



CNOOC INTERNATIONAL FLEMISH PASS EXPLORATION DRILLING (2018 – 2028)

Environmental Impact Statement Addendum Responses to Round Two Information Requirements and Required Clarifications

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LIST OF APPENDICES

There are no appendices in the Round Two Response Package

ACRONYMS AND SHORT FORMS

ADM	Advection Dispersion Model
ADW	Application to Drill a Well
Agency	Canadian Environmental Assessment Agency
BoF	Bay of Fundy
BOP	Blowout Preventer
CEAA	<i>Canadian Environmental Assessment Act</i>
CEPA	<i>Canadian Environmental Protection Act</i>
CO ₂	Carbon Dioxide
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CBD	Convention on Biological Diversity
CNOOC	CNOOC Petroleum North America ULC. (formerly Nexen Energy ULC)
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Services
DFO	Fisheries and Oceans Canada
DP	Dynamically Positioned
DND	Department of National Defence
DWH	Deepwater Horizon
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
ECCC	Environment and Climate Change Canada
ECMP	Environmental Compliance Monitoring Plan
ECMWF	European Centre for Medium-Range Weather Forecasts
ECRC	Eastern Canada Response Corporation
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EL	Exploration Licence
EO	Environmental Observer
EPCMP	Environmental Protection and Compliance Monitoring Plan
EPP	Environmental Protection Plan
FAD	Fish Aggregation Device
FCAs	Fishing Closure Areas

FTWT	Formation Testing While Tripping
GB	Grand Bank
GHG	Greenhouse Gas
GPS	Global Positioning System
IBA	Important Bird Area
iBoF	Inner Bay of Fundy
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IR	Information Requirement
IUCN	International Union for Conservation of Nature
LOMA	Large Ocean Management Area
LSA	Local Study Area
MAH	Major Accident Hazards
MMO	Marine Mammal Observer
MODU	Mobile Offshore Drilling Unit
MSC	Meteorological Service of Canada
MSW	Multi-Sea-Winter
MTI	Mi'gmawe'l Tplu'taqnn Incorporated
NAFO	Northwest Atlantic Fisheries Organization
NEBA	Net Environmental Benefit Analysis
NL	Newfoundland and Labrador
NOBE	Newfoundland Offshore Burn Experiment
NO _x	Nitrogen Oxide
NRCan	Natural Resources Canada
OA	Operations Authorization
oBoF	Outer Bay of Fundy
OCSG	Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands
ODI	Ocean Data Inventory
OSR	Oil Spill Response
OSRP	Oil Spill Response Plan
OWTG	Offshore Waste Treatment Guidelines
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PB	Placentia Bay

PNET	Predicted No Effect Threshold
PSV	Platform Supply Vessel
RMS	Root Mean Square
ROV	Remotely Operated Vehicle
RSA	Regional Study Area
SA	Subscription Agreement
SAR	Species at Risk
SARA	<i>Species at Risk Act</i>
SBM	Synthetic Based Mud
SDL	Significant Discovery Licence
SHP	Seabird Handling Permit
SIMA	Spill Impact Mitigation Assessment
SSDI	Subsea Dispersant Injection
SST	Sea Surface Temperature
THC	Total Hydrocarbon Concentrations
TNASS	Trans North Atlantic Sightings Survey
TTS	Temporary Threshold Shift
UD	Utilization Distributions
UK	United Kingdom
UN	United Nations
UNB	University of New Brunswick
UXO	Unexploded Ordnance
VC	Valued Component
VME	Vulnerable Marine Ecosystem
VOC	Volatile Organic Compounds
VSP	Vertical Seismic Profile
WBM	Water Based Mud
WMP	Waste Management Plan

1 INTRODUCTION

CNOOC Petroleum North America ULC (CNOOC) is planning to conduct a program of petroleum exploration drilling and associated activities in the eastern portion of the Newfoundland and Labrador (Canada) Offshore Area over the period of 2018 to 2028 (the Project). The Project includes two Exploration Licences (ELs 1144 and 1150), in the Flemish Pass region located over 400km off the coast of Newfoundland, CNOOC is currently the Operator and sole interest holder and the two ELs have not yet been subject to exploration drilling activity.

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

The CNOOC International Flemish Pass Exploration Drilling EIS (the EIS Report) was planned, prepared and submitted by CNOOC in accordance with the requirements of CEAA 2012 as well as the EIS Guidelines and other generic EA guidance issued by the Agency. The EIS Report was directed and submitted by CNOOC, as the Proponent, and was prepared by a Study Team comprised of personnel from AMEC Foster Wheeler (now Wood PLC) and several specialized subcontractors (including RPS Group, JASCO Applied Sciences). The EIS Report was submitted for conformance review in February 2018 and was accepted for regulatory review in April 2018. The 30-day public comment period on the EIS Report was started on April 04, 2018 and closed on May 04, 2018. The Agency initiated its technical review of the EIS Report and received submissions from government experts, the public and Indigenous groups. The Agency determined that additional information (IRs) or clarifications (CLs) were required as part of their technical review. The Agency consolidated the requested IRs and CLs and provided them to CNOOC on June 08, 2018 as “Round One Information Requirements and Required Clarifications for the Nexen Energy ULC Flemish Pass Exploration Drilling Project” (Round One) with 85 IRs and 28 CLs.

Some of the Round One IRs or CLs required additional oil spill modelling work to be completed to address specific information requirements. In following, CNOOC initiated the additional oil spill modelling work in September 2018. In the interest of continuing to progress the regulatory review of the EIS Report while this additional technical work was completed, discussions were held with the Agency to split the Round One IRs and CLs into two parts. The first part (Part One), consisted of approximately 80 IRs and 27 CLs that were not directly linked to the additional oil spill modelling work. The second part (Part Two), consisted of all remaining IRs and CLs that were directly linked to the additional oil spill modelling work. As part of this additional oil spill modelling work, the Accidental Events section of the EIS Report (Section 16) was also revised and included as an appendix in the Part Two submission.

CNOOC submitted the Round One Part One responses to the Agency in September 2018 for compliance review. The Round One responses were submitted as an EIS Addendum Report (the EIS Addendum). The EIS Addendum acts as a supplement to the EIS Report.

In October 2018, as a result of its compliance review of Round One Part One, the Agency identified three IR responses (IR-04, IR-17, and IR-45) that required additional information while the remainder of the Round One Part One responses were determined to be compliant and were moved back into the EIS Report technical review.

CNOOC submitted the complete Round One responses to the Agency on February 08, 2019 which included the original Part One responses, the revised responses to IR-04, IR-17, and IR-45, plus the additional Part Two responses which encompassed the additional oil spill modelling work that was completed (Revised EIS Addendum – February 2019). The supplemental report from the additional oil spill modelling work and a revised Accidental Events section (Section 16 of the EIS Report) were included in accompanying appendices in the Revised EIS Addendum (February 2019). The Revised EIS Addendum (February 2019) completed its compliance review and was accepted by the Agency on February 26, 2019 for continued technical review with the EIS Report.

The Agency has continued its technical review of the EIS Report and supporting EIS Addendum materials. It has received additional submissions from government experts and Indigenous groups and the Agency has again determined that additional IRs or CLs are required as part of its ongoing technical review. The Agency has consolidated the additional IRs and CLs and provided them to CNOOC on April 16, 2019 as the "CNOOC International Flemish Pass Exploration Drilling Project – Round II Information Requirements" with 22 IRs and 2 CLs. All of the Round Two IRs and CLs are follow-up questions to Round One IRs or CLS and were identified by the Agency with a "-02" following each IR or CL number.

The EIS Addendum is presented in a "question and answer" format in the numerical order established by the Agency. At the request of the Agency, this Round Two EIS Addendum is a standalone document and does not contain any of the earlier Round One responses and supporting appendices (EIS Addendum Round Two). For Round One responses and the supporting appendices, the reader is referred to the Revised EIS Addendum that was filed with the Agency in February 2019.

2 RESPONSES TO INFORMATION REQUIREMENTS

2.1 Alternative Means

2.1.1 Information Requirement: IR-08-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Section 5 - All Part 2, Section 2.2 Alternative Means of Carrying Out the Project

Reference to EIS Guidelines: Section 2.10 Alternative Means of Carrying Out the Project

Context and Rationale: In IR-08, the Agency required additional information on the technical feasibility of reduced flaring and if well testing while tripping or a pipe conveyed well flow test approach were considered as alternative means. The proponent stated that flaring would be kept to the minimum required. It also stated that a formation flow test may be carried out using a drill pipe conveyed test assembly, reducing the amount of produced water sent to a flare, which suggests that this alternative is a technically and economically feasible alternative to standard well flow testing with flaring. A fulsome analysis of this alternative means in accordance with the Agency's Operational Policy Statement: Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012 has not been provided. If this method of well testing is indeed technically and economically feasible, and if it reduces or eliminates the need for flaring, it is not clear why it has not been selected as the preferred option.

Specific Question/ Information Requirement: Given that the proponent has identified pipe conveyed well flow test technology as a viable alternative to standard well flow testing with flaring, and that this alternative could eliminate or greatly reduce the need to flare, provide a discussion of this alternative means of carrying out the Project in accordance with the Agency's Operational Policy Statement: Addressing "Purpose of" and "Alternative Means" under the Canadian Environmental Assessment Act, 2012. Provide information on how these tests are carried out, how they might interact with the environment, and potential environmental effects. Given that this method of well testing could reduce or eliminate the need for flaring, discuss under what circumstances or for what reasons it would not be selected as the preferred option for well testing.

Response:

As was discussed by CNOOC Petroleum North America ULC (CNOOC) in its response to IR-08 (Revised EIS Addendum - February 2019) and in Section 2.5.2.4 of the Environmental Impact Statement (EIS), well flow testing is required pursuant to the Newfoundland Offshore Petroleum Drilling and Production Regulations, prior to obtaining a Significant Discovery Licence (SDL) from the Canada – Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB). The C-NLOPB will determine the required methods of well testing to validate the presence of hydrocarbons.

It was noted, in response to IR-09, that a Mobile Offshore Drilling Unit (MODU) does not carry all the necessary equipment for a well test (e.g., flaring equipment) and any additional equipment would need to be transported to the wellsite. A test would only be carried out on wells where hydrocarbons are discovered and additional information on the discovery is required. CNOOC also noted that there are alternative testing technologies, with the potential for improved safety and environmental performance, that could be proposed for the Project. The noted "Formation Testing While Tripping" (FTWT) is a test technology that is patented by Schlumberger and Equinor. For this reason, that particular licensed technology was not mentioned in the EIS or discussed as an alternative means to undertake the Project. Section 2.5.2.4 of the EIS and the response to IR-08 (Revised EIS Addendum February 2019) leave open the possibility of utilizing

similar “alternative testing technologies” that may become available to the entire industry. A direct quote from the EIS: “A formation flow test may, for example, be carried out using a drill pipe conveyed test assembly”. However, there are several factors that would need to be considered to determine if a proposed “alternative testing technology” was suitable for a specific well. These would include, but are not limited to:

- The properties of the reservoir and the suitability of the alternative testing technology to successfully complete the test;
- The data to be collected and the suitability of the alternative testing technology to successfully complete the test;
- The availability of the alternative testing technology within the Project timeline;
- The economic viability, technical feasibility, and benefits and limitations of using the proposed alternative testing technology to complete the test;
- The C-NLOPB required methods of well testing to validate the presence of hydrocarbons and the suitability and validity of the alternative testing technology to meet those requirements; and
- If proprietary technologies (e.g., FTWT noted above) are proposed for a well test, what are the logistic, technical, economic, and time requirements for use.

CNOOC will continue to evaluate alternative means of undertaking the Project that meet the regulatory, technical, and economic requirements and have the potential for improved safety and environmental performance. This could include alternative testing technologies as they become available.

2.2 Fish and Fish Habitat/Marine Mammals and Turtles

2.2.1 Information Requirement: IR-12-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(i) Fish and Fish Habitat

Reference to EIS Guidelines: Part 2, Section 6.3.1 Fish and Fish Habitat

Reference to EIS: Section 8.4.4 Atlantic Salmon

Context and Rationale: *Additional information on potential habitat use by Atlantic Salmon* Wolastoquey Nation in New Brunswick (WNNB) has advised that the following published research paper presents further evidence of potential use of the project area, not only as a migratory corridor, but also an important foraging area and nursery habitat for Atlantic Salmon:

Soto DX, Trueman CN, Samways KM, Dadswell MJ, Cunjak RA (2018). Ocean warming cannot explain synchronous declines in North American Atlantic salmon populations. *Mar Ecol Prog Ser* 601:203-213. <https://doi.org/10.3354/meps12674>

Sea-surface temperatures - link to Atlantic Salmon presence Both the EIS and IR-12 response emphasize that sea-surface temperatures in the project area limit the potential for interaction between Atlantic Salmon and the Project. However, WNNB noted that there are competing statements in the response to IR-12. Part 1 of the response states that variable sea-surface temperatures in the project area, particularly regular temperatures below 3°C, will limit the potential for interactions with the Project. Part 3 states that the limited interaction between salmon migrating within and near the project area and post-smolt and adults feeding north in the Labrador Sea and kelts along the southern edge of the Grand Banks will most likely remain low given the predicted increases in sea-surface temperatures near the project area. WNNB noted that this would only hold true if sea-surface temperatures increased above the thermal tolerance of Atlantic Salmon, and that based on EIS Figure 5-69, mean water temperatures in the project area are projected to increase by as much as 2°C, putting water temperatures in the preferred thermal range for Atlantic Salmon.

WNNB further noted that, although it has been shown that water temperature has been linked to declines in Atlantic Salmon, more recent studies (i.e. Soto et al 2018) have shown that climate change, and in particular increasing ocean temperatures cannot explain the declines in Atlantic Salmon in the North Atlantic.

Specific Question or Information Requirement: Provide a discussion of the results of the Soto et al. (2018) research in the context of the potential use of the project area by Atlantic Salmon. Update the environmental effects analysis, mitigation and follow-up, as applicable.

Provide clarification on contradictory information regarding sea-surface temperatures in the project area and the potential contribution this may make to current and future habitat use trends, taking into consideration the published research by Soto et al. on sea-surface temperatures and Atlantic Salmon distribution.

Response:***Part 1: Discussion of Soto et al (2018) paper and context of the potential use of the project area by Atlantic Salmon.***

The paper published by Soto et al (2018) investigated the stable isotope signatures (carbon and nitrogen) of returning adult salmon to the Saint John River, New Brunswick, over a long-time series (approximately 1980-2011) using archived scale samples from DFO. They compared the carbon isotope ($\delta^{13}\text{C}$) signatures in the scales to the known relationship between carbon isotopes at the base of the marine food web (marine algae – which are influenced by sea surface temperature [SST]). Potential marine feeding areas for each marine age, one- [1SW] and multi-sea winter [MSW]) of salmon, were proposed based on the relative strength of linear correlations between temporal trends of SST and Suess-corrected scale $\delta^{13}\text{C}$ values. The approach was based on the premise that the extent of carbon isotopic discrimination during photosynthesis by phytoplankton co-varies with temperature such that warmer waters lead to more ^{13}C -enriched particulate organic matter (POM) or higher $\delta^{13}\text{C}$ values. Therefore, if salmon spend time in different parts of the Atlantic Ocean with different SSTs, they would be eating things with different carbon signatures. The change over time in carbon signature within the scales of salmon can therefore provide an indirect record of the temporal trends in SST experienced by fish during marine feeding. The location of potential feeding areas can be inferred (estimated) through comparisons of temporal trends in fish scale isotopes and SST (measured by remote sensing). In general, the higher the carbon ^{13}C value, the warmer the water where the salmon was feeding.

The study found that MSW salmon from the Saint John River appear to be using different areas to feed than 1SW salmon from the same river. The paper determined that the larger MSW salmon were travelling and feeding to a greater extent through various SSTs while the 1SW fish were using the same general SST throughout the entire time series. It was therefore concluded that SST alone cannot explain the declines in salmon returns because both size classes of salmon have been showing similar declines throughout the time series.

Using the data, they also concluded that salmon from the Saint John River were most closely correlated to feeding areas in the western North Atlantic (Irminger Sea near Iceland, southwest Greenland or Labrador / Newfoundland), the southern North Sea, and northern Norwegian Sea regions (see darker green-blue areas in Figure 4 below from Soto et al [2018]); however, they suggest the western North Atlantic is the more likely feeding region for these fish. This western North Atlantic region (darker green and bluish in the Figure 4 below) is off the coast of Labrador and northern Newfoundland (Labrador Sea area) and does not include the Project Area in terms of higher correlation. The general location of the Project Area has been indicated by a red dot placed on Figure 4 below from Soto et al (2018) (see lower left corner) to show its relative location to the suggested feeding regions.



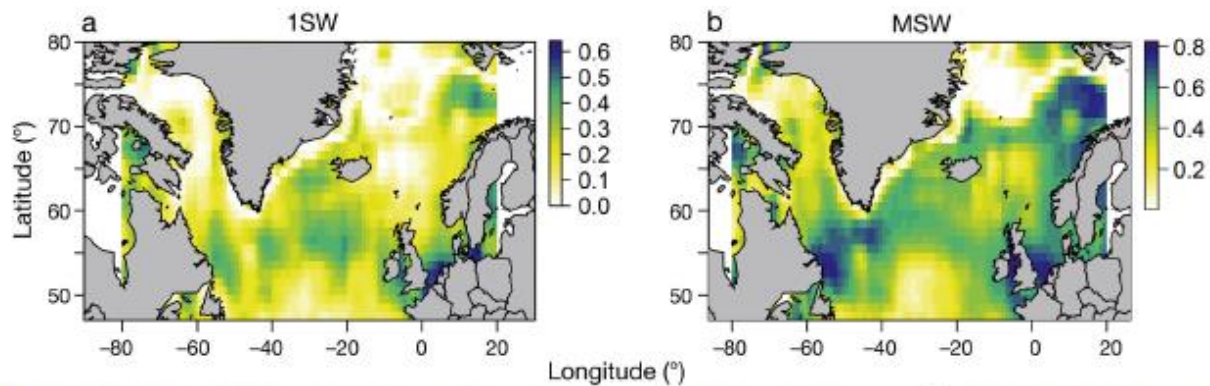


Fig. 4. Probable marine summer feeding locations derived from correlations of LOESS-fit scale $\delta^{13}\text{C}$ and yearly median sea surface temperature (SST) for Atlantic salmon after spending (a) 1 winter at sea (1SW) or (b) multiple winters at sea (MSW) and returning successfully to the St. John River during the period 1982–2011. Colours indicate the degree of correlation (R^2)

(reproduced from Soto et al. [2018])

There are other discussion points in Soto et al (2018) where they argue that warming in oceanic feeding areas cannot be the principal cause of synchronous population declines in 1SW and MSW salmon returning to the Saint John River. Soto et al (2018) conclude that environmental conditions in early post-smolt environments are the more likely causes of the synchronous population declines experienced by 1SW and MSW returning fish than conditions experienced during their time in open-ocean regions after the post-smolt year. They suggest their results support analyses identifying early post-smolt habitats as critical targets for conservation efforts focused on reducing marine mortality of Atlantic salmon. They do not identify the specific areas of focus; however, general migratory pathways of young smolt as they leave their natal stream and migrate toward marine feeding areas are most likely. For Saint John River salmon for example, these would likely include immediate estuary habitat, the Bay of Fundy, south coast of Nova Scotia, and coastal Newfoundland and Labrador, where predation, bycatch, and migration interference could occur. The Soto et al. (2018) paper does not therefore alter the context of the potential use of the Project Area by Atlantic Salmon. Updates to the environmental effect analysis, mitigation and follow-up are not required.

Part 2: Provide clarification on contradictory information regarding sea-surface temperatures in the project area and the potential contribution this may make to current and future habitat use trends, taking into consideration the published research by Soto et al. on sea-surface temperatures and Atlantic Salmon distribution.

As outlined in the Environmental Impact Statement (EIS) (see Section 6.1.8.6), migration routes for Atlantic salmon can be variable based on environmental conditions such as SST, which can vary considerably within the marine environment. In terms of habitat preferences, it has been shown that avoidance of lower water temperatures, particularly below 3°C, can play a predictive role in habitat use near the Grand Bank and Flemish Pass. Preferred water temperatures range between 4°C to 8°C.

It is agreed that Soto et al. (2018) provides evidence that although links to water temperature and declines in Atlantic Salmon have been shown, climate change, and in particular increasing ocean temperatures, cannot fully explain salmon declines in the North Atlantic. This recent information along with measures of reduced health and condition of returning Atlantic salmon (e.g., Todd et al. 2008), indicate that other factors may be greater contributors. Factors suggested by Todd et al. (2005) and Soto et al. (2018) include reduced prey availability within traditional feeding areas or increased mortality in the early period of post-smolt migration and not direct changes in feeding locations per se. Given the information available, it appears unlikely that the Project Area will become a key feeding area due to changes in thermal regimes. It is true

that the predicted SST increases due to climate change modelling to 2050 may increase mean SST within the Project Area to within the 4-8°C preferred thermal range during the assumed March-May period of migration between the Labrador Sea and the East Grand Banks area (see Figure 6.36 in the EIS). However, these predicted increases would also simultaneously push the predicted maximum SSTs beyond this preferred thermal range and therefore the overall suitability may only be slightly increased for migration. The predicted limited interaction between salmon migrating within and near the Project Area and the Project are expected to remain low. As the potential for environmental effects of planned Project activities and overall risk to Atlantic salmon is low, it is predicted that the Project will not contribute, nor exacerbate declines, to salmon populations.

The conclusion in the EIS, based on available data, remains valid. The Project is not likely to result in significant adverse environmental effects on marine fish and fish habitat, including Atlantic salmon.

There is appreciation of the knowledge gaps in the understanding of Atlantic salmon migration patterns in the North Atlantic and support for additional research is discussed in response to IR-13-02.

2.2.2 Information Requirement: IR-13-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(i) Fish and Fish Habitat

Reference to EIS Guidelines: Part 2, Section 6.3.1 Fish and Fish Habitat

Reference to EIS: Section 8.4.4 Atlantic Salmon

Context and Rationale: In IR-13, the Agency required the proponent to discuss the need for follow-up related to project-specific or cumulative effects on Atlantic Salmon, including participation in future regional initiatives and potential for collaboration with Indigenous communities. In response, the proponent stated that, in collaboration with industry and other research partners (potentially including Indigenous groups), it may consider supporting research on migratory routes within the offshore project area. The Agency notes that potential effects of the Project on Atlantic Salmon continues to be a key concern for Indigenous groups, and there continues to be some uncertainty regarding the use of the project area by Atlantic Salmon. The Agency understands that additional research in this area is being considered through Petroleum Research Newfoundland and Labrador or through the Environmental Studies Research Fund.

Specific Question or Information Requirement: Indicate whether the proponent has become involved in any of the salmon related research initiatives that are being considered or proposed through Petroleum Research Newfoundland and Labrador or through the Environmental Studies Research Fund, and if so, describe how the proponent is supporting these initiatives. If the proponent has identified or is pursuing any other research initiatives or collaborations to improve understanding of Atlantic Salmon in the marine environment and their potential interaction with oil and gas activity in the offshore Newfoundland area, provide information on these activities. For any research activities being considered or undertaken, elaborate on how Indigenous groups would or are being engaged.

Response:

There are efforts underway to address knowledge gaps regarding Atlantic salmon migration, including planned studies already underway such as the Atlantic Salmon tagging program by the Atlantic Salmon Federation (ASF) and potential initiation of new studies with the Environmental Studies Research Fund (ESRF).

The ASF is conducting a salmon tagging program of kelt in Greenland. The purpose of the tagging is to provide additional information regarding the migratory routes of adult salmon from Greenland to the coastal waters of Canada. The data from the ASF program will add to the migration dataset, and the results will become available on their website. In addition, acoustic receivers are being placed on production facilities (e.g., Husky Energy has placed acoustic receivers on its SeaRose production facility located on the Grand Banks), that will be able to detect signals from tags that pass within range, and this data will contribute to the body of knowledge regarding salmon migration in this area. The effects prediction in the Environmental Impact Statement (EIS) conservatively assumed that salmon migrate through the Project Area, although data on this matter are scarce. Results from this ASF study will provide additional information regarding the migration routes of the tagged salmon and may assist in the determination of whether this assumption is valid.

A longer-term research initiative would be through the ESRF, a national industry-funded research program which sponsors environmental and social studies. The ESRF is designed to assist in the decision-making process related to oil and gas exploration and development on Canada's frontier lands.

The funding for the ESRF is provided through levies on frontier lands paid by interest holders such as oil and gas companies (including CNOOC Petroleum North America ULC (CNOOC)). The ESRF is directed by a joint government / industry / public management board and is administered by a secretariat which resides in the Office of Energy Research and Development, Natural Resources Canada (Ottawa). There is an open and transparent process to identify priority research areas and solicit proposals. The data gap related to the migratory routes of Atlantic salmon has already been presented to the ESRF Secretariat as a new research priority. Research funded by the ESRF is published and made publicly available on the ESRF website.

The ESRF has issued a new call for proposals on May 15, 2019 for Environmental and Social Studies related to Atlantic Salmon. Additional information on this most recent call for proposals can be found here: <https://www.esrfunds.org/181>.

2.2.3 Information Requirement: IR-15-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(i) Fish and Fish Habitat

Reference to EIS Guidelines: Part 2, Section 6.3.1 Fish and Fish Habitat

Reference to EIS: Section 8.3 Environmental Effects

Context and Rationale: The Agency required the proponent to provide an assessment of the potential effects to Swordfish from noise, spills, and light. In its response, the proponent provides information on the effects of routine project operations on Swordfish, but did not discuss the potential effects of spills.

Specific Question or Information Requirement: Provide an assessment of the potential effects of a spill, including of a large scale blowout, on Swordfish. This assessment should include consideration of any existing published research on the biological and behavioural responses of Swordfish to spills and/or exposure to hydrocarbons. The assessment should focus on any effects that may be unique or particularly acute in Swordfish. Update the proposed mitigation and follow-up, as well as effects predictions, accordingly, including providing an overview of any monitoring of effects on Swordfish or fish species in general that would occur in the event of a spill.

Response:

The biology and distribution of swordfish and avoidance capabilities to anthropogenic effects is discussed in the response to IR-15 (Revised EIS Addendum - February 2019) and are considered in the assessment of Project activities on this species.

The potential effects of an unmitigated hydrocarbon release on swordfish can be derived from studies on other large pelagic fishes (i.e., tuna, billfish) and fish species in general. Exposure to crude oil and associated polycyclic aromatic hydrocarbons (PAHs) to early life history stages (e.g., eggs, larvae) of various fish species have been shown to result in reduced growth rates and various developmental impairments (Incardona et al. 2013, 2014, Brette et al. 2014, 2017, Incardona and Scholz 2018). Laboratory exposure of juvenile yellowfin tuna and Pacific bluefin tuna resulted in impaired cardiac function and output (Brette et al. 2014, Incardona and Scholz 2018). Phenanthrene, a PAH found in crude oil, was experimentally exposed to Pacific mackerel and juvenile yellowfin and Pacific tuna hearts resulting in cardiac contractile failure and abnormal contractile rhythm (Brette et al. 2017). Direct effects of crude oil on adult swordfish is less understood, however studies on other fish species in general have shown that hydrocarbon exposure to adult fish have led to increased physiological stress and reduced swimming performance (Gonçalves et al. 2008, Klinger et al. 2015, Stieglitz et al. 2016). Preliminary analysis, of samples taken following the Deepwater Horizon spill event, did not detect DNA damage in adult swordfish (Hueter n.d.).

Based on laboratory studies of other fish species including large pelagics, swordfish eggs and larvae would be the primary life stages that are sensitive to hydrocarbons and crude oil exposure. However, the spawning areas and nursery areas in the Gulf of Mexico and eastern continental shelf of the United States (Govoni et al. 2003, Arocha 2007, IR-15) where swordfish primary life stages occur are beyond the predicted geographic extent of an unmitigated North Atlantic hydrocarbon release. There are results from numerous oil spill models of unmitigated hydrocarbon releases in the North Atlantic region, including the CNOOC Petroleum North America ULC (CNOOC) results, indicating that such a spill would not travel in the direction of the spawning and nursery areas in the Gulf of Mexico and eastern continental shelf of the United States. Therefore, swordfish early life stages are not likely to interact with the crude oil from an unmitigated oil spill event on the CNOOC Project.

For adult swordfish in Canadian waters, an unmitigated hydrocarbon release may reduce abundance of prey (e.g., squid, mackerel, herring, sand lance) (Scott and Tibbo 1968, Stillwell and Kohler 1985) resulting in a change in food availability and quality for swordfish. Swordfish are highly mobile species with ocean-basin distributions (Neilson et al. 2014) that may be able to search for prey in areas outside of affected areas reducing potential effects of changes to food availability and quality. Furthermore, avoidance capabilities to anthropogenic activities as described in the response to IR-15 (Revised EIS Addendum February 2019) would also reduce any potential direct effects on adult swordfish. This species' seasonal distribution in Canadian waters, combined with their non-schooling behavior, also reduces any potential population level effects (Sharma and Arocha 2017) in Canadian waters.

There are no updates or changes necessary for the mitigations or follow-up as currently proposed.

References

- Arocha, F. 2007. Swordfish reproduction in the Atlantic Ocean: and overview. *Gulf and Caribbean Research* 19:21–36.
- Brette, F., B. Machado, C. Cros, J. P. Incardona, N. L. Scholz, and B. A. Block. 2014. Crude Oil Impairs Cardiac Excitation-Contraction Coupling in Fish. *Science* 343:772–776.
- Brette, F., H. A. Shiels, G. L. J. Galli, C. Cros, J. P. Incardona, N. L. Scholz, and B. A. Block. 2017. A Novel Cardiotoxic Mechanism for a Pervasive Global Pollutant. *Scientific Reports* 7:41476.
- Gonçalves, R., M. Scholze, A. M. Ferreira, M. Martins, and A. D. Correia. 2008. The joint effect of polycyclic aromatic hydrocarbons on fish behavior. *Environmental Research* 108:205–213.
- Govoni, J. J., E. H. Laban, and J. A. Hare. 2003. The early life history of swordfish (*Xiphias gladius*) in the western North Atlantic. *Fishery Bulletin* 101:778–789.
- Hueter, R. E. (n.d.). Mote Marine Laboratory: Effects of the Deepwater Horizon Oil Spill on epipelagic and large coastal sharks and teleosts of the Gulf of Mexico. FIO Block Grants-Final Report.
- Incardona, J. P., L. D. Gardner, T. L. Linbo, T. L. Brown, A. J. Esbaugh, E. M. Mager, J. D. Stieglitz, B. L. French, J. S. Labenia, C. A. Laetz, M. Tagal, C. A. Sloan, A. Elizur, D. D. Benetti, M. Grosell, B. A. Block, and N. L. Scholz. 2014. Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish. *Proceedings of the National Academy of Sciences* 111:E1510–E1518.
- Incardona, J. P., and N. L. Scholz. 2018. Case Study: The 2010 Deepwater Horizon Oil Spill and Its Environmental Developmental Impacts. Pages 235–283 *in* W. Burggren and B. Dubansky, editors. *Development and Environment*. Springer International Publishing, Cham.
- Incardona, J. P., T. L. Swarts, R. C. Edmunds, T. L. Linbo, A. Aquilina-Beck, C. A. Sloan, L. D. Gardner, B. A. Block, and N. L. Scholz. 2013. Exxon Valdez to Deepwater Horizon: Comparable toxicity of both crude oils to fish early life stages. *Aquatic Toxicology* 142–143:303–316.
- Klinger, D. H., J. J. Dale, B. E. Machado, J. P. Incardona, C. J. Farwell, and B. A. Block. 2015. Exposure to Deepwater Horizon weathered crude oil increases routine metabolic demand in chub mackerel, *Scomber japonicus*. *Marine Pollution Bulletin* 98:259–266.
- Neilson, J. D., J. Loefer, E. D. Prince, F. Royer, B. Calmettes, P. Gaspar, R. Lopez, and I. Andrushchenko. 2014. Seasonal distributions and migrations of Northwest Atlantic swordfish: inferences from integration of pop-up satellite archival tagging studies. *PLoS One* 9:e112736.
- Scott, W., and S. Tibbo. 1968. Food and feeding habits of swordfish, *Xiphias gladius*, in the western North

- Atlantic. Journal of the Fisheries Board of Canada 25:903–919.
- Sharma, R., and F. Arocha. 2017. Resiliency for north Atlantic Swordfish using Life History parameters 74:1306–1321.
- Stieglitz, J. D., E. M. Mager, R. H. Hoenig, D. D. Benetti, and M. Grosell. 2016. Impacts of Deepwater Horizon crude oil exposure on adult mahi-mahi (*Coryphaena hippurus*) swim performance. Environmental toxicology and chemistry 35:2613–2622.
- Stillwell, C., and N. Kohler. 1985. Food and feeding ecology of the swordfish *Xiphias gladius* in the western North Atlantic Ocean with estimates of daily ration. Marine ecology progress series. Oldendorf 22:239–247.

2.2.4 Information Requirement: IR-01/16-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Section 5 - All Part 2, Section 3 Project Description

Reference to EIS Guidelines: Section 2.1 Project Scope and Overview; Section 2.5.2.2 Offshore Well Drilling; Section 4.1 Scope of the Environmental Assessment and Factors Considered

Context and Rationale: In IR-01 the Agency required further information on batch drilling. In response, the proponent provided information on when and how batch drilling may occur and indicated “batch drilling would be considered if the plan involved drilling multiple close proximity wells with similar well designs.” The proponent also provided information on the benefits of batch drilling, including potential environmental benefits; however, there is no discussion of potential negative environmental effects. In IR-16, the Agency required information on the “likely distance” between individual wells in making the determination that there is no potential for overlap and clarification on what is the closest distance that wells could occur to each other. The proponent provided information on the factors that influence the locations of and distances between the exploration wells, but did not provide a likely minimum distance or general “likely distance” between wells. Additional information is required to support the proponent’s assertion that there is little or no potential for environmental releases from individual wells to interact or accumulate in the local study area (LSA) and to support conclusions related to cumulative effects of the multi-well drilling program.

Specific Question/ Information Requirement: Indicate an estimated minimum distance between two wells, both exploration and delineation, and in consideration of this estimate, provide information on potential environmental effects of drilling wells (both batch drilling and standard drilling) in close proximity to each other, including information on potential overlap of released discharges from two or more close proximity wells. If no such overlapping effects are anticipated, provide appropriate justification. Update proposed mitigation and follow-up, as well as significance predictions, as applicable.

Response:

The potential exploration well sites are still being evaluated by the CNOOC Petroleum North America ULC (CNOOC) team and the identification of delineation wells would only be determined after one or more exploration wells have been drilled. The information developed to this point indicates that the minimum estimated distance between a potential exploration well and a potential delineation well could be as little as six kilometres but given the large area to be evaluated in each EL, the more likely minimum estimated distance between an exploration and delineation well would be 10-20 kilometres.

The cumulative effects were considered in terms of spatial and temporal overlap. For spatial considerations and based on this early well information, the predicted minimum estimated distance between potential wells would be six kilometers. The Environmental Impact Statement (EIS) dispersion modelling of drill cuttings (Section 8.3.4.2; Appendix D) predicted a small footprint for drill cuttings that limits the potential burial of benthic species to less than 500 metres around the wellsite. Very small quantities (less than four percent) of SBM cuttings are predicted to disperse beyond 1-2 kilometres. The remaining low quantities of cuttings dispersed beyond two kilometers are not predicted to have any potential interactions due to the expected low concentration in the water column and lack of accumulation on the seabed. There are no other Project effects predicted with potential spatial overlap.

For temporal considerations, CNOOC is proposing to use a single MODU (see the response to IR-01 for more details; Revised EIS Addendum - February 2019), meaning that drilling at different sites within the Project Area will not be occurring concurrently. With no temporal overlap in the drilling of separate wells,

this removes the potential for other Project effects such as noise and light effects from further consideration in this discussion.

Cumulative effects of adjacent drilled wells were considered but they will have spatial and or temporal separations. The original cumulative effects assessment (Section 15 of the EIS), therefore is still valid in that the Project is not likely to result in significant adverse cumulative environmental effects on any of the VCs in combination with other projects and activities. There are no updates to the current mitigations or follow-up as proposed.

2.2.5 Information Requirement: IR-26-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(i) Fish and Fish Habitat, 5(1)(a)(ii) Aquatic Species

Reference to EIS Guidelines: Part 2, Section 8 Follow-Up and Monitoring Programs

Reference to EIS: Section 10.6 Environmental Monitoring and Follow-up

Context and Rationale: In IR-26, the Agency required the proponent to state whether it intends to verify noise predictions and/or the effectiveness of mitigation measures through a follow-up program. In response, the proponent states that any uncertainty associated with predicted sound levels during operation, as well as predicted effects on marine mammals and sea turtles, is considered low. In addition, it states that the planned mitigation measures would reduce the potential for adverse environmental effects. The Mi'gmawei Mawiomi Secretariat (MMS) and other Indigenous groups have noted that there remains uncertainty regarding the effects of noise, and in particular seismic activity, in the offshore on marine life. MMS has stated that there may be a negative correlation between seismic activity and plankton, which is the very base of the marine food chain. MMS has requested that additional research be completed with regards to seismic testing and negative impacts on marine life. The MMS also stated that there is insufficient research to support the proponent's claim that the proposed mitigation measures are sufficient.

Specific Question or Information Requirement: Provide an analysis of the potential effects of vertical seismic profiling on plankton. Discuss any potential areas of uncertainty regarding the effects of seismic activity on plankton and on other marine life.

Response:

The level of certainty regarding effects assessment is based on standard environmental effects assessment methodology (Section 4.3.3 of the Environmental Impact Statement (EIS)) and includes consideration of the knowledge of existing conditions, potential effects, and mitigations.

The potential effects of seismic activities on the Marine Fish and Fish Habitat VC (which includes plankton) are presented in Section 8.3.5.1 of the EIS. These studies are generally focused on seismic survey programs that have longer duration and higher geographic extent compared to vertical seismic profiling (VSP) activities. The effects of these larger seismic surveys on zooplankton were recently examined by McCauley et al. (2017) off the coast of Tasmania that used a 150 cubic inch compressed air source. The study involved assessments of local zooplankton abundance with sonar backscatter surveys, and measurements of zooplankton mortality before and after seismic surveys. There was an observed decrease in zooplankton abundance and a two-to-threefold increase in dead adult and larval zooplankton along exposure transects compared to controls. Effects on zooplankton were observed up to a maximum of 1.2 km sampling range (McCauley et al. 2017). However, the study was limited by low sample size and replicates (12 exposure and 12 control samples) as it was conducted over two days. There were also uncertainties associated with this study regarding the lack of attenuation with distance of the impact and immediate declines in abundance. Although the mechanism for potential injury on zooplankton from seismic activities is not known, the authors suggest that sensory hairs may be damaged by exposure to compressed air sources, resulting in sublethal effects (McCauley et al. 2017).

A simulation to assess the potential effects of a seismic survey in the Australian region was conducted by Richardson et al. (2017) on zooplankton populations using mortality rates determined by McCauley et al. (2017) and considered zooplankton growth, movement by current, and population mixing. The model simulation was based on a typical seismic survey over the summer period at water depths ranging from 300

to 800 m over a survey acquisition area of approximately 2,900 m². The effects of the air source were measured as mortality or absence from the area over the 35-day seismic survey period. Modelling results indicated the effects of seismic activity on zooplankton populations only occurred at the local scale (within 15 km of the survey area), with less of an impact on a larger regional scale (within 150 km of the survey area). Within 15 km of the study area, zooplankton biomass was also predicted to recover to pre-seismic levels within 3 days after completion of the seismic survey (Richardson et al. 2017). Richardson et al. (2017) also suggest that the decline in abundance observed by McCauley et al. (2017) may be due to zooplankton avoidance behaviour as deceased zooplankton would not immediately sink from surface layers or be immediately consumed.

While these (Richardson et al. 2017; McCauley et al. 2017) and other studies (see Section 8.3.5.1 of the EIS) provide information regarding the potential effects on zooplankton they are based on their own regional context. This must be considered when applying this information to the North Atlantic and to VSP activities as the studies are influenced by local ocean currents, plankton species, compressed air source level and configuration, study area, and study designs. Richardson et al. (2017) indicates that potential effects on plankton would likely be less in regions with more dynamic ocean circulation, however, recovery may be slower in colder regions. Furthermore, the actual mechanism for seismic effects on plankton and if it affects all life stages equally is not well understood (Richardson et al. (2017)). The literature is also typically focused on seismic surveys (2D, 3D, 4D) that are of longer duration, larger spatial extent, and larger source sound than a VSP survey and therefore the “seismic effects” identified in the literature on marine fish and fish habitat including plankton are expected to be overestimated for VSP.

VSP activities are described in Section 2.5.2.3 of the EIS. These profiling activities will be conducted on individual well sites using a stationary compressed air source suspended from the MODU. A walk-away VSP may be conducted where the air source is placed on a vessel which then moves away from the well site. The receivers for this activity are placed at pre-determined depths within the well. In comparison to seismic or other geophysical surveys that are discussed above and in various other studies (see Section 8.3.5.1 of the EIS), the typical sound source for VSP activities are smaller, the duration is shorter (sound source activation is generally limited to a few hours per instance), and the sound emissions are mainly directed downward into the well. Furthermore, as the activity is stationary or localized around the wellsite, the potential area of “seismic effect” from the VSP relative to a large seismic survey is expected to be much lower.

As indicated in Section 8.3.2, 9.3.2, and 10.3.2 of the EIS, for any required VSP activity using seismic sound arrays, CNOOC will operate in compliance with the **Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment**. These guidelines were based upon a peer review of the potential effects of seismic sound on marine mammals, marine sea turtles, marine fish and invertebrates, including marine zooplankton, ichthyoplankton, eggs and larvae (DFO 2007).

Key mitigations that will be applied include:

- Seismic sound levels will be kept at the minimum level possible based on the associated technical requirements for the survey.
- At the commencement of the VSP survey, a gradual “ramp-up” procedure of the seismic sound array will be implemented to allow any mobile marine animals to move away from the area if they are disturbed by it.
- There will also be a planned shut-down of the seismic sound arrays or reduction to the smallest, single source element during any required maintenance activities.

Therefore, in consideration of the existing knowledge and currently proposed mitigations, the effects assessment of VSP activities on Marine Fish and Fish Habitat (including plankton) remains unchanged from

the EIS as adverse, low in magnitude, within the LSA, a short term, sporadic activity, that is reversible and this assessment was made with a high degree of certainty.

References

- DFO (Fisheries and Oceans Canada). 2007. Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment. Available online: <http://waves-vagues.dfompo.gc.ca/Library/363838.pdf>.
- McCauley, R., Day, R. D., Swadling, K. M., Fitzgibbon, Q. P., Watson, R. A. and J.M. Semmens. (2017). Widely used marine seismic survey air gun operations negatively impact zooplankton. *Nature Ecology and Evolution*, 1: 1-8.
- Richardson, A.J., R.J. Matear, and A. Lenton. 2017. Potential impacts on zooplankton of seismic surveys. Australia: CSIRO, 10.

2.2.6 Information Requirement: IR-29-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species

Reference to EIS Guidelines: Part 2, Section 6.4 Mitigation Measures

Reference to EIS: Section 10.3.2 Summary of Key Mitigation; Table 10.5 Environmental Effects Assessment Summary: Marine Mammals and Sea Turtles; Section 10.6 Environmental Monitoring and Follow-up

Context and Rationale: In its response to IR-29, the proponent states that a trained Marine Mammal Observer “will continuously observe a pre-determined zone for 30 minutes prior to the start-up of the vertical seismic profile (VSP) sound source array” and that “the pre-determined zone is typically defined as a 500 metre (m) radius surrounding the mobile offshore drilling unit”.

This response suggests that only offset VSP surveys would be undertaken; however, in section 2.5.2.3 of the EIS, the proponent states “walk-away VSP surveys may also be undertaken”. Having the Marine Mammal Observer positioned on the mobile offshore drilling unit during a walk-away VSP survey may not result in desired mitigation outcomes.

Specific Question or Information Requirement: In the event that walk-away VSP surveys are undertaken, describe where the Marine Mammal Observer would be positioned and the location and size of the pre-determined observation zone.

Response:

During a Vertical Seismic Profile (VSP) survey (offset or walk-away) the Marine Mammal Observer (MMO) will continuously observe a predetermined safety zone with a circle radius of at least 500 metres measured from the center of the proposed VSP sound source as per the **Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment** (DFO, 2013). The MMO will be located and positioned such that they have an unobstructed view of the entire safety zone before (at least 30 minutes prior to start up) and for the duration of the VSP activity. In the event that a walk-away VSP survey is proposed, the optimum location for the Marine Mammal Observer will be determined in advance of the start of the VSP program.

References:

DFO (Fisheries and Oceans Canada), 2013. Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment. Available online at: <http://www.dfo-mpo.gc.ca/oceans/publications/seismic-sismique/index-eng.html>.

2.3 Migratory Birds

2.3.1 Information Requirement: IR-34-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(iii) Migratory Birds

Reference to EIS Guidelines: Part 2, Section 6.3.5 Migratory Birds and 6.6.3 Cumulative Effects Assessment

Reference to EIS: Section 9.3.3.2 Residual Environmental Effects Assessment

Context and Rationale: In its response to IR-34, the proponent states that “available studies on attraction of birds to offshore lighting from oil and gas production facilities have demonstrated attraction distances of less than 2 kilometres (km) (Day et al 2015) to as much as 5 km (Poot et al 2008), although attraction from distances of much greater than 5 km could not be ruled out in the Poot study. Attraction of marine and migratory birds from greater distances than the 5 km zone of influence assumed in the EIS would result in a greater number of birds potentially affected by artificial lighting associated with the Project. To date, we are unaware of any studies demonstrating attraction from such large distances.”

Based on this response, ECCC has advised that, due to the uncertainty of the Poot et al (2008) study, specifically that distances larger than 5 km could not be ruled out, there is no scientific basis that would support an assumption that a 5 km zone of influence is sufficient. Additionally, given the lack of research related to the specific distance that birds are attracted to lit structures in an otherwise dark environment, the proponent should adopt a precautionary approach that assumes a larger zone of influence, pending additional evidence to support a smaller zone of influence.

In its response to IR-84, the proponent also states that “a recent global positioning system tracking study on the related Cory’s shearwater found that fledging birds from colonies up to 16 km away...were apparently susceptible to stranding due to light attraction”.

The proponent also stated that “MODUs typically have fewer light sources than stationary production facilities such as those considered in the Poot study. The potential for associated attraction effects from a MODU is predicted to be smaller in magnitude and there are no implications for the assessment of associated effects in the EIS.”

Based on this response, ECCC has advised that the presence of artificial lighting along the foraging flight path for nocturnal seabirds, particularly the Leach’s Storm-Petrel, should be the basis of the analysis rather than the magnitude of the lighting on MODUs compared to stationary production facilities.

ECCC has also advised that, In addition to migratory birds being attracted to offshore exploration and production facilities, the cumulative effects of artificial lighting has created a significant footprint in the offshore which did not exist a few decades ago. See the following website (<https://www.lightpollutionmap.info/>) and the associated research paper (Cizano et al 2001) for a worldwide light pollution atlas that depicts the footprint created by all existing projects currently present in the offshore environment. The cumulative effects of multiple artificial light footprints illuminating a previously pristine environment should be considered, particularly with respect to how this may be altering the behaviour of nocturnal species (e.g. millions of Leach’s Storm-petrels that regularly forage in and migrate through the project area). References:

Cizano, P., Falchi, F., and Elvidge, C.D. (2001). The first World Atlas of the artificial night sky brightness.

Monthly Notices of the Royal Astronomical Society. 328(3): 689-707

Specific Question or Information Requirement: 1) Using a precautionary approach that assumes a larger zone of influence than 5 km, and potentially up to 16 km or more, update the effects assessment of artificial lighting on marine and migratory birds.

2) Provide an assessment of the cumulative effects of artificial lighting from the Project in combination with lighting from other sources in the offshore along the foraging flight path for nocturnal seabirds, particularly Leach's Storm-Petrel, and the associated mitigation measures to reduce the effects to nocturnal seabirds.

Response:

Using a precautionary approach assuming a larger potential zone of influence of 16 km or more due to project lighting, the overall magnitude of the potential effect of the presence and operation of the MODU on marine and migratory birds is anticipated to be low. There may be a slight increase in mortality / injury levels due to collisions, disorientation and potential predation, although the mortality rate is anticipated to be low as many stranded birds encountered on offshore installations and vessels are released successfully. Some localized and short-term behavioral effects (change in presence and abundance) are likely to occur, with some species displaced from the LSA and others attracted by lighting and associated foraging opportunities. Even a 16 km zone of influence of the Project at any one time or location represents a very small proportion of the available feeding, breeding or migration area of any species within the RSA, and birds will not be displaced from any key habitats or during important activities, or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region. Any changes in habitat and food availability will be on a localized scale and temporary in nature. These effects are predicted to be adverse, low in magnitude, localized to within the LSA, short- to medium-term in duration, regular in frequency, and reversible, with a moderate to high level of certainty.

While the effects of the Project on marine and migratory birds is anticipated to be low in magnitude, it is acknowledged that within the RSA, cumulative effects of the Project in combination with other light sources in the offshore environment have potential to alter foraging behaviour for the Leach's Storm-petrel and other nocturnal seabirds, when compared with conditions of a few decades ago. The current petroleum production projects (Hibernia, Terra Nova, White Rose and Hebron) are located at considerable distance from the Project Area / LSA, and even taking into account a larger zone of potential influence, any environmental disturbances that are relevant to this VC resulting from Project activities (including light emissions that may attract and/or disorient night-flying birds) in the 16 km zone of influence will not likely overlap with those of the current production projects with the possible exception of associated vessel transits. Zones of influence associated with lighting from other marine traffic (including oil and gas exploration activity and fishing vessels) may overlap with that of the Project, causing some temporary short-term alteration of foraging activities as birds and their forage species may be attracted to these light sources.

2.3.2 Information Requirement: IR-37-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(iii) Migratory Birds

Reference to EIS Guidelines: Part 2, Section 6.3.5 Migratory Birds

Reference to EIS: Section 9.3.3. Presence and Operation of MODUs

Context and Rationale: In IR-37, the Agency required additional information and context regarding information presented in Section 9.3.3 of the EIS in relation to bird strandings and searches on offshore vessels. The following is a quote from the proponent's response to IR-37:

"In both Ellis et al. 2013 and Environment Canada 2015, Leach's Storm-petrels were the most commonly found species stranded on vessels. These reports were not specific to oil and gas, and included vessels of various types, including fishing and research vessels as well as oil and gas-related vessels."

ECCC has advised that strandings information is usually restricted to oil and gas related vessels because these vessels require a seabird handling permit. Generally, fishing and research vessels (and other vessels) do not report strandings information.

In addition, ECCC has advised that the use of Environment Canada 2015 is not appropriate in this context. The guidance document only briefly summarizes the issue of strandings on vessels and does not specifically reference Leach's Storm-petrel strandings.

Specific Question or Information Requirement: Clarify whether Ellis et al.'s 2013 results were restricted to the number of birds found on decks of oil and gas platforms only.

Response:

Ellis et al. 2013 cited a report by Burke et al. (2005), which stated that from 1998-2002, 469 birds, most of which were Leach's Storm-Petrels, were found stranded on "various offshore oil and gas platforms, i.e., various dredge ships, mobile offshore drilling units (MODU), and drill ships". Mortality due to fishing activities discussed in Ellis et al. were primarily reports of bycatch and did not provide data on shipboard strandings.

Reference:

Burke, C. M., G. K. Davoren, W. A. Montevecchi, and F. K. Wiese. 2005. Surveys of seabirds on support vessel transects and at oil platforms on the Grand Bank. Pages 587-614 in P. Cransford and K. Lee, editors. Offshore oil and gas environmental effects monitoring. Battelle, Columbus, Ohio, USA.

2.3.3 Information Requirement: IR-39-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(iii) Migratory Birds

Reference to EIS Guidelines: Part 2, Section 6.3.5 Migratory Birds

Reference to EIS: Section 9.6 Environmental Monitoring and Follow-Up

Context and Rationale: In its response to IR-39, the proponent states that, if there is a future regulatory requirement to incorporate technology such as radar and thermal imaging into monitoring, it would comply with it. However, the proponent does not provide information on the benefits and potential effectiveness of implementing these measures compared to and in combination with the use of trained seabird observers and standard reporting in accordance with the Seabird Handling Permit.

Specific Question or Information Requirement: Provide details on the potential benefits, effectiveness, and need for incorporating technology such as radar and thermal imaging into bird monitoring. Comment on the technical and economic feasibility of incorporating these measures into the Project.

Response:

In the context and rationale provided by the Canadian Environmental Assessment Agency (CEAA) for IR-39, it was noted that onsite observers and/or automated sensors were recommended on platforms to reduce uncertainty related to seabird attraction to platforms, mortality events, and chronic spills and discharges. In its response to IR-39 (Revised EIS Addendum February 2019), CNOOC Petroleum North America ULC (CNOOC) noted that an Environmental Observer (EO) responsible for wildlife observation and reporting (including marine birds) will be present on the MODU. As was detailed in CNOOC's response to IR-38, marine bird observations will be undertaken in accordance with Environment and Climate Change Canada-Canadian Wildlife Service's (ECCC-CWS's) monitoring protocol from stationary platforms (Revised EIS Addendum - February 2019). Additional surveillance and monitoring of small spills and the associated reporting efforts can also be undertaken by this EO on an as-needed basis.

Regarding the use of "automated sensors" on platforms for seabird monitoring, it is assumed this refers to remotely operated real time tracking of bird movements around the platform. The potential use of and performance of remotely-operated techniques (such as radar) to observe the behavior of birds at distance and or under low visibility conditions has undergone study since the 1940's when the military noted that military radar could track birds as well as enemy aircraft. The first coordinated use of a group of radar installations to study bird movements over a large area was initiated in Canada in 1964 to try to address bird collisions with aircraft (Eastwood 1967). The study of remotely operated techniques (primarily radar) to try to observe / document bird presence and movements ("radar ornithology") has been ongoing since that time (Gauthreaux and Schmidt 2013). More recent studies of remotely operated techniques to observe bird behavior have also included follow-up monitoring related to wind turbine installations (onshore and offshore) to try to determine the number of bird collisions with turbine blades (Desholm, Fox, and Beasley 2004; d'Entremont, Hartley, and Otter. 2017). The large majority of these studies have tested variations of radar technologies. A smaller number of studies have looked at other potential technologies (e.g., thermal imaging / detection) (McCafferty 2013). A comparison of a number of these technologies is discussed in the Desholm, Fox, and Beasley 2004 study "Best practice guidance for the use of remote techniques for observing bird behaviour in relation to offshore wind farms".

The different technologies operate at different spatial scales (i.e., resolution, distance, horizon) and require differing levels of supporting equipment (e.g., handheld equipment through to large skid or trailer or barge

mounted installations). A large number of the studies have identified that these technologies do not track all bird movements (e.g., some species of birds are too small, flocks of birds that are not clustered together, precipitation can interfere with detection, large waves and other stationary or moving objects can occlude birds, etc.), and given the overall uncertainty with the accuracy of the collected data in offshore applications, there remains a need to compare the remotely observed data with documented visual observations undertaken at the same time in order to prove / improve the level of accuracy (Gerringer, Lima, and DeVault 2016). Given this need for data comparison (remotely observed vs. visually observed), the feasibility of these technologies for real time tracking is limited until the collection methods and accuracy of the data are validated. In a large number of the studies, the limitations of each of the technologies generally outweigh the potential benefits except in very specific or controlled applications (e.g., at a commercial airport where infrastructure installations are more permanent, visual observations are common practice and overhead traffic is more controlled).

The intended goal of using these technologies on the Project is to accurately monitor real time bird movements. To try to address the documented limitations of specific technologies and validate the data, one would likely need to use a combination of various technologies which would still need to be tested in parallel with visual observations. As a result, given the short term and transient nature of the Project and the fact that the Project will already be utilizing visual observation, these technologies are not considered economic or technically feasible at this time.

References:

- Desholm, M.A., D. Fox, and P.D.Beasley. 2004. Best Practice Guidance for the Use of Remote Techniques for Observing Bird Behavior in Relation to Offshore Wind Farms. Report Prepared for Collaborative Offshore Wind Research into The Environment Consortium. National Environmental Research Institute, Ronde, Denmark, and QinetiQ, Malvern Technology Centre, Worcestershire, United Kingdom.
- d'Entremont, M. V., M. I. Hartley, and K. A. Otter. 2017. Comparing pre- versus postoperational movement of nocturnal migrants around a wind energy facility in northeast British Columbia, Canada. *Avian Conservation and Ecology* 12(2):3. <https://doi.org/10.5751/ACE-01046-120203> Copyright © 2017 by the author(s).
- Eastwood, E. 1967. Radar ornithology. Methuen, London. 278 p.
- Gauthreaux, S. A. Jr., and P. M. Schmidt. 2013. Application of radar technology to monitor hazardous birds at airports. Pages 141–151 in T. L.
- DeVault, B. F. Blackwell, and J. L. Belant, editors. *Wildlife in airport environments: preventing animal–aircraft collisions through science-based*

2.4 Special Areas

2.4.1 Information Requirement: IR-47-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Section 5 – All

Reference to EIS Guidelines: Part 2, Section 6.3 Predicted Effects on Valued Components

Reference to EIS: Section 11.3.3 Environmental Effects Assessment (All Planned Components and Activities)
Table 11.3

Context and Rationale: In its response to IR-47 the proponent provides updated information on special areas that could be affected by the Project, including updated tables and figures with listings of all special areas that could be affected by the Project. This includes a table indicating the minimum distances to the ELs for special areas in the regional study area (RSA). However, in CL-19-02 below the Agency requests that the proponent update the RSA in consideration of the revised model domain and zone of influence. The list of special areas occurring in the RSA, their distances to the ELs, and the potential effects of the Project on these special areas has not been updated based on this new RSA.

Specific Question or Information Requirement: In conjunction with the required update to the RSA (see CL-19-02 below), provide updated tables and a related figure(s) with listings of all special areas in the RSA. Indicate closest distances of all special areas to both ELs 1140 and 1150. For any newly identified special areas that are within the updated RSA, provide an assessment of potential effects on these special areas and consider proposed mitigation and follow-up.

Response:

Based on IR-64, CNOOC Petroleum North America ULC (CNOOC) expanded the study domain for the additional oil spill modelling undertaken in September 2018. That expanded study domain has been incorporated into the environmental assessment (Addendum February 2019). The Special Areas valued component (VC) regional study area (RSA) was not delineated based on the oil spill modelling study domain, and has not been adjusted based on that expanded study domain (refer to CL-19-02). The Special Areas RSA is defined in Sections 4.3 of the Environmental Impact Statement (EIS) and is consistent with Section 3.2.3 of the Guidelines and in keeping with other recent similar oil and gas exploration projects environmental assessments in the NL offshore area.

Since submission of the Revised EIS Addendum in February 2019, several changes to Special Areas have been identified. The following information provides an updated environmental effects assessment for Special Areas based on information current to May 2019.

ADDITIONAL AND REVISED SPECIAL AREAS

Section 6.4 of the Environmental Impact Statement (EIS) presents information, tables and figures to describe all identified Special Areas within the extent of the identified study areas. This information shows intersections of, and distances between, the Project ELs / the Project Area and identified Special Areas as well as proximity to all Special Areas within the Regional Study Area (RSA) and the larger Eastern Newfoundland offshore area for regional context. Section 11 of the EIS presents the effects assessment for Special Areas. The following text provides updated or additional information on Special Areas identified or changed since the submission of Section 11 of the EIS.

Marine Refuges

Section 6.4.1.4 of the EIS illustrates and discusses Marine Refuges off eastern Newfoundland. Three Marine Refuges are in the RSA. These include Northeast Newfoundland Slope Closure (formerly known as Tobin's Point), Funk Island Deep Closure and Hawke Channel Closure, none of which intersect with the LSA (i.e., Project Area and zone of influence for potential Project effects) as discussed in Section 6.4 and Section 11 of the EIS. The Hopedale Saddle Closure Marine Refuge and Hatton Basin Conservation Area Marine Refuge are off the coast of Labrador outside of the RSA) and thus, were not identified or addressed in the EIS.

UN Convention on Biological Diversity EBSAs

In 1992, Canada ratified the UN Convention on Biological Diversity, which came into effect in December 1993. Identified EBSAs include ocean habitat areas of eastern Newfoundland and Labrador outside of Canada's Exclusive Economic Zone (EEZ) (Figure 2.2 of the EIS). These EBSAs are described based on their defining features in Table 47-02.1 below. The Project Area and LSA (i.e., zone of influence of the Project) intersect with the Slopes of the Flemish Cap and Grand Bank UNCBD EBSA.

Table IR-47-02.1 UN Convention on Biological Diversity EBSAs

EBSA	Rationale for Identification/Designation	Area
Labrador Sea Deep Convection Area	The only North-West Atlantic site where winter convection exchanges surface and deep ocean waters. Provides mid-water overwintering refuge for pre-adult <i>Calanus finmarchicus</i> , a key species for zooplankton populations of the Labrador Shelf and downstream areas. Annual variability in convection results in significant yearly change through ecosystems of the North-West Atlantic.	Approximately 43,278 km ² . Not a fixed geographic area but delineated annually by physical oceanographic properties
Seabird Foraging Zone in the Southern Labrador Sea	Supports globally significant populations of marine vertebrates, including an estimated 40 million seabirds annually. Important foraging habitat for seabirds, including 20 populations of overwintering black-legged kittiwakes (<i>Rissa tridactyla</i>), thick-billed murres (<i>Uria lombia</i>) and breeding Leach's storm-petrels (<i>Oceanodroma leucorhoa</i>). Encompasses the pelagic zone of the Orphan Basin, continental shelf, slope and offshore waters inside and outside the Canadian EEZ.	152,841 km ²
Orphan Knoll	Seamounts typically support endemic populations and unique faunal assemblages. This seamount is an island of hard substratum with uniquely complex habitats that rise from the seafloor of the surrounding deep, soft sediments of the Orphan Basin. Although close to the adjacent continental slopes, Orphan Knoll is much deeper and appears to have distinctive fauna. Fragile and long-lived corals and sponges have been observed and a Taylor Cone circulation provides a mechanism for retention of larvae.	12,742 km ²
Slopes of the Flemish Cap and Grand Bank	Contains most of the aggregations of indicator species for VMEs in the NAFO Regulatory Area. Includes NAFO closures to protect corals and sponges and a component of Greenland halibut fishery grounds in international waters. A high diversity of marine taxa, including threatened and listed species, are found within the EBSA.	87,817 km ²

EBSA	Rationale for Identification/Designation	Area
Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank	The Southeast Shoal is an ancient beach relic that provides a unique offshore capelin-spawning ground, nursery ground for yellowtail flounder and spawning areas for depleted American plaice, depleted Atlantic cod and striped wolffish (listed as a species of special concern under SARA), and unique populations of blue mussels and wedge clams. Due to abundant forage fish, the Tail of the Grand Bank is an important feeding area for cetaceans, including humpback and fin whales, and a large numbers of seabirds, including species that travel over 15,000 km from breeding sites in the South Atlantic, during the nonbreeding season.	Not available
Source: UNCBD (2019)		

Other Special Areas and Amendments

Since the EIS was submitted, other Special Areas have been identified in the marine environment. In addition, some Special Areas have been refined or amended. These changes to the existing environment, as discussed in the following paragraphs, are current to May 2019.

Canadian fisheries closures include marine and coastal areas where certain types of fishing activities are restricted or prohibited. Snow crab fishing is prohibited in various Stewardship Exclusion Zones including portions of Bonavista Bay, Trinity Bay, Conception Bay, the Eastern Avalon and St. Mary's Bay as well as Near Shore and Mid Shore crab fishing areas (DFO 2015). Lobster fishing is prohibited in seven areas (totaling 94 km²) around coastal Newfoundland to protect lobster spawning habitat and increase egg production (DFO 2017). Two Lobster Closures (i.e., Gooseberry Island and Gander Bay) are in the RSA in Eastern Newfoundland. Outside of the EEZ, NAFO has removed the Eastern Flemish Cap (14) FCA (NAFO 2019).

In 2016-2017, DFO reevaluated the PBGB-LOMA EBSAs. Complete and final detailed information on the revised EBSAs have not yet been released publicly (N. Wells pers comm 2018). Based on draft information, five new EBSAs have been delineated, two areas are no longer listed as EBSAs and the total combined EBSA area has been increased by 26 percent. Portions of the EBSAs that previously extended beyond the Canadian EEZ into the NAFO regulatory area are no longer considered to be within EBSA boundaries (DFO 2016). These Special Areas and their defining features are included in the effects assessment as appropriate.

In 2016, DFO identified Significant Benthic Areas (SBAs) as "significant areas of cold-water corals and sponge dominated communities" in various areas of eastern Canada including the Newfoundland and Labrador Shelves Bioregion (Kenchington et al. 2016). These areas are identified through modelling based on data obtained in DFO research trawl surveys and other sources to predict high presence probability for various types of benthic species (Table IR-47-02.2).

Table IR-47-02.2 Newfoundland and Labrador Shelves Bioregion Significant Benthic Areas

SBA	Rationale for Identification/Designation
Sea Pens	The highest predicted sea pen presence probability occurred in the Laurentian Channel and on the slope off the Northeast Newfoundland Shelf. Small pockets are distributed across the continental shelf though much of the shelf was noted for absence of sea pens.
Large Gorgonian Corals	The highest predicted presence probability of large gorgonian corals occurred on the edge of Saglek Bank and slope off northern Labrador. Moderate presence probability was

SBA	Rationale for Identification/Designation
	predicted along the Labrador Slope. Small pockets are distributed across the continental shelf but much of the shelf was predicted as having absence of large gorgonian corals.
Small Gorgonian Corals	The highest predicted presence probability of small gorgonian corals occurred along the slope in the 30 Coral Closure Area southwest of the Grand Banks. Small pockets of moderate presence were predicted along the Labrador Slope. Much of the continental shelf was predicted as having absence of small gorgonian corals.
Sponges	Most of the shelf and slopes off Labrador have been predicted to have sponge presence with highest predicted presence probabilities along the Labrador Slope and Saglek Bank. Small pockets are distributed across the continental shelf. The Majority of the Grand Banks were classified as having absence of sponges.
Source: Kenchington et al. (2016)	

The following effects assessment has been updated to address changes to Special Areas, as identified above (i.e., Marine Refuges, UN Convention on Biological Diversity EBSAs, Snow Crab Stewardship Exclusion Zones, Lobster Closures and revised Canadian EBSAs). Also, to provide a more detailed effects assessment than the EIS, all Special Areas in the RSA have been included in this analysis. Sections 11.0 to 11.3.2 of the EIS have not been revised. Sections 11.3.3 to 11.5 of the EIS have been updated with the following information.

SPECIAL AREAS: REVISED ENVIRONMENTAL EFFECTS ASSESSMENT (Updated Response to IR-47 (Revised EIS Addendum – February 2019) and Updated Section 11.3.3 of the EIS)

This section summarizes the residual effects of the Project on Special Areas and presents a determination of significance for the environmental effects assessment for this VC. Some of the key components and activities, and potential interactions, that may be associated with the Project and which would be particularly relevant to the environmental effects analysis for Special Areas, include:

- Presence and operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed investigation);
- Drilling and associated marine discharges (including fluids and cuttings);
- Vertical seismic profiling;
- Well testing;
- Well abandonment or suspension; and
- Supply and servicing.

Based on these various components and activities, some of the key potential environmental issues and potential environmental changes that may be associated with the Project are identified below:

- The general presence of Project components (MODUs, vessels, other equipment) and activities in the offshore environment, including the noise, light and other associated disturbances.
- Possible effects on water quality and on the seabed (benthic) environment due to physical disturbance of the substrate (and associated sedimentation), the discharge and deposition of drill cuttings and fluids, and other potential environmental emissions during planned activities.
- Potential changes in the presence, abundance, diversity and health of marine biota in the area due to potential injury or mortality, or possible behavioral effects. This may include temporary avoidance of areas by marine fish, birds, mammals and sea turtles due to underwater noise or other

disturbances, which may alter their presence and abundance as well as disturbing movements/migration, feeding or other activities. There may also be possible attraction of marine fish, birds, mammals and sea turtles to MODUs and vessels, with increased potential for injury, mortality, contamination or other interactions (e.g., collisions).

These or other environmental changes and biophysical effects resulting from planned Project components and activities may, in turn, have adverse effects on Special Areas by affecting their real or perceived overall ecological characteristics, integrity, use and value. Project activities may also result in direct interference with, and possible reduced human access to, important and valued marine areas during Project activities in certain locations, with possible decreases in these activities and their success, efficiency, value or enjoyment. A description (and mapping) of each of the marine and coastal areas within and adjacent to the Project Area/LSA and RSA that have been designated as protected or identified as otherwise special or sensitive was provided in Section 6.4 of the EIS. The following sections provide an assessment and evaluation of the potential effects of planned Project activities on these Special Areas. Again, the previously identified mitigation measures are considered integrally within the environmental effects analysis, as relevant.

Table IR-47-02.2 below provides a summary of the (minimum) distance between the edge of the Project Area, ELs 1144 and 1150, and LSA, and the various Special Areas in the RSA. As indicated, planned Project activities will occur in an offshore marine area that is more than 400 km from the shoreline of Eastern Newfoundland. These planned Project activities will therefore not occur within, or otherwise interact directly with, any of the existing provincially-defined Special Areas (e.g., Provincial Ecological Reserves, Parks and Protected Areas or Historic Sites). Likewise, the Project will not have a direct interaction with most federally designated areas (e.g., Marine Protected Areas, Fisheries Closures within Canada's EEZ, Preliminary Representative Marine Areas, Migratory Bird Sanctuaries, National Parks and Historic Sites). International designations such as Important Bird Areas will also not be directly affected by the Project.

The Project Area intersects with small portions of three NAFO FCAs and one UNCBD EBSA (Table IR-47-02.2). Only one of these NAFO Closure Areas and the UNCBD EBSA intersect with any part of the ELs themselves (Figure IR-47-02.1). Various other Special Areas (VMEs, NAFO FCAs, a Marine Refuge, and a Canadian EBSA) are located within the general vicinity of the Project but do not intersect with the LSA, which encompasses the identified general vessel/aircraft traffic route from Eastern Newfoundland to the Project Area. As it surrounds the Project Area, the LSA intersects the four Special Areas in the Project Area as well as a VME, in the offshore. The LSA also intersects with a Canadian EBA, two Snow Crab Stewardship Exclusion Zones, two National Historic Sites, and an IBA.

Table IR-47-02.3 Minimum Distances Summary for Special Areas in the RSA (Updated Table 47.2 of Revised EIS Addendum (February 2019) and Table 11.3 of the EIS)

Special Areas	Minimum Distance (km)		
	PROJECT AREA	EL 1144 and/or EL 1150	LSA
Canadian EBSAs			
Northeast Slope	33	54	10
Eastern Avalon	358	380	Intersects

Special Areas	Minimum Distance (km)		
	PROJECT AREA	EL 1144 and/or EL 1150	LSA
Virgin Rocks	237	265	69
Lilly Canyon-Carson Canyon	197	231	187
Southeast Shoal	336	370	298
Southwest Slope	514	549	274
Placentia Bay	493	513	72
Smith Sound	446	469	69
Fogo Shelf	451	477	181
Grey Islands	552	579	273
Notre Dame Channel	431	458	225
Orphan Spur	223	251	180
St. Mary's Bay	468	490	59
Haddock Channel Sponges	533	558	190
Baccalieu Island	354	376	3
Bonavista Bay	456	481	105
Marine Protected Areas and Areas of Interest			
Eastport - Duck Island	484	508	140
Eastport - Round Island MPA	492	515	130
Marine Refuges			
Northeast Newfoundland Slope Closure	40	67	30
Funk Island Deep Closure	428	456	224
Federal Fisheries Closure Areas			
Funk Island Deep Box	428	456	224
Eastport Peninsula Lobster Management Area	470	494	127
Snow Crab Stewardship Exclusion Zones			
Crab Fishing Area 5A	404	429	104
Crab Fishing Area 6A	381	403	49
Crab Fishing Area 6B	413	391	3
Crab Fishing Area 6C	360	381	Intersects

Special Areas	Minimum Distance (km)		
	PROJECT AREA	EL 1144 and/or EL 1150	LSA
Crab Fishing Area 8A	387	410	62
Crab Fishing Area – 8BX	113	140	60
Crab Fishing Area 9A	464	486	57
Crab Fishing Area Near Shore	309	330	Intersects
Lobster Closure Areas			
Eastport Peninsula Lobster Management Area	470	494	126
Gander Bay	552	578	232
Gooseberry Island	483	504	86
Preliminary Representative Marine Areas			
Virgin Rocks	230	256	54
South Grand Bank Area	281	315	268
Northwestern Conception Bay	402	424	30
Migratory Bird Sanctuaries			
Terra Nova	500	524	140
Coastal National Parks			
Terra Nova	484	507	125
Coastal National Historic Sites			
Cape Spear Lighthouse	403	423	Intersects
Signal Hill	407	427	Intersects
Ryan Premises	440	464	114
Castle Hill	507	528	91
Coastal Ecological Reserves			
Baccalieu Island	413	435	54
Witless Bay	418	440	28
Mistaken Point	461	484	98
Cape St. Mary's	531	553	130
Funk Island	477	504	237
Provincial Parks			

Special Areas	Minimum Distance (km)		
	PROJECT AREA	EL 1144 and/or EL 1150	LSA
The Dungeon	438	462	116
Chance Cove	445	468	81
Windmill Bight	486	511	190
Bellevue Beach	487	507	69
Deadman's Bay	497	523	200
Gooseberry Cove	518	540	108
Provincial Historic Sites			
Cape Bonavista Lighthouse	439	463	119
Heart's Content Cable Station	457	478	50
United Nations Convention on Biological Diversity EBSAs			
Slopes of the Flemish Cap and Grand Bank	Intersects	Intersects	Intersects
Orphan Knoll	211	239	201
Seabird Foraging Zone in the Southern Labrador Sea	179	200	169
Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank	295	327	285
Vulnerable Marine Ecosystems			
Southern Flemish Pass to Eastern Canyons	6	31	Intersects
Northern Flemish Cap	32	64	22
Sackville Spur	36	57	26
Northeast Shelf and Slope (within Canadian EEZ)	36	57	14
Beothuk Knoll	60	81	50
Flemish Cap East	171	193	161
South East Shoal and Adjacent Shelf Edge/Canyons	329	360	292
Deep Water Coral Area	120	147	110
Division 3O Coral Closure	553	588	318
NAFO Fisheries Closures			
Tail of the Bank (1)	327	358	317
Flemish Pass/Eastern Canyon (2)	Intersects	15	Intersects
Beothuk Knoll (3)	117	138	107

Special Areas	Minimum Distance (km)		
	PROJECT AREA	EL 1144 and/or EL 1150	LSA
Eastern Flemish Cap (4)	137	162	127
Northeast Flemish Cap (5)	120	150	110
Sackville Spur (6)	39	59	29
Northern Flemish Cap (7)	56	89	46
Northern Flemish Cap (8)	79	111	69
Northern Flemish Cap (9)	58	88	48
Northwest Flemish Cap (10)	Intersects	6	Intersects
Northwest Flemish Cap (11)	Intersects	Intersects	Intersects
Northwest Flemish Cap (12)	25	52	15
Beothuk Knoll (13)	77	97	67
3O Coral Closure	551	586	318
Orphan Knoll Seamount	227	248	217
Newfoundland Seamounts	339	359	329
Fogo Seamounts 1	664	698	550
Fogo Seamounts 2	753	785	706
<i>Newfoundland and Labrador Shelves Bioregion Significant Benthic Areas</i>			
Sea Pens	35	58	25
Large Gorgonian Corals	63	87	Intersects
Small Gorgonian Corals	189	221	121
Sponges	362	389	211
<i>Important Bird Areas</i>			
Quidi Vidi Lake	406	426	Intersects
Cape St. Francis	408	428	13
Baccalieu Island	410	432	49
Witless Bay Islands	414	435	21
Grates Point	416	438	52
Mistaken Point	452	476	96
Funk Island	471	498	230

Special Areas	Minimum Distance (km)		
	PROJECT AREA	EL 1144 and/or EL 1150	LSA
Cape Freels Coastline and Cabot Island	472	497	163
Terra Nova National Park	480	503	119
The Cape Pine and St. Shotts Barren	483	506	109
Placentia Bay	497	518	81
Wadham Islands and adjacent Marine Area	507	533	221
Cape St. Mary's	521	543	120
UNESCO World Heritage Sites			
Mistaken Point	459	483	101

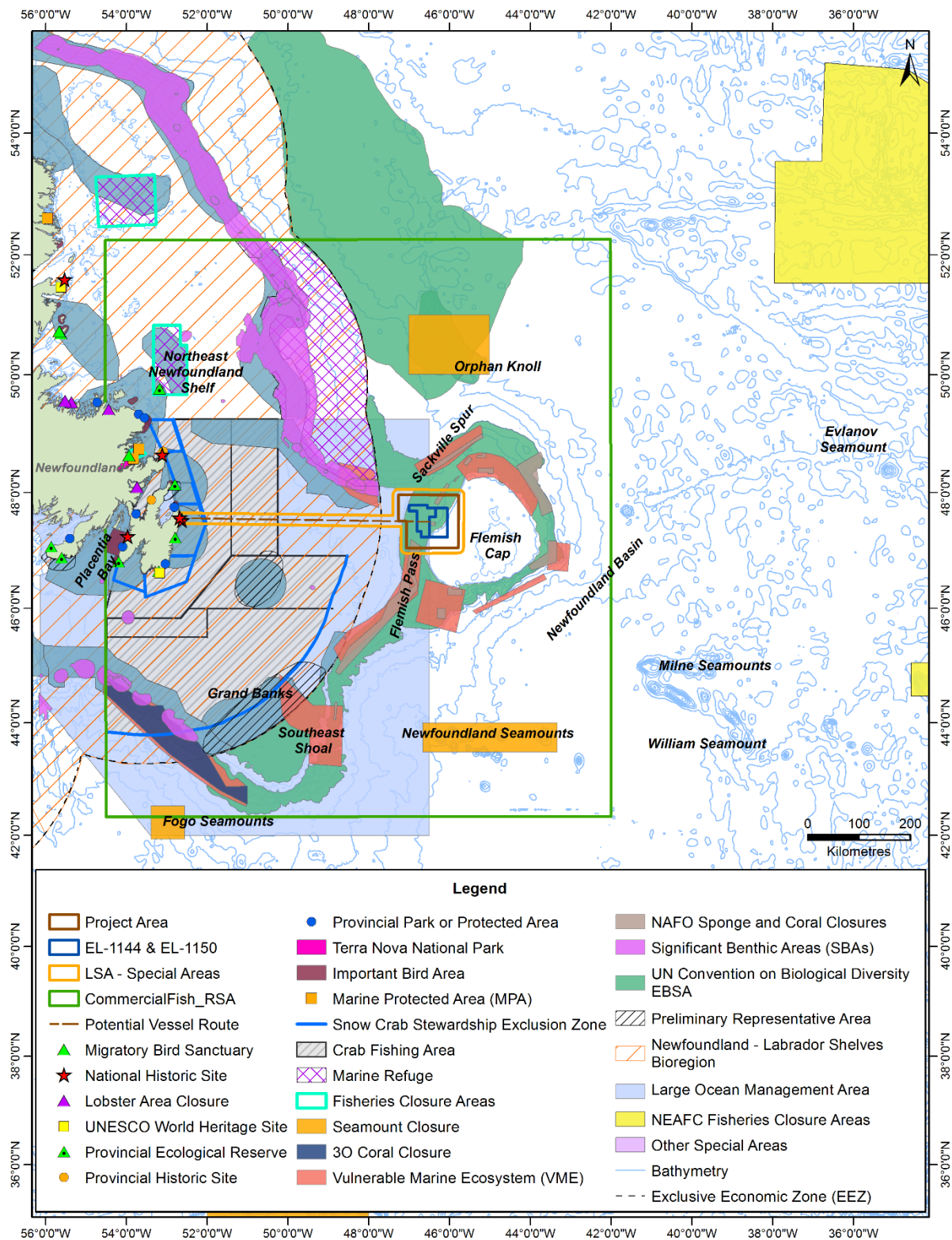


Figure IR-47-02.1 Overview of Special Areas in the RSA

Presence and Operation of the MODU

As described in Section 2 of the EIS, the Project will include drilling of up to 10 exploration wells in CNOOC-operated licenses (ELs 1144 and 1150). The offshore exploration drilling program will involve positioning and operation of a MODU, which may include use of semi-submersibles and/or drill ships.

The presence and operation of a MODU and supporting vessels may result in associated environmental interactions with Special Areas in the marine environment. Drilling operations will involve direct interaction with the seabed itself through any required anchoring. In addition, marine fish and invertebrates may be exposed to underwater noise, lighting and other environmental discharges that may be associated with Project activities.

Two Special Areas intersect with Project ELs (Figure IR-47-02.2). These are Northwest Flemish Cap (11) NAFO FCA, which has been identified and protected for coral and sponge habitat (Table IR-47-02.3). The Slopes of the Flemish Cap and Grand Bank UNCBD EBSA has also been identified for benthic habitats, including corals and sponges, as well as high biodiversity and a portion of a commercial fishery.

Table IR-47-02.4 Defining Features Special Areas Intersecting Project ELs

Special Areas	Defining Features
Slopes of the Flemish Cap and Grand Bank UNCBD EBSA	Aggregations of corals and sponges and high diversity of marine taxa including threatened and listed species (i.e., Marine Fish and Fish Habitat) Includes a component of the Greenland halibut fishery grounds in international waters (i.e., Marine Fisheries)
Northwest Flemish Cap (11)	Closed to protect high coral and sponge concentrations (e.g., crinoids, cerianthids and black corals). Includes sea pen fields, which serve as habitat structure in low-relief sand and mud habitats and provide refuge for small planktonic and benthic invertebrates (i.e., Marine Fish and Fish Habitat).

The presence and operation of a MODU will include localized direct physical interaction with the seabed and may result in exposure, injury, and / or mortality of benthic organisms, including corals, sponges and sea-pens. These organisms are vulnerable to physical disturbance due to their low avoidance capabilities (Clark et al. 2016; Cordes et al. 2016). Coral and sponge biogenic habitats, where habitat is created by an organism itself, are fragile and recover slowly (Cordes et al. 2016). See Section 8 Marine Fish and Fish Habitat VC of the EIS for more detailed information on potential Project effects.

In fine mud substrate habitat, such as that common in the Flemish Pass (Murillo et al. 2016), Project activities may temporarily disturb the seabed environment, resuspending sediments. 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).

While anthropogenic sound associated with offshore oil and gas activities is transmitted through water and may result in disturbances to marine biota, there is no direct evidence of mortality to marine fish and invertebrates resulting from exposure to continuous underwater sound (Popper and Hastings 2009; Popper et al. 2014). Mobile, and sessile species depending on life stages (many sessile species have mobile larval stages), can move away from an area temporarily if they are disturbed by operational noises and this may result in localized area avoidance.

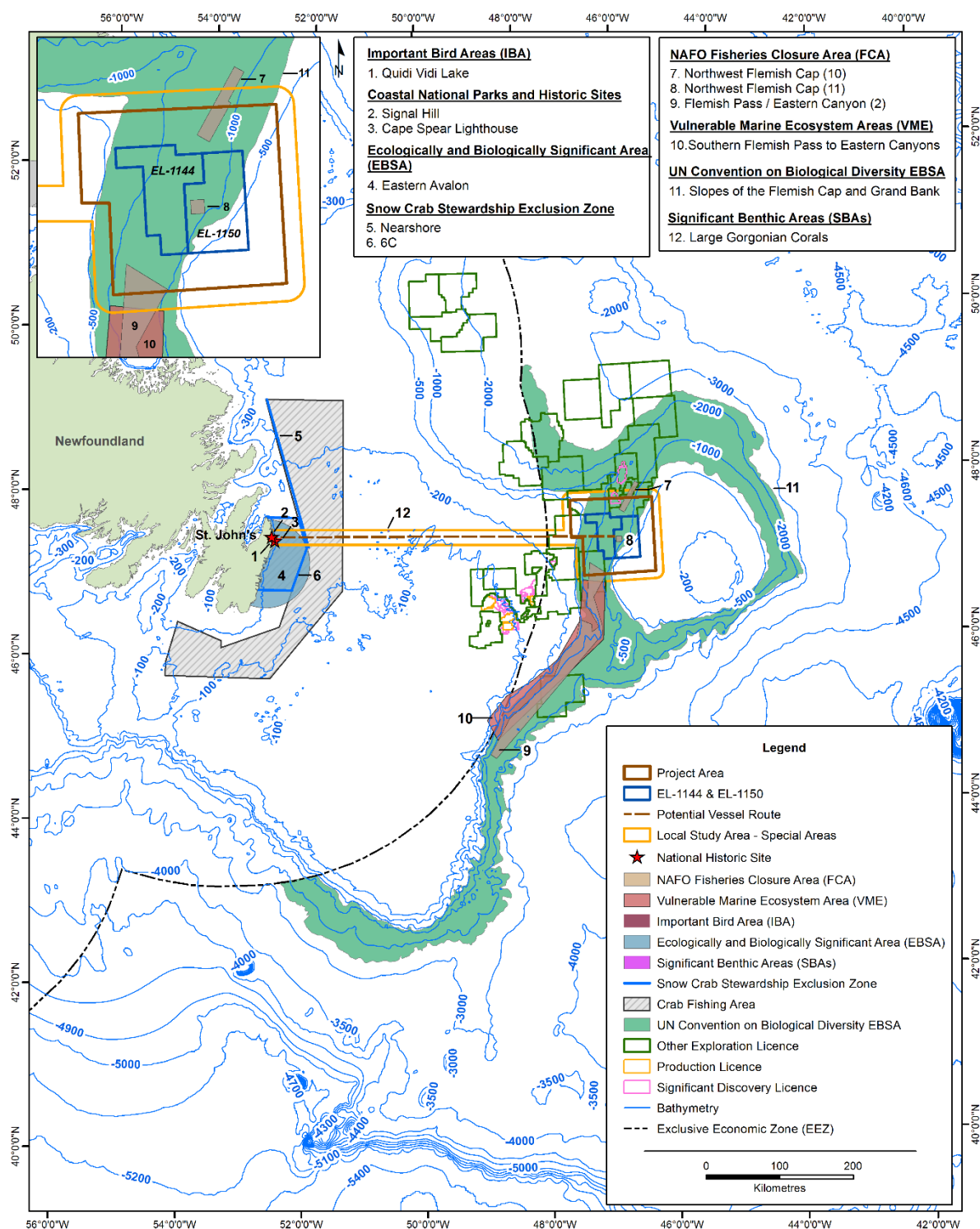


Figure IR-47-02.2 Special Areas Intersecting the LSA (Updated Figure 47.2 of Revised EIS Addendum (February 2019) and updated Figure 11.2 of the EIS)

The Slopes of the Flemish Cap and Grand Bank UNCBD EBSA is also noted as having high biodiversity, which likely includes fish and invertebrate species. Suspended sediments resulting from subsea activities may promote temporary avoidance of the Project Area by mobile fish and invertebrates, particularly visual predators. Project activities will likely result in low intensity sounds that also promote temporary avoidance of the area by mobile fishes with return after cessation of the underwater noise (Bergström et al. 2014, Popper and Hastings 2009). Section 8 of the EIS has determined that with implementation of proposed mitigation measures to avoid or reduce residual Project effects, the Project is unlikely to result in significant adverse effects on Marine Fish and Fish Habitat including benthic habitats.

The MODU operator will manage and dispose of waste products in accordance with applicable regulations and standards and CNOOC will establish a Waste Management Plan for the Project. Proper waste management practices and adherence to associated regulatory requirements will minimize potential effects. The relatively low discharge volumes that are released high in the water column would likely become highly dispersed in the marine environment. Other potential environmental discharges include oily water and other substances. All wastewater will be treated to minimize contaminant or hydrocarbon levels prior to discharge in accordance with the OWTG and other regulatory requirements.

Human use of the Project Area is mainly limited to activities such as commercial fisheries, oil and gas exploration and production, and marine transportation. A portion of the Greenland Halibut fishery in international waters has been identified as being within the Slopes of the Flemish Pass and Grand Bank UNCBD EBSA. However, as this EBSA is so large (i.e., 87,817 km²) and the Greenland Halibut fishery is limited within the Project Area (additional information is included in Section 13.3 of the EIS), limited access to the Project Area is not likely to result in Project-related effects on the Greenland halibut fishery in this special area. Section 13 of the EIS has determined that with the implementation of the proposed mitigation measures to avoid or reduce residual Project effects, the Project is unlikely to result in significant adverse effects on Fisheries and Other Ocean Uses.

Residual Environmental Effects Assessment (Presence and Operation of the MODU)

As described in Section 8 of the EIS, and above, the Project is not expected to result in significant adverse effects upon marine fish or habitat such as that of the Slopes of the Flemish Cap and Grand Bank UNCBD EBSA and Northwest Flemish Cap (11) NAFO FCA. Therefore, it is not likely to adversely affect the ecological features, processes and integrity, nor the human use and societal value, of these Special Areas.

The primary interactions, resulting from the presence and operation of MODUs, that may have adverse effects on these Special Areas are direct interaction with the seabed and resuspension of sediments, which may result in injury or mortality to benthic species. Disturbances from exposure to sound from Project activities may result in temporary avoidance by fish species. Section 8 of the EIS has determined that the number of individuals that may be affected is not anticipated to have overall ecological or population-level effects. The localized extent of the activities, along with the implementation of planned mitigation measures, will mean that any potential residual effects on these Special Areas may be adverse, low in magnitude and localized, short-term, regular and reversible. This prediction is made with a high level of confidence.

Drilling and Associated Marine Discharges

As discussed, the defining features of Special Areas (i.e., the Slopes of the Flemish Pass and Grand Bank UNCBD EBSA and NAFO FCAs) that intersect with the Project Area are mainly the presence of sensitive benthic habitats. Physical interaction with the seabed may result in direct disturbance to the seafloor and benthic habitats.

This may also result in exposure, injury, and / or mortality of benthic organisms, including corals, sponges and sea-pens, through burial by deposition of cuttings and the introduction of suspended solids in the water column.

Drilling will include discharge of associated drill cuttings. Corals and sponges 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). As described in Section 2.9 of the EIS, all chemicals that will be utilized as part of the Project – including drilling fluids – will be screened and selected in accordance with the OCSG and in accordance with CNOOC's chemical screening and management practices.

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). Any 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).

Based on laboratory experiments and field evaluations of SBM-associated drill cuttings piles, acute toxicity of SBMs is relatively low (Still et al. 2000; Tsvetnenko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016). Any potential effects on these Special Areas are likely to be temporary in nature as SBMs biodegrade within a few years (Terrens et al. 1998; Ellis et al. 2012; IOGP 2016). Any released SBM and SBM-associated drill cuttings resulting from the Project will not result in adverse effects from contamination of marine biota or habitats, as these materials have low toxicity and localized biological effects (Bakke et al. 2013; Deblois et al. 2014). As previously stated, CNOOC will use proven and practicable best available technologies and practices for the treatment of SBM cuttings prior to discharge.

Detailed drill cuttings dispersion modelling was prepared to provide Project-specific information and analysis related to the nature and extent of drilling fluid and associated cuttings deposition. This included modelling at representative sites within each of the two exploration licenses (EL 1144 and EL 1150) to evaluate the potential dispersion and eventual seabed "footprint" of these cuttings in seasonal scenarios (for more information see Section 8.2 or Appendix D of the EIS).

The modelling indicated that deposition of WBM and SBM drill cuttings will be highly localized with most materials predicted to settle within 500 m of a well head. Small quantities (less than four percent) of SBM cuttings are predicted to disperse beyond 1-2 km from the deepwater wellsite with predicted accumulations (less than 0.1 mm) well below Predicted No Effect Threshold (PNET) values. Due to the relatively low quantities, dispersed SBM cuttings are only expected to have low potential for interactions with organisms in the water column and benthic areas beyond 1-2 km from the wellsite.

The initial high settling of particles and relatively low quantities of dispersed cuttings beyond two kilometres also indicates that there should not be any substantial interaction with pelagic species. Project Area depths are beyond the photic zone. Therefore, it is also not expected that there will be any interaction with marine macroflora species. Discharge of drill cuttings particles may form aggregates with phytoplankton resulting

in rapid settling of plankton to the seafloor (Pabortsava et al 2011). However, due to the low quantities, it is unlikely that there will be high settling or turbidity effects that may adversely affect any suspended phytoplankton species.

A deep-water drilling site (380 m depth) in the Faroe-Shetland Channel produced similar project footprints with 30,700 m² covered completely by cuttings and greater than 70,890 m² partially covered by cuttings (Jones et al 2012). Environmental monitoring of the site showed relatively higher faunal density and richness three and 10 years from the initial disturbance indicating recovery of the site over time (Jones et al 2012). Localized accumulations indicate that potential burial effects are relatively low spatially and presence of surrounding undisturbed areas may further promote recolonization and recovery.

As described in Section 8.3.2 of the EIS, prior to the start of drilling activity at a wellsite, a seabed investigation will be undertaken with an underwater video system to investigate the potential presence of aggregations of sensitive benthic organisms or habitats in the immediate area (such as corals gardens and sponge grounds). Should such organisms be observed within or in proximity to a planned wellsite location, CNOOC will move the wellsite where possible to avoid or reduce the potential for direct interaction with them or other potential effects (such as sedimentation or burial from drill cuttings disposal). In addition, the likely distance between individual wells that will be drilled as part of this Project means that there is also little or no potential for these environmental releases from individual wells to interact or accumulate in the LSA.

Residual Environmental Effects Assessment (Drilling and Associated Marine Discharges)

Exploration drilling activities associated for this Project have the potential to result in injury or mortality of benthic species and habitats. This could be due to direct contact or deposition of drilling cuttings and muds. Both WBM and SBMs are used at various stages of well drilling. Predrilling coral surveys will be used to identify and avoid sensitive benthic habitats.

WBM drilling fluids and associated cuttings will be discharged directly to the seabed, as permitted under the OWTG. As described in Section 2.9 of the EIS, all chemicals that will be utilized as part of the Project – including drilling fluids – will be screened and selected in accordance with the OCSG and in accordance with CNOOC's chemical screening and management practices. Any released WBM and WBM-associated drill cuttings resulting from the Project are not anticipated to result in adverse effects from contamination of marine biota or habitats.

SBM-associated drill cuttings are permitted to be discharged at the drill site provided they are appropriately treated prior to discharge in accordance with proven and practicable best available technologies and practices. SBM drill fluids and cuttings will be returned to the MODU for treatment. Once onboard the MODU, drill cuttings will be separated from the drilling fluids. Most fluids will be reconditioned and reused, and any spent SBM fluids will be returned to shore for disposal or recycling/reuse.

In summary, discharged volumes of WBM and SBM drill cuttings will be highly localized to the wellsite with very low quantities dispersing widely. The predicted small footprint limits smothering effects on benthic species to less than 500 m around the wellsite. The remaining low quantities of cuttings dispersed beyond two kilometres are not predicted to have any potential interactions due to the expected low concentration in the water column and lack of accumulation on the seabed. Released SBM associated drill cuttings will be treated in accordance with the OWTG to minimize any toxic and bioaccumulation effects.

With the application of mitigations outlined throughout this VC, drilling and associated discharges are predicted to have adverse but low magnitude effects, primarily localized, but occurring within the Project Area overall, long-term duration, regular and reversible with eventual recovery and recolonization. These predictions were determined with a high level of confidence.

Vertical Seismic Profiling

VSP acquisition surveys are typically short-term activities of one to two days duration, with seismic source activation often limited to just a few hours. The VSP array and its sound emissions are also typically small and localized, with the majority of sound directed downwards into the well and a lesser degree directed horizontally. The effects of VSP surveys have not been well studied and the available literature mainly describes the effects of larger offshore seismic (geophysical) surveys. Sound emitted during a 3D / 4D seismic survey represents the worst-case scenario with respect to exposure of marine species to underwater sound. Appendix E provides an analysis of the underwater sound that will be generated by the VSP surveys such as those that may be generated as part of this Project. Section 8 of the EIS provides a comprehensive discussion of the potential effects of geophysical surveys on marine fish and invertebrates.

The Special Areas that intersect with the Project ELs are identified for the presence of aggregations of corals and sponges, though one of these areas is also identified for general high biodiversity. The principal aspects of VSP surveys that have potential to cause effects on these Special Areas are those that interact with benthic habitat or result in artificial light and underwater sound. Underwater noise generated by geophysical activities has the potential to affect fish and invertebrate species. Most fishes and invertebrates appear to be more sensitive to low-frequency sound (<1 kHz) (Popper et al. 2014) such as that emitted by seismic air sources, marine vessels and drilling. Some fishes with morphological structures 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).

Fishes exhibit both subtle and overt behavioural changes in response to seismic air source sound and these effects appear to be quite variable between and within species. Generally, behavioural effects are localized and temporary. For example, Løkkeborg et al. (2012) described a 2009 study of the effect of exposure to seismic sound on commercial fishes, which showed that longline catches of Greenland halibut decreased during seismic operations but increased again after surveying was completed; gillnet catches were higher during surveying and remained elevated after the program.

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 minimal. In addition, the suggested physical effects were observed when constrained marine invertebrates were exposed to air source sound at very close range, resulting in exposures unrepresentative of those that would occur under conditions such as those that would be induced by Project activities.

Operational procedures, such as use of a gradual “ramp-up” or soft-start procedures will be implemented for this Project. This will allow mobile marine fish and invertebrates to move away from the area if they are disturbed by the underwater sound levels. This will help to reduce the potential for fish injury or mortality, as well as reduce any startle effects and resulting stress on fish in the nearby area. These procedures, along with the relatively short-term nature of any seismic sound used for the Project, will reduce any potential for fish injury or mortality from VSP surveys.

Residual Environmental Effects Assessment (Vertical Seismic Profiling)

Although there may be some short-term behavioural effects by fish in the immediate vicinity of VSP survey activities, it is very unlikely that any fish will be displaced from key habitats or disrupted during key activities over extended areas or periods in a manner that causes adverse and detectable effects to fish populations in the region. Best practices for seismic operations will be used to reduce or avoid any potential effects on marine fish.

With the application of mitigations outlined throughout this VC, potential effects from VSP activities are therefore predicted to be adverse but low in magnitude, localized short term in nature, occurring regularly and reversible. These predictions were determined with a high level of confidence.

Well Testing

During well testing, any hydrocarbons would be separated from produced water on the MODU and subject to analysis. Larger quantities of produced water would be treated prior to disposal to the ocean in compliance with the OWTG. As any such emissions will become rapidly diluted, adverse effects on fish and fish habitat are not anticipated. Small quantities of resulting produced water would be sent for flaring on the MODU and flaring would last for one to three days per analysis period. Artificial light from flaring is not anticipated to affect marine fish and fish habitat. Atmospheric emissions may be released due to well flow testing with overall low effects due to the infrequent and short time periods for flaring and will adhere to relevant legislation and regulations discussed in Section 2 of the EIS.

Residual Environmental Effects Assessment (Well Testing)

Any produced water to be discharged will be treated in accordance with the OWTG prior to discharge and thus, is not anticipated to affect fish and fish habitat. Light and emissions from formation fluid flaring are considered low and unlikely to adversely affect fish and fish habitat.

With the application of mitigations outlined throughout this VC, potential residual effects due to well testing are therefore predicted to be neutral to adverse, negligible, localized in extent, short term in nature, occurring sporadically and reversible. These predictions were determined with a high level of confidence.

Well Abandonment or Suspension

Well abandonment plans have not been finalized but will adhere to the requirements of the Newfoundland Offshore Petroleum Drilling and Production Regulations SOR/2009-316 as well as CNOOC 's internal governance. Use of explosives is not considered a well abandonment option for environmental and safety reasons.

Upon completion of the exploration drilling program, wellheads will be abandoned or suspended for future re-entry. Abandonment involves installation of cement plugs, and / or mechanical devices and then cutting of the wellhead if required. An ROV or other equipment will be used to monitor and inspect the condition of the wellsite in accordance with applicable regulatory requirements at the time of abandonment. If a wellhead remains in place, the position will be reported to Canadian Hydrographic Services so nautical charts can be updated. Where wells are suspended, this will be done in accordance with C-NLOPB requirements.

As discussed, physical interaction with the seabed may result in disturbances to benthic habitats and organisms. This may also result in injury, and / or mortality of corals, sponges and sea-pens, through introduction of suspended solids in the water column. However, if a wellhead is not removed, the remaining

seabed infrastructure in deeper parts of the Project Area may add small quantities of habitat heterogeneity to the barren environment and potentially aid in recolonization of benthic species and overall recovery.

Plug installation and wellhead cutting may result in short term (i.e., hours), of emissions of noise and light that would be no more than for drilling operations. Fish may temporarily avoid or remain in the area during activities depending on species-specific sensitivities to light and sound. Removal of subsea infrastructure, including wellheads, may cause short-term localized suspended particle and sedimentation disturbance effects, to marine fish and fish habitat, similar to other Project activities. Use of ROVs in the water column could potentially elicit temporary behavioural responses from certain fishes and invertebrates. When these Project activities cease, effects on fish and fish habitat would be reduced accordingly.

Residual Environmental Effects Assessment (Well Abandonment or Suspension)

Fishes may temporarily avoid an area during plug installation and wellhead cutting depending on species-specific sensitivities to light and sound emissions. Any remaining wellheads in deeper parts of the Project Area may potentially aid in recolonization of benthic species and overall habitat recovery.

With the application of mitigations outlined throughout this VC, potential effects from well abandonment or suspension are predicted to be adverse, low in magnitude, localized, short term in nature, occurring sporadically, and reversible. These predictions were determined with a high level of confidence.

Supply and Servicing

The Project will involve vessel and aircraft use for Supply and Servicing to, from and within the Project Area year-round throughout Project duration. A stand-by vessel will also attend to the MODU throughout the drilling program. It is expected that offshore supply vessel and aircraft (helicopter) services for the Project will be based in St. John's, NL. Thus, supply and servicing is considered within the LSA, which includes the zone of influence for light and sound around the offshore Project Area and the associated vessel and aircraft traffic route to the onshore supply base.

Servicing the MODU will involve two to three return vessel transits per week by the supply vessels during the Project. It is estimated that there would be one to three helicopter transits per day to the MODU. Marine vessel and helicopter traffic will interact with Special Areas due to associated sound, lighting, and discharges / emissions while in transit within the vessel traffic route, or at a location within the Project Area. Potential environmental effects of vessel and aircraft presence and movements include disturbances to marine fish, marine and migratory birds, marine mammals and sea turtles in Special Areas.

The LSA intersects with various Special Areas, including the Slopes of the Flemish Cap and Grand Bank UNCBD EBSA and the Northwest Flemish Cap (11) NAFO FCA as described above. The defining features of Special Areas that intersect the LSA (i.e., zone of influence) are summarized in Table IR-47-02.4. These Special Areas are identified for the presence of benthic habitat, marine fish, marine and migratory birds, marine mammals and sea turtles, and human uses including the fishing industry. More detailed information regarding the potential effects of the Project on overall marine biota is included in Sections 8.2, 9.2, and 10.2 of the EIS.

Table IR-47-02.5 Defining Features of Special Areas Intersecting the LSA (Updated Table 47.4 of Revised EIS Addendum (February 2019))

Special Areas	Defining Features
Snow Crab Stewardship Exclusion Zone in Crab Fishing Area 6C	Refuge areas for snow crab (i.e., Marine Fish and Fish Habitat).
Snow Crab Stewardship Exclusion Zone in Crab Fishing Area Near Shore	
Eastern Avalon Canadian EBSA	Seabird feeding areas (i.e., Marine and Migratory Birds). Cetaceans, leatherback turtles and seals feed in the area from spring to fall (i.e., Marine Mammals and Sea Turtles).
Cape Spear National Historic Site	Restored historical lighthouse and lighthouse keepers home, most eastern point of North America (i.e., Other Ocean Uses).
Signal Hill National Historic Site	Historic site of wireless communication and military defence of St. John's Harbour (i.e., Other Ocean Uses).
Southern Flemish Pass to Eastern Canyons VME	Large gorgonians and high density of sponges. Vulnerable fish species: striped wolffish, redfish, spiny tailed skate, northern wolffish, some black dogfish, deep-sea cat shark (i.e., Marine Fish and Fish Habitat).
Slopes of the Flemish Pass and Grand Bank UNCBD EBSA	Includes NAFO closures to protect corals and sponges (i.e., Marine Fish and Fish Habitat). A component of Greenland halibut fishery grounds in international waters (i.e., Fisheries). A high diversity of marine taxa, including threatened and listed species (Assumed Marine Fish and Fish Habitat).
Flemish Pass / Eastern Canyon (2) NAFO FCA	Closed to protect extensive sponge grounds large gorgonian corals (i.e., Marine Fish and Fish Habitat).
Northwest Flemish Cap (10) NAFO FCA	Closed to protect high coral and sponge concentrations (e.g., crinoids, cerianthids and black corals). Includes sea pen fields, which serve as habitat structure in low-relief sand and mud habitats and provide refuge for small planktonic and benthic invertebrates.
Northwest Flemish Cap (11) NAFO FCA	
Large Gorgonian Coral SBA	Identified as having high predicted presence probability for significant concentration of large gorgonian corals.
Quidi Vidi Lake IBA	Important daytime resting site for gulls including significant numbers of herring, great black-backed, Iceland, glaucous and common black-headed gulls from late fall to early spring; locally rare ring-billed gull, mew gull and lesser black-backed gull occasionally reported; waterfowl including American black ducks, mallards and northern pintails common in the winter (i.e., Marine and Migratory Birds).

Special areas in the RSA that are regularly used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas which are more than 400 km away from the Project Area. National Historic Sites are valued for cultural / historical reasons and are used for recreational purposes such as hiking and sight-seeing. Snow Crab Stewardship Exclusion Zones are closed to crab fishing. Users of either of these Special Areas could potentially experience increased sound from marine vessel and aircraft traffic, but any sound would be generally consistent with the overall marine traffic that has occurred throughout the region for many years. Section 13 of the EIS has determined that with the implementation and application of the

proposed mitigation measures to avoid or reduce residual effects, the Project is unlikely to result in significant adverse effects on Fisheries and Other Ocean Uses.

As discussed in Section 8.3.8 of the EIS, Supply and Servicing is not anticipated to result in interactions with benthic species and habitats such as those found in the Slopes of the Flemish Pass and Grand Bank UNCBD EBSA, Southern Flemish Pass to Eastern Canyons VME, Flemish Pass / Eastern Canyon (2) NAFO FCA, Northwest Flemish Cap (10) NAFO FCA, Northwest Flemish Cap (11) NAFO FCA or Significant Benthic Areas for Large Gorgonian Corals. The following paragraphs discuss potential effects of Supply and Servicing on marine fish, marine and migratory birds, and marine mammals and sea turtles such as those found in Special Areas in the LSA.

Although the presence of marine vessels may result in some level of attraction, avoidance or other behavioural responses by individual fish and invertebrates due to light and sound emissions (Røstad et al. 2006; De Robertis and Handegard 2013), marine fishes and invertebrates will likely not be disturbed by Project-related vessel activity given its transitory nature and short-term presence at any one location.

Atmospheric emissions would originate from vessel exhausts, although these would be negligible overall. Environmental disturbances and effects due to emissions from vessels will also be transient in nature. Other potential environmental discharges from vessels and equipment relate to the possible release of oily water and other substances through deck drainage, bilge/ballast water, open drains, sanitary waste/grey water, and other hazardous/non-hazardous wastes. All wastewater will be treated to minimize contaminant or hydrocarbon levels prior to discharge in accordance with the OWTG and other regulatory requirements.

All vessels that are used for this Project will meet the operational and environmental capabilities needed for the associated exploration activities, including for implementing relevant environmental mitigations and safety and emergency response procedures. All vessels will be in compliance with applicable legislation and regulations and will be inspected by Transport Canada and approved for operation by the C-NLOPB before beginning any Project-related work. They will have appropriate oil spill / pollution prevention and emergency response plans in place, and each will be MARPOL compliant.

The LSA intersects Special Areas (i.e., Eastern Avalon EBSA and Quidi Vidi Lake IBA), including coastal feeding, resting and wintering areas, that have been identified for various marine and migratory bird populations. Supply and Servicing vessels may interact with marine and migratory birds through lighting, sound, marine discharges and other associated emissions, which may result in disturbances in feeding, breeding or migration areas of marine and migratory birds. Marine and migratory birds are vulnerable to changes in the abundance of prey species (e.g., fish, plankton, cephalopods) on which they may rely for food and the presence of vessels may disturb prey species and disrupt foraging activities. Vessel lighting at night may attract some fish species to the surface, which in turn may attract some gull species for improved foraging opportunities (Davis et al. 2017). Detailed information can be found in Section 9 of the EIS.

Birds are likely to experience some localized and short-term behavioural effects (change in presence and abundance), with some species being displaced from the LSA and others attracted by lighting. The greatest potential for interaction between artificial light emissions and marine and migratory birds is in the attraction of Leach's storm-petrels. 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 Flemish Pass and adjacent areas, averaging 4 days per foraging trip (Hedd et al 2018). There may be a slight increase in mortality / injury levels due to collisions and disorientation resulting in birds being stranded on vessels although the mortality rate is anticipated to be low as most birds stranded on platforms and vessels are

released successfully. 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).

Release of organic wastes by vessels can attract birds, which may increase the potential for interactions including risk of predation, collision and exposure to contaminants. Each of the vessels involved in this Project will manage and dispose of waste in accordance with applicable regulations and standards in compliance with the Project Waste Management Plan. Proper waste management practices and adherence to MARPOL requirements will minimize potential effects. The relatively low discharge volumes would likely become highly dispersed in the marine environment, and any discharges are unlikely to accumulate in any specific area due to the mobile nature of vessels.

Marine vessels are transitory and thus, short-term at any one location. Thus, it is anticipated that bird species, 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. Changes in habitat and food availability and quantity will also be on a localized scale and for a short-term duration. The activities of supply vessels are generally consistent with overall marine traffic that has occurred throughout the region for many years. Project support vessels will use existing and established routes wherever possible. Vessels will avoid coastal seabird colonies during the nesting season as per the *Seabird Ecological Reserve Regulations, 2015* and CWS guidelines.

Aircraft traffic may affect seabirds through lighting, noise, and other emissions. Helicopters will be used for crew transfers and other purposes, and 1 to 3 return transits per day are anticipated for the MODU. Additional helicopter trips may be required (e.g., transportation of technical personnel, parts or equipment, or removal of a crew member in an emergency situation), but these are anticipated to be infrequent.

Helicopter use is of relevance to the marine and migratory birds VC because this activity and its associated noise can potentially disturb nesting seabirds. Flushing of breeding birds from nests in response to loud noises, such as helicopter overflights, can have immediate negative consequences including predation of eggs and chicks and decreased incubation and brooding (Burger 1981; Brown 1990; Bolduc and Guillemette 2003; Beale 2007; Burger et al 2010). Nestlings may also be vulnerable to exposure, and adults may inadvertently knock eggs and flightless young from the nest, which is of concern for cliff-nesting species such as murres and kittiwakes (Burger 1981; Carney and Sydeman 1999). Disturbance to adult foraging and provisioning activities may impact nestling growth and survival (Davis and Wiseley 1974; Lynch and Speake 1978; Belanger and Bedard 1990; Delaney et al 2002; Goudie 2006).

Noise may deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure (Larkin 1996; Beale 2007). Reactions of marine birds to helicopters and other aircraft depends on factors such as the species and previous exposure levels of individuals (i.e., degree of habituation), as well the location, altitude and frequency of flights (Hoang 2013). Research has shown that flushing may occur at distances greater than 350 m for common murres (Rojek et al 2007), although there is inherent variability in behavioural responses between and even within species (Blumstein et al 2005; Hoang 2013).

Aircraft overflights may result in temporary loss of useable habitat 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, as cited in Statoil Canada Ltd. 2017).

Project-related flights will use existing and established routes wherever possible. Known and observed bird colonies, large aggregations of avifauna, protected or sensitive areas and times will also be avoided

wherever possible. Helicopter operations will avoid coastal seabird colonies during the nesting season as per the Seabird Ecological Reserve Regulations, 2015 (i.e., by not taking off or landing in, and by flying at an altitude greater than 300 m over seabird ecological reserves during sensitive times of year to avoid disturbance. Therefore, adverse interactions with, and effects on, coastal breeding colonies, including areas identified as Special Areas, are unlikely.

Marine mammals and sea turtles may be affected by Supply and Servicing activities. 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). Seals often show considerable tolerance to vessels but may also show signs of avoiding vessel traffic. Baleen whales, such as humpbacks, often interrupt their normal behaviour and swim rapidly away from vessels that have strong or rapidly changing noise, especially when a vessel heads directly towards a whale. Stationary vessels or slow-moving, “non-aggressive” vessels typically elicit very little response from baleen whales. Vessel traffic and associated noise can be a source of chronic stress for marine mammal populations (Rolland et al 2012; Wright et al. 2011; Atkinson et al. 2015). Cetaceans and some seal species have been observed to adjust their movement behaviour around ships (Richardson et al 1995; Lalas and McConnell 2015).

Marine mammals (and likely sea turtles) may exhibit minor, short-term disturbance responses to underwater sounds from vessels. Underwater sound may also result in hearing impairment, injury, masking, behavioural responses in marine mammal and sea turtles. However, 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). Section 10 of the EIS provides more information on potential Project effects on Marine Mammals and Sea Turtles.

Ship noise, through masking, can 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 length of time (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007; NMFS 2016). In addition to the frequency and duration of masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of masking (Branstetter et al. 2013, 2016; Finneran and Branstetter 2013). Cetaceans have been observed to modify their vocal patterns around ships (Clark et al 2009).

Available information indicates that single or occasional aircraft overflights cause no more than brief behavioural responses in baleen whales and seals (summarized in Richardson et al. 1995). Offshore helicopter traffic may also result in changes in habitat quality or use for marine mammals and sea turtles due to both auditory and visual sensory disturbance. Helicopter sound frequencies are mainly below 500 Hz, and transmission of these sounds into the marine environment depends primarily on altitude and sea surface conditions, with noise from helicopters being most intense just below the water surface and directly beneath the aircraft, with sounds attenuating over shorter distances underwater than in the air (Richardson et al 1995). Behavioural responses of cetaceans to aircraft noise can include diving, reduced surfacing periods, and breaching (Ptenaude et al 2002; Luksenburg and Parsons 2009) and can depend on their activity at the time of exposure (Würsig et al 1998; Luksenburg and Parsons 2009). Responses of sea turtles to helicopter traffic are expected to be similar to marine mammals, although research indicates that turtles are more reliant on visual cues (Hazel et al 2007).

Project-related marine vessel traffic has the potential to result in mortality or injury of marine mammals due to vessel strikes (Williams and O'Hara 2010). Baleen whales are more susceptible to mortality from vessel strikes than other marine mammal groups (Laist et al 2001; Jensen and Silber 2003). All six baleen whale

species found in the northwest Atlantic, including humpbacks, which are common in Eastern Newfoundland, have been struck by ships (Jensen and Silber 2003). North Atlantic right whales, fin whales, humpback whales and grey whales have the highest risk of mortalities (Vanderlaan and Taggart (2007). Vessel strikes have been implicated in mortalities of North Atlantic right whales in the Gulf of St. Lawrence (Science 2017).

As indicated in Section 10 of the EIS, the potential for vessel strikes on marine mammals and sea turtles is unlikely. Vessel strikes can have serious consequences for individuals involved, but avoidance behaviour tends to reduce the risk of collision. For example, beaked whales tend to avoid approaching vessels by diving for extended periods (Kasuya 1986; Würsig et al 1998). 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). Reducing vessel speed has been shown to decrease the number of marine mammal deaths and severe injuries due to vessel strikes (Vanderlaan and Taggart 2007; Vanderlaan et al 2008, 2009; van der Hoop et al 2012). Lethal strikes are infrequent at vessel speeds less than 25.9 km/h (14 knots) and rare at speeds less than 18.5 km/h (10 knots) (Laist et al 2001).

Residual Environmental Effects Assessment (Supply and Servicing)

As is the case for all marine traffic, the operation of supply vessels and aircraft will introduce potential changes to the environment, including the noise, light and other possible emissions that are typically associated with such activities. Project-related vessel movements will have a short-term presence at any one location and create noise types and levels similar to daily and frequent marine traffic in the area. Given the transitory nature of aircraft movements and the planned avoidance of low level flights wherever possible, no adverse environmental effects on fish and fish habitat in Special Areas are anticipated due to air traffic. With the application of mitigations outlined throughout this VC, potential effects from Supply and Servicing on Special Areas identified for marine fish and fish habitat are predicted to be adverse, but low in magnitude, within the LSA, of short term duration, occurring regularly, and reversible. These predictions were determined with a high level of confidence.

The presence and operation of vessels and aircraft may result in adverse effects on avifauna in Special Areas in the LSA, primarily through attraction or avoidance behaviour associated with lighting and other potential environmental interactions and emissions leading to some increased potential for changes in individual bird mortality / injury or other health effects. However, these will be avoided or reduced through the various mitigation measures identified in Section 9.3 of the EIS and will not result in population-level effects. Project-related support vessel and aircraft activities may result in temporary disturbance to bird colonies. Such traffic will be transitory and short-term at any one location, and the amount of traffic is generally in keeping with the overall marine traffic that has occurred throughout the region for many years. Project-related supply vessel traffic will utilize existing and established routes wherever possible and avoid concentrations of marine and migratory birds whenever possible. Helicopter operations adhere to regulations and best practices such as the *Seabird Ecological Reserve Regulations, 2015* and Measures to Protect and Monitor Seabirds in Petroleum-Related Activity in the Canada-Newfoundland and Labrador Offshore Area. Supply and Servicing is not likely to result in population level effects on marine and migratory birds. With the application of these and other mitigations outlined throughout this VC, potential effects on Special Areas identified for marine and migratory birds are predicted to be adverse, low in magnitude, within the LSA, short-term, regular, and reversible. These predictions were determined with a high level of confidence.

Any interactions between Project-related Supply and Servicing vessels and marine mammals and sea turtles in Special Areas in the LSA are anticipated to be minor due to the localized and transitory nature of these activities, and because it will generally be in keeping with the overall marine traffic that has occurred throughout the region for decades. Project-related supply vessel traffic will use established routes, seek to

maintain a steady course and safe speed and avoid concentrations of marine mammals and sea turtles whenever possible to reduce the risk of vessel strikes.

While there is some potential for individuals in close range of the support vessels to be exposed to sound levels that may trigger a behavioural response, vessel-related underwater noise during transit to the Project Area will be temporary and transient at any one location, and therefore, any potential disturbance is expected to be minor and temporary. Underwater sound levels produced by Project-related support vessels and helicopters are not expected to exceed threshold levels for either marine mammals or sea turtles. The potential for exposure of marine mammals or sea turtles to disturbance from helicopter overflights is anticipated to be negligible and infrequent. Marine mammals and sea turtles are not likely to be displaced from any key habitats or during important activities or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region. With the application of mitigations outlined throughout this VC, potential effects on Special Areas identified for marine mammals and sea turtles are predicted to be adverse, low in magnitude, within the LSA, short-term, regular, reversible, and are predicted with a high level of confidence.

Organic wastes and other waste materials that may be generated and discharged by offshore vessels can attract marine biota. All vessels involved in this Project will manage and dispose of waste in accordance with applicable regulations and standards and the Project Waste Management Plan. Other potential emissions and discharges will be managed through strict adherence to applicable regulations, standards, and best practices. All Project-related support vessels will also follow applicable environmental and safety regulations and guidelines. The transitory nature of these activities means that any environmental discharges are not likely to accumulate in any single area, and will not have detectable, adverse environmental effects upon marine biota and their habitats or food sources.

In summary, Supply and Servicing is not likely to result in significant adverse environmental effects on Special Areas. With the application of mitigations outlined throughout this VC and in the relevant biological VC sections of the EIS, potential effects on Special Areas identified for marine biota are predicted to be adverse, low in magnitude, within the LSA, short-term, regular, and reversible. These predictions were determined with a high level of confidence.

Environmental Effects Evaluation

This section summarizes the residual effects of the Project on marine fish and fish habitat and presents a determination of significance for the environmental effects assessment for this VC.

Residual Environmental Effects Summary

Table IR-47-02.5 provides a summary of potential residual effects of the Project on Special Areas. As described for the biophysical VC sections of the EIS (Sections 8: Marine Fish and Fish Habitat, 9: Marine and Migratory Birds, 10: Marine Mammals and Sea Turtles, 13: Fisheries and Other Ocean Uses), the Project is not expected to result in significant adverse effects upon the physical, biological and socioeconomic features in the LSA. The implementation of the various mitigation measures (including a pre-drilling seabed investigation survey to identify sensitive benthic habitat and species such as corals and sponges and adherence to regulations and best practices related to avoidance of sensitive areas for marine and migratory birds and marine mammals and sea turtles), outlined throughout the EIS will reduce potential direct or indirect effects on the existing environmental characteristics and conditions. Therefore, the Project is not likely to result in significant adverse residual environmental effects on Special Areas.

The planned exploration activities are characterized by small environmental footprints. Moreover, the implementation of the various environmental mitigation measures outlined throughout the EIS, including those designed to avoid or reduce Project-related discharges and/or disturbances and their associated environmental changes, will address any direct or indirect potential environmental effects that may have implications for intersecting or adjacent Special Areas. Additionally, the short duration of the various activities associated with this Project, along with the offshore and dynamic marine environment involved and the implementation of planned mitigation measures, means that any potential adverse effects will be of generally low magnitude, localized extent though some occur in the Project Area or LSA, short to long term, occurring sporadically or regularly and reversible. These effects are predicted with a high level of certainty.

Table IR-47-02.6 Environmental Effects Assessment Summary: Special Areas (Updated Table 47.5 of Revised EIS Addendum (February 2019) and Table 11.4 of the EIS)

ENVIRONMENTAL EFFECTS ASSESSMENT SUMMARY *								
Summary of Existing Conditions and Environmental Context <ul style="list-style-type: none">A number of marine and coastal areas in Newfoundland and Labrador have been designated as protected under provincial, federal and / or other legislation or agreements due to their biological / ecological or socio-cultural characteristics and importance, and other areas have been identified as being special or sensitive through relevant processes and initiatives.Special areas identification is often directly related to the existing physical and biological environment, including habitat of marine fish, marine and migratory birds and marine mammals and sea turtles or socio-cultural values such as economy, culture, history or recreation, which are also covered in other sections of the EIS.Many Special Areas are located on land or in coastal areas outside of the Project Area and LSA.None of the Special Areas (i.e., a UNCBD EBSA and a NAFO FCA) that intersect the Project ELs have prohibitions for offshore oil and gas activities.Special areas located in the general vicinity are valued for their biological and ecological characteristics and their importance for activities such as the fishing industry, but none are likely to have an active commercial fishery.Special areas in the LSA or zone of influence for Project effects such as light, sound and drill cuttings emissions are identified for sensitive benthic habitat, marine fish, marine and migratory birds, and marine mammals and sea turtles.Special areas most regularly used by humans for recreation, subsistence, or tourism activities, are in coastal and onshore areas 400 to 500 km from the Project Area.					Key Mitigation Measures <ul style="list-style-type: none">Mitigations designed to avoid or reduce effects of activities on marine biota, habitats and marine users will address effects on Special AreasMODU and supply vessel / aircraft contractors will maintain equipment, to reduce excess light, noise, emissions and discharges.Project activities will avoid or minimize discharges, emissions and waste. This includes compliance with regulations, and company procedures.Seabed investigations will be used to investigate presence of sensitive benthic organisms or habitats in the immediate area of the wellsite.VSP surveys will conform with the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment.Produced hydrocarbons will be flared using high-efficiency burners. Produced water will be treated in keeping with regulatory requirements.CNOOC will operate in accordance with Measures to Protect and Monitor Seabirds in Petroleum-Related Activity in the Canada-Newfoundland and Labrador Offshore Area.Vessel and aircraft traffic transits will be minimized, and low-level aircraft operations will also be avoided, or minimized.Existing and common vessel travel routes will be used wherever practical, vessels will seek to maintain a steady course and vessel speed.If wellhead removal is required during abandonment, wells will be cut by mechanical separation as opposed to the use of explosives.			
Project Component or Activity	Potential Environmental Effects	Residual Environmental Effects Summary Descriptors						
		Nature	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Certainty
Presence and Operation of MODUs (including lights, noise, air emissions, positioning / mooring, on-site vessels, seabed	<ul style="list-style-type: none">Possible change in environmental features and/or processesPossible change in human use and/or societal value	A	N	L	S	R	R	H

investigation)								
Drilling and Associated Marine Discharges (including fluids and cuttings)	<ul style="list-style-type: none"> Possible change in environmental features and/or processes Possible change in human use and/or societal value 	A	L	L	L	R	R	H
Vertical Seismic Profiling	<ul style="list-style-type: none"> Possible change in environmental features and/or processes Possible change in human use and/or societal value 	A	L	L	S	R	R	H
Well Testing	<ul style="list-style-type: none"> Possible change in environmental features and/or processes 	N-A	N	L	S	S	R	H
Well Abandonment or Suspension	<ul style="list-style-type: none"> Possible change in environmental features and/or processes 	A	L	L	S	S	R	H
Supply and Servicing	<ul style="list-style-type: none"> Possible change in environmental features and/or processes Possible change in human use and/or societal value 	A	L	LSA	S	R	R	H
Evaluation of Significance <i>Not Significant</i> <ul style="list-style-type: none"> Activities such as those planned for this Project are not likely to result in significant adverse environmental effects on Special Areas. Oil and gas exploration activities are not prohibited within any of the Special Areas that overlap with the Project Area or LSA. 								

- For the various Special Areas that overlap with or are in the vicinity of the Project Area (offshore) or LSA (associated vessel and aircraft traffic route), the overall and defining physical, biological and socioeconomic environments within these areas are not likely to be adversely affected by the Project.
- * The results of the environmental effects assessment summarized above apply to Project activities related to both EL 1144 and EL 1150, unless otherwise indicated.

<p>KEY</p> <p>Nature / Direction:</p> <p>P Positive</p> <p>A Adverse</p> <p>N Neutral (or No Effect)</p> <p>Magnitude:</p> <p>N Negligible</p> <p>L Low</p> <p>M Medium</p> <p>H High</p> <p>Geographic Extent:</p> <p>L Localized, In Immediate Vicinity of Activity</p> <p>PA Within Project Area</p> <p>LSA Within LSA</p> <p>RSA Within RSA or Beyond</p>	<p>Frequency:</p> <p>N Not likely to occur</p> <p>O Occurs once</p> <p>S Occurs sporadically</p> <p>R Occurs on a regular basis</p> <p>C Occurs continuously</p> <p>Duration:</p> <p>S Short term (For duration of the activity / disturbance)</p> <p>M Medium term (Beyond duration of the activity / disturbance – weeks or months)</p> <p>L Long term (Beyond duration of the activity / disturbance – years)</p> <p>P Permanent (Recovery unlikely)</p> <p>Reversibility:</p> <p>R Reversible (Will recover to baseline)</p> <p>I Irreversible (Permanent)</p>	<p>Certainty in Predictions:</p> <p>L Low level of confidence</p> <p>M Moderate level of confidence</p> <p>H High level of confidence</p> <p>N/A Not Applicable</p>
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The offshore support vessel and aircraft activity within the Project Area and to and from Eastern Newfoundland will make a relatively minor contribution to the overall offshore petroleum activity (especially, vessel and aircraft traffic) that has occurred throughout the region for decades and general marine traffic that has existed for hundreds of years. Supporting vessels and aircraft engaged in Project activities will, under normal conditions, be expected to travel directly between an established facility in Eastern Newfoundland and the MODU operating within an EL in the Project Area. Specific travel routes may vary at times based on the location of the active MODU, the shore-based support facility being used, environmental conditions (including weather and ice) and other logistical factors.

The planning and conduct of Project-related support vessel traffic will be undertaken in consideration of these factors, relevant regulatory requirements, and through established cooperative processes that involve discussions and communications between the oil and gas sector, fishing industry and other ocean uses to minimize interactions between these activities and Special Areas.

The various environmental monitoring and follow-up initiatives, outlined in Section 18.4 of the EIS, in relation to relevant components of the biophysical environment will be indirectly applicable to Special Areas. CNOOC will also continue to track any new or revised special area designations or conditions within the RSA over the course of the Project. No additional and specific environmental monitoring or follow-up is considered necessary in relation to this VC.

Determination of Significance

As determined in the biological and socioeconomic VCs, the Project is not anticipated to result in significant residual effects on the defining physical, biological, and socio-economic features of these areas. Many of the offshore activities and associated disturbances will be localized and short-term at a specific location. The implementation of mitigation measures outlined in Sections 9 of the EIS to avoid sensitive corals, sponges, and sea pens will reduce direct or indirect potential effects on Special Areas identified for the presence of sensitive benthic habitats and marine species. Subsea infrastructure and well drilling sites will represent small areas of disturbance to benthic habitats within the extensive areas of marine environment of Special Areas in the offshore. The results of drill cuttings modelling, and a pre-drill seabed investigation will enable identification and avoidance of sensitive habitat areas in determining the location of infrastructure, drilling wells and drill cuttings deposition sites. Discharges, including drill cuttings, will be treated as per regulations and best practices prior to discharge. Thus, the Project is not likely to result in significant adverse residual effects on the defining features of Special Areas that intersect with the Project Area.

Special areas within the LSA have also been identified based on the presence of sensitive benthic habitats and to a lesser extent on marine fish, marine and migratory birds, marine mammals and sea turtles, and human activities. Planned Project activities in the LSA (e.g., Supply and Servicing) will not result in direct contact with the seabed and will therefore not physically disturb benthic animals or their habitats. These activities may cause light and noise that could result in temporary behavioural changes in marine species. Humans may also be subject to noise and light from Project-related traffic, but this activity is not anticipated to result in an increase in the general marine traffic that occurs in the area. Based on present knowledge of Special Areas, and planned mitigations, the predicted residual environmental effects from planned Project activities on Special Areas in the LSA are also likely to be not significant.

In summary, the predicted residual effects on Special Areas resulting from planned Project activities would be neutral to adverse, negligible to low in magnitude, within the Project Area or LSA. The effects would be generally short-term in duration, sporadic to regular, but reversible. These predictions are determined with a high level of confidence and based on the outcomes of effects assessments for the Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles VCs as well as Commercial Fisheries and Other Ocean Uses

VC for this Project. As described and summarized above, the Project is therefore not likely to result in a detectable adverse change in environmental processes or features of Special Areas, or a decrease in its overall or use or societal value.

Environmental Monitoring and Follow-up

The various environmental monitoring initiatives outlined earlier in relation to relevant components of the biophysical environment will also be applicable to Special Areas (see Sections 8.6, 9.6, and 10.6 of the EIS). CNOOC will also continue to track any new or revised special area designations within the RSA over the course of the Project. No additional and specific environmental monitoring or follow-up is considered necessary in relation to this VC.

- CNOOC will obtain the required authorizations for the Project, and comply with applicable regulations, guidelines, and mitigation measures as identified and committed to in the preceding sections, the implementation of which will be planned, managed, and monitored in accordance with existing operational procedures and policies. Based on the information presented in the EIS, and the conclusion of the effects assessment, a follow-up program will be undertaken in consideration of sensitive benthic habitat in the following circumstances:
 - When a planned well site is located within an identified FCA; or
 - In an area where the results of the pre-drill seabed investigation and subsequent review by DFO and C-NLOPB indicate that monitoring is required.
- The purpose of the program would be to determine the effectiveness of mitigation measures in protecting the sensitive benthic habitat. It may include parameters such as:
 - Post-drilling seabed core samples to measure drill cuttings deposition; and/or
 - Post-drilling visual assessment using high-definition images / video.

If exploration wells are planned to be drilled under the circumstances identified above, a follow-up monitoring plan will be developed and submitted for DFO and C-NLOPB for review prior to commencement of drilling.

SPECIAL AREAS: ACCIDENTAL EVENTS

Refer to Appendix C: Section 16.6.6 of the Revised EIS Addendum (February 2019) for an updated assessment of potential Accidental Events.

References

- Allers, E., R.M.M. Abed, L.M. Wehrmann, T. Wang, A.I. Larsson, A. Purser, and D. de Beer. 2013. Resistance of *Lophelia pertusa* to coverage by sediment and petroleum drill cuttings. *Marine Pollution Bulletin*, 74(2013): 132-140.
- Atkinson, S., D. Crocker, D. Houser, and K. Mashburn. 2015. Stress physiology in marine mammals: how well do they fit the terrestrial model? *J. Comp. Physiol. B* 185: 463-486.
- Bakke, T., J. Klungsøyr, and S. Sanni. 2013. Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. *Marine Environmental Research*, 92(2013): 154-169.
- Baessant, T., M. Nilsen, E. Ravagnan, S. Westerlund, and S. Ramanand. 2018. Effects of suspended drill cuttings on the coral *Lophelia pertusa* using pulsed and continuous exposure scenarios. *Journal of Toxicology and Environmental Health, Part A*, 81(10): 361-382.
- Beale, C.M. 2007. The behavioral ecology of disturbance responses. *International Journal of Comparative Psychology*, 20:111-120.

- Belanger, L. and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging in snow geese. *Journal of Wildlife Management*, 54: 36-41.
- Bell, J.J., E. McGrath, A. Biggerstaff, T. Bates, H. Bennett, J. Marlow, and M. Shaffer. 2015. Sediment impacts on marine sponges. *Marine Pollution Bulletin*, 94(2015): 5-13.
- Bergström, L., L. Kautsky, T. Malm, R. Rosenberg, M. Wahlberg, N.Å. Capetillo, and D. Wilhelmsson. 2014. Effects of offshore wind farms on marine wildlife—a generalized impact assessment. *Environmental Research Letters*, 9(3), 034012.
- Blumstein, D. Fernandez-Juricic, E., Zollner, P. and Garity, S. 2005. Inter-specific variation in avian responses to human disturbance. *Journal of Applied Ecology*, 42: 943-953.
- Bolduc, F. and M. Guillemette. 2003. Human disturbance and nesting success of common eiders: interaction between visitors and Gulls. *Biological Conservation*, 110:77-83.
- Branstetter, B.K., J.S. Trickey, H. Aihara, J.J. Finneran, and T.R. Liberman. 2013. Time and frequency metrics related to auditory masking of a 10 kHz tone in bottlenose dolphins (*Tursiops truncatus*). *Journal of Acoustical Society of America*, 134(6): 4556-4565.
- Branstetter, B.K., K.L. Bakhtiari, J.S. Trickey, and J.J. Finneran. 2016. Hearing mechanisms and noise metrics related to auditory masking in bottlenose dolphins (*Tursiops truncatus*). In: A.N. Popper and A. Hawkins (eds.), *The Effects of Noise on Aquatic Life II*. Springer, New York, NY, pp. 109-116.
- Brown, A.L. 1990. Measuring the effect of aircraft noise on sea birds. *Environment International*, 16: 587-592.
- Burger, J. 1981. Behavioral responses of Herring Gulls (*Larus argentatus*) to aircraft noise. *Environmental Pollution Series A*, 24: 177-184.
- Burger, J., M. Gochfeld, C. Jenkins and F. Lesser. 2010. Effect of approaching boats on nesting black skimmers: Using response distances to establish protective buffer zones. *Journal of Wildlife Management*, 74: 102-108.
- Buhl-Mortensen, P., E. Tenningen, and A.B.S. Tysseland. 2015. Effects of water flow and drilling waste exposure on polyp behavior in *Lophelia pertusa*. *Marine Biology Research*, 11(7): 725-373.
- Carney, K.M. and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. *Waterbirds*, 22: 68-79.
- Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S.M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. *Marine Ecology Progress Series*, 395: 201-222. <http://dx.doi.org/10.3354/meps08402>.
- Clark, M.R., F. Althaus, T.A. Schlacher, A. Williams, D.A. Bowden, and A.A. Rowden. 2016. The impacts of deep-sea fisheries on benthic communities: A review. *ICES Journal of Marine Science*, 73 (Supplement 1): i51-i69.

- Cordes, E.E., D.O.B. Jones, T.A. Schlacher, D.J. Amon, A.F. Bernardino, S. Brooke, R. Carney, D.M. DeLeo, K.M. Dunlop, E.G. Escobar-Briones, A.R. Gates, L. Génio, J. Gobin, L. Henry, S. Herrera, S. Hoyt, M. Joye, S. Kark, N.C. Mestre, A. Metaxas, S. Pfeifer, A.K. Sweetman, and U. Witte. 2016. Environmental impacts of the deep-water oil and gas industry: A review to guide management strategies. *Frontiers in Environmental Science*, 4: 1-26.
- Davis, R. A., A.L. Lang, and B. Mactavish. 2017. Study of Seabird Attraction to the Hebron Production Platform: A Proposed Study Approach. Rep. No. SA1190. Rep. by LGL Limited, St. John's, NL, for Hebron Project, ExxonMobil Properties Inc., St. John's, NL. 30 pp. + app..
- Davis, R.A. and A.N. Wiseley. 1974. Normal behavior of snow geese on the Yukon-Alaska North Slope and the effects of aircraft-induced disturbance on this behavior. Pp. 1-85. In: W. Gunn, W. Richardson, R. Schweinsburg and T. Wright. (eds.). *Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory and Alaska*. Arctic Gas Biological Report, Vancouver, BC.
- DeBlois, E.M., E. Tracy, G.G. Janes, R.D. Crowley, T.A. Wells, U.P. Williams, M.D. Paine, A. Mathieu, and B.W. Kilgour. 2014. Environmental effects monitoring at the Terra Nova offshore oil development (Newfoundland, Canada): Program design and overview. *Deep Sea Research Part II: Topical Studies in Oceanography*, 110: 4-12.
- Delaney, D.K., L.L. Pater, R.H. Melton, B.A. MacAllister, R.J. Dooling, B. Lohr, B.F. Brittan-Powell, L.L. Swindell, T.A. Beaty, L.D. Carlile and E.W. Spadgenske. 2002. Assessment of training noise impacts on the Red-cockaded Woodpecker: final report. US Army Construction Engineering Research Laboratories Technical Report 99/51, Fort Stewart, GA.
- DFO. 2007. Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP) Available at: <http://www.dfo-mpo.gc.ca/oceans/publications/seismic-sismique/index-eng.html>. Accessed October 2018.
- DFO (Fisheries and Oceans Canada). 2015. Integrated Fisheries Management, Plan Snow Crab (*Chionoecetes opilio*) - Newfoundland and Labrador Region Effective February 6, 2015.
- DFO (Fisheries and Oceans Canada). 2016. Refinement of Information Relating to Ecologically and Biologically Significant Areas (EBSAs) identified in the Newfoundland and Labrador (NL) Bioregion. Canadian Science Advisory Secretariat, Science Advisory Report, 2016/032.
- DFO (Fisheries and Oceans Canada). 2017. Lobster Area Closures (Trout River, Shoal Point, Penguin Islands, Gooseberry Island, Glovers Harbour, Mouse Island, Gander Bay). Available at: from <http://www.dfo-mpo.gc.ca/oceans>.
- De Robertis, A. and N.O. Handegard. 2013. Fish avoidance of research vessels and the efficacy of sound-reduced vessels: A review. *ICES Journal of Marine Sciences*, 70(1): 34-45.
- Ellis, D.H., C.H. Ellis and D.P. Mindell. 1991. Raptor Responses to Low-Level Jet Aircraft and Sonic Booms. *Environmental Pollution*, 74: 53-83.
- Ellis, J.I., G. Fraser, and J. Russell. 2012. Discharged drilling waste from oil and gas platforms and its effects on benthic communities. *Marine Ecology Progress Series*, 456: 285-302.

- Finneran, J.J. and B.K. Branstetter. 2013. Effects of noise on sound perception in marine mammals. In: H. Brumm (ed.), *Animal communication and noise*. Springer Berlin, Heidelberg, pp. 273-308.
- Goudie, R.I. 2006. Multivariate behavioural response of harlequin ducks to aircraft disturbance in Labrador. *Environmental Conservation*, 33: 28-35.
- Hamoutene, D., J.F. Payne, C. Andrews, J. Wells, and J. Guiney. 2004. Effect of a Synthetic Drilling Fluid (IPAR) on Antioxidant Enzymes and Peroxisome Proliferation in the American Lobster, *Homarus americanus*. Canadian technical report of fisheries and aquatic sciences (2554), 15.
- Hedd, A., I.L. Pollet, R.A. Mauck, C.M. Burke, M.L. Mallory, L.A. McFarlane Tranquilla, W.A. Montevecchi, G.J. Robertson, R.A. Ronconi, D. Shutler, S.I. Wilhelm, and N.M. Burgess. 2018. Foraging areas, offshore habitat use, and colony overlap by incubating Leach's storm-petrels *Oceanodroma leucorhoa* in the Northwest Atlantic. *PLoS One* 13:e0194389.
- Holdway, D.A. 2002. The acute and chronic effects of wastes associated with offshore oil and gas production on temperate and tropical marine ecological processes. *Marine Pollution Bulletin*, 44(2002): 185-203.
- IOGP. 2016. Environmental Fate and Effects of Ocean Discharge of Drill Cuttings and Associated Drilling Fluids from Offshore Oil and Gas Operations. IOGP Report 543.
- Järnægren, J., S. Brooke, and H. Jensen. 2016. Effects of drill cuttings on larvae of the cold-water coral *Lophelia pertusa*. *Deep Sea Research Part II: Topical Studies in Oceanography*. <https://doi.org/10.1016/j.dsr2.2016.06.014>.
- Jensen, A.S. and G.K. Silber. 2003. Large whale ship strike database. US Department of Commerce, NOAA Technical Memorandum, NMFS-OPR-25, 37 pp.
- Jones, E.L., G.D. Hastie, S. Smout, J. Onoufriou, N.D. Merchant, K.L. Brookes, and D. Thompson. 2017. Seals and shipping: quantifying population risk and individual exposure to vessel noise. *Journal of Applied Ecology*. <https://doi.org/doi:10.1111/1365-2664.12911>.
- Kasuya, T. (1986). Distribution and behavior of Baird's beaked whales off the Pacific coast of Japan. *Sci. Rep. Whales Res. Inst.*, 37: 61-83.
- Kenchington, E., L. Beazley, C. Lirette, F.J. Murillo, J. Guijarro, V. Wareham, K. Gilkinson, M. Koen Alonso, H. Benoît, H. Bourdages, B. Sainte-Marie, M. Treble, and T. Siferd. 2016. Delineation of Coral and Sponge Significant Benthic Areas in Eastern Canada Using Kernel Density Analyses and Species Distribution Models. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/093. vi + 178 p. Available at: <https://waves-vagues.dfo-mpo.gc.ca/Library/40577806.pdf>.
- Komenda-Zehnder, S., M. Cevallos and B. Bruderer. 2003. Effects of Disturbance by aircraft overflight on waterbirds – An experimental approach (ISSC26/WP-LE2). Warsaw, Poland: International Bird Strike Committee.
- Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., and Podesta, M. 2001. Collisions between ships and whales. *Marine Mammal Science*, 17(1): 35-75.
- Larkin, R.P. 1996. Effects of military noise on wildlife: a literature review. US Army Construction Engineering Research Laboratories Technical Report 96/21. January 1996.

- Larsson, A.I., and A. Purser. 2011. Sedimentation of the cold-water coral *Lophelia pertusa*: Cleaning efficiency from natural sediments and drill cuttings. *Marine Pollution Bulletin*, 62(2011): 1159-1168.
- Liefmann, S., J. Järnegren, G. Johnsen, and F. Murray. 2018. Eco-physiological responses of cold-water soft corals to anthropogenic sedimentation and particle shape. *Journal of Experimental Marine Biology and Ecology*, 504: 61-71.
- Løkkeborg, S., Ona, E., Vold, A., and A. Salthaug. 2012. Sounds from seismic air guns: gear-and species-specific effects on catch rates and fish distribution. *Canadian Journal of Fisheries and Aquatic Sciences*, 69(8), 1278-1291.
- Luksenburg, J.A. and E.C.M. Parsons. 2009. The effects of aircraft on cetaceans: implications for aerial whale watching. International Whaling Commission, SC/61/WW2. Available from: http://www.researchgate.net/publication/228409420_The_effects_of_aircraft_on_cetaceans_implications_for_aerial_whalewatching/file/9fcfd50b0a3b9d8a7a.pdf.
- Lynch, T.E. and D.W. Speake. 1978. Eastern wild turkey behavioral responses induced by sonic boom. Pp: 47-61. In: J. Fletcher and R.G. Busnel (eds.). *Effects of Noise on Wildlife*, Academic Press, New York, NY.
- Miles, W., S. Money, R. Luxmoore and R.W. Furness. 2010. Effects of artificial lights and moonlight on petrels at St Kilda. *Bird Study*, 57: 244-251.
- Murillo, F.J., A. Serrano, E. Kenchington, and J. Mora. 2016. Epibenthic assemblages of the Tail of the Grand Bank and Flemish Cap (Northwest Atlantic) in relation to environmental parameters and trawling intensity. *Deep-Sea Research Part I: Oceanographic Research Papers*, 109: 99-122.
- NAFO (Northwest Atlantic Fisheries Organization). 2019. Conservation and Enforcement Measures 2019. Serial No. N6901 NAFO/COM Doc. 19-01. Available at: <https://www.nafo.int/Portals/0/PDFs/COM/2019/comdoc19-01.pdf>
- Neff, J.M., S. McKelvie and R.C. Ayers Jr. 2000. Environmental Impacts of Synthetic-based Drilling Fluids. Report prepared for MMS by Robert Ayers & Associates, Inc. August 2000. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2000-064.
- Neff, J.M. 2010. Fate and Effects of Water-based Drilling Muds and Cuttings in Cold Water Environments. Houston (TX): Report to Shell Exploration and Production Company.
- NMFS. 2008. Summary report of the workshop on interactions between sea turtles and vertical lines in fixed-gear fisheries. L. Schwartz (ed.). Rhode Island Sea Grant, Narragansett, RI. Available at: https://www.greateratlantic.fisheries.noaa.gov/protected/seaturtles/docs/vertical_line_workshop_2008-web.pdf. Accessed November 2018.
- NMFS. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-OPR-55. 178 pp.
- Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. *Mammal Review*, 37: 81-115.
- Pabortsava, K., Purser, A., Wagner, H. and L Thomsen. 2011. The influence of drill cuttings on physical characteristics of phytodetritus. *Marine Pollution Bulletin*, 62(2011): 2170-2180.

- Paine, M.D., E.M. DeBlois, B.W. Kilgour, E. Tracy, P. Pocklington, R.D. Crowley, U.P. Williams, and G.G. Janes. 2014. Effects of the Terra Nova offshore oil development on benthic macro-invertebrates over 10 years of development drilling on the Grand Banks of Newfoundland, Canada. *Deep Sea Research Part II: Topical Studies in Oceanography*, 110: 38-64.
- Patenaude, N.J., W.J. Richardson, M.A. Smultea, W.R. Koski, G.W. Miller, B. Wuersig, B., and C.R. Greene, Jr. (2002). Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. *Marine Mammal Science* 18, 309-355.
- Popper, A. N., and M. C. Hastings. 2009. The effects of human-generated sound on fish. *Integrative Zoology*, 4: 43-52.
- Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Løkkeberg, S., Rogers, P., Southall, B. L., Zeddies, D. and W.N. Tavolga. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI," ASA S3/SC1.4 TR-2014. Springer and ASA Press, Cham, Switzerland (2014).
- Purser, A. 2015. A time series study of *Lophelia pertusa* and reef megafauna response to drill cuttings exposure on the Norwegian margin. *PLOS One*, 10(7).
- Ragnarsson, S.Á., J.M. Burgos, T. Kutti, I. van den Beld, H. Egilsdóttir, S. Arnaud-Haond, and A. Grehan. 2017. The impact of anthropogenic activity on cold-water corals. *Marine Animal Forests: The Ecology of Benthic Biodiversity Hotspots*: 1-35.
- Raimondi, P.T., A.M. Barnett, and P.R. Krause. 1997. The effects of drilling muds on marine invertebrate larvae and adults. *Environmental Toxicology and Chemistry*, 16(6): 1218-1228.
- Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Sound*. Academic Press, San Diego, CA.
- Rojek, N.A, M.W. Parker, H.R. Carter and G.J. McChesney. 2007. Aircraft and vessel disturbances to Common Murres *Uria aalge* at breeding colonies in Central California, 1997-1999. *Marine Ornithology*, 35: 61-69.
- Rolland, R.M., S.E. Parks, K.E. Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S.K. Wasser, and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. *Proceedings of the Royal Society of London B: Biological Sciences*. <https://doi.org/10.1098/rspb.2011.2429>.
- Røstad, A., S. Kaartvedt, T.A. Klejvar, and W. Melle. 2006. Fish are attracted to vessels. *ICES Journal of Marine Science*, 63: 1431-1437.
- Smit, M.G.D., J.E. Tamis, R.G. Jak, C.C. Karman, H. Kjeilen-Eilertsen, H. Trannum, and J. Neff. 2006. Threshold levels and risk functions for non-toxic sediment stressors: burial, grain size changes and hypoxia. Summary. ERMS Report no. 9.
- Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals*, 33: 411-521.

- Still, I., S. Rabke, and J. Candler. 2000. Development of a standardized reference sediment to improve the usefulness of marine benthic toxicity testing as a regulatory tool. *Environmental Toxicology*, 15(5), 406-416.
- Tait, R.D., C.L. Maxon, T.D. Parr, and F.C. Newton III. 2016. Benthos Response following petroleum exploration in the southern Caspian Sea: Relating effects of nonaqueous drilling fluid, water depth and dissolved oxygen. *Marine Pollution Bulletin*, 110(2016): 520-527.
- Terrens, G.W., D. Gwyther, M.J. Keough, and R.D. Tait. 1998. Environmental assessment of synthetic based drilling mud discharge to Bass Strait, Australia. SPE 46622.
- Tranum, H.C., H.C. Nilsson, M.T. Schaanning, and S. Øxnevad. 2010. Effects of sedimentation from water based drill cuttings and natural sediment on benthic macrofaunal community structure and ecosystem processes. *Journal of Experimental Biology and Ecology*, 383: 111-121.
- Tranum, H.C., H.C. Nilsson, M.T. Schaanning, and K. Norling. 2011. Biological and biogeochemical effects of organic matter and drilling discharges in two sediment communities. *Marine Ecology Progress Series*, 442: 23-36.
- Trimper, P.G., K. Know, T. Shury, L. Lye, and B. Barrow. 2003. Response of moulting black ducks to jet activity. *Terra Borealis*, 3: 58-60.
- Tsvetnenko, Y.B., A.J. Black, and L.H. Evans. 2000. Development of marine sediment reworker tests with Western Australian species for toxicity assessment of drilling mud. *Environmental Toxicology*, 15(5): 540-548.
- UNCBD (United Nations Convention on Biodiversity). 2019. COP 12 Decision XII/22 Marine and coastal biodiversity: ecologically or biologically significant marine areas (EBSAs). Available at: <https://www.cbd.int/decision/cop/default.shtml?id=13385>.
- Vad, J., G. Kazanidis, L.A. Henry, D.O. Jones, O.S. Tendal, S. Christiansen, T. Henry, and J.M. Roberts. 2018. Potential Impacts of Offshore Oil and Gas Activities on Deep-Sea Sponges and the Habitats They Form. *Advances in Modern Biology*, 58: 06Z.
- van der Hoop, J.M., Vanderlaan, A.S.M., and Taggart, C.T. 2012. Absolute probability estimates of lethal vessel strikes to North Atlantic right whales in Roseway Basin, Scotian Shelf. *Ecological Applications*, 22(7): 2021-2033.
- Vanderlaan, A.S.M., and Taggart, C.T. 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed. *Marine Mammal Science*, 23: 144-156.
- Vanderlaan, A.S.M., Taggart, C.T., Serdynska, A.R., Kenney, R.D., and Brown, M.W. 2008. Reducing the risk of lethal encounters: Vessels and right whales in the Bay of Fundy and on the Scotian Shelf. *Endangered Species Research*, 4: 282-297.
- Vanderlaan, A.S.M., Corbett, J.J., Green, S.L., Callahan, J.A., Wang, C. Kenney, R.D., Taggart, C.T., and Firestone, J. 2009. Probability and mitigation of vessel encounters with North Atlantic right whales. *Endangered Species Research*, 6: 273-285.
- Wells, Nadine. 2018. Updated data for the Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. Personal communication. February 2018.

- Wilhelm, S.I., J.J. Schau, E. Schau, S.M. Dooley, D.L. Wiseman and H.A. Hogan. 2013. Atlantic puffins are attracted to coastal communities. *Northeastern Naturalist*, 20(4): 624-630.
- Wright, A.J., T. Deak, and E.C.M. Parsons. 2011. Size matters: management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones. *Marine Pollution Bulletin*, 63(1-4): 5-9.
- Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. *Aquatic Mammal*, 24(1): 41-50.

2.5 Commercial Fisheries

2.5.1 Information Requirement: IR-56-02 (Round Two – May 2019)

Project Effects Link to CEEA 2012: 5(2)(b)(i) Health and Socio-Economic Conditions

Reference to EIS Guidelines: Part 2, Section 6.3.8.2, Commercial Fisheries

Reference to EIS: Section 13.3.7 Wellhead Decommissioning; Section 2.5.2.5 Well Abandonment or Suspension

Context and Rationale: In its response to IR-56, the proponent provides further information related to wellhead removal and potential effects of the presence of a wellhead on commercial fisheries. However, additional information is required with respect to decisions associated with leaving a wellhead in place rather than cutting it below the mud line.

While the proponent states that there has been no indication of damage to fishing gear in Atlantic Canada due to the presence of abandoned wellheads, information on actions to be taken if damage did occur to fishing gear from an abandoned or suspended wellhead is required.

Specific Question or Information Requirement: Provide information on the specific circumstances in which a wellhead would be cut above the seafloor/mudline rather than below the seafloor/mudline. Provide information related to the height at which a wellhead would protrude above the seafloor if it was not cut below the surface/mudline. If the height of wellheads could vary, discuss the factors that would determine the height at which they are cut.

In addition, confirm if compensation would be provided if fishing gear was damaged as a result of a suspended wellhead or an abandoned wellhead that was not cut at or below the seafloor/mudline.

Response:

CNOOC Petroleum North America ULC (CNOOC) understands the concerns regarding potential damage to fishing gear that may result from abandoned wellheads. In keeping with the United Nations Convention of the Law of the Sea Article 60 (and Article 80), "Appropriate publicity shall be given to the depth, position and dimensions of any ... structures not entirely removed." In particular, in the event that a wellhead is left in place and protrudes above the seafloor, CNOOC will provide the location and other relevant information to the Canadian Coast Guard MCTS and the Canadian Hydrographic Service (for the issuance of Navigational Warnings, Notices to Mariners and chart updates), as well as to regional Canadian fishing organizations and NAFO. CNOOC will develop and implement a compensation program to address any claims for damage to fishing gear.

There are a number of factors that must be considered when deciding on the removal of a wellhead and these factors will determine if, when, and how a wellhead is removed. These factors would include, but are not limited to:

- Water depth;
- Well design (casing type and thickness);
- Wellhead design (size and thickness);
- Weather conditions/ sea state; and
- Availability to participate in a wellhead removal campaign with other oil and gas companies.

In deeper water and/or under poor weather conditions, there are numerous challenges with attempting to remove a wellhead. These challenges may prompt a company to avoid attempting to remove the wellhead using the MODU and instead leave the wellhead in place until some future date when a separately contracted vessel with more specialized cutting and removal equipment is available.

Different cutting technologies (existing or future potential) have or would be expected to have different capabilities (e.g., cut below the seafloor/mudline versus above the seafloor, amount of time to complete the cut, support vessel required to undertake the work, etc.). Given the unique challenges regarding each wellhead and uncertainty over how specific wellheads may be removed in the future, it is difficult to discuss the potential amount of abandoned wellhead that might be left in place. In situations where CNOOC undertakes to remove a wellhead and the wellhead is to be cut above the seafloor, then the planned maximum height of wellhead remaining above the seafloor would be 0.85 metres.

2.6 Accidents and Malfunctions – Vessels, SBMs, Riser & Equipment

2.6.1 Information Requirement: IR-59-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 6.6.1, Effects of Potential Accidents or Malfunctions

Reference to EIS: Section 16.2.2 Dropped Objects

Context and Rationale: In its response to IR-59, the proponent states that if larger inert objects, such as drill pipe, core sampling equipment, etc., are lost overboard, efforts would be made to recover these objects. If the object is not recoverable due to technical or safety reasons, the object would be left on the seabed. However, information is not provided in relation to the factors that would be considered in the decision to leave the object on the seabed or if other ocean users would be notified of the object.

Specific Question or Information Requirement: Provide an overview of the process for determining if an object would be left in place on the seabed and the factors that would be considered in making the decision. Confirm if other ocean users and/or regulatory agencies would be notified of the decision to leave an object on the seabed and its location. If so, discuss how other oceans would be notified.

Response:

CNOOC Petroleum North America ULC (CNOOC) does not propose to leave objects on the seafloor/seabed as part of the planned Project except potentially wellhead stumps as outlined in response to IR-56-02. CNOOC will undertake a seabed clearance survey following the completion of each well to document the condition of the seafloor after wellhead removal. If, as a result of an accidental event, a larger inert object is dropped overboard, CNOOC will undertake discussions with the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) to evaluate hazards, risks, and options related to removing the object or leaving some or all of it in place. If it is determined in these discussions that leaving some or all of the lost object in place is the best option with the least hazards and risks, then in keeping with the United Nations Convention of the Law of the Sea Article 60 (and Article 80), "Appropriate publicity shall be given to the depth, position and dimensions of any ... structures not entirely removed." In particular, if the decision is to leave the dropped object in place on the seafloor/seabed, CNOOC will provide the location and other relevant information to the Canadian Coast Guard MCTS and the Canadian Hydrographic Service (for the issuance of Navigational Warnings, Notices to Mariners and chart updates), as well as to regional Canadian fishing organizations and NAFO. CNOOC will implement a compensation program to address any claims for damage to fishing gear resulting from dropped objects left in place that have not been so communicated, or if CNOOC has provided inaccurate information about their locations.

2.7 Accidents and Malfunctions – Model Inputs

2.7.1 Information Requirement: IR-61-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 3.1, Project Components; and Section 3.2.1, Drilling and Testing Activities

Reference to EIS: Section 16.4.3 Model Data Input

Context and Rationale: In response to IR-61, the proponent provided additional information on the composition of marine diesel and crude oil used in modelling and the fate of crude oil and diesel in the environment. NRCan notes that there seems to be an assumption that biodegradability depends only on time and not on the contents of different types of hydrocarbons. NRCan notes that diesel hydrocarbons are mostly biodegradable; however, a significant proportion of crude oil hydrocarbons are not biodegradable, particularly components of the hydrocarbons that boil above 380°C (e.g. aromatics, resins, and asphaltenes). This is the reason why crude oil is persistent.

Specific Question or Information Requirement: Provide an explanation of the scientific basis for the apparent assumption that organic components of hydrocarbons that boil above 380°C (e.g. aromatics, resins, and asphaltenes) can be completely biodegraded.

Response:

Degradation including both biotic (i.e. biodegradation) and abiotic (i.e. photo-oxidation) processes are considered within SIMAP. At depth, because light is attenuated rapidly within the water column, biodegradation is the primary driver of degradation. The hydrocarbon “pseudo-component” approach is used to describe the biodegradation rates of petroleum hydrocarbons in marine aquatic environments.

The hydrocarbon biodegradation rates are dependent on the accessibility to microbes. The hydrocarbon compounds could either be available as dissolved compounds in the aqueous phase or accessible at the surfaces of particles. Likewise, the hydrocarbon degraders are either bundled with particulates as agglomerates or present as free swimmers in the aquatic environments (Chang et al. 2009; Southam et al. 2001). Biodegradation rates of oil and hydrocarbon compounds are also dependent on oil chemical composition and various environmental conditions. When chemical dispersants are applied to surface oil slicks or at the subsurface oil release, the oil can be dispersed into smaller oil droplets due to the mixing energy of breaking waves, or by turbulence at a subsurface release location. Therefore, chemical dispersant is anticipated to enhance the biodegradation rate of oil.

Factors determining petroleum biodegradation rates in seawater fall into three broad categories: (A) oil constituents (e.g., concentration, composition, properties, and weathering), (B) microorganisms (e.g., community structure, function, activities, and accessibility), and (C) environmental conditions (e.g., temperature, pressure, dissolved oxygen, and nutrients) (NRC 2003).

Most petroleum hydrocarbons are biodegradable but different hydrocarbon components degrade at varying rates (Stout and Wang 2007). Hydrocarbon compounds may either be available to microbes as dissolved compounds in the aqueous phase or accessible at the surfaces of particles (NRC, 2003). From the primary biodegradation perspective, the normal n-alkanes in the range of C10–C22 are the most readily and frequently utilized hydrocarbon substrates (Belhaj et al. 2002; NRC 2003); low molecular weight aromatics such as benzene, toluene, ethylene, and xylenes (BTEX) are also readily biodegradable by marine organisms (Cho et al. 2007; Krumholz et al. 1996; Van Hamme et al. 2003). The C5- C10 homologues (i.e., pentane, hexane, heptane, octane, nonane, and

decane) have been shown to be inhibitory to the majority of hydrocarbon degraders (Bartha and Atlas 1977); as solvents, these homologues tend to disrupt lipid membrane structures of microorganisms; similarly, the mono-cycloaliphatic compounds (cyclopentane, cyclohexane, and cycloheptane) have a strong solvent effect on lipid membranes and are toxic to hydrocarbon degrading microorganisms (Leahy and Colwell 1990). However, as physical weathering at the surface affects constituents with a boiling point $\leq 250^{\circ}\text{C}$ (e.g., n- C14 alkanes), the effect of pressure in the deep ocean environment can result in greater solubility, reduced oil droplet sizes and reduced degassing of these compounds (Harayama et al. 1999; Newfields 2012). Biodegradation of longer alkanes occurs at rates that exceed their respective dissolution rates and are a function of hydrocarbon surface area available for emulsification or physical attachment by microbes (Leahy and Colwell 1990). Long chain alkanes in the C20-C40 range are highly hydrophobic (including C18 and longer paraffin waxes that are solid at ambient temperature) and adversely influence their biodegradation (Wentzel et al. 2007). The isoalkanes, cycloalkanes, and high molecular weight aromatics are degraded more slowly. High molecular weight cycloparaffinic and asphaltenic petroleum compounds are biodegraded at extremely slow rates.

Biodegradation rates used in the 19-component model of SIMAP came from numerous sources including, but not limited to: BioHCwin, Brakstad et al. 2004, Brakstad and Faksness 2000, Brakstad and Bonaunet 2006, Brakstad et al. 2015, Campo et al. 2013, Hazen et al. 2010, Howard et al. 2005, Mackay et al. 2006, Prince et al. 2007, Prince et al. 2008, Prince et al. 2013, Reed et al. 2001, Venosa and Holder 2007, Zahed et al. 2011.

For a full references and a full description of degradation, please refer to:

French McCay, D. K. Jayko, Z. Li, M. Horn, T. Isaji, M. Spaulding. 2018b. Volume II: Appendix II - Oil Transport and Fates Model Technical Manual. p.60-277 in: Galagan, C.W., D. French-McCay, J. Rowe, and L. McStay, editors. Simulation Modeling of Ocean Circulation and Oil Spills in the Gulf of Mexico. Prepared by RPS ASA for the US Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2018-040; 422 p.

See Annex C to Appendix II: Review of Biodegradation Rates of Crude Oil and Hydrocarbons in Seawater (pages 167-277). For the residual compounds specifically mentioned in the question, biodegradation rates of residual compounds (other non-volatile and non-soluble hydrocarbons) in seawater, refer to the extracted tables below.

Table II-C-43. Biodegradation rates of residual compounds (Other non-volatile, non-soluble hydrocarbons) in seawater.

References	Compounds	Summary half-life (d)	Summary Rate (d ⁻¹)
Brakstad et al. 2015 (10 µm droplets)	C26–C36 saturates based on boiling point. nC26. nC27. nC28. nC29. nC30. nC31. nC32. nC33. nC34. nC35. nC36 (10 µm droplets)	72.2	0.010
Brakstad et al. 2015 (30 µm droplets)	C26–C36 saturates based on boiling point. nC26. nC27. nC28. nC29. nC30. nC31. nC32. nC33. nC34. nC35. nC36 (30 µm droplets)	128.3	0.005
Brakstad and Faksness 2000	C26–C36 total saturates + aromatics	18.4	0.038
Venosa and Holder 2007	C26–C32 5°C	13.9	0.05
	C33–C35 5°C	34.7	0.02
	C26–C32 25°C	4.6	0.15
	C33–C35 25°C	6.9	0.10
Zahed et al. 2011 (Whole oil)	100 mg/l natural attenuation	90.0	0.008
	500 mg/l natural attenuation	102.0	0.007
	1000 mg/l natural attenuation	116.0	0.006
	2000 mg/l natural attenuation	124.0	0.006
	100 mg/l crude oil bioremediation	31.0	0.022
	500 mg/l crude oil bioremediation	40.0	0.017
	1000 mg/l crude oil bioremediation	50.0	0.014
	2000 mg/l crude oil bioremediation	75.0	0.009
	100 mg/l dispersed crude oil bioremediation	28.0	0.025
	500 mg/l dispersed crude oil bioremediation	32.0	0.022
	1000 mg/l dispersed crude oil bioremediation	38.0	0.018
	2000 mg/l dispersed crude oil bioremediation	58.0	0.012
Campo et al. 2013	(5°C droplets without dispersant) C25	1.9	0.371
	(5°C droplets without dispersant) C26	1.9	0.364
	(5°C droplets without dispersant) C27	1.9	0.362
	(5°C droplets without dispersant) C28	1.9	0.359
	(5°C droplets without dispersant) C29	1.9	0.363
	(5°C droplets without dispersant) C30	1.9	0.356
	(5°C droplets without dispersant) C31	1.9	0.357
	(5°C droplets without dispersant) C32	2.0	0.346
	(5°C droplets without dispersant) C33	2.1	0.335
	(5°C droplets without dispersant) C34	1.9	0.357
	(5°C droplets without dispersant) C35	1.9	0.358
	(5°C droplets with dispersant) C25	20.7	0.033

References	Compounds	Summary half-life (d)	Summary Rate (d ⁻¹)
	(5°C droplets with dispersant) C26	25.4	0.027
	(5°C droplets with dispersant) C27	34.0	0.020
	(5°C droplets with dispersant) C28	36.7	0.019
	(5°C droplets with dispersant) C29	45.3	0.015
	(5°C droplets with dispersant) C30	45.3	0.015
	(5°C droplets with dispersant) C31	105.8	0.007
	(5°C droplets with dispersant) C32	151.6	0.005
	(5°C droplets with dispersant) C33	n/a	0.000
	(5°C droplets with dispersant) C34	n/a	0.000
	(5°C droplets with dispersant) C35	n/a	0.000
	(25°C droplets with dispersant) C25	3.8	0.185
	(25°C droplets with dispersant) C26	6.8	0.103
	(25°C droplets with dispersant) C27	10.2	0.068
	(25°C droplets with dispersant) C28	11.6	0.060
	(25°C droplets with dispersant) C29	13.2	0.052
	(25°C droplets with dispersant) C30	16.4	0.042
	(25°C droplets with dispersant) C31	21.2	0.033
	(25°C droplets with dispersant) C32	25.4	0.027
	(25°C droplets with dispersant) C33	33.6	0.021
	(25°C droplets with dispersant) C34	42.8	0.016
	(25°C droplets with dispersant) C35	39.7	0.017

The summary of biodegradation rates are provided below for residuals:

AL Component	Basis	First-order rate (d ⁻¹)		References
		mean	stdev	
Residual	Boiling Cut	0.01	0.00	Brakstad et al. 2015
	Boiling Cut	0.04	N/A	Brakstad and Faksness 2000
	Individual alkanes	0.08	0.06	Venosa and Holder 2007
	Individual alkanes	0.01	0.01	Zahed et al. 2011
	Individual alkanes	0.15	0.16	Campo et al. 2013

Table II-C-45. First-order biodegradation rates (instantaneous, daily) and half-lives for components of oil in the water column used as model input for the 19-component model.

Component Group	First-order rate (day ⁻¹)	Half-Life (days)
AR1	0.23	3.0
AR2	0.29	2.4
AR3	0.28	2.5
AR4	0.06	11.6
AR5	0.28	2.5
AR6	0.18	3.9
AR7	0.15	4.6
AR8	0.10	6.9
AR9	0.17	4.1
AL1	0.24	2.9
AL2	0.12	5.8
AL3	0.06	11.6
AL4	0.06	11.6
AL5	0.06	11.6

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Component Group	First-order rate (day ⁻¹)	Half-Life (days)
AL6	0.05	13.9
AL7	0.04	17.3
AL8	0.04	17.3
Residual	0.02	34.7

Table C-46. First-order biodegradation rates (instantaneous, daily) and half-lives for components of oil in the water column used as model input for the 7-component model.

Component Group for 7-Component Model	Included Components of the 19-Component Model	First-order Rate (day ⁻¹)	Half-Life (days)
AR1	AR1-AR3	0.267	2.6
AR2	AR5-AR6	0.230	3.0
AR3	AR7-AR8	0.125	5.5
AL1	AR9, AL1-AL2	0.177	3.9
AL2	AL3-AL5	0.060	11.6
AL3	AL6-AL8	0.0433	16.0
Residual	Residual	0.02	34.7

2.7.2 Information Requirement: IR-63-02A (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 6.6.1 Effects of Potential Accidents or Malfunctions

Reference to EIS: Revised Section 16

Context and Rationale: The Agency required completion of fate and behavior modelling to reflect the worst-case discharge scenario, and updated effects assessment as applicable. In response, the proponent completed oil spill modelling based on a longer release duration of 120 days, with a model duration to 160 days. Following completion of the revised spill modelling, the proponent updated the Accidental Events section (Section 16) of the EIS to include additional modelling information.

Section 16.6.1.4 was updated to include Table 16.19 illustrating valued components and corresponding relevant modelling results for subsurface/subsea releases (120-day release). This table indicates for special areas that there is a low chance of interaction with the sea surface following a 120-day release. However, Table 16.18 indicates for special areas that there is a high chance of interaction of the valued component with the sea surface following a 30-day release.

It is unclear why there is a higher chance of interaction in the 30-day release than for the 120-day release.

Specific Question or Information Requirement: Provide clarification on the chance of interaction between a spill and the sea surface component of special areas (Table 16.18 and Table 16.19 in revised Section 16). If the chance of interaction is higher for a 30-day release compared to a 120-day release, provide further details to explain this conclusion.

Response:

Tables 16.18 and 16.19 (Appendix C of the Revised EIS Addendum (February 2019)) provide VCs and corresponding relevant oil spill modelling results for subsurface/subsea releases. Table 16.18 is associated with 30-day releases modeled for 60 days while Table 16.19 is for 120-day releases modeled for 160 days. Each of the representative deterministic scenarios was identified based upon the unmitigated 95th percentile worst-case for surface oil (area), water column contamination (mass), and shoreline (length) affected out of the simulations modeled within each stochastic scenario. Each run is a unique result of the currents, winds, temperature, ice cover, etc. that is present at the time of the release and at each subsequent 15-minute timestep over the entire modelled simulation. It is quite possible that a smaller total volume release simulation may predict impacts to a set of VC's, while a larger total volume release (under different environmental conditions) may move in an entirely different direction and predict impacts to a different set of VC's or none at all. Therefore, it is likely that the results for one or more of the identified VC's with potential effects will differ between the modelling runs.

Stochastic simulations are useful to identify areas that could potentially be affected above specified thresholds, along with the likelihood (i.e. probability) and minimum time (i.e. shortest time to threshold exceedance). Deterministic simulations are useful in understanding the time varying nature of thicknesses, concentrations, and masses of oil that may be possible throughout a modelled simulation based upon the release conditions.

In the revised Chapter 16 (Appendix C of the Revised EIS Addendum (February 2019)), there is an error in Table 16.19; the component terms for Special Areas row should be 'High' (H) for the Sea Surface, Water Column, and Shoreline based on the potential presence of Special Areas with defining features such as Marine Fish and Fish Habitat, Marine and Migratory Birds and Marine Mammals and Sea Turtles; the correct Tables are reproduced

below. Tables 16.18 and 16.19 (Appendix C of the Revised EIS Addendum (February 2019)) provide VCs and corresponding relevant oil spill modelling results for subsurface/subsea releases. The tables (Appendix C of the Revised EIS Addendum (February 2019)) only highlight the relevant importance of each component (sea surface, water column, or shoreline) in relation to the VC. These tables (Appendix C of the Revised EIS Addendum (February 2019)) show the method of selecting relevant modelling results to make a reasonable assessment of the effects of the spill on the particular VC. Special Areas have been identified and/or protected for the potential presence of various types of marine species and are therefore deemed 'High' in interaction for all three components for both the 30-day and 120-day oil spill scenario.

Table IR-63-02A.1 VCs and Corresponding Relevant Modelling Results for Subsurface Release (30-day) (Updated Table 16.18 of Revised EIS Addendum (February 2019))

VC	Component ¹			Relevant Deterministic Model Results	Corresponding Simulations
	Sea Surface	Water Column	Shoreline		
Marine Fish and Fish Habitat	L	H	L	95 th Percentile Water Concentration ²	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
Marine and Migratory Birds	H	M	H	95 th Percentile Oil Thickness	June 13, 2006 (EL 1144)/April 20, 2007 (EL 1150)
				99 th Percentile Shoreline Exposure ²	October 2, 2008 (EL 1144) ³
				95 th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
Marine Mammals and Turtles	H	H	M	95 th Percentile Oil Thickness	June 13, 2006 (EL 1144)/April 20, 2007 (EL 1150)
				95 th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
Special Areas	H	H	H	95 th Percentile Water Concentration ²	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
				99 th Percentile Shoreline Exposure	October 2, 2008 (EL 1144) ³
Indigenous Peoples	H	H	H	95 th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
				99 th Percentile Shoreline Exposure	October 2, 2008 (EL 1144) ³
				95 th Percentile Oil Thickness ²	June 13, 2006 (EL 1144)/April 20, 2007 (EL 1150)
Fisheries and Other Ocean Uses	H	H	L	95 th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)
				95 th Percentile Water Concentration ²	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)

¹High(H), Medium(M), and Low (L) chance of interaction of the VC with the component

²To give further spatial context relating the oil spill scenarios and the corresponding VCs, these deterministic modelling results were overlaid on the relevant VC information in the following sections

³Only EL 1144 example well site had a model prediction that reached the shoreline

Table IR-63-02A.2 VCs and Corresponding Relevant Modelling Results for Subsurface Release (120-day) (Updated Table 16.19 of Revised EIS Addendum (February 2019))

Appendix Table 1: Results of the Deterministic Modelling (February 2013)						
	Component ¹					
VC	Sea Surface	Water Column	Shoreline	Relevant Deterministic Model Results	Corresponding Simulations	
Marine Fish and Fish Habitat	L	H	L	95 th Percentile Water Concentration ²	June 19,2012 (EL 1144)/May 28, 2009 (EL 1150)	
Marine and Migratory Birds	H	M	H	95 th Percentile Oil Thickness	Oct. 22, 2009 (EL 1144)/Feb. 5, 2008 (EL 1150)	
				95 th Percentile Shoreline Exposure ²	Mar. 7, 2006, 2008 (EL 1144)/Jul. 22, 2006 (EL 1150)	
				95 th Percentile Water Concentration	June 19,2012 (EL 1144)/May 28, 2009 (EL 1150)	
Marine Mammals and Turtles	H	H	M	95 th Percentile Oil Thickness	Oct. 22, 2009 (EL 1144)/Feb. 5, 2008 (EL 1150)	
				95 th Percentile Water Concentration	March 22, 2008 (EL 1144)/Dec. 3, 2006 (EL 1150)	
Special Areas	H	H	H	95 th Percentile Water Concentration ²	June 19,2012 (EL 1144)/May 28, 2009 (EL 1150)	
				95 th Percentile Shoreline Exposure	Mar. 7, 2006, 2008 (EL 1144)/Jul. 22, 2006 (EL 1150)	
Indigenous Peoples	H	H	H	95 th Percentile Water Concentration	June 19,2012 (EL 1144)/May 28, 2009 (EL 1150)	
				95 th Percentile Shoreline Exposure	October 2, 2008 (EL 1144) ³	
				95 th Percentile Oil Thickness ²	Oct. 22, 2009 (EL 1144)/Feb. 5, 2008 (EL 1150)	
Fisheries and Other Ocean Uses	H	H	L	95 th Percentile Water Concentration ²	June 19,2012 (EL 1144)/May 28, 2009 (EL 1150)	
				95 th Percentile Oil Thickness	Oct. 22, 2009 (EL 1144)/Feb. 5, 2008 (EL 1150)	
¹ High(H), Medium(M), and Low (L) chance of interaction of the Valued Component with the component						
² To give further spatial context relating the oil spill scenarios and the corresponding VCs, these deterministic modelling results were overlaid on the relevant VC information in the following sections						

The results of oil spill modelling indicate that there is potential for interaction (above threshold of 0.01 mm) with valued components sensitive to sea surface changes (e.g., marine birds, mammals and sea turtles) within Special Areas in the 120-day release scenarios. The results of modelling for a 30-day release indicate that there is low probability of interaction as the Special Areas with valued components sensitive to sea surface changes. The Special Areas intersecting with areas of potential interaction are identified for benthic habitat and not likely to be affected by oil on the sea surface.

2.7.3 Information Requirement: IR-63-02B (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 6.6.1 Effects of Potential Accidents or Malfunctions

Reference to EIS: Revised Appendix – Trajectory Modelling in Support of the Nexen Energy ULC Flemish Pass Exploration Drilling Project

Context and Rationale: Characterization of the type of shoreline habitat in the revised trajectory modelling appendix (Figure 3-1) differs from the characterization of the type of shoreline habitat in the original spill modelling appendix (Figure 3-1). The proponent has not provided any explanation as to why this characterization has changed in the revised appendix. DFO has advised that the retention of oil along the shoreline depends in part on habitat type, and it is important to have a clear understanding of shoreline habitat characterization.

Specific Question or Information Requirement: Confirm that the characterization of the type of shoreline habitat in Figure 3-1 of the revised appendix is accurate or provide an updated characterization of shoreline habitat.

Response:

The shoreline habitat used in both modeling studies was identical. Figure 3-1 in the trajectory modeling results presented in the Environmental Impact Statement (EIS) (Appendix G) is correct and used the latest references from Canada (Therrien, 2017), the US (NOAA 2016), and Maine (MDEP 2016). Figure 3-1 in the additional trajectory modelling results from Jan 7, 2019 (Appendix B of the Revised EIS Addendum – February 2019) was prepared using the incorrect data. However, that incorrect data was not used in the oil spill modelling. Both sets of modelling results used the correct data noted above.

2.7.4 Information Requirement: IR-63-02C (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 6.6.1 Effects of Potential Accidents or Malfunctions

Reference to EIS: Revised Section 16

Context and Rationale: The third paragraph of page C-34 of the revised Section 16 states that the “EL 1144 example well site is located closer to shore than the EL 1150 example well site” (this statement is repeated on page C-35). The fourth paragraph of page C-35 of the revised Section 16 contradicts this statement, and states that “the hypothetical releases at the EL 1144 example well site were deeper [and] farther offshore...than those at the EL 1150 example well site”.

When discussing qualitative distance from shore, it is unclear whether the shore being referenced is the Canadian coast or the Azores.

Specific Question or Information Requirement: Clarify the contradictory statements on pages C-34 and C-35 in the revised Section 16 regarding the relative distances offshore of EL 1144 and EL 1150. Provide clarification on which shoreline is being referenced.

Response:

The EL 1144 example well site is located closer to Canadian shores than the EL 1150 example well site. Conversely, the EL 1150 example well site is technically closer to the Azores coastline but these relative proximities are less likely to have an effect on shoreline/oil spill interactions in Europe. The model results reflect this with the 120-day release at sites EL 1144 and EL 1150 being very similar for the Azores shoreline interactions (see Table 16.12 in Appendix C of the Revised EIS Addendum – February 2019).

To avoid confusion, the sentences of C-34 and C-35 (Appendix C of the Revised EIS Addendum – February 2019) can be revised to the following (changes are underlined):

(Pg. C-34, last sentence of 3rd paragraph) - *EL 1144 example well site is located closer to Canadian shores than the EL 1150 example well site and was therefore predicted to result in a very small probability (less than three percent) of shoreline oil contamination at Sable Island within 60 days (Table 16.10; Figure 16.13). Releases at the EL 1150 example well site were not predicted to make contact with Canadian shores (Figures 16.16 to 16.17).*

(Pg. C-34, 2nd sentence of 4th paragraph) - *However, the hypothetical releases at the EL 1144 example well site were deeper, farther offshore (i.e. further from Canadian shores), and had a release volume that was over four times larger than those at the EL 1150 example well site, resulting in much larger predicted areas for the 10 percent and 90 percent likelihood of threshold exceedance (Table 16.10).*

(Pg. C-35, 7th Sentence of 1st paragraph) - *Shoreline oiling probabilities were predicted to be higher along the Canadian coast and the Azores with a release at the EL 1144 example well site, which was located closer to Canadian shores than the EL 1150 example well site (Figure 16.18 through Figure 16.20 and Figure 16.21 through Figure 16.23).*

2.7.5 Information Requirement: IR-63/64-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: 5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species

Reference to EIS Guidelines: Part 2, Section 6.6.1 Effects of Potential Accidents or Malfunctions

Reference to EIS: Revised Section 16 and Revised Appendix – Trajectory Modelling in Support of the Nexen Energy ULC Flemish Pass Exploration Drilling Project

Context and Rationale: The Agency required completion of fate and behavior modelling to reflect the worst-case discharge scenario and provision of the rationale for the selection of boundaries for stochastic modeling. In addition, the proponent was required to provide a discussion of the limitations of the truncated spatial extent of the spill dispersion results. In response, the proponent repeated its oil spill modelling based on a longer release duration of 120-days, and a model duration to 160 days, and expanded the model domain to include Canadian, United States, other national territorial seas and International waters.

As a result of increased release duration, increased volume of oil released, and the larger model domain, the model results predicted a higher potential for oil to reach shorelines. The updated model results predicted shoreline exposure for the Azores, Newfoundland, Labrador, and Nova Scotia.

Section 16.4.4.2 of the revised Section 16 indicates that the 120-day model predicted shoreline contact to occur in the Azores from hypothetical releases at both the EL 1144 and EL 1150 example well sites. However, it is not evident if or how other countries may be involved in spill response planning or if they will receive notification in the unlikely event of a spill.

Specific Question or Information Requirement: Discuss if and how members of the international community and other countries will be engaged in spill response planning.

In the unlikely event of an accidental release of oil, discuss the process for notifying other provinces within Canada or other countries (i.e. Portugal) for which the model predicts shoreline contact.

Response:

The Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) is the single window, life cycle regulator for the oil and gas industry in offshore Newfoundland and Labrador. The Oil Spill Response Plan is developed as part of the Operations Authorization (OA) which is reviewed and approved by the C-NLOPB. As such, the C-NLOPB manages the relationship with other government agencies or jurisdictions as part of its energy project review, approval, and oversight and will determine when to reach out to those other government agencies or jurisdictions for specific expertise or to advise on matters related to an energy project.

The C-NLOPB has the lead agency responsibility for pollution response with respect to incidents related to offshore Newfoundland and Labrador petroleum exploration or production installations. In the event of such an incident, the C-NLOPB manages the interaction with other government agencies, such as the Canadian Coast Guard, Transport Canada, Environmental and Climate Change Canada, or other jurisdictions, such as the United States (in accordance with the Canada-United States Joint Marine Pollution Contingency Plan).

In the unlikely event of a spill, CNOOC Petroleum North America ULC (CNOOC) would be required to immediately notify the C-NLOPB and the Canadian Coast Guard and CNOOC would keep the C-NLOPB (plus any other parties as directed by the C-NLOPB) apprised of the ongoing response activities. The C-NLOPB would determine what other agencies or jurisdictions should be notified of the event. As the lead agency, the C-NLOPB would have an oversight role on all response activities.

2.8 Accidents and Malfunctions – Model Inputs

2.8.1 Information Requirement: IR-68-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 6.6.1, Effects of Potential Accidents or Malfunctions

Reference to EIS: Section 16.1.4.3 Potential OSRP Tactics

Context and Rationale: In IR-68 the Agency required a discussion of the differences in potential effects between subsea, surface and aerial dispersant application. In its response, the proponent discusses differences between dispersion application methods, including the benefits and goals of various application methods. However, the proponent does not discuss the differences in potential effects between subsea, surface, and aerial dispersant application.

Specific Question or Information Requirement: Discuss differences in potential environmental effects between subsea, surface and aerial dispersant application.

Response:

The differences between surface and aerial dispersant application is more a logistic consideration rather than a difference in potential environmental effects. Both methods treat the oil spill present at the sea surface by reducing the droplet size, thereby increasing the amount of surface area of each smaller-sized oil droplet for weathering and biodegradation, thereby enhancing the removal of oil from the system and reducing the likelihood of shoreline contamination (Joye 2015). Surface application (from a vessel) typically has a longer range (i.e., longer time to get dispersant to site) than aerial application (from a fixed wing or helicopter) but has a larger payload. As dispersant efficacy has a limited time window, a fixed wing aerial dispersant may be the fastest way to apply dispersants to a remote area (assuming mobilization times are short) but payloads would be limited compared to a vessel. The direct ecological implications are more affected by efficacy of the dispersant (within the limited time window) and volume dispersed in relation to the spill thickness rather than the method of application (i.e., surface vs. aerial).

Subsea dispersant application is slightly different than the surface and aerial dispersant applications discussed above in that the dispersant is injected directly into the subsea oil plume prior to sea surface exposure and allows for a lower dispersant to oil ratio. For the Deepwater Horizon (DWH) spill the subsea dispersant was applied directly at the wellhead (Joye 2015). This application method reduces the amount of oil that reaches the sea surface. This would, therefore, reduce the interaction of oil with VCs that occupy the sea surface such as birds. However, subsea application could also reduce the effect of oil elimination via atmospheric evaporation (Reddy et al. 2012). One of the potential concerns with subsea dispersant application, that arose during the DWH spill, is there is potential for an increased amount of oil to become attached to sediments and deposit on the seafloor and or become trapped within the deeper-water plume which could increase oil exposure to the benthos and deep-sea corals (Joye 2015).

References:

Joye, S.B., 2015. Deepwater Horizon, 5 years on. *Science*, 349(6248), pp.592-593.

Reddy, C.M., Arey, J.S., Seewald, J.S., Sylva, S.P., Lemkau, K.L., Nelson, R.K., Carmichael, C.A., McIntyre, C.P., Fenwick, J., Ventura, G.T. and Van Mooy, B.A., 2012. Composition and fate of gas and oil released to the water column during the Deepwater Horizon oil spill. *Proceedings of the National Academy of Sciences*, 109(50), pp.20229-20234.

2.9 Accidents and Malfunctions – Capping Stack

2.9.1 Information Requirement: IR-69/71-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 6.6.1, Effects of Potential Accidents and Malfunctions

Reference to EIS: Section 16.1.4.2 Emergency Response Contingency Plans, Well Containment Procedure (Capping Stack)

Context and Rationale: In IR-69 the Agency required information on the feasibility of options for decreasing capping stack response times, including through potentially establishing a capping stack facility in eastern Canada, shipping a capping stack by air, or having a capping stack available on a vessel for rapid deployment. In its response, the proponent states that, “while the capping stack is being mobilized, there are other integral operations (e.g., site assessment, debris removal, tactical oil spill response measures, replacement MODU mobilized to the region) taking place. Therefore, having a capping stack in closer proximity to the wellsite does not necessarily translate into faster capping times.” The proponent also states that “air-freighting is a faster mode of transportation compared to that of sea-freighting, but the faster shipment may not translate into faster capping times for a variety of reasons including availability of the required multi-purpose installation vessel in the region, on-going debris removal operations, need to break down to ship by air and reassemble the capping stack in the region, etc.”

In IR-71 the Agency required additional information on the steps and timeframes involved in the deployment of subsea incident response equipment. In its response, the proponent provides some information on the sequence and timing of spill response operations.

The proponent’s response does provide additional information on the schedule for mobilization of a capping stack and the eventual capping of a well, as well as the feasibility for decreasing capping stack response times; however, it is not clear how the proponent reached the conclusion that “a time estimate to perform the previously described operations would be 30 days, which should account for delays”, nor has it been clearly demonstrated how having a capping stack in eastern Canada would not help reduce this response time. Furthermore, it is not clear which operations or other factors may delay the capping of the well and how or if mobilization of the capping stack may be one of these limiting factors.

The proponent also does not discuss the feasibility or potential for decreasing response times in having a capping stack available on a vessel for rapid deployment.

Specific Question or Information Requirement: Discuss the economic and technical feasibility of CNOOC maintaining a capping stack in eastern Canada.

Discuss the economic and technical feasibility, as well as the potential decrease in capping stack response times, of having a capping stack available on a vessel ready for rapid deployment while drilling and testing any wells. Provide additional detail on the sequence and estimated timing of spill response operations, including information on which specific prerequisite measures and actions are required prior to installation of the capping stack. This information should provide clarity regarding: how the mobilization of the capping stack fits into other required and parallel steps to cap a well; what are the limiting factors affecting the timeline to cap a well; the breakdown of steps, and timing of those steps, that occur in the estimated 30 day timeline to cap a well; and whether capping stack mobilization and overall capping time could be reduced through establishing a capping stack facility in eastern Canada or shipping a capping stack by air.

Response:

A “capping stack” is far more than just the physical piece of equipment, just as a fire response service is much more than just a fire engine. Globally, subsea containment solutions (including capping stacks) are built around a highly specialized network of strategically located teams and facilities. The “subsea containment solution” companies operate world-class response facilities that provide highly trained staff, specialized equipment, a redundant array of specialized parts, and the facilities necessary to modify, inspect, test, and maintain their subsea containment solutions in a ready to deploy condition. Detailed transport and logistics plans are already in place to ensure key aspects of the transport process are clearly understood and ready to execute. By locating their facilities in strategic global locations, they ensure the necessary services (e.g. technicians, parts, plans, trucks, cranes, vessels, aircraft) are readily available to quickly design/modify a subsea containment solution to address a specific incident and transport the solution (including custom capping stack, supporting equipment and trained response staff) when and where required. Regular workshops and drills are held to maintain preparedness to respond at short notice if a well source control incident were to occur.

The capping stacks are custom designed to withstand site specific conditions (e.g., water depths, well pressures, temperatures) and have specific capabilities (e.g., install a mechanical barrier vs install a hydrostatic barrier) which will vary and one capping stack unit is not suitable for all wells in a region. To establish a “capping stack” in eastern Canada that would be expected to address all potential subsea incidents in eastern Canada, this would require one or more of these specialized companies to establish a new facility with the highly trained staff, specialized equipment, redundant array of specialized parts, and the capability to modify, inspect, test, and maintain their subsea containment solutions in a ready to deploy condition.

CNOOC Petroleum North America ULC (CNOOC) outlined its multi-pronged well control emergency response approach in its response to IR-69 and with additional detail provided in its responses to IR-70 and IR-71 (Revised EIS Addendum - February 2019). A number of simultaneous key activities must be conducted in preparation for the capping stack installation and to gain control of the well. Many of these key activities would be started immediately after call out and most would be well underway or completed while the capping stack is in transit to the incident location (Figure IR-69/71-02.1).

The time to perform the described activities, including deployment of the subsea containment solution, has been previously estimated as 15 to 30 days. That estimate is based on a number of assumptions which should account for potential delays due to vessel/aircraft availability, mechanical issues, and or due to weather. While having a capping stack in Eastern Canada or on a ready to deploy vessel could result in quicker mobilization of the capping stack unit to the incident site, the ability to modify the capping stack for the specific incident would be limited to the equipment, parts, and staff on hand (or what can be readily flown in by aircraft) and once at the incident site the capping stack would be waiting on other activities (e.g., debris removal) which would likely still be in progress to ensure safe installation of the capping stack solution. In summary, it is unlikely that having a capping stack in Eastern Canada, either on land or on a ready to deploy crane vessel, would reduce the overall time to install the subsea containment solution.

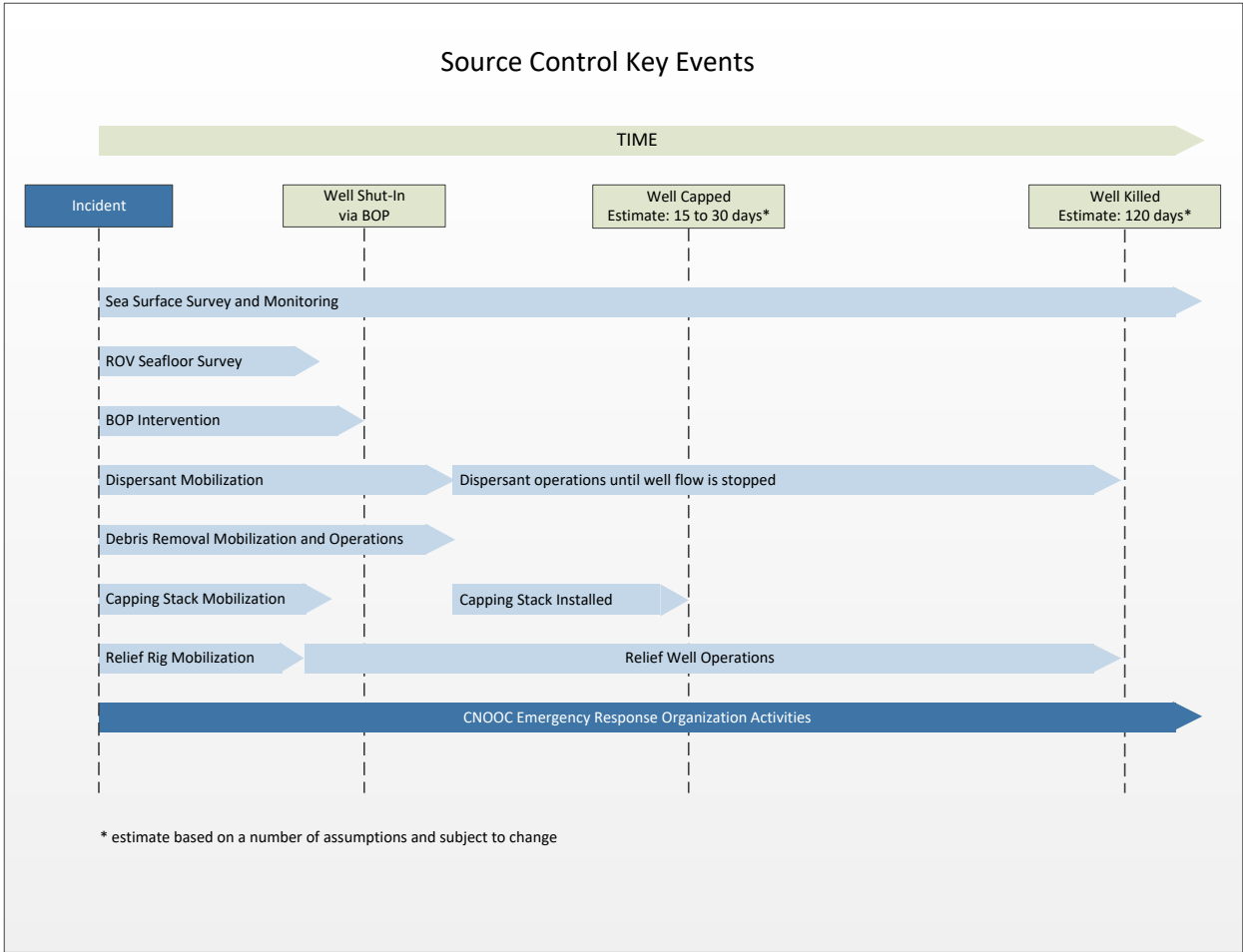


Figure IR-69/71-02.1: Source Control Key Events

2.9.2 Information Requirement: IR-72-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: All – Project Description

Reference to EIS Guidelines: Part 2, Section 3, Project Description Relevant to All Section 5 Effects

Reference to EIS: Section 16.1.4.2 Emergency Response Contingency Plans, Well Containment Procedure (Capping Stack)

Context and Rationale: In IR-72 the Agency required information on capping wells in shallow waters. The proponent has not provided information on the technology available to cap a shallow-water well. Rather, it states “the current expectation is that all of the proposed ten wells will remain in deeper water (i.e., >500 m). Thus, the need to employ shallow water technologies and techniques does not apply to this project”. As the project area covers water depths less than 500 m, all potential emergency response options need to be explored.

Specific Question or Information Requirement: Provide information on the technology available to cap a shallow-water well, including information available to support the effectiveness of the technology, with respect to the potential shallow depths in the exploration licenses.

Discuss limitations associated with the use of a capping stack in particular in shallow water environments, including any differences in the steps taken to affix a capping stack in shallow water that may not be required when capping a deep water well (e.g. use of dispersants to reduce flow rate). Explain how the limitations of the technology could affect the length of time it may take to effectively cap a well.

If applicable, update the effects analysis to reflect these additional considerations.

Response:

CNOOC Petroleum North America ULC (CNOOC) noted in its response to IR-72 (Revised EIS Addendum - February 2019) that through its continued evaluation of potential wellsite locations, the current prospectivity across EL 1144 and EL 1150 does not show CNOOC drilling wells in water depths shallower than 700m. The potential need to employ shallower water technologies and techniques for subsea well containment should not apply.

Each incident involving loss of well control is different and requires analysis and consideration of potential tactics and equipment to safely bring the well under control. Shallower water wells can pose unique challenges to the installation of a capping stack as a result of the gas / oil flow from the wellhead and the resulting surface “boil” above the well site. The boil can be located immediately above the wellsite or, under varying current or wind conditions, the boil can be offset some distance away from the wellsite. At, and downwind of, the boil site there are hazardous fluids or gases surfacing, and conditions that make it challenging and unsafe for vessels and crew to safely operate. With increasing water depths (and increasing water pressure), the gas / oil flow and resulting surface boil tend to be less pronounced and more influenced by subsea pressure and currents. Optimally, the gas / oil flow and boil are offset and a safe distance down current and downwind from the wellhead which would allow vertical access above the wellhead to lower a capping stack solution.

In order to install a capping stack solution on a shallow water well, where vertical well access is not technically feasible, the capping stack solution must be installed from the side. This could be achieved using either:

1. A large crane that has sufficient radial reach (i.e., estimated minimum 50m) to remain offset and up wind and reach in over the ‘boil’ and attempt to vertically lower a capping stack solution to the wellsite; or
2. Using specialized subsea equipment (e.g., the Offset Installation Equipment package available through Oil Spill Response Ltd). that could approach the wellhead from the side.

There may also be other possible tactics, selected at the time of the incident, to position a crane overtop of the wellhead to attempt to vertically lower the capping stack solution. The tactics undertaken would be unique to the specific incident. However, given the potential challenges of a shallower water well, the installation of a capping stack solution from the side or offset would be expected to take more time than a standard vertical installation.

2.10 Accidents and Malfunctions – Effects

2.10.1 Information Requirement: IR-75-02 (Round Two – May 2019)

Project Effects Link to CEAA 2012: Multiple VCs – Accidents and Malfunctions

Reference to EIS Guidelines: Part 2, Section 3.1, Project Components; and 3.2.1, Drilling and Testing Activities

Reference to EIS: Section 16.4.4.2 Summary of Deterministic Results

Context and Rationale: In IR-75, the Agency required the proponent to provide additional analysis of the portion of the crude oil that would persist in the environment, including an analysis of the effects of the persistent components on valued components, and possible follow-up monitoring. In response, the proponent provided information on the persistence of crude oil in the environment, but did not provide additional analysis on the effects of the oil on valued components, nor discuss possible follow-up monitoring.

Specific Question or Information Requirement: Provide additional analysis of the effects of persistent crude oil on valued components and possible follow-up monitoring related to these effects.

Response:

Effects of persistent crude oil

Much of the recent literature related to *in situ* exposure to oil is from studies that assessed the effects of the DeepWater Horizon spill (DWH), which lasted 87 days (Dubinsky et al. 2013). Those studies were previously cited in the updated Section 16.6 (Appendix C of the Revised EIS Addendum – February 2019). Therefore, the effects of persistent crude oil on valued components, on a scale similar to the scenarios modelled for this Project (i.e. up to 120 days), were considered in the updated version of Section 16 (Appendix C of the Revised EIS Addendum – February 2019).

Follow-up monitoring

Although a follow-up monitoring plan would be largely dependent on the specifics of an actual spill event and could not be described in detail at this time, there are several components and lessons learned from the DWH post-spill monitoring that should be considered. This list is by no means exhaustive and is currently limited to monitoring of ecological effects or damage rather than the more physical measurements used in determining spill sizes, flowrates, and footprints.

The DWH spill resulted in the largest mobilization of resources to address an environmental emergency in the history of the United States (Lubchenko et al. 2012). As such, there were many studies undertaken and technologies developed and used that can provide insight into potential follow-up monitoring related to a future accidental spill event.

A key component in the initial phase of a large spill response is the establishment of a working group comprised of scientists from diverse disciplines and federal, academic, and NGOs. This would be a similar strategy to the Strategic Sciences Working Group (SSWG) established by the US Department of Interior after the DWH spill (Machlis and McNutt 2010). The SSWG was independent from the incident command group that was formed to deal with the logistics and clean up of the DWH spill.

In addition, another key component would be the use of real-time monitoring technologies including satellite, airborne passive, and airborne active remote sensing. Technologies that were further developed and tested in the DWH spill include Airborne Visible/Infrared Imaging Spectrometry (AVIRIS), Airborne and Synthesis Aperture Radar (SAR), Moderate Resolution Imaging Spectroradiometer (MODIS) Satellites, Cloud Aerosol Lidar, and Infrared

Pathfinder Satellite Observations (CALIPSO). A review of these technologies and their applicability to large oils spills is available in Leifer et al. (2012).

There were also VC-specific follow-up monitoring strategies employed during the DWH event that could be considered for a future large spill. Several have been briefly highlighted here to give further context on the type and scale of potential monitoring that could be used for follow-up studies.

Fish and Fish Habitat (monitoring of water column, fish, and the seafloor (benthos))

- Water column monitoring considerations-
 - Consider the use of toxicity tests using assays with quick turnover times and a range of sensitivities such as Microtox (assesses toxicity to bacteria), Microscreen (assesses gene mutations in bacteria), Qwiklite (assessed DNA damage in bacteria). These tests can be performed on samples from the water column as well as porewaters in sediments (Paul et al. 2013). Note that the Microtox assay is currently used in Environmental Effects Monitoring of Oil and Gas Operations on the Grand Banks.
 - Consider the use of complimentary ship-based monitoring such as the Special Monitoring of Applied Response Technologies (SMART) where water samples can be analyzed for hydrocarbon concentrations relative to SMART field assessments of dispersant effectiveness (Bejarano et al. 2013). Although this analysis has been previously focused on dispersant effectiveness and not specifically to evaluate biological effects, the authors suggest that this system could be used to further assess environmental impacts and improve environmental monitoring efforts.
 - During and after the DWH spill, there were changes in the plankton food web and changes in oxygen levels due to the pulse of organic matter in the form of hydrocarbons. DWH assessed these affects using isotope analysis of oxygen due to consumption of hydrocarbons (Hu et al, 2016) as well as benthic landers (observational platforms that are placed on the seafloor with varying instruments) to assess oxygen depletion near the seafloor (Martens et al. 2016). In addition, new probes (e.g., 16s rRNA) to identify the presence of bacteria that play an important role in hydrocarbon biodegradations were developed (McKay et al 2016, Yang et al, 2016).
- Fish monitoring considerations –
 - Fish in the DWH event were assessed for liver genome expression profiles such as CYP1A expression, a common biomarker for PAHs exposure (Whitehead et al. 2012). The results of these assays were then correlated with oil exposure using remote detection imagery (discussed above). Note that similar biomarker assays are currently used in Environmental Effects Monitoring of Oil and Gas Operations on the Grand Banks.
 - Carbon isotope ratios were used in the DWH spill to assess and track the uptake of oil into the planktonic food web and in turn to fish and invertebrates (Wilson et al. 2016).
- Benthic Monitoring considerations –
 - Benthic samples for the DWH were taken using a multi-corer deployed from a vessel. A multicorer was used so that chemical, physical and biological (macrofauna and meiofauna) would be taken simultaneously and analyzed together using multivariate methods (Montagna et al. 2013). The footprint of the benthic effects on the DWH spill was identified by using principal component analysis on the multicore data.
 - Sedimentation traps were also an important tool at the DWH spill to understand the amount of oil deposited into the sediments (Joye 2015) and the role of marine snow to shuttle oil to the seafloor (Passow 2016).
 - Corals were assessed at the DWH spill largely by using research ROVs (*i.e.*, Jason II) and Alvin-class Deep Submergence Vehicles (*i.e.*, Alvin) with *in situ* video imagery, shipboard microscopic analysis, and petroleum biomarker analysis of the floc adherent to the coral (White et al. 2012).

Marine and Migratory Birds

Several monitoring methods were employed for the DWH including modelling estimates of birds present and vulnerable to lethal exposure as well as shoreline and shore-based carcass surveys (Haney et al, 2014).

Marine Mammals and Sea Turtles

Similarly, the methods of Williams et al. (2011) could be considered for any marine mammal monitoring efforts to reduce the chances of underestimating the impacts on marine mammal mortalities. In their study, they accounted for the fact that only a fraction of marine mammal carcasses are ever recovered so a correction factor was needed for estimated mortalities based on species-specific estimates of abundance, survival rates, and stranding records.

Fisheries and other Ocean Users

Newly developed and rigorously implemented protocols for testing of seafood for components of hydrocarbons (PAHs) and/or dispersants to assess the duration of fisheries closure areas were developed for use by US government agencies as part of the DWH monitoring related to fisheries effects and fisheries closure areas (Lubchenco et al. 2012).

Atmospheric Environment

The DWH used airborne measurements of the gaseous and aerosol composition of air over the spill using National Oceanic and Atmospheric Administrations (NOAA) WP-3D research aircraft. (De Gouw et al. 2011). This aircraft was also used to gather oceanographic and meteorological information in order to model oil spill trajectories during the DWH spill (Shay et al, 2011).

Reference:

- Bejarano, A.C., Levine, E. and Mearns, A.J., 2013. Effectiveness and potential ecological effects of offshore surface dispersant use during the Deepwater Horizon oil spill: a retrospective analysis of monitoring data. *Environmental monitoring and assessment*, 185(12), pp.10281-10295.
- De Gouw, J.A., Middlebrook, A.M., Warneke, C., Ahmadov, R., Atlas, E.L., Bahreini, R., Blake, D.R., Brock, C.A., Brioude, J., Fahey, D.W. and Fehsenfeld, F.C., 2011. Organic aerosol formation downwind from the Deepwater Horizon oil spill. *Science*, 331(6022), pp.1295-1299.
- Dubinsky, E.A., Conrad, M.E., Chakraborty, R., Bill, M., Borglin, S.E., Hollibaugh, J.T., Mason, O.U., M. Piceno, Y., Reid, F.C., Stringfellow, W.T. and Tom, L.M., 2013. Succession of hydrocarbon-degrading bacteria in the aftermath of the Deepwater Horizon oil spill in the Gulf of Mexico. *Environmental science & technology*, 47(19), pp.10860-10867.
- Haney, J.C., Geiger, H.J. and Short, J.W., 2014. Bird mortality from the Deepwater Horizon oil spill. II. Carcass sampling and exposure probability in the coastal Gulf of Mexico. *Marine Ecology Progress Series*, 513, pp.239-252.
- Hu, X., Cai, W.J., Rabalais, N.N. and Xue, J., 2016. Coupled oxygen and dissolved inorganic carbon dynamics in coastal ocean and its use as a potential indicator for detecting water column oil degradation. *Deep Sea Research Part II: Topical Studies in Oceanography*, 129, pp.311-318.
- Leifer, I., Lehr, W.J., Simecek-Beatty, D., Bradley, E., Clark, R., Dennison, P., Hu, Y., Matheson, S., Jones, C.E., Holt, B. and Reif, M., 2012. State of the art satellite and airborne marine oil spill remote sensing: Application to the BP Deepwater Horizon oil spill. *Remote Sensing of Environment*, 124, pp.185-209.
- Joye, S.B., 2015. Deepwater Horizon, 5 years on. *Science*, 349(6248), pp.592-593.

- Lubchenco, J., McNutt, M.K., Dreyfus, G., Murawski, S.A., Kennedy, D.M., Anastas, P.T., Chu, S. and Hunter, T., 2012. Science in support of the Deepwater Horizon response. *Proceedings of the National Academy of Sciences*, 109(50), pp.20212-20221. Machlis and McNutt 2010
- Martens, C.S., Mendlovitz, H.P., Seim, H., Lapham, L. and D'Emidio, M., 2016. Sustained in situ measurements of dissolved oxygen, methane and water transport processes in the benthic boundary layer at MC118, northern Gulf of Mexico. *Deep Sea Research Part II: Topical Studies in Oceanography*, 129, pp.41-52.
- McKay, L.J., Gutierrez, T. and Teske, A.P., 2016. Development of a group-specific 16S rRNA-targeted probe set for the identification of *Marinobacter* by fluorescence in situ hybridization. *Deep Sea Research Part II: Topical Studies in Oceanography*, 129, pp.360-367.
- Montagna, P.A., Baguley, J.G., Cooksey, C., Hartwell, I., Hyde, L.J., Hyland, J.L., Kalke, R.D., Kracker, L.M., Reuscher, M. and Rhodes, A.C., 2013. Deep-sea benthic footprint of the Deepwater Horizon blowout. *PloS one*, 8(8), p.e70540.
- Passow, U., 2016. Formation of rapidly-sinking, oil-associated marine snow. *Deep Sea Research Part II: Topical Studies in Oceanography*, 129, pp.232-240.
- Paul, J.H., Hollander, D., Coble, P., Daly, K.L., Murasko, S., English, D., Basso, J., Delaney, J., McDaniel, L. and Kovach, C.W., 2013. Toxicity and mutagenicity of Gulf of Mexico waters during and after the Deepwater Horizon oil spill. *Environmental science & technology*, 47(17), pp.9651-9659.
- Shay, L.K., Jaimes, B., Brewster, J.K., Meyers, P., McCaskill, E.C., Uhlhorn, E., Marks, F., Halliwell Jr, G.R., Smedstad, O.M. and Hogan, P., 2011. Airborne ocean surveys of the Loop Current complex from NOAA WP-3D in support of the Deepwater Horizon oil spill. *NAVAL RESEARCH LAB STENNIS DETACHMENT STENNIS SPACE CENTER MS*.
- White, H.K., Hsing, P.Y., Cho, W., Shank, T.M., Cordes, E.E., Quattrini, A.M., Nelson, R.K., Camilli, R., Demopoulos, A.W., German, C.R. and Brooks, J.M., 2012. Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico. *Proceedings of the National Academy of Sciences*, 109(50), pp.20303-20308.
- Whitehead, A., Dubansky, B., Bodinier, C., Garcia, T.I., Miles, S., Pilley, C., Raghunathan, V., Roach, J.L., Walker, N., Walter, R.B. and Rice, C.D., 2012. Genomic and physiological footprint of the Deepwater Horizon oil spill on resident marsh fishes. *Proceedings of the National Academy of Sciences*, 109(50), pp.20298-20302.
- Wilson, R.M., Cherrier, J., Sarkodee-Adoo, J., Bosman, S., Mickle, A. and Chanton, J.P., 2016. Tracing the intrusion of fossil carbon into coastal Louisiana macrofauna using natural ¹⁴C and ¹³C abundances. *Deep Sea Research Part II: Topical Studies in Oceanography*, 129, pp.89-95.
- Williams, R., Gero, S., Bejder, L., Calambokidis, J., Kraus, S.D., Lusseau, D., Read, A.J. and Robbins, J., 2011. Underestimating the damage: interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. *Conservation Letters*, 4(3), pp.228-233.
- Yang, T., Nigro, L.M., Gutierrez, T., Joye, S.B., Highsmith, R. and Teske, A., 2016. Pulsed blooms and persistent oil-degrading bacterial populations in the water column during and after the Deepwater Horizon blowout. *Deep Sea Research Part II: Topical Studies in Oceanography*, 129, pp.282-291.

3 RESPONSES TO REQUIRED CLARIFICATIONS

3.1 Air Quality

3.1.1 Clarification Requirement: CL-08-02 (Round Two – May 2019)

External Reviewer(s): NRCAN-07-Nx

Project Effects Link to CEAA 2012: NA

Reference to EIS Guidelines: Part 2, 3.1. Project Components and Part 2, 3.2.1. Drilling and Testing and Activities

Reference to EIS: Section 14.3.7 Greenhouse Gases

Context and Rationale: NRCAN has reviewed the proponent's calculations, and based on the information presented of two wells being tested and 10,000 Mcf of gas and 36,000 bbl flared per well, NRCAN has advised that the calculations would be as follows and do not require durations:

Example Well Testing

CO₂ Emission Rate (gas)

$(10000 \text{ Mcf/well}) \times (1000 \text{ cf/MCF}) / (35.3 \text{ cf/m}^3) \times (2.482 \text{ kgCO}_2/\text{m}^3) / (1000 \text{ kg/tonne}) \times (2 \text{ wells}) = 1406.232 \text{ tonnes}$

CO₂ Emission Rate (oil)

$(36000 \text{ bbl/well}) \times (158.9873 \text{ Litres/bbl}) \times (2663 \text{ g CO}_2/\text{L}) / (1000 \text{ g/kg}) / (1000 \text{ kg/tonne}) \times (2 \text{ wells}) = 30,483.588 \text{ tonnes}$

Total Well Testing

$= 1406 + 30,484 = 31,890 \text{ tonnes}$

Specific Question or Information Requirement: Review greenhouse gas emissions calculations based on the examples provided by NRCAN, and re-calculate emissions as necessary. In addition, confirm that the decision to simply use emission factors for natural gas and oil is conservative when compared to the procedures specific to flaring in the referenced Guidance Document for Reporting Greenhouse Gas Emissions for Large Industry in Newfoundland and Labrador (Section 8.3.1.5).

Reference: Government of Newfoundland and Labrador Office of Climate Change (2017). A Guidance Document for Reporting Greenhouse Gas Emissions for Large Industry in Newfoundland and Labrador, March 2017.

Response:

In order to address the NRCAN information requirement to revise emissions based upon the NRCAN examples, the Greenhouse Gas (GHG) emissions for the flaring of gas and oil during well testing were calculated based on the estimated volumes of gas and oil, published emission factors, and the total number of wells expected to be tested over the Project.

Using this alternative approach, the total GHGs emissions estimated for well testing were lower than those presented in the Environmental Impact Statement (EIS). The GHG emissions forecast in Table 14.11 of Appendix A of the Revised EIS Addendum (February 2019) are provided in Table CL-08-02.1, and the revised GHG emissions are presented in Table CL-08-02.2 for comparison. The highlighted cells in CL-08-02.2 indicate values that differ

from Table 14.11 provided in Appendix A of the Revised EIS Addendum (February 2019).

Table CL-08-02.1 Table 14.11 Project Total GHG Emissions by Activity (Appendix A of Revised EIS Addendum – February 2019)

Activity	Emission Rate (t/project) for the Project			
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Drill Ship MODU	582,032	29	87	606,014
Well Testing (based upon operating hours)	35,405	6	5.1	37,076
Supply Vessels	164,244	8	25	171,011
Helicopters	8,727	0.28	0.79	8,970
Project Total	790,224	43	118	822,711

Table CL-08-02.2 Project Total GHG Emissions by Activity

Activity	Emission Rate (t/project) for the Project			
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Drill Ship MODU	582,032	29	87	606,014
Well Testing (based upon fuel volumes)	31,889	5.2	4.6	33,394
Supply Vessels	164,244	8	25	171,011
Helicopters	8,727	0.28	0.79	8,970
Project Total	786,892	42	118	819,389

Note: highlights indicate revised values from Table 14.11 of Appendix A of the Revised EIS Addendum – February 2019.

In addition, NRCan also requested that the GHG emissions be compared to those that would be estimated using the procedures of Section 8.3.1.5 (for flares) of the noted NL Guidance Document for Reporting Greenhouse Gas Emissions for Large Industry in Newfoundland and Labrador (the NL Guidance Document; specifically, equations 8-15, 8-17, and 8-18 of the NL Guidance Document).

To satisfy this request, GHG emissions from gas and oil flaring were calculated using this approach, with the estimates presented in Table CL-08-02.3.

Table CL-08-02.3 GHG Emissions from Well Testing

Activity	Emission Rate (t/project) for the Project			
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Well Testing (based on NL Guidance Document Approach)	25,705	78	0.26	27,721

As shown in Table CL-08-02.3, the GHG emissions estimated using the NL Guidance Document were lower than those in Table CL-08-02.1 and Table CL-08-02.2. Sample calculations for CO₂ from flaring of both gas and oil according to the approach of the NL Guidance Document are provided herein.

In summary, the GHG emissions from Well Testing presented in the Appendix A of the Revised EIS Addendum (February 2019) have been confirmed to be conservative based upon comparison with the GHG emission estimated using the two approaches identified by NRCan, namely:

- i. using emission factors with fuel consumption rather than flaring hours (Table CL-08-02.2), and using the NL Guidance Document (Table CL-08-02.3).

3.2 Accidents and Malfunctions

3.2.1 Clarification Requirement: CL-19-02 (Round Two – May 2019)

External Reviewer(s): DFO-01-Nx

Project Effects Link to CEAA 2012: Multiple VCs - Regional Study Area (Accidents and Malfunctions)

Reference to EIS Guidelines: Part 1, Section 3.2.3 Spatial and Temporal Boundaries

Reference to EIS: Section 4.3.1.1 Study Areas

Context and Rationale: CL-19 required the proponent to update the map and text describing the RSA, taking into consideration spill modelling results. In its response, the proponent explained that it expanded the study area (i.e. model domain) boundaries as part of the revised oil spill modelling, but it did not update the map and text describing the RSA.

Specific Question or Information Requirement: Update the map and text describing the RSA, taking into consideration the revised spill modelling results.

Response: Based on IR-64, CNOOC Petroleum North America ULC (CNOOC) expanded the study domain for the additional oil spill modelling undertaken in September 2018. That expanded study domain has been incorporated into the environmental assessment (Addendum February 2019). The three RSA's that were originally defined for the Environmental Impact Statement (EIS) (See Figure 4.1) were not delineated wholly upon the oil spill modelling study domain but also took into consideration a number of other variables as detailed in Table 4.3 of the EIS. As a result, when undertaking the additional oil spill modelling, the RSAs were not adjusted based on that expanded study domain. The RSA's as defined in the EIS (Section 4: EA Scope, Focus and Approach) are consistent with Section 3.2.3 of the EIS Guidelines and in keeping with other recent similar oil and gas exploration project environmental assessments in the NL offshore area.

The predictions in the oil spill modelling illustrate unmitigated accidental events including subsea releases over 30-day and 120-day timeframes. The footprints of the modelled oil releases depicted by the analyses are representative of cumulative, unmitigated releases and the study domain was made sufficiently large to try to display all potential variations of those unmitigated footprints. However, the footprints do not represent the anticipated distribution from any single release and do not provide specific information on the quantity of oil predicted in any given area. The results, as shown in the mapping, denote the probability of oil exceeding the given threshold passing through each model grid cell location within the model study domain over the model duration based on multiple release iterations (119 and 171 individual release scenarios). For example, stochastic maps of dissolved hydrocarbon water column concentrations depict the likelihood that concentrations would exceed the identified threshold at some depth within the water column, but do not specify the depth at which this occurs and do not imply that the entire water column (i.e., surface to bottom) will experience a concentration above threshold.

The EIS assesses potential Project effects within the Project Area, the Local Study Area, the RSA, and areas beyond the defined RSA's as appropriate (see Accidental Events: Section 16 which considers the oil spill modelling results). The oil spill modelling predictions show cumulative oil spills without any mitigation. The Project effects assessment considers potential effects after mitigation. Therefore, the potential effects of the Project, including accidental events with exposure to oil spills potentially over areas larger than the RSA, has been considered and assessed fully within the EIS for each component VC and thus, the originally defined RSA's and effects predictions remain valid.