000 to 7000 individuals from post-commercial whaling lows (COSEWIC 2009a; Doniol-Valcroze et al. 2015; Fraiser et al. 2015). The continued listing of this bowhead whale population reflects uncertainty surrounding how the whales will respond to climate-associated changes in habitat, in addition to the increased industrial activity that such changes could facilitate in their habitat (COSEWIC 2009a).
- The Atlantic population of fin whale is listed as a species of Special Concern under Schedule 1 of SARA. Trends in population abundance are uncertain as is how anthropogenic threats may affect this population (COSEWIC 2005). The key threats to fin whales as identified by DFO in the Management Plan for this species are habitat degradation from anthropogenic sound, changes in prey availability and quality, ship strikes, and entanglement in fishing gear (DFO 2017a).

Five listed odontocete species have the potential to occur in the Project Area and RSA:

- The Scotian Shelf population of northern bottlenose whale is listed as Endangered both under Schedule 1 of SARA and by COSEWIC, whereas the Davis Strait-Baffin Bay-Labrador Sea population is listed as a species of Special Concern by COSEWIC. The Scotian Shelf population is estimated at 143 individuals (O'Brien and Whitehead 2013), but there are no estimates of the size of the Davis Strait-Baffin Bay-Labrador Sea population or the total number of northern bottlenose whales in the Northwest Atlantic (COSEWIC 2011). Threats to northern bottlenose whale include entanglement in fishing gear, acoustic disturbance from oil and gas activities (including geophysical surveys), and exposure to contaminants (COSEWIC 2011; DFO 2017b).

- The Atlantic population of Sowerby's beaked whale is listed as a species of Special Concern both under Schedule 1 of SARA and by COSEWIC. There are currently no estimates for the size of this population in Atlantic Canada (COSEWIC 2007b; DFO 2017c). Threats to this population include acoustic disturbance, entanglement in fishing gear, vessel strikes, and exposure to contaminants (COSEWIC 2007b; DFO 2017c).
- The Northwest Atlantic-Eastern Arctic population of killer whale is listed as a species of Special Concern by COSEWIC. The number of individuals in this population is unknown, though it believed there are fewer than 1,000 mature individuals, and likely less than 250 (COSEWIC 2009b). Despite this population's small size, the number of killer whale sightings in eastern Canada have been more frequent over the past decade (NOAA 2015). The main threats facing killer whales are disturbance (both physical and acoustic), prey depletion, and contaminants, though the exact threats facing the Northwest Atlantic/Eastern Arctic population are not well documented (COSEWIC 2009b).
- The St. Lawrence Estuary population of beluga whale is listed as Endangered under Schedule 1 of SARA. The relatively recent (1979) cessation of commercial whaling has resulted in a severely depleted population and recovery may be hampered by pollutants in their habitat as contaminant levels are high in the tissue of belugas from this area (COSEWIC 2014). The prevalence of threats such as pollution, industrial activity, sound, and disease, coupled with decreased juvenile survival mean that the risk to this population continues to increase (COSEWIC 2014).
- The Northwest Atlantic population of harbour porpoise is listed as a species of Special Concern by COSEWIC and Threatened under Schedule 2 of SARA. Range-wide estimates for the abundance of harbour porpoise in eastern Canada do not exist, however, this population is considered to be abundant in the region (COSEWIC 2006). The most important recent and current threat to this population is the susceptibility of harbour porpoises to bycatch in fishing gear. The relatively secure status of this population is due, in large part, to measures taken to restore groundfish stocks rather than to conserve harbour porpoises, and it is likely that bycatch will increase significantly if groundfish stocks recover in the region (COSEWIC 2006).

Two listed species of sea turtles have the potential to occur in the Project Area and/or RSA:

- The Atlantic population of leatherback sea turtle is listed as Endangered both under Schedule 1 of SARA and by COSEWIC. Sightings data suggest that the population in Atlantic Canadian waters numbers in the thousands, and although current data are insufficient to determine fluctuations and trends in this population, most major Northwest Atlantic nesting populations are thought to be secure or increasing slightly (COSEWIC 2012f). The main threat facing this population is bycatch in fisheries, though globally, the species is threatened by ship strikes, marine debris, oil and gas exploration, the poaching of eggs, and the effects of climate change on nesting beaches and marine habitat (COSEWIC 2012f).
- The Atlantic population of loggerhead sea turtle is listed as Endangered both under Schedule 1 of SARA and by COSEWIC. Based on bycatch records, it has been determined that this species has a substantive presence in Atlantic Canadian waters, though the size of this population is not known (COSEWIC 2010d). This population is

threatened by commercial fishing, particularly as bycatch in the pelagic longline fleet, and by loss and degradation of nesting beaches in the southeastern USA and the Caribbean (COSEWIC 2010d). Globally, loggerhead sea turtles face threats due to poaching, construction and development on nesting beaches, pollution, and climate change (COSEWIC 2010d).

The RSA is, in general, a productive area for Marine Mammals and Sea Turtles and there are a number of Ecologically and Biologically Significant Areas (EBSAs) that intersect the area, some of which represent important foraging habitat and migratory routes for these species. No critical habitat for marine mammals or sea turtles has been designated in the Project Area or in the RSA. However, there are indications that the Sackville Spur area is regularly used by northern bottlenose whales and Sowerby's beaked whales. It is uncertain whether these areas provide important habitat to these beaked whale species (and secure marine mammals species like sperm whales).

The main potential environmental interactions between the Project, other projects and SAR are the same as those for the Marine Mammals and Sea Turtles VC as a whole. These species are highly mobile, and many have broad ranges and show large movements across annual migration routes. Large seasonal and even daily variations in presence and abundance within the Project Area and RSA are therefore likely. Although the widespread and often migratory nature of some species increases the potential for individuals and populations to be affected by multiple perturbations, these mobile species likewise have capability for avoidance. While there is some potential for overlap and interaction between the Project and other projects and activities (particularly with respect to underwater sound), cumulative effects are likely to be transient and temporary in nature without significant adverse cumulative effects on individuals or populations. Cumulative effects would pose more of an issue for a marine mammal species that has a finite habitat range and in areas considered important for foraging, migrating, nursing, and/or breeding. There is limited information to ascertain whether the Sackville Spur area (i.e., the Project Area) provides important habitat for marine mammals.

15.4.6 Cumulative Effects Summary and Evaluation

Table 15.10 summarizes the results of the cumulative effects assessment for the Marine Mammal and Sea Turtle VC. As assessed here, the Project is unlikely to result in significant adverse cumulative environmental effects on Marine Mammals and Sea Turtles (including SAR) in combination with other projects and activities that have been or will be carried out. The relative contribution of the residual effects of the Project to cumulative effects on this VC within the overall RSA is generally predicted to be low for most marine mammal species and for sea turtles. However, there is some uncertainty associated with this prediction, particularly for a scenario involving concurrent Project drilling and seismic surveys with additional non-project seismic surveys (possibly two or more) near the Project Area.

Table 15.10 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and Ongoing Activities)	• Species that occur in the RSA may experience cumulative effects from the Project in combination with other projects and activities include: 23 species of cetaceans, of which 7 are mysticetes (baleen whales) and 16 are odontocetes (toothed whales); 4 species of phocids (seals); and 2 species (possibly 4) of sea turtles. • While some of these species are migratory, others may be present in the Project Area and adjacent areas year-round. • Eleven of these species are SAR listed under Schedule 1 of SARA or have been identified as SOCC by COSEWIC. • EBSAs, some of which represent important foraging habitat and migratory routes for Marine Mammals and Sea Turtles, intersect the RSA. • There is no overlap with designated critical habitat for marine mammals or sea turtles in the Project Area or RSA. • There are indications that the Sackville Spur area is regularly used by northern bottlenose whales and Sowerby's beaked whales. It is uncertain whether these areas provide important habitat to these beaked whale species (and secure marine mammals species like sperm whales).
Residual Environmental Effects of the Project	• The Project may result in residual changes in habitat quality or use, prey availability or quality, health, and/or injury levels for Marine Mammals and Sea Turtles, including secure species and SAR. Changes in mortality level are considered highly unlikely. These potential residual effects are predicted to be not significant and the Project is not expected to result in overall ecological or population-level effects on Marine Mammals and Sea Turtles. • This prediction is generally made with a moderate level of confidence given that there are uncertainties in predicting the effects of the Project on Marine Mammals and Sea Turtles (refer to Section 11.5). More specifically, there is uncertainty as to whether the Project Area or certain portions of the Project Area are regularly used and important foraging areas, migratory corridors, and/or breeding areas for marine mammals—particularly northern bottlenose whales.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia	Continuous underwater sound and other environmental disturbances are generated by the production facility and attending supply vessels. Transient sound is generated by associated shuttle tankers and supply vessels transiting to and from Hibernia. There will be limited potential for cumulative effects of the Project due to the separation distances between the Project Area and Hibernia (i.e., approximately 157 km). It is also unlikely that short-term and localized effects experienced by a marine mammal at Hibernia would lead to additive cumulative effects for that individual that may move to the Project Area. Sea turtles are considered uncommon at Hibernia and rare in the Project Area.

Table 15.10 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles

Summary of Potential Cumulative Environmental Effects	
Terra Nova	Continuous underwater sound and other environmental disturbances are generated by the FPSO and attending supply vessels. Transient sound is generated by associated shuttle tankers and supply vessels transiting to and from Terra Nova. There will be limited potential for cumulative effects of the Project due to the separation distances between the Project Area and Terra Nova (i.e., approximately 166 km). It is also unlikely that short-term and localized effects experienced by a marine mammal at Terra Nova would lead to additive cumulative effects for that individual that may move to the Project Area. Sea turtles are considered uncommon at Terra Nova and rare in the Project Area.
White Rose and Extension Project	Continuous underwater sound and other environmental disturbances are generated by the FPSO and attending supply vessels. Transient sound is generated by associated shuttle tankers and supply vessels transiting to and from White Rose. There will be limited potential for cumulative effects of the Project due to the separation distances between the Project Area and White Rose (i.e., approximately 118 km). It is also unlikely that short-term and localized effects experienced by a marine mammal at White Rose would lead to additive cumulative effects for that individual that may move to the Project Area. Sea turtles are considered uncommon at White Rose and rare in the Project Area.
Hebron	Continuous underwater sound and other environmental disturbances are generated by the production platform and attending supply vessels. Transient sound is generated by associated shuttle tankers and supply vessels transiting to and from Hebron. There will be limited potential for cumulative effects of the Project due to the separation distances between the Project Area and Hebron (i.e., approximately 160 km). It is also unlikely that short-term and localized effects experienced by a marine mammal at Hebron would lead to additive cumulative effects for that individual that may move to the Project Area. Sea turtles are considered uncommon at Hebron and rare in the Project Area.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	Underwater sound generated by geophysical surveys (especially concurrent seismic surveys) near the Project Area, particularly in deep waters, has the potential for cumulative effects (avoidance and masking) on marine mammals. There is limited potential for auditory injury, particularly given mitigation measures that will be implemented (as per the SOCP). The effects of a single geophysical seismic survey are expected to result in localized and temporary behavioural effects on marine mammals (and sea turtles which may occur in the area); however, there is some uncertainty in how marine mammals will respond to potentially, multiple concurrent seismic surveys.
Offshore Petroleum Exploration – Drilling	Continuous underwater sound and other environmental disturbances are generated by the drilling installation and attending supply vessels. Behavioural effects are predicted to be localized and short-term particularly given the relatively low source level and attenuation of drilling sound at short ranges to levels below measured ambient levels. In addition, it is unlikely that short-term and localized effects experienced by a marine mammal (and sea turtle) during exploration drilling would lead to additive cumulative effects for an individual that may move to the Project Area.

Table 15.10 Summary of Potential Cumulative Environmental Effects: Marine Mammals and Sea Turtles

Summary of Potential Cumulative Environmental Effects	
Fishing Activity	Marine mammals and sea turtles may be affected by commercial fishing activities through entanglement in fishing gear resulting in mortality or injury. Marine mammals and sea turtles may exhibit localized and short-term avoidance of fishing vessels. Given that the Project is not expected to result in mortality or injury to marine mammals and sea turtles, there is limited potential for this type of cumulative effect. There is some potential for cumulative effects from underwater sound from fishing vessels and Project activities. However, this potential is reduced because fishing activities occur in select parts of the Project Area only, primarily in the western and northern section, outside of the Core BdN Development Area and the number of fishing vessels active in the area at a given time is limited. Additive or synergistic cumulative behavioural effects on this VC are unlikely. It is also unlikely that short-term and localized behavioural effects experienced by a marine mammal near a fishing vessel outside of the Project Area would lead to additive cumulative effects for that individual that may move to the Project Area.
Other Marine Vessel Traffic	Underwater sound generated from vessel traffic may result in changes in behaviour and there is increased risk of vessel strikes resulting in mortality or injury. Given that the Project is not expected to result in mortality or injury to marine mammals and sea turtles, there is limited potential for this type of cumulative effect. There is potential for cumulative behavioural effects from underwater sound from marine traffic and Project activities. However, this potential is reduced because the Project Area is distant from major shipping routes to North America as well as the primary shipping route into St. John's (see Figure 7-45). Additive or synergistic cumulative behavioural effects on this VC are unlikely. It is also unlikely that short-term and localized behavioural effects experienced by a marine mammal near a transiting vessel outside of the Project Area would lead to additive cumulative effects for that individual that may move to the Project Area.
Other Harvesting Activity	Seal harvesting (harp and hooded seals) in nearshore areas of the RSA will result in mortalities. Given that the Project is not expected to result in mortality or injury to seals, there is very limited potential for this type of cumulative effect.
Cumulative Effects Summary	Project components and activities are not likely to result in significant residual adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out in the RSA. There is a moderate level of confidence with this effects prediction particularly regarding the effects of underwater sound from multiple exploration activities and Project activities on marine mammals in and near the Project Area.

15.5 Special Areas

Various marine and coastal areas in NL have been designated as protected under provincial, federal and/or other legislation or agreements due to their ecological, historical or socio-cultural characteristics and importance. Other areas have been formally identified as being special or sensitive through relevant processes and initiatives. These special areas are described in detail in Section 6.4 of this EIS.

15.5.1 Past and Ongoing Effects (Baseline)

Offshore NL is subject to various types of anthropogenic activities that may result in adverse effects to the marine environment. These activities include marine transportation that has occurred for hundreds of years. Commercial fisheries have also occurred in the waters off NL for centuries but fishing, and particularly bottom-contact fishing, in the Flemish Pass area intensified with technological advances of the 20th century. This activity has been the focus of identification and protection of various types of special areas off NL due to the presence of sensitive benthic habitats. Oil and gas exploration has occurred off NL for approximately 50 years with production in the past 20 years, as discussed above.

Direct or indirect changes to the existing natural or human environments in the area resulting from Project-related interactions (e.g., the presence of Project-related facilities, equipment, personnel, and activities within a special area, and associated emissions and discharges) may affect the key environmental characteristics and processes that define and distinguish these areas, and thus, affect their overall and underlying characteristics, integrity, and value. Identified biophysical effects have potential to spread to adjacent Special Areas by affecting the marine fish, birds, mammals or other environmental components that move through these areas.

The current environmental conditions within the existing, identified Special Areas off eastern NL reflect the occurrence and environmental consequences of past and ongoing anthropogenic activities and natural processes within and beyond their boundaries, as well as those that may have affected the larger natural and socioeconomic features and processes that characterize and influence them. Special Areas are identified and designated to recognize their importance and / or protect particularly important or sensitive environmental features. In certain cases, this is based on the objective of conserving the presently pristine nature of these areas, while in other cases their designation is intended to help prevent further damage to already affected and sensitive environmental features and components.

15.5.2 Potential Project-Related Contributions to Cumulative Effects

Many of the identified Special Areas in eastern NL are in nearshore and onshore areas outside of the LSA and thus will not have direct contact with, or be within the zone of influence of, Project-related activities. These Special Areas include provincial (ecological reserves, parks and protected areas and historic sites), national (Marine Protected Areas [MPAs], Marine Refuges, Migratory Bird Sanctuaries [MBSs], parks, and historic sites) and international (World Heritage Sites [WHSs] and Important Bird Areas [IBAs]) designations, none of which will be directly affected by the Project. Three Special Areas, or portions of them, in the offshore NL area, overlap with the Core BdN Development Area. These include the Slopes of the Flemish Cap and Grand Bank United Nations Convention on Biological Diversity (UNCBD) EBSA, a Vulnerable Marine Ecosystem (VME) identified for Sea Pens and the Northwest Flemish Cap (10) NAFO Fisheries Closure Area (FCA), which have all been identified due to the presence of sensitive benthic habitat. NAFO FCAs are closed to bottom-contact fishing. The Slopes of the Flemish Cap and Grand Bank is also identified for a high diversity of marine taxa and a potation of the Greenland halibut fishery in international waters though it is not known if these features intersect the Project Area. The Project Area intersects these Special Areas and four other VMEs (i.e., three identified for Sponges and one for Large Gorgonian Corals).

Eighteen (18) other Special Areas (not including those that intersect with the Core BdN Development Area and Project Area) intersect or overlap with the LSA, including the vessel traffic route. Some of the special areas intersecting with the LSA are also identified for sensitive benthic habitats and to lesser extents for bird habitat (e.g., seabirds, waterfowl), fish, marine mammals (e.g., cetaceans, pinnipeds, seals) and leatherback sea turtles. Two Special Areas are historic sites and seven have fishing restrictions. None of the Special Areas that intersect with the Core BdN Development Area or Project Area are subject to prohibitions related to offshore oil and gas activities.

Changes to the environment resulting from offshore oil and gas activities and their potential effects on Special Areas may be both direct and indirect in nature and cause. For example, the conduct of oil and gas exploration and development activities within or near Special Areas may have adverse implications for these locations and their important and defining ecological and socio-cultural characteristics. Direct environmental effects may result from the presence of oil and gas production facilities, drilling installations, vessels, aircraft, other equipment, drilling, supporting surveys (e.g., geophysical, seismic, sampling), personnel and activities along with associated discharges, light, sound and other emissions, resulting in environmental disturbances. Biophysical effects may spread to adjacent Special Areas through marine fish, birds or mammals that move to and through these areas. Biophysical effects resulting from offshore oil and gas or other human activities either within or outside of these areas may also indirectly affect them by affecting the marine fish, birds, mammals or other environmental components and systems that are relevant to their identification and their key and relevant characteristics and importance. An associated decrease in the real or perceived integrity of these sites in the short- or long-term may, in turn, affect their ecological and / or socio-cultural importance, value and, where applicable, the use and enjoyment of these areas.

As described in Chapter 12, based on the nature and characteristics of the Project, the existing environment for this VC within the LSA and RSA, and planned mitigations, the Project is not likely to result in significant residual adverse effects on Special Areas.

15.5.3 Other Projects and Activities and Their Effects

Ongoing and other future projects and activities that may affect Special Areas include fisheries, general vessel traffic, and other current and planned offshore oil and gas production and exploration activities, as listed in Table 15.11. Their overlap with identified Special Areas is shown in Figure 15-2 (legend for Figure 15-2 is provided in Table 15.12).

The cumulative effects assessment considers the effects of interactions on these areas, and thus, potential effect on their overall and underlying characteristics, integrity, and value.

Table 15.11 Special Areas: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia	• Change in environmental features and/or processes • Change in human use and/or societal value	• Hibernia has a small and well-defined footprint, which does not overlap with existing special areas. • Hibernia has been producing oil year-round since 1997 and is expected to be in production until at least 2040.
Terra Nova		• Terra Nova has a small and well-defined footprint, which does not overlap with existing special areas. • Terra Nova, which operates year-round, began producing oil in 2002 with an estimated production life of 25 years.
White Rose and Extension Project		• White Rose has a small and well-defined footprint, which does not overlap with existing special areas. • White Rose, which operates year-round, achieved first oil in 2005 and is expected to produce oil until at least 2020.
Hebron		• Hebron has a small and well-defined footprint, which does not overlap with existing special areas. • Hebron, which operates year-round, began producing oil in 2017 with an estimated life of 30 years.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities		• Although the large survey areas covered by some types of offshore geophysical surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, most survey activities operate for a short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence overall.
Offshore Petroleum Exploration – Drilling		• Exploration drilling activities are typically relatively short-term and localized. This can reduce the potential for the residual effects of exploration drilling programs to overlap spatially and temporally with the residual effects of other projects and activities in such a way that cumulatively affects Special Areas. • If the Project's drilling activities were to occur concurrently with another exploration drilling program, the required 500 m safety zone for each installation, will ensure a minimum separation distance of 1 km. Based on drill cuttings modelling completed for the Project, deposition of cuttings is predicted to be within 200 m from a wellhead, and therefore likely confined within the safety zone. Spatial overlap of cuttings is not predicted.

Table 15.11 Special Areas: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Fishing Activity	• Change in environmental features and/or processes • Change in human use and/or societal value	• Commercial fishing activity in the region is extensive and diverse, involving a variety of participants, species, gear types, and occurs year-round. • Fishing activity takes place within Special Areas (such as EBSAs) unless otherwise prohibited (e.g., bottom fishing activities within FCAs, see below) • The Northwest Flemish Cap coral closure (NAFO FCA) and the Sackville Spur coral, sponge, and sea pen closure (NAFO VME), which overlap portions of the Project Area, are closed to bottom-contact fishing. Commercial fishing activities will also be excluded from the anti-collision zones around the FPSO and/or drilling installation(s). Except where noted above, commercial fishing activity has potential to occur anywhere else in the Project Area. However, the level of commercial fishing effort in the Project Area is relatively low and is primarily concentrated in the western portion of the Project Area. Fishing activity is most intense in the summer months (May to August).
Other Marine Vessel Traffic		• Marine vessel traffic occurs in the offshore year-round but some sectors, such as the cruise ship industry, may be more active from spring to fall. • Vessels are highly transitory, reducing effects in a given location and time.
Other Harvesting Activity		• The potential presence in Special Areas of vessels engaged in harvesting of marine and migratory birds (specifically, murres and waterfowl) and mammals (seals) may result in a change in habitat quality and use for marine species within the affected special area(s). • There is no known harvesting activity within Special Areas offshore, nor targeting key species relevant to their designations.

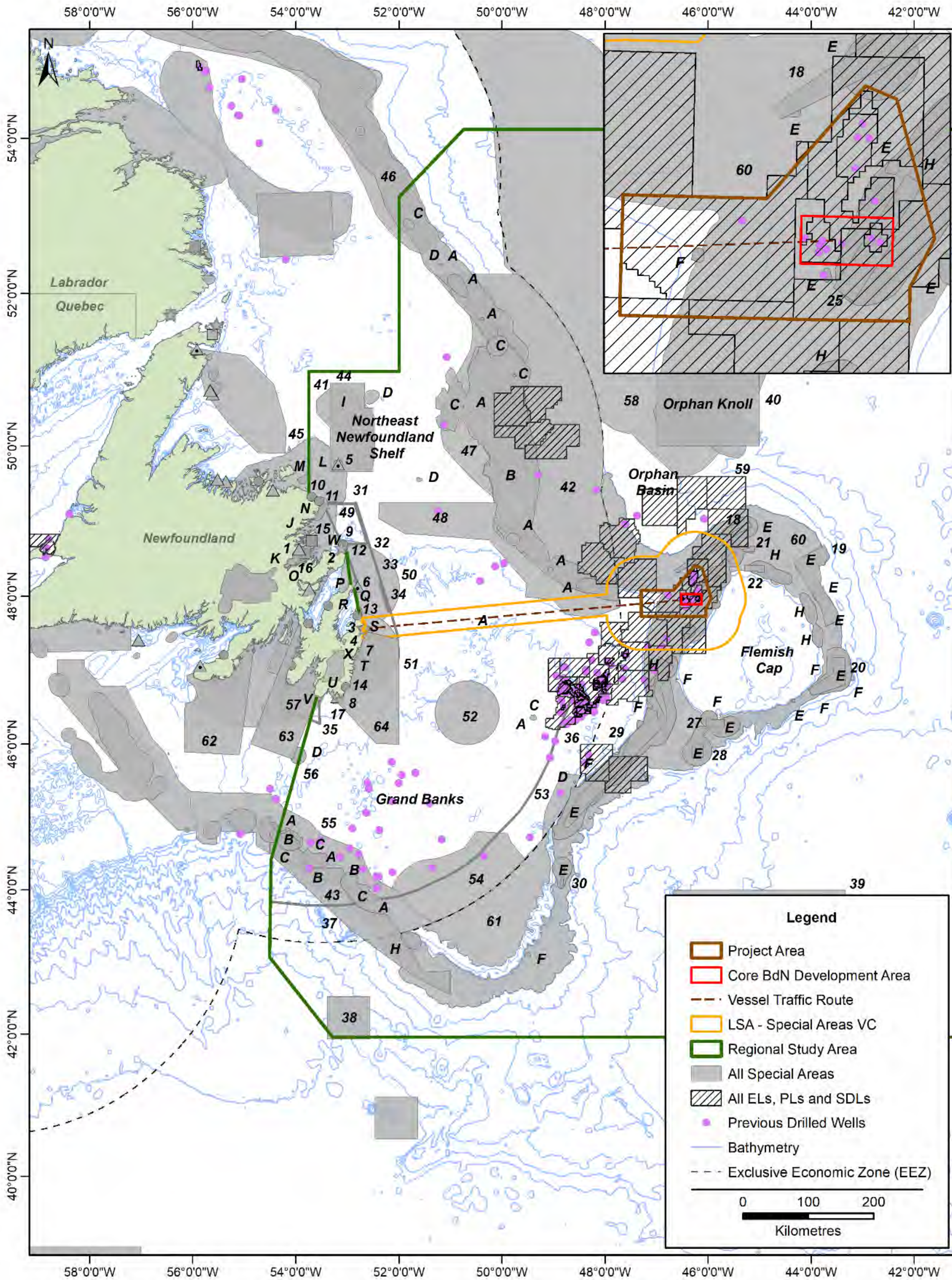

Figure 15-2 Special Areas and Oil and Gas Activities in Offshore Newfoundland

Table 15.12 Legend for Figure 15-2

Map Reference	Special Area
1	Terra Nova Migratory Bird Sanctuary
2	Ryan Premises National Historic Site
3	Signal Hill National Historic Site
4	Cape Spear National Historic Site
5	Funk Island Seabird Ecological Reserve
6	Baccalieu Island Seabird Ecological Reserve
7	Witless Bay Seabird Ecological Reserve
8	Mistaken Point Fossil Ecological Reserve
9	Cape Bonavista Lighthouse Historic Site
10	Deadman's Bay Provincial Park
11	Cape Bonavista Lighthouse Historic Site
12	The Dungeon Provincial Park
13	Hearts Content Cable Station Historic Cite
14	Chance Cove Provincial Park
15	Eastport – Duck Islands Marine Protected Area
16	Eastport – Round Island Marine Protected Area
17	Mistaken Point Ecological Reserve World Heritage Site
18	Sackville Spur (6) NAFO Fisheries Closure Area
19	Northeast Flemish Cap (5) NAFO Fisheries Closure Area
20	Eastern Flemish Cap (4) NAFO Fisheries Closure Area
21	Northern Flemish Cap (8) NAFO Fisheries Closure Area
22	Northern Flemish Cap (7) NAFO Fisheries Closure Area
23	Northern Flemish Cap (9) NAFO Fisheries Closure Area
24	Northwest Flemish Cap (12) NAFO Fisheries Closure Area
25	Northwest Flemish Cap (10) NAFO Fisheries Closure Area
26	Northwest Flemish Cap (11) NAFO Fisheries Closure Area
27	Beothuk Knoll (13) NAFO Fisheries Closure Area
28	Beothuk Knoll (3) NAFO Fisheries Closure Area
29	Flemish Pass/Eastern Canyon (2) NAFO Fisheries Closure Area
30	Tail of the Bank (1) NAFO Fisheries Closure Area
31	Crab Fishing Area 5A (2 zones) Snow Crab Stewardship Exclusion Zone
32	Crab Fishing Area 6A (2 zones) Snow Crab Stewardship Exclusion Zone
33	Crab Fishing Area 6B Snow Crab Stewardship Exclusion Zone
34	Near Shore (2 zones) Snow Crab Stewardship Exclusion Zone
35	Crab Fishing Area 9A (2 zones) Snow Crab Stewardship Exclusion Zone

Table 15.12 Legend for Figure 15-2

Map Reference	Special Area
36	Crab Fishing Area – 8BX Snow Crab Stewardship Exclusion Zone
37	30 Coral Area Closure NAFO Fisheries Closure Area
38	Fogo Seamounts (1) NAFO Fisheries Closure Area
39	Newfoundland Seamounts NAFO Fisheries Closure Area
40	Orphan Knoll Seamount NAFO Fisheries Closure Area
41	Funk Island Deep Closure Marine Refuge
42	Northeast Newfoundland Slope Closure Marine Refuge
43	30 Coral Closure (portion inside EEZ) Marine Refuge
44	Notre Dame Channel Ecologically and Biologically Significant Area
45	Fogo Shelf Ecologically and Biologically Significant Area
46	Labrador Slope E Ecologically and Biologically Significant Area BSA
47	Orphan Spur Ecologically and Biologically Significant Area
48	Northeast Slope Ecologically and Biologically Significant Area
49	Bonavista Bay Ecologically and Biologically Significant Area
50	Baccalieu Island Ecologically and Biologically Significant Area
51	Eastern Avalon Ecologically and Biologically Significant Area
52	Virgin Rocks Ecologically and Biologically Significant Area
53	Lilly Canyon-Carson Canyon Ecologically and Biologically Significant Area
54	Southeast Shoal Ecologically and Biologically Significant Area
55	Southwest Slope Ecologically and Biologically Significant Area SA
56	Haddock Channel Sponges Ecologically and Biologically Significant Area
57	St. Mary's Bay Ecologically and Biologically Significant Area
58	Seabird Foraging Zone in the Southern Labrador Sea CBD Ecologically and Biologically Significant Area
59	Orphan Knoll CBD Ecologically and Biologically Significant Area
60	Slopes of the Flemish Cap and Grand Bank CBD Ecologically and Biologically Significant Area
61	Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank CBD Ecologically and Biologically Significant Area
62	Representative Marine Area I- South Burin / St. Pierre Bank
63	Representative Marine Area II- West Avalon/Green Bank-
64	Representative Marine Area III- East Avalon/Grand Banks
A	Large Gorgonian Corals Significant Benthic Area
B	Sea Pens Significant Benthic Area
C	Small Gorgonian Corals Significant Benthic Area

Table 15.12 Legend for Figure 15-2

Map Reference	Special Area
D	Sponges Significant Benthic Area
E	Sponge Vulnerable Marine Ecosystem
F	Large Gorgonian Coral Vulnerable Marine Ecosystem
H	Sea Pen Vulnerable Marine Ecosystem
I	Funk Island Deep Box Fisheries Closures Area
J	Eastport Lobster Management Area Fisheries Closures Area
K	Terra Nova National Park
L	Funk Island Important Bird Area
M	Wadham Islands and adjacent Marine Area Important Bird Area
N	Cape Freels Coastline and Cabot Island Important Bird Area
O	Terra Nova National Park Important Bird Area
P	Grates Point Important Bird Area
Q	Baccalieu Island Important Bird Area
R	Cape St. Francis Important Bird Area
S	Quidi Vidi Lake Important Bird Area
T	Witless Bay Islands Important Bird Area
U	Mistaken Point Important Bird Area
V	The Cape Pine and St. Shotts Barren Important Bird Area
W	Dungeon Provincial Park
X	Crab Fishing Area 6C Snow Crab Stewardship Exclusion Zone

15.5.4 Potential Cumulative Environmental Effects

Twenty-five Special Areas intersect with the LSA and are listed in Table 15.13. Three Special Areas intersect the Core BdN Development Area and seven with the Project Area.

Table 15.13 Special Areas Intersecting with the Project

Special Area	CBdN	PA	LSA
Canadian Ecologically and Biologically Significant Areas (EBSAs)			
Northeast Slope	–	–	Intersect
Eastern Avalon	–	–	Intersect (TR)
Baccalieu Island	–	–	Intersect (TR)
Marine Refuges			
Northeast Newfoundland Slope Closure	–	–	Intersect

Table 15.13 Special Areas Intersecting with the Project

Special Area	CBdN	PA	LSA
Significant Benthic Areas (SBAs)			
Sea Pens	–	–	Intersect
Large Gorgonian Corals	–	–	Intersect (TR)
Canadian Fisheries Closures (FCA) within the EEZ			
Near Shore Snow Crab Stewardship Exclusion Zone	–	–	Intersect (TR)
Representative Maine Areas (RMAs)			
III East Avalon / Grand Banks	–	–	Intersect (TR)
National Historic Sites			
Cape Spear	–	–	Intersect (TR)
Signal Hill	–	–	Intersect (TR)
EBSA (UN Convention on Biological Diversity)			
Slopes of the Flemish Cap and Grand Bank	Intersect	Intersect	Intersect
Vulnerable Marine Ecosystems			
Sponge (3 areas intersect PA, 6 intersect LSA)	–	Intersect	Intersect
Sea Pen (2 areas intersect LSA)	Intersect	Intersect	Intersect
Large Gorgonian Coral		Intersect	Intersect
NAFO FCA			
Sackville Spur (6)	–	–	Intersect
Northern Flemish Cap (9)	–	–	Intersect
Northwest Flemish Cap (10)	Intersect	Intersect	Intersect
Northwest Flemish Cap (11)	–	–	Intersect
Northwest Flemish Cap (12)	–	–	Intersect
Important Bird Areas (IBA)			
Quidi Vidi Lake	–	–	Intersect (TR)

These Special Areas are located at distances of approximately 60 km to nearly 1,000 km away from the offshore petroleum production projects that are currently operating in the RSA (i.e., Hibernia, Terra Nova, White Rose, and Hebron). The Core BdN Development Area intersects with three Special Areas and the Project Area intersects with seven Special Areas but none of the other offshore petroleum production projects overlap with the Special Areas in the Project / Core BdN Development Area, meaning that there will be no direct cumulative effects from this Project and other offshore petroleum production projects on the benthic environment of these Special Areas.

There is potential for cumulative interactions on Special Areas intersecting the Core BdN Development Area resulting from previous exploration drilling in the Core BdN Development Area in combination with the Project activities (installation of subsea infrastructure and development drilling). As indicated in Section 9.3.2.4, subsea infrastructure and potential zone of influence from cuttings deposition is estimated to occupy 7.5 percent of the Core BdN Development Area. Within the fisheries closure area Northwest Flemish Cap (10), the zone of influence from subsea infrastructure and drill cutting deposition is estimated to be approximately 0.05 percent of the FCA. Given the localized nature of Project-related interactions, in combination with the localized effects of previous exploration drilling on Special Areas, and the conclusion that the Project will not have a significant effect on these Special Areas, potential cumulative interactions are similarly anticipated to be localized and unlikely to result in significant adverse cumulative environmental effects.

Various ELs (e.g., EL1134, EL 1135, EL 1138, EL 1139, EL 1140, EL 1141, EL 1142, EL1143, EL 1144, EL 1145, EL 1150, EL 1154, EL 1156, EL 1157, EL 1158, and EL 1159) intersect with these Special Areas especially the Slopes of the Flemish Cap and Grand Bank UNCBD EBSA, which is an extensive area. The Project LSA for this Project and seven ELs intersect with the Northeast Newfoundland Slope Closure Marine Refuge. Thus, exploration drilling activities carried out on these ELs (i.e., EL 1138, EL 1145, EL 1146, EL 1148, EL1157 and EL 1158) in combination with the Project could result in cumulative effects on the Northeast Newfoundland Slope Closure Marine Refuge. However, the minimum distance of the Project area to the Northeast Newfoundland Slope Closure Marine Refuge is approximately 31 km. Due to the localized footprint of drilling activities predicted for the BdN Project, the zone of influence for drilling cuttings deposition (i.e., (less than 2 km based on drill cuttings modelling in shallow waters; 200 m in deeper waters), and anti-collision zones (i.e., 500 m) around installations, cumulative effects from the project in combination with exploration drilling activities are not anticipated.

There is potential for cumulative effects from Project aircraft and vessel traffic and similar activities related to other projects as well as general marine traffic, fishing and oil and gas exploration activities in these special areas. The identified special areas include the Snow Crab Stewardship Exclusion Zones in the Near Shore Crab Fishing Area, which is closed to crab fishing and a SiBA identified for large gorgonian corals. The Eastern Avalon and Baccalieu Island EBSAs have been identified for the presence of seabird populations, cetaceans and leatherback turtles. Quidi Vidi Lake IBA is identified as bird habitat. Cape Spear and Signal Hill National Historic Sites are popular destinations for tourists and local people. Due to the short term and transient nature of vessel and aircraft traffic, and the existence of general marine traffic in eastern Newfoundland, cumulative effects from the Project in combination with other activities are not anticipated.

Marine species such as mammals and fish may be sensitive to light and sound from vessel and aircraft traffic and are potentially vulnerable to injury from collisions with marine vessels. Overall, interactions between Project-related supply and servicing activities and fish, marine mammals and users of coastal sites are anticipated to be minor due to the localized, short-term, and mobile (transitory) nature of these activities, and because they are generally in keeping with the overall marine traffic that has occurred throughout the region for many years. Though vessel and aircraft traffic for supply and servicing of the Project will be additional to marine traffic for other activities in the St. John’s area, it represents a small contribution to the overall vessel traffic off eastern NL.

Sound and artificial light from marine vessels and aircraft would be the primary potential concern for interactions with marine birds and bird habitats from supply and servicing activities in the St. John’s area. Marine traffic may affect seabirds through lighting, sound, and other associated environmental emissions and discharges. Various bird species that occupy the Special Areas near the LSA in the St. John’s area may experience these types of effects from Project traffic and that of other oil and gas projects and general marine activities. However, they will not likely be further disturbed by Project-related vessel activity or associated aircraft use, due to its short-term and transitory nature and thus, its short-term presence at any one location. Other general marine traffic occurs throughout the NL offshore and is likely to intersect with Special Areas that overlap the Project Area, but vessel traffic is intermittent and transient at any one location and time, with negligible contributions to cumulative effects.

The potential effects of Project-related discharges from vessels are described in Section 10.3.4 of the EIS. Supply vessel traffic to and from the drilling installation(s) will be mobile, therefore, environmental disturbances and effects will be highly transient in nature. The release of organic wastes by vessels and activities may attract birds, which may increase the potential for interactions including risk of predation, collision and exposure to contaminants. However, this will be minimized with proper waste management practices and adherence to associated MARPOL requirements. The potential effects of waste discharges on marine-associated birds, will be managed in keeping with regulatory requirements and a negligible addition to that of other activities.

The primary interaction associated with helicopter use with Marine and Migratory Birds is the possible disturbance effects of aircraft overflights. These effects include a potential temporary loss of useable habitat and increased energy expenditure due to escape reactions, increased heart rate, and lower food intake due to interruptions. Helicopter sound can disturb nesting seabirds at colonies, although seabird reactions to helicopters and other aircraft depend on several factors including species, previous exposure levels, and the location, altitude, and number of flights. The most obvious behavioural effect of helicopter sound on birds is that breeding birds may be flushed from the nest in response to loud sounds, which can have immediate negative consequences including predation of eggs and chicks and decreased incubation and brooding. Nestlings may also be vulnerable to exposure, and adults may inadvertently knock eggs and flightless young from the nest, which is of concern for cliff-nesting species. Other behavioural effects may include reduced foraging and provisioning due to sound. Sound may also deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure. Research has shown that overt behavioural responses, such as flushing, in response to aircraft traffic may occur at a distance of 366 m for common murres, although there is inherent variability in behavioural responses between, and within, species.

Overall, interactions between Project-related supply and servicing activities and bird species are anticipated to be minor due to the localized, short-term, and mobile (transitory) nature of these activities, and because they are generally in keeping with the overall marine traffic that has occurred throughout the region for many years. Vessel traffic for supply and servicing of the FPSO and drilling installations represents a negligible contribution to the overall vessel traffic off eastern NL, and Project-related supply vessel traffic will use existing and common routes wherever possible. Helicopters will be used for crew transfers and other purposes as required, but these are anticipated to be infrequent. Helicopters will avoid coastal seabird colonies during the nesting season as per the *Seabird Ecological Reserve Regulations, 2015*. Other vessel traffic is likely to intersect with Special Areas that overlap with the Project Area, but vessel traffic is intermittent and transient at any one location and time, with negligible contributions to cumulative effects.

Adverse interactions with and effects on coastal breeding colonies and other bird habitat are unlikely. In accordance with standard practices, vessels will generally transit in a straight-line approach from port (see Figure 7-45), unless the presence of pack ice or other environmental phenomena requires routes to be altered, and the helicopter routes that will be used have been commonly used by the offshore oil and gas industry over the past 20 years. Therefore, the amount of time these vessels are near coastal habitats will be brief. The amount of helicopter traffic will be reduced to the lowest level practical for the Project, and low-level aircraft operations will be avoided, as appropriate. Known and observed bird colonies, large aggregations of avifauna, critical habitats and protected or sensitive areas and times will also be avoided wherever possible. Helicopter flight paths and OSV transit routes will adhere to the periods of avoidance, and specific set back distances, associated with specific, established migratory bird nesting colonies outlined in the NL *Seabird Ecological Reserve Regulations, 2015*. Again, marine traffic for this Project will represent a small addition to existing activities and only overlap near the St. John's area.

Project activities will interact spatially with planned or potential oil and gas exploration activities in the region, including offshore geophysical surveys and drilling, and these activities may intersect with Special Areas including those affected by the Project. Although the specific location and timing of other offshore oil and gas exploration activities in the RSA over the life of the Project is not and cannot be known and defined, exploration drilling activities themselves are short-term and drilling wells have small footprints. Other exploration surveys and activities typically result in a short-term disturbance and are highly mobile in nature. In addition, the application of mitigation measures identified in the EIS serves to avoid or reduce the environmental effects. This reduces the potential for Special Areas and their defining biological features to be affected. However, simultaneous exploration programs may occur especially in large Special Areas and repeatedly by multiple programs along with other marine activities, which may result in cumulative environmental effects over time.

Although commercial fishing activity in the region is extensive and diverse, the level of commercial fishing effort in the Project Area is relatively low and is primarily concentrated in the western portion of the Project Area. Commercial fishing results in direct loss (mortality) of fish and/or fish habitat in the case of bottom-trawling fisheries, and introduces other disturbances into the marine environment, such as sound and artificial lights, its occurrence at a given location and time is limited, and these activities have relatively small footprints and are of short duration. Fishing activity is subject to applicable management processes and regulations. The Project is not likely to affect the overall environmental integrity and viability of these Special Areas due to its small footprint. Bottom contact fishing is prohibited within the Northwest Flemish Cap (10) NAFO FCA, which overlaps the Core BdN Development Area; therefore, this Special Area will not be directly affected by such fishing activity in combination with Project activities.

Other activities such as general marine vessel traffic also occur throughout the LSA, resulting in sound, light, emissions, and effluents, and these are relatively short-term and localized disturbances with low environmental effects. Bird harvesting activity likely does not occur within these offshore areas and does not target many of the species that are relevant to the identification of these Special Areas (see Section 6.4).

Various planning and mitigation measures, as described in Chapters 9 through 14, to reduce interactions with and likely effects on the VCs will reduce overall cumulative effects. Given the relatively localized nature of Project-related disturbances within Special Areas, and the determination that the Project will not have a significant effect on these Special Areas, potential cumulative interactions are similarly anticipated to be localized and unlikely to result in significant adverse cumulative environmental effects.

15.5.5 Cumulative Effects Summary and Evaluation

Table 15.14 summarizes the results of the cumulative effects assessment for Special Areas. As illustrated, the Project is not likely to result in significant adverse cumulative environmental effects on Special Areas in combination with other projects and activities that have been or will be carried out. The relative contribution of the residual effects of the Project to cumulative effects on this VC is predicted to be low.

Potential cumulative effects on biological / ecological aspects and human use related to Special Areas have also been addressed in the other VCs considered in this Chapter. Implementation of the various environmental mitigation procedures outlined throughout this EIS, including those which are designed to avoid or reduce Project-related discharges and / or disturbances and their associated environmental effects, will also serve to help address potential Project-related contributions to cumulative effects on Special Areas.

Table 15.14 Summary of Potential Cumulative Environmental Effects: Special Areas

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and Ongoing Activities)	• Various types of Special Areas are located within the RSA, including coastal and marine areas protected through legislation or formally identified as being special or sensitive. • Many of these Special Areas in the RSA are in mid-shore, nearshore and onshore areas. These include provincial ecological reserves, parks and protected areas and historic sites, Canadian MPAs, Marine Refuges, fisheries closures within the EEZ, national parks and historic sites, EBSAs, MBSs, as well as international designations such as IBAs and WHSs. • Several types of Special Areas are in the LSA within the offshore environment as well as offshore to coastal areas of the LSA surrounding the vessel traffic route. These include Canadian crab fishery closures, EBSAs, national historic sites, and provincial seabird ecological reserves. Several international Special Areas including a UNCBD EBSA, VMEs and NAFO FCAs intersect with the LSA.
Residual Environmental Effects of the Project	• The Project may result in residual changes in environmental features and / or processes and / or human use and / or societal value of Special Areas. These potential residual effects are predicted to be not significant and the Project is not expected to result in significant residual adverse effects on the overall and defining physical, biological, and socioeconomic environments within Special Areas. • These predictions were made with a moderate to high level of confidence.

Table 15.14 Summary of Potential Cumulative Environmental Effects: Special Areas

Summary of Potential Cumulative Environmental Effects	
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia	No special areas overlap with the Hibernia project.
Terra Nova	No special areas overlap with the Terra Nova project.
White Rose and Extension Project	No special areas overlap with the White Rose and Extension project.
Hebron	No special areas overlap with the Hebron project.
Offshore Petroleum Exploration - Geophysical and Other Exploration Activities	Some potential for interaction, although localized and short-term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Offshore Petroleum Exploration – Drilling	Some potential for interaction, although localized and short-term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Fishing Activity	Fishing activity occurs throughout the offshore area. Fishing activity and ELs that may be drilled as part of this Project both overlap with portions of the Northeast Shelf and Slope EBSA.
Other Marine Vessel Traffic	Some potential for interaction, although these activities and their effects are highly localized and transient. Anti-collision zones around Project activities will limit interactions and thus cumulative effects on this VC.
Other Harvesting Activity	No harvesting activity within Special Areas offshore, nor targeting key species relevant to their designations.
Cumulative Effects Summary	Project components and activities are not likely to result in significant residual adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or will be carried out in the RSA.

15.6 Commercial Fisheries and Other Ocean Uses

15.6.1 Past and Ongoing Effects (Baseline)

Domestic and foreign commercial fisheries that occur in the RSA are described in Section 7.1. Although overall fishing activity has historically been very low in the Core BdN Development Area, the fisheries most likely to occur in and near the Project Area are foreign and domestic ground fisheries (e.g. for redfish, Atlantic cod, Greenland halibut/turbot) using mobile trawls during all months of the year. Available locational data indicate that harvesting activity is comparatively low in most parts of the Project Area, with most occurring near the northernmost boundaries and in some areas to the west of the Core BdN Development Area. Harvesting of several large pelagic species (e.g. sharks) may also take place in the eastern parts of the LSA. To the west of the Project Area within the LSA, along the Project's vessel traffic route, and throughout much of the RSA, snow crab fishing (fixed gear pots) is widespread during spring and summer. Groundfish gillnet harvesting is also common particularly in northwest portions of the LSA (mainly for Greenland halibut) and northward between the 500 m and 1000 m depth contours in NAFO Divisions 3K and 2J, and to the south in 3O, typically from spring to autumn. Otter trawling may also occur throughout the year in these same areas and in Divisions 3N towards the Tail of the Grand Banks. Other species harvested in the RSA at different times include deep-sea clams (using hydraulic dredges, mainly in Division 3N and the southern part of 3L), small pelagic species (e.g. herring and capelin, with nets, mainly in nearshore areas and bays), lobster (nearshore pots), and sealing off the coasts of the Island and Labrador. Recreational fisheries, while they do not occur in the Project area or LSA, are pursued seasonally in bays and coastal areas of the RSA during the summer months. Aquaculture operations also occur in the coastal/bay areas of the RSA.

Northern shrimp is an active fishery during many months in northern parts of the RSA, in Divisions 3K and 2J.

DFO and/or collaborative DFO-industry fisheries science surveys take place within the Project Area, LSA and parts of the RSA, usually in the spring to autumn months, as may other scientific studies and surveys by NAFO signatory-state researchers.

Other marine activities occur in the RSA and are described in Section 7.2. These include commercial shipping, military operations, marine tourism, and other oil and gas related projects and activities. Within the RSA there are also other submarine artifacts and infrastructure, such as communication cables, shipwrecks, military legacy sites and the possible presence of unexploded ordnance (UXO). Within the Project Area there are two communications cables (one active and one abandoned) and no other known subsea artifacts. As indicated in Table 15.2 and Figure 15-1 no other petroleum production operations are within the LSA or near the Project Area.

15.6.2 Potential Project-Related Contributions to Cumulative Effects

Potential interactions identified between the Project and Commercial Fisheries and Other Ocean Uses include loss of access due to of the presence of the anti-collision zone(s) established for the FPSO and drilling installation(s), potential gear damage, and behavioural changes to fish that may affect the quality and availability of commercial fish resources. These potential interactions and effects may result in lost time and gear, reduced catch abundance, lower economic returns on catches, and increased operational costs for fishers and other ocean users in the area, or physical damage to existing infrastructure or other artifacts. Due to the localized nature and the implementation of standard mitigation measures, it was predicted that there would be no significant residual adverse environmental effects on this VC (Chapter 13). Although the presence of anti-collision zones may reduce access for fishing and other activities in certain areas, such interactions will be localized and reversible once Project activity ceases. To mitigate the potential of fishing gear damage, Notices to Shipping, Notice to Mariners, and other communication protocols will be implemented. In the unlikely event of damage to fishing gear, compensation to harvesters would be available through existing legal mechanisms or, if the operator cannot be determined, through the CAPP (2007) Non-Attributable compensation program.

Considering these factors and the implementation of other mitigation measures discussed in Chapters 9 and 13, the Project is not likely to result in significant residual adverse environmental effects on Commercial Fisheries or Other Ocean Uses.

15.6.3 Other Projects and Activities and Their Effects

Fisheries and other human activities in the marine environment may be affected both individually and collectively by offshore oil and gas exploration and production activities, general marine traffic, and other activities and associated disturbances. This assessment considers damage to equipment or infrastructure, effects on marine resource availability and/or other interactions or conflicts, which effects may accumulate or interact over time on a regional scale, resulting in potential cumulative environmental effects on the Commercial Fisheries and Other Ocean Uses VC.

The diverse and dynamic nature of fishing and other marine activity throughout the region (in terms of locations, seasons, gear/equipment, types of infrastructure or artifacts, and key species fisheries) makes it difficult to predict specific areas and times from year-to-year for domestic or foreign harvesters and other activities, and thus the potential for interactions between separate projects, activities, and their effects. This includes projects and activities related to oil and gas production, exploration, and other types of marine vessel traffic and activity, as summarized in Table 15.15.

Table 15.15 Commercial Fisheries and Other Ocean Uses: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia	• Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity, and/or function of Commercial Fishing and Other Ocean Uses • Damage caused by the Project to fishing gear, vessels, and other existing subsea infrastructure, and associated loss of catch for harvesters	• The Hibernia field is located approximately 157 km from the Project Area and 226 km from the Core BdN Development Area. • Production at Hibernia is year-round for the life of the project. • Safety zone, including the anti-collision zone of 53 km^2 around the Hibernia GBS, offloading system, and Hibernia Southern Extension, • EEM results for fish species indicated no statistical effect. (HMDC 2017).
Terra Nova	• Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity and/or function of Commercial Fishing and Other Ocean Uses • Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch for harvesters	• The Terra Nova field is located approximately 166 km from the Project Area and 229 km from the Core BdN Development Area • Exclusion zone of 14 km2, within the 270 km2 safety zone. The only established fisheries exclusion zone; no other offshore production operation has an established fisheries exclusion zone. • EEM results for fish species did not identify fish / shellfish taint and there was no evidence of muscle tissue contamination (Suncor 2017).

Table 15.15 Commercial Fisheries and Other Ocean Uses: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
White Rose and Extension Project	• Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity and/or function of Commercial Fishing and Other Ocean Uses • Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch for harvesters	• The White Rose field is located approximately 118 km from the Project Area and 180 km from the Core BdN Development Area • White Rose safety zone is approximately 105 km2. • EEM results for fish species did not identify fish taint and there was no evidence of muscle tissue contamination (Husky Energy 2017)
Hebron	• Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity and/or function of Commercial Fishing and Other Ocean Uses • Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch for harvesters	• The Hebron field is located approximately 160 km from the Project Area and 225 km from the Core BdN Development Area • Safety zone for Hebron is approximately 6 km2 around the GBS and offloading system.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity and/or function of Commercial Fishing and Other Ocean Uses • Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch for harvesters	• Geophysical activities can cover large overall areas, but activity (and associated interference) and effects are localized at any given time/place, short-term and transient. • Standard communication and coordination procedures between the offshore oil and gas industry and fishers/fisheries science managers help to limit or eliminate the potential for adverse temporal/spatial interactions.
Offshore Petroleum Exploration – Drilling	• Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity and/or function of Commercial Fishing and Other Ocean Uses • Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch for harvesters	• Anti-collision zones of either 1 km^2 or 12 km^2 (depending on use of anchors) • Exploration drilling programs occur in localized areas and are short-term.

Table 15.15 Commercial Fisheries and Other Ocean Uses: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Fishing Activity	• Other vessel traffic avoidance of active fishing vessels and gear. • Inefficiencies during other vessel transits and/or exploration programs.	• Domestic fishing is active year-round in many parts of the RSA; foreign fishing occurs year-round in the NRA, beyond Canada's EEZ • Well-developed communication, coordination and avoidance procedures between the offshore oil and gas industry and fishing activity allows planning to minimize adverse effects on exploration activities.
Other Marine Vessel Traffic	• Direct interference caused by the Project with fishing activity and other marine activities, resulting in a change in the distribution, intensity and/or function of Commercial Fishing and Other Ocean Uses • Damage caused by the Project to fishing gear, vessels and other existing subsea infrastructure, and associated loss of catch for harvesters	• Oil and gas related supply vessels follow common routes to production fields and drilling installations. • DFO research vessel schedules are released annually. • Vessel activity is typically higher during summer months.
Other Harvesting Activity	• Change in abundance, distribution and quality of marine resources, resulting in a change in the distribution, intensity and/or function of Commercial Fishing and Other Ocean Uses	• Recreational groundfish fishery in inshore waters off NL during the summer and early fall using angling gear or handlines • Indigenous groups conduct traditional harvesting activities throughout the RSA but no such harvesting is known to occur in the Project Area

15.6.4 Potential Cumulative Environmental Effects

There are four operating production facilities offshore NL. Terra Nova has a unique series of zones, including a precautionary zone and an exclusion zone around the FPSO and drill centres, whereas the other producing operations only have safety and anti-collision zones. Hibernia has been on its present site since June 1997 and, along with the other operations that came afterwards, is now an established and known part of the seascape in offshore NL. Anti-collision zone from these fields occupy a relatively small footprint in comparison to the available fishing grounds and vessel traffic routes. The potential for cumulative effects on Commercial Fisheries and Other Ocean Uses is further reduced by the distance between the Project Area and the other offshore petroleum production projects in the RSA.

Supply vessels and other support vessels for existing operations use common routes when transiting between shore base and production platforms. Shuttle tankers, when on route to the transshipment facility typically follow a common route. Operators have established communication protocols to mitigate interactions with Commercial Fisheries and Other Ocean Uses. Together these factors and measures help reduce the potential for interactions between existing oil production and Commercial Fisheries and Other Ocean Uses.

The eastern NL offshore area is also subject to ongoing and planned oil and gas exploration activities, including exploration drilling and geophysical surveys which may occur within the timeframe of the Project. Drilling installations would establish anti-collision zones, approximately 1 km^2 or 12 km^2, depending if the installation was using DP or anchored (Statoil 2017) representing a very small portion of the available fishing areas. Assuming two anchored drilling installations were operating simultaneously, this would represent less than 0.002 percent (maximum) of the RSA, or approximately 0.005 percent of the fished areas of the RSA. As described in Chapter 13, no measurable changes in interference with Commercial Fisheries and Other Ocean Uses are expected to result from planned Project activities, and therefore will not interact cumulatively with other current or anticipated marine activities in these areas.

Offshore geophysical surveys may be spatially extensive, which increases the potential for commercial fishing and other activities to be affected by multiple projects activities in a region, and vice versa, as these surveys are typically required to avoid active fishing areas, including fisheries science study locations. As part of the planning and implementation of such survey activities, operators communicate and coordinate with relevant marine users and other stakeholders, including fisheries representatives and other oil and gas exploration operators working in the area, to plan activities in order to reduce potential interactions and to implement other mitigation measures that avoid or reduce other potential effects.

As described in Chapter 13, no measurable changes in the abundance or distribution of fishing resources in the RSA are expected to result from planned Project activities, and therefore will not interact cumulatively with other current or anticipated marine activities in these areas.

Other marine activities and vessel traffic are also sources of potential interactions between fishing vessels and Project activities within the Project Area, LSA and RSA. Ongoing communications and, standard marine navigation will reduce direct interference with and damage to fishing gear and equipment.

15.6.5 Cumulative Effects Summary and Evaluation

Table 15.16 summarize the results of the cumulative effects assessment for the Commercial Fisheries and Other Ocean Uses VC. As described, the Project is not likely to result in significant adverse cumulative environmental effects on this VC in combination with other projects and activities that have been or are likely to be carried out. The relative contribution of the residual effects of the Project to cumulative effects on the VC is therefore predicted to be low.

Table 15.16 Summary of Potential Cumulative Environmental Effects: Commercial Fisheries and Other Ocean Uses

<table>
<tr><th colspan="2">Summary of Potential Cumulative Environmental Effects</th></tr>
<tr><td>VC Existing Condition (Past and Ongoing Activities)</td><td>
Commercial fishing and other ocean activity occurs regularly – some year-round – throughout the Grand Banks, the Labrador Shelf and adjacent waters including around the Flemish Cap and to a lesser extent within the Core BdN Development Area and Project Area.
Key species currently harvested within the RSA are snow crab and groundfish (most areas), shrimp (now only in northern areas) and deep-sea clams (mainly in southern areas), as well as more limited quantities of large and small pelagic species.
Within the Project Area the principal fished species are groundfish, primarily harvested with bottom trawls.
Domestic fishing activity is most common from April to September, while foreign fishing effort is year-round.
Routine activities, to date have not resulted in negative effects to the quality or marketability of fisheries resources.
Domestic and foreign fisheries science surveys may occur annually in many parts of the RSA and the LSA, and potentially within the Project Area.
Other ocean use activity (other research, shipping, military exercises) also occur throughout the Project Area and LSA.
OSVs, including shuttle tankers, are active year-round transiting in common routes to and from the existing production facilities.
Oil and gas exploration activities occur throughout the RSA, LSA and possibly in the Project Area
The RSA also encompasses other submarine artifacts and infrastructure such as trans-Atlantic and regional communication cables, shipwrecks, military legacy sites and possible UXO. Within the Project area there are two communications cables (one active and one abandoned) but no other known subsea artifacts
</td></tr>
<tr><td>Residual Environmental Effects of the Project</td><td>
The Project may result in loss of access to localized areas, potential interference with marine activities, including fishing and fishing gear damage, changes in commercial species abundance, quality or market perception, or physical damage to existing infrastructure or other artifacts.
Considering the relatively low level of recorded activities in the Project Area, and with the implementation of mitigation measures the Project is predicted not to result in significant residual adverse effects on this Commercial Fisheries or Other Ocean Uses. This prediction is made with a high level of confidence.
</td></tr>
<tr><th>Other Projects / Activities</th><th>Potential for Interaction with Effects of Project</th></tr>
<tr><td>Hibernia</td><td>Operations are located well outside of the Project Area, with localized environmental effects.</td></tr>
<tr><td>Terra Nova</td><td>Operations are located well outside of the Project Area, with localized environmental effects</td></tr>
<tr><td>White Rose and Extension Project</td><td>Operations are located well outside of the Project Area, with localized environmental effects.</td></tr>
</table>

Table 15.16 Summary of Potential Cumulative Environmental Effects: Commercial Fisheries and Other Ocean Uses

Other Projects / Activities	Potential for Interaction with Effects of Project
Hebron	Operations are located well outside of the Project Area, with localized environmental effects.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	There is a potential for cumulative interactions between the Project and other exploration activities within the LSA and/or RSA through temporary loss of access and increased marine traffic associated with these activities. Although there is some potential for interaction with fish harvesting and other marine activities, the localized and short-term nature of these activities and their effects, along with planned mitigations and required separation measures, will reduce the potential for interaction.
Offshore Petroleum Exploration – Drilling	Offshore oil and gas exploration drilling activity may occur within the RSA, including the LSA There is a potential for cumulative interactions between the Project and other exploration drilling activities within the Project Area through loss of access and increased marine traffic. Although there is some potential for interaction, localized and short-term nature of these activities and their effects, along with planned measures will reduce potential for interactions with commercial fisheries.
Fishing Activity	N/A
Other Marine Vessel Traffic	Vessel traffic from other marine industries could increase in the RSA. Increases in marine traffic may result in damage to fishing gear and equipment. There is some potential for interaction, although these activities and their effects are highly localized and transient. The potential for cumulative interaction effects will be reduced through ongoing communication with other ocean users and use of the vessel traffic route.
Other Harvesting Activity	Operations are located well outside of the Project Area, with localized environmental effects.
Cumulative Effects Summary	Project components and activities are not likely to result in significant residual adverse cumulative environmental effects on Commercial Fisheries and Other Ocean Uses in combination with other projects and activities that have been or will be carried out in the RSA.

15.7 Indigenous Peoples

The EIS Guidelines (Appendix A) for the Project identify 41 Indigenous groups in NL, the Maritime provinces (NS, NB and PEI), and Québec that have the potential to be affected by Project activities. An overview of available information on the Indigenous groups (i.e., health and socioeconomic conditions, physical and cultural heritage, current use of lands and resources for traditional purposes and asserted and established Aboriginal or treaty rights) of Indigenous groups is presented in Section 7.3.

The evaluation of potential effects of the Project on Indigenous Peoples is presented in Chapter 14. The effects assessment focuses on each of the associated factors specified in and required under section 5(1)(c) of CEAA 2012. The assessment also takes into consideration potential adverse impacts of the Project on asserted or established Aboriginal or treaty rights (section 35 rights). It is

Equinor Canada's understanding that no Indigenous group has asserted or established Section 35 rights in the Project Area or LSA. As well, Chapter 14 concluded that there are no known structures, sites or things of historical, archaeological, paleontological or architectural significance to Indigenous Peoples in the Project Area or LSA.

15.7.1 Past and Ongoing Effects (Baseline)

Other past and ongoing projects and activities in eastern Canada have, to varying degrees, interacted with and affected Indigenous communities and activities. The nature and scale of any such effects, depends on the location of the projects in relation to the communities, activities, and other components and interests of individual Indigenous groups.

A number of Indigenous groups hold commercial-communal licences for marine species in NAFO areas 3L and 3M, including licences for swordfish and tuna, (see Table 7.17 and Table 7.18), which encompass the Project Area. However, while licences have been issued, it is not clear that all licences are active as certain species may be subject to moratoria or quota reductions or area closures. No domestic commercial fishing activity, including commercial-communal harvesting, was recorded in the Core BdN Development Area between 2011 to 2016 and no swordfish/tuna landings were recorded in the Project Area during that same period. Nonetheless, commercial-communal fishing in the RSA is an important source of employment and revenue for Indigenous groups and this revenue may be used to fund community development as well as programs and services. Indigenous groups in eastern Canada may currently use lands and resources in the RSA for traditional purposes but such activities, including FSC and treaty-based harvesting, generally occur in coastal or riverine areas near communities. Presently, there is no known current use of lands and resources for traditional purposes within or near the Core BdN Development Area, Project Area, or LSA although some marine species, which are of importance to Indigenous groups, have the potential to migrate through these areas (Chapters 7, 9, 11, 14). As a result of ongoing engagement with the Indigenous groups identified in the EIS Guidelines (Appendix A), Atlantic salmon, American eel and North Atlantic right whales (see Section 15.2.5) have been identified as species of importance, which may be potentially affected by the Project. In addition, certain Indigenous groups have also expressed concerns respecting the potential effects of the Project upon migratory birds, sea turtles and seals.

15.7.2 Potential Project-Related Contributions to Cumulative Effects

As described in Chapter 13, routine Project activities of the Core BdN Development and Potential Future Development have the potential to affect future commercial-communal harvesting that may occur in the LSA. These potential effects may be direct or indirect through displacement from fishing grounds, impediments to traffic to or from fishing grounds, lost or damaged fishing gear, and associated socioeconomic and cultural effects. Indigenous groups have indicated that commercial-communal licences for swordfish and tuna are currently inactive off eastern NL (Chapter 13). However, this does not suggest that Indigenous communities will not exercise their right to fish in those areas in the future. Given the nature of the Project, including its limited and localized environmental disturbances and the associated small anti-collision zone(s), the lack of significant adverse effects on commercially-harvested species and the implementation of mitigation measures (e.g., notification), it is predicted that there will be no significant residual adverse effects from planned activities on commercial-communal fishing activity over the course of the Project.

Although there is no known current use of lands and resources for traditional purposes within or near the Core BdN Development Area, the Project Area or LSA, Project activities and components may interact with migratory species, including marine fish, mammals, and marine and migratory birds, which are harvested by Indigenous groups elsewhere (see desktop Indigenous Knowledge Study, Appendix H). However, there is limited potential for species used by Indigenous groups to occur in or pass through the Project Area (see Table 7.20). As discussed in Chapters 9 to 11, Project activities are not expected to result in significant residual adverse effects on Marine Fish and Fish Habitat, Marine and Migratory Birds, and Marine Mammals and Sea Turtles, including those species which are used for traditional purposes. As most Project-related activities will take place in the offshore marine environment at a range of approximately 640 km to 2,000 km from various Indigenous communities listed in the EIS Guidelines (Appendix A), and because associated potential environmental changes are expected to be localized in nature, there is little or no potential for the biophysical effects of Project to translate into any decrease in the presence, nature, intensity, abundance, distribution, or quality or cultural value of marine-associated resources, and thus, their overall availability and suitability for use for traditional purposes by any Indigenous groups. As a result, as concluded in Chapter 14, it is predicted that there will be no effects on the current use of lands and resources for traditional purposes, including any associated health or socioeconomic conditions, resulting from routine Project activities.

Since there are no effects (direct or indirect) on the current use of lands and resources for traditional purposes or on the exercise of Aboriginal and treaty rights or on sites, structures or things of historical, architectural, archaeological or paleontological significance, the assessment of cumulative effects relating to the Indigenous Peoples VC resulting from the Project will focus on commercial-communal fisheries.

15.7.3 Other Projects and Activities and Their Effects

Other ongoing and likely future projects and activities that may affect Indigenous Peoples within the Project Area and RSA, as described in Table 15.7, include other petroleum resource developments, geophysical activities, exploration drilling, fishing activity, and vessel traffic. Details on other projects and activities are described in Section 15.1.3. Indigenous Peoples may be affected both directly and indirectly by offshore oil and gas exploration and production activities, general marine traffic, and other activities and associated disturbances.

Commercial-communal fisheries may be affected by other offshore oil and gas exploration and production activities, general marine traffic, and other activities and associated disturbances. Each of these may result in direct disturbance, damage to equipment or infrastructure, effects on marine resource availability and/or other conflicts, which effects may accumulate or interact over time on a regional scale, resulting in potential cumulative environmental effects on commercial-communal fisheries.

Marine Fish and Fish Habitat may be affected by discharges and emissions, including sound, from ongoing drilling and production operations. Future commercial-communal harvesters may be required to exert a higher level of effort to achieve the same catch due to the temporary displacement of target fish species because of underwater sound, which could affect catch rates or otherwise result in a change in availability of fisheries resources.

Commercial fisheries have the potential to result in a change in the availability of fisheries resources for competing commercial-communal fishing activity if it occurs within the LSA. If fisheries resources are not harvested sustainably, this could result in resource reduction and / or decreased catch rates, and the availability of fisheries resources for future commercial-communal fishing could be affected.

Table 15.17 provides a summary of past, present, and future projects and activities within the RSA that have the potential to cause a residual change in commercial-communal fisheries.

Table 15.17 Indigenous Peoples: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Hibernia	• Change in commercial-communal fisheries	• Production at Hibernia is year-round for the life of the project. • Safety zone of 53 km^2 including the anti-collision zone, around the Hibernia GBS, offloading system, and Hibernia Southern Extension • Refer to Table 15.3 for an overview of the results of the fish health survey carried out in 2014 (the latest year for which Hibernia EEM results are available) regarding effects on marine water quality and fish health, contamination, and tainting. • Production activities at Hibernia are planned to extend throughout the temporal duration of this Project.
Terra Nova	• Change in commercial-communal fisheries	• Terra Nova safety zone extends approximately 9.26 km (5 nautical miles) from the FPSO. • Terra Nova exclusion zone is approximately 14 km^2. • Refer to Table 15.3 for an overview of the results of the fish health survey carried out in 2014 (the latest year for which Terra Nova EEM results are available) regarding effects on marine water quality and fish health, contamination, and tainting. • Production activities at Terra Nova are planned to extend throughout the temporal duration of this Project.

Table 15.17 Indigenous Peoples: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
White Rose and Extension Project	• Change in commercial-communal fisheries	• Production at White Rose is year-round for the life of the project. • White Rose and White Rose Extension safety zone is approximately 105 km^2. • Refer to Table 15.3 for an overview of the results of the fish health survey carried out in 2014 (the latest year for which White Rose EEM results are available) regarding effects on marine water quality and fish health, contamination, and tainting. • Production activities at White Rose are planned to extend throughout the temporal duration of this Project.
Hebron	• Change in commercial-communal fisheries	• Production at the Hebron field is year-round for the life of the project. • Safety zone including the anti-collision zone, around Hebron is approximately 6 km^2 around the GBS and offloading system. • Production activities at Hebron are planned to extend throughout the temporal duration of this Project.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	• Change in commercial-communal fisheries	• Geophysical activities can cover large overall areas, but activity (and associated interferences) at any one location localized, short-term and transient in nature. • Standard communication and coordination procedures between the offshore oil and gas industry and fishers help to limit the potential for adverse interactions. • It is likely that geophysical and other exploration activities will extend throughout the temporal duration of this Project.
Offshore Petroleum Exploration – Drilling	• Change in commercial-communal fisheries	• Residual effects from other exploration drilling programs are generally anticipated to be similar in nature and extent (including similar spatial and temporal scales) to predicted Project-related residual environmental effects on Indigenous Peoples and community values (Chapter 14). • Typically, exploration drilling programs occur in localized areas and are short-term in nature. This can reduce the potential for individuals and populations of species of importance to commercial-communal harvesters to be affected simultaneously and repeatedly by multiple physical activities. • It is likely that exploration drilling programs will extend throughout the temporal duration of this Project.

Table 15.17 Indigenous Peoples: Other Projects and Activities and their Environmental Effects

Project / Activity	Potential Effects on this VC	Spatial and Temporal Considerations
Fishing Activity	• N/A	• N/A
Other Marine Vessel Traffic	• Change in commercial-communal fisheries	• The highly transitory nature of the vessels of other ocean users reduces potential residual effects on Indigenous fishers in any particular location and at any particular time. • Oil and gas related supply vessels follow common routes to production fields and drilling installations. • DFO research vessel schedules are released annually. • Vessel activity is higher during summer months. • Other marine vessel traffic will extend throughout the temporal duration of this Project
Other Harvesting Activity	• Change in commercial-communal fisheries	• Intermittent (and primarily coastal) activities with limited potential for interaction with other ocean uses.

15.7.4 Potential Cumulative Environmental Effects

In addition to the Project, there are four offshore production facilities in operation, and various exploration programs proposed to be undertaken within the RSA that may occur in a similar timeframe (Table 15.3). In addition, other activities such as marine traffic and commercial fishing are ongoing and have occurred in offshore NL.

The establishment of a Project anti-collision zone around the FPSO and/or drilling installation(s) potentially limits access to fishing grounds. However, the potential for loss of access to preferred fishing / harvesting grounds as a result of the Project is anticipated to be negligible and is unlikely to have any discernable effect on the overall distribution of fishing / harvesting effort within the RSA. Anti-collision zones from the four operating production facilities occupy a relatively small footprint in comparison to the available fishing grounds and vessel traffic routes offshore.

The potential for cumulative effects on commercial-communal fisheries is further reduced by the distance between the Project Area and the other offshore petroleum production projects (approximately 118 km to 160 km from the Project Area). Consequently, a change in commercial-communal fisheries is not anticipated to result from the cumulative interaction of the anti-collision zones associated with offshore oil and gas exploration, drilling, and production activities as these zones represent a very small proportion of the total fishing grounds available in the RSA.

The presence of marine vessels, competing fishing vessels, and marine traffic associated with other ocean users are sources of potential interaction with commercial-communal fishers, within the RSA. Ongoing commercial fish harvesting activities could potentially have an adverse effect on commercial-communal fisheries through direct competition for productive fishing grounds in such a way that may cause a change in commercial-communal fisheries. This could result in additional pressure on fishing activity in the LSA, thereby causing a cumulative change in commercial-communal fisheries.

All activities within the RSA, including the Project, have the potential to result in damage to fishing gear. In the event debris causes damage to fishing gear, compensation to harvesters would be provided through the Project's compensation program or if the operator cannot be determined, through the CAPP (2007) Non-Attributable compensation program.

15.7.5 Cumulative Effects Summary and Evaluation

Table 15.18 summarizes the results of the cumulative effects assessment. As illustrated, the Project, in combination with other known projects and activities that have been or will be carried out, is not likely to result in significant adverse cumulative environmental effects on this VC. Moreover, the relative contribution of the residual effects of the Project to cumulative effects on this VC is predicted to be low.

Table 15.18 Summary of Potential Cumulative Environmental Effects: Indigenous Peoples

Summary of Potential Cumulative Environmental Effects	
VC Existing Condition (Past and Ongoing Activities)	• The EIS Guidelines for the Project identify Indigenous groups in NL, the Maritime provinces (NS, NB, PEI), and Québec that have the potential to be affected by Project activities. • Other past and ongoing projects (Table 15.3) and activities in eastern Canada may have interacted with Indigenous communities and activities, and other components and interests of individual Indigenous groups. • Section 7.3 discusses socioeconomic components, including traditional land use, physical and cultural heritage and health and socioeconomic conditions related to Indigenous groups in the RSA. • The Project Area is not within the traditional territory of any of the Indigenous groups. There are no sites, structures or things of historical, archaeological, paleontological or architectural significance overlap with the Project Area. • There is no current use of lands and resources for traditional purposes occurs in the LSA, Project Area or Core BdN Development Area. • The Indigenous communities are located between 640 km and 2,000 km from the Project Area. • Commercial-communal fishing is important for employment and revenue that funds community development and social programs and services • Indigenous groups hold commercial-communal fishing licences for a variety of species, including swordfish and tuna, in NAFO 3L and 3M, portions of which overlap the Project Area. • There is no recorded commercial-communal fishing in the Core BdN Development Area and no recorded landings of swordfish or tuna in the Project Area between 2011 and 2016. • No Indigenous group has indicated that commercial-communal fishing is conducted in the Project Area.

Table 15.18 Summary of Potential Cumulative Environmental Effects: Indigenous Peoples

Summary of Potential Cumulative Environmental Effects	
Residual Environmental Effects of the Project	• The Project will not result in residual adverse effects on - any structure, site or thing that is of historical, archaeological, paleontological or architectural significance - physical and cultural heritage - the current use of lands and resources for traditional purposes • The Project will have no residual effects upon the exercise of Aboriginal or treaty rights • The Project may result in residual adverse effects on commercial-communal fisheries. These residual effects are predicted to be not significant • This prediction is made with a high level of confidence based on an understanding of the general effects on commercial fisheries in the LSA. • With the application of proposed Project-related mitigation and environmental protection measures, the residual environmental effects on Indigenous Peoples, including health and socioeconomic conditions are predicted to be not significant.
Other Projects / Activities	**Potential for Interaction with Effects of Project**
Hibernia	There is some potential for interaction. Operations are located at a substantial distance from the Project Area and may have localized environment effects. The anti-collision zone may interact cumulatively regarding available fishing areas, but the area will be very small in comparison to the overall fishing areas in the RSA. Offshore oil and gas production activities may also interact with commercially harvested due to the generation of underwater sound and water quality effects associated with discharges. Transiting marine vessels may also cause mortality of marine mammals due to vessel strikes. However, these effects are generally not expected to be of sufficient magnitude, duration, or extent to affect catch rates or otherwise cause a change in commercial-communal fisheries.
Terra Nova	There is some potential for interaction. Operations are located at a substantial distance from the Project Area and may have localized environment effects. The exclusion zone may interact cumulatively regarding available fishing areas, but the area will be very small in comparison to the overall fishing areas in the RSA. Offshore oil and gas production activities may also interact with commercially harvested due to the generation of underwater sound and water quality effects associated with discharges. Transiting marine vessels may also cause mortality of marine mammals due to vessel strikes. However, these effects are generally not expected to be of sufficient magnitude, duration, or extent to affect catch rates or otherwise cause a change in commercial-communal fisheries.
White Rose and Extension Project	There is some potential for interaction. Operations are located at a substantial distance from the Project Area and may have localized environment effects. The anti-collision zone may interact cumulatively regarding available fishing areas, but the area will be very small in comparison to the overall fishing areas in the RSA. Offshore oil and gas production activities may also interact with commercially harvested due to the generation of underwater sound and water quality effects associated with discharges. Transiting marine vessels may also cause mortality of marine mammals due to vessel strikes. However, these effects are generally not expected to be of sufficient magnitude, duration, or extent to affect catch rates or otherwise cause a change in commercial-communal fisheries.

Table 15.18 Summary of Potential Cumulative Environmental Effects: Indigenous Peoples

Other Projects / Activities	Potential for Interaction with Effects of Project
Hebron	There is some potential for interaction. Operations are located at a substantial distance from the Project Area and may have localized environment effects. The anti-collision zone may interact cumulatively regarding available fishing areas, but the area will be very small in comparison to the overall fishing areas in the RSA. Offshore oil and gas production activities may also interact with commercially harvested due to the generation of underwater sound and water quality effects associated with discharges. Transiting marine vessels may also cause mortality of marine mammals due to vessel strikes. However, these effects are generally not expected to be of sufficient magnitude, duration, or extent to affect catch rates or otherwise cause a change in commercial-communal fisheries.
Offshore Petroleum Exploration – Geophysical and Other Exploration Activities	Although there is some potential for interaction, the localized and short-term nature of these activities and their effects, along with planned and required separation measures will reduce potential for interaction.
Offshore Petroleum Exploration – Drilling	Some potential for interaction, although localized and short-term in nature. There is potential for cumulative interactions between the Project and other exploration activities through increased marine traffic and loss of access associated with anti-collisions zones, but these areas will be very small in comparison to the overall fishing areas in the RSA. Although some potential for interaction, localized and short-term nature of these activities and their effects, along with mitigation measures will reduce potential for interaction.
Fishing Activity	N/A
Other Marine Vessel Traffic	There is some potential for interaction, although these activities and their effects are highly localized and transient. Marine vessel traffic from various industries could increase in the Project Area over the temporal scope of the Project. Increase in marine traffic may result in increased risk of damage to fishing gear and equipment. Marine mammals may be affected by vessel strikes.
Other Harvesting Activity	There is no potential for interaction as non-commercial harvesting does not occur in the Project Area.
Cumulative Effects Summary	Project components and activities are not likely to result in significant residual adverse cumulative environmental effects on Indigenous Peoples in combination with other projects and activities that have been or will be carried out in the RSA.

15.8 Cumulative Effects Summary

It is predicted that the Project will not result in significant adverse cumulative environmental effects on the VCs in combination with other projects and activities that have been or will be carried out in the RSA.

15.9 Monitoring and Follow-up

Monitoring or follow-up programs that have been identified and described for the VCs as part of the Project-specific environmental effects assessment (Chapters 9 to 14) would be relevant to cumulative effects, in that they are relevant to the Project's potential contribution to cumulative effects in the region. No additional follow-up is required or proposed related specifically to potential cumulative environmental effects.

15.10 References

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