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Newfoundland and Labrador Region | Canadian Science Advisory Secretariat
Science Response 2022/041

REVIEW OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE BP CANADA ENERGY GROUP NEWFOUNDLAND ORPHAN BASIN EXPLORATION DRILLING PROGRAM

Context

The Proponent, BP Canada Energy Group ULC (BP), proposes to conduct exploration drilling activities in the Grand Banks region within the area of its offshore exploration licences (ELs). The ELs 1145, 1146 and 1148 are located in the West Orphan Basin within Canada's 200 nautical mile Exclusive Economic Zone (EEZ) and EL 1149 is located in the East Orphan Basin, beyond the EEZ. The Project is a multi-well exploration drilling program and would include up to 20 wells to be drilled up to 2026.

The Project requires review and approval pursuant to the requirements of the *Canadian Environmental Assessment Act* (CEAA 2012) as it has been determined that the drilling of a well constitutes a designated project under Section 10 of the Regulations Designating Physical Activities. In addition, the Canada-Newfoundland and Labrador Offshore Petroleum Board (CNLOPB) requires a project-specific Environmental Assessment (EA) be completed for offshore oil and gas activities, pursuant to *the Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* and the *Canada-Newfoundland Atlantic Accord Implementation Act* (the Accord Acts). It is intended that the EA review process for the Project will satisfy the requirements of CEAA 2012 and the C-NLOPB's Accord Acts EA processes. Environmental Impact Statements (EIS) have been prepared in accordance with requirements of CEAA 2012, the project-specific Guidelines for the Preparation of an Environmental Impact Statement (EIS Guidelines [CEA Agency 2018]) issued by the Canadian Environmental Assessment Agency (the Agency), and other generic EA guidance documents issued by the Agency as referenced throughout.

On November 14, 2018, the Fisheries Protection Program (FPP) of the Ecosystems Management Branch in the Newfoundland and Labrador (NL) Region of Fisheries and Oceans Canada (DFO) requested that Science undertake a review of specific sections of the EIS for the proposed exploration drilling. DFO Science undertook a Science Response Process for this review. The information from this scientific review was provided to Ecosystems Management to help form part of the Department's response to the overall adequacy of the EIS documents.

The objective of this review was to evaluate:

- The sufficiency of baseline data and appropriateness of methodologies to predict effects;
- The mitigation measures proposed by the Proponent;
- The level of certainty in the conclusions reached by the Proponent on the effects;
- The manner in which significance of the environmental effects, as they pertain to DFO's mandate, have been determined (i.e., the scientific merit of the information presented and the validity of the Proponent's methodologies and conclusions);
- The follow-up program proposed by the Proponent; and

- Whether additional information is required from the Proponent to complete the technical review.

The information required for this review can be found in a number of sections throughout the EIS reports, and associated appendices. The EIS reports are available on the Agency's website.

This Science Response Report results from the Science Response Process of December 14, 2018 on the Review of the Environmental Impact Statement (EIS) for the BP Newfoundland Orphan Basin Exploration Drilling Project.

Analysis and Response

The comments provided by DFO Science, NL Region as requested by the Fisheries Protection Program (FPP) are related to the following sections of the EIS reports:

- **Chapter 6.0 – Existing Biological Environment**
  - 6.1.6 – Benthic Invertebrates and Habitat (pages 6.13–6.18)
- **Chapter 8.0 – Assessment of Potential Effects on Marine Fish and Fish Habitat**
  - 8.2 – Project Interactions with Marine Fish and Fish Habitat (pages 8.8–8.9)
  - 8.3 – Assessment of Residual Environmental Effects on marine Fish and Fish Habitat (pages 8.9–8.33)
  - 8.4 – Determination of Significance (page 8.34)
- **Chapter 11.0 – Assessment of Potential Effects on Special Areas**
  - 11.2 – Project Interactions with Special Areas (pages 11.7–11.8)
  - 11.3 – Assessment of Residual Environmental Effects on Special Areas (pages 11.8–11.15)
  - 11.4 – Determination of Significance (page 11.5)
- **Appendix B – Drill Cuttings Modelling Report**

Section 8.4 was examined but no comments were submitted during the review process. Sections 11.2–11.4 were not evaluated due to the unavailability of designated subject matter experts during the review period.

DFO Science also provided comments on additional sections to those requested by FPP. The additional comments can be found throughout this Science Response Report.

General Comments

The methodologies for seismic testing and mitigation of potentially adverse environmental effects are thorough and have been developed and applied to other drilling projects. The conclusions are generally supported by the literature review although it should be emphasized that the effect of seismic testing on marine species has significant knowledge gaps due to the lack of standardization of both terminology and measurements of sound exposure which makes comparisons among studies difficult and precludes single species studies from reaching general conclusions on other regions and taxa (reviewed in Carroll et al. 2017).

Hybrid Coordinate Ocean Model (HYCOM) models are used in the EIS. The EIS should be expanded to include an analysis on whether HYCOM is coherent with the literature findings, and why World Ocean Atlas (WOA) was used for stratification instead of HYCOM.

Executive Summary

Page I – "*The EIS is focused on the identification and assessment of potential adverse environmental effects of the Project on valued components (VCs),*" with secondary consideration of adverse environmental effects on the proposed operations. It cannot be assumed that the latter secondary consideration is appropriate for a harsh deep-water environment, where potential severe environmental conditions may pose exceptional risks to the various operations which may in turn increase the adverse environmental effects on the VCs. More attention to extreme environmental conditions is necessary.

The potential effects of the environment on the Project are discussed in Section 16, after the extensive discussion of potential effects of the Project on the VCs. It is suggested that the effects of the environment be discussed first, so that they can be considered in the effects on the VCs.

The existence of a 2003 Strategic Environmental Assessment (SEA) for the Orphan Basin and a 2014 Eastern Newfoundland SEA (both available from the CNLOPB website) is not noted in the text in the Executive Summary nor in Section 1. The 2014 SEA (Amec 2014) is listed in the references for Section 1 but its relevance is not indicated. This SEA is also referenced in Section 5 where it is indicated as "submitted to CNLOPB", and in Section 16. The relevance and roles of the SEAs should be clarified early in this EIS, and consistent treatment should be used throughout the EIS.

Chapter 1.0 – Introduction

1.2 – Scope of the Environmental Impact Statement

"The Project Area encompasses the immediate area in which Project activities and components may occur, including direct physical disturbance to the marine benthic environment (ELs 1145, 1146, 1148, and 1149) plus a 20-km buffer (Figure 1.1). Based on discussion with the Canadian Environmental Assessment Agency (the Agency), one Project Area was identified that encompassed both the West Orphan Basin (ELs 1145, 1146, and 1148) and East Orphan Basin (EL 1149)." The choice of a 20 km buffer zone is questionable in view of the occurrence of strong currents in the area, and different VCs in neighbouring shelf and slope regions.

The basis for the choice of a single Project Area should be explained, particularly in the context of spatial structure of environmental conditions and VCs.

At a minimum, the description of the physical environment in Section 5 should discuss the differences between the two subareas of the leases.

Chapter 2.0 – Project Description

The planned environmental monitoring of atmospheric and oceanographic conditions (as per the Physical Environmental Monitoring Guidelines) should be discussed, with reference to Section 16 and the approval process.

2.2 – Project Location

"For the purpose of environmental assessment, a Regional Assessment Area (RAA) has been defined as the main Study Area boundary for describing existing baseline conditions and assessing potential direct and cumulative environmental effects of the Project (refer to Figure 2.1). The RAA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present, and future (i.e., certain or reasonably foreseeable) physical activities. The RAA extends from latitude 55.5° N to 42°N and from longitude 54.5°W to 40°W. Portions of the

Island of Newfoundland are also included since oil spill modelling indicates that weathered oil could potentially reach the coast line in the unlikely event of an unmitigated oil spill." The consideration of an area larger than the Project Area (including its buffer zone) is important. The size of the RAA is adequate. However, it is unclear how a proper assessment of effects throughout the RAA can be completed without a more detailed consideration of the physical environment in relevant parts of the RAA.

Page 2.5 – The Proponent states that they are committed to determining the pre-drill survey requirements with the CNLOPB and DFO, and that environmental sensitivity will be taken into consideration in well siting and an image-based survey for geophysical hazards and sensitive habitats will be carried out on a 500 m radius for this purpose. The EIS does not indicate how sensitive habitats are characterized or what species would be considered. It is also not clear whether there is any provision for follow up monitoring.

2.4 – Project Activities

The schematics of various aspects of the operations are helpful aids to support review of the EIS.

Clarification is necessary on whether there will be another pre-drill survey side track drilling used as a mitigation measure.

2.8 – Emissions, Discharges and Waste Management

Cement discharges are not modelled and are not considered in the assessment of potential effects.

The use of a model hindcast current dataset instead of an observed current dataset in the drill waste disposition modelling is questionable unless the model has been validated for representative and extreme current conditions. This is particularly relevant to the high (energetic) currents case, as Section 5 indicates observed currents at one location to be much stronger than indicated from the model.

It is suggested that the current and wave conditions in the cases chosen for modelling various discharges be discussed in terms of known phenomena such as storms, inertial current oscillations, eddies and sea ice (western lease areas).

The extents and thicknesses estimated from the EIS' modelling (Tables 2.8–2.13) appear to be in the range of those that are likely to occur, with the possible exceptions of a larger extent (but with reduced thickness) during strong currents and a greater thickness (but with reduced extent) in the presence of a tall eddy. The possible exceptions seem unlikely to result in depositions of concern. However, the accuracy of model estimates regarding extent and thickness are much less than implied by the number of significant figures retained in some entries in the tables in the EIS.

Chapter 5.0 – Physical Environment

The existence of the Eastern Newfoundland SEA (Amec 2014) is noted at the start of this section (page 5.1) and the SEA is referred to in the subsections on Geology (5.1) and Bathymetry (5.4.1). However, it is not referenced in the subsections on the Atmospheric Environment (5.3), Ocean Currents (5.4.2) and Seawater Properties (5.4.4). Also, as noted earlier, it is listed only as "submitted to CNLOPB" (page 5.139). The status and role of this SEA are thus unclear from Section 5.

5.3 – Atmospheric Conditions

5.3.1 – Data Sources

Page 5.10 – There is no reference provided for "*the MSC50 North Atlantic wind and wave climatology database*." It should be recognized that MSC50 data are from a model hindcast, not observations.

5.3.2 – Climate Overview

It is unclear whether the North Atlantic Oscillation (NAO) and atmospheric blocking should be considered, or if the latter is covered by 'upper-level' ridges. There is recent literature on the topic related to stalling of storm systems in the North Atlantic that should be summarized and referenced (see Booth et al. 2017, Hanna et al. 2018).

5.3.8 – Fog and Visibility

The EIS states that reductions in visibility are seen in approximately 37% of observations. Although Figure 5.15 is unclear due to very high percentage values for <1 km, the EIS does not mention that the International Comprehensive Ocean Atmosphere Data Set (ICOADS) contains several categories for <1 km, and putting them all together leads to these high values, e.g. relative to next categories such as <2 km, <4 km, <10 km.

5.4 – Physical Oceanography

5.4.1 – Bathymetry

From an oceanographic perspective, it is appropriate to recognize the existence of a continental slope and continental rise, rather than just a continental shelf and off-shelf basins. The placement of the label "Northeast Newfoundland Shelf" in Figure 5.20 is misleading because it is over the slope region.

5.4.2 – Ocean Currents

This subsection does not provide an adequate description of ocean currents in the Orphan Basin region. The EIS does not recognize vertical structure in the currents and circulation in the Orphan Basin such as the bottom-intensified Deep Western Boundary Current and surface-intensified wind-driven currents including inertial oscillations. The EIS provides a more lengthy discussion on currents and circulation outside of the Project Area than inside (even though these are relevant to the discussion of effects on VCs in the RAA).

The circulation map (Figure 5.21) does not cover the entire Project Area and, therefore, excludes important elements of the ocean circulation north of the Project Area.

Figure 5.21 depicts the surface or top layer. The deep current patterns have different patterns and should be included in this section.

The subsection does not draw on literature regarding observed currents and circulation in the Orphan Basin and nearby regions, including oceanographic phenomena that are relevant to potential effects of the environment on the Project and potential effects of the Project on VCs. This includes literature on the vertical and cross-slope structure of the currents from a long-term German moored measurement program at 53^{o}N just to the north of the Project Area (e.g. Fischer et al. 2010, 2011, 2015), on inertial currents on the northern Grand Bank (Tang and Belliveau 1994; strong inertial currents have also been reported for the Orphan Basin by Loder et al. 2011), and deep-ocean drifters deployed in the Orphan Basin (e.g. Bower et al. 2009, 2011).

The subsection also does not draw on recent circulation model studies in the region (e.g. Wu et al. 2012, Wang et al. 2015, 2016, 2018).

The description of currents is limited to basic statistics and tidal currents. The frequency structure, vertical coherence and extent, and origin of any strong currents (like those presented for 20 m at Lona O-55) should also be discussed.

The EIS should not make broad conclusions about currents in the whole domain as the report includes only two current meter records which span a few seasons.

Additional and more extensive moored current measurements in the Orphan Basin region have been made by the Bedford Institute of Oceanography (BIO). Data and descriptions from some of these measurements are available. The observations indicate strong inertial currents in the upper ocean and tall eddies extending over the water column (Loder et al. 2009, 2011).

It is suggested that the EIS include information from a data report (Narayanan 1994) and paper (Narayanan et al. 1996) discussing the West Orphan Basin current measurements (pages 5.43–5.46).

The description of currents for the East Orphan Basin (pages 5.45–5.50) is limited to a portion of the BIO measurements that are currently available.

Page 5.45 - Table 5.14 – Clarification should be provided on whether the column should be for minimum speed instead of mean velocity.

Page 5.49 - Table 5.16 – The entries in max speed column are incorrect. It appears that the headers and values in the four right-most columns of this table are incorrect.

Page 5.54 - Figure 5.28 – The current speeds presented for the 20 m level at Lona O-55 are much higher than at other sites and depths, and therefore require additional assessment and discussion. Stronger currents are certainly expected at this shallow depth and have been observed in BIO observations at 30 m depth (Loder et al. 2011). The possibility that these currents are artifacts of surface sidelobe reflection for this Acoustic Doppler Current Profiler (ADCP) moored at ~300 m should be examined. The origin and implications of these and other strong upper-ocean currents measured by the Lona and BIO ADCPs should be investigated.

5.4.3 – Waves

Page 5.55 – It would be useful for the EIS to use MSC50 data to construct extremes for geographical contours in the area east of Newfoundland, for return periods of 1-yr, 10-yr, 50-yr and 100-yr. As an example, see Figure 10 in Wang et al. 2018.

This following statement is incorrect, *"The wave climate is dominated by extra-tropical storms, primarily during October through March.*" Extra-tropical storms having tropical characteristics do not occur in winter (see Section 5.3.5 and Table 5.6).

Page 5.74 – Using a constant value such as 1.06 and 1.22 to convert hourly wind values to 10- and 1-minute values may not be appropriate to obtain estimates of the extreme values. The wind profile in the boundary layer can be estimated using a power law, no matter whether the boundary is or is not stable. When the boundary layer is neutral, the power law becomes logarithmic law. At a minimum, an estimate of the error should be given.

5.4.4 – Seawater Properties

This section presents the basic statistics of temperature and salinity from automated electronic profiling systems (Conductivity, Temperature, and Depth; CTD) profiles in the region. It is suggested that the EIS examine moored temperature time-series (e.g. from current meters) for indications of large internal waves (especially in continental slope areas) and of tall eddies (which could have strong currents) passing through the mooring sites.

For temperature and salinity, using all points selected within a large box averaged for each month at certain depths has limitations. There is no analysis of gradient zones to demonstrate how temperature and salinity vary over the basin. A more thorough explanation of the method of data binning is suggested for the results presented on temperature and salinity.

The ocean bottom layer is an important physical feature of this region. However, there is no description of how many near-bottom observations there were below 500 m and how close to the bottom they were. Clarification is suggested on whether there are any temperature and salinity features in the deeper layers.

Tables 5.35 and 5.36 – The deeper layers should not have more profiles than the upper layers. This suggests that the values are inflated because the report counts points in profiles (CTD or bottle depth) rather than the number of profiles. This error should be addressed in the EIS.

Page 5.93 - Table 5.37 – The EIS should be updated to clarify whether the standard deviation, minimum and maximum for 1,000–3,000 m layer numbers are based on all possible values within the region and the depth range. It should also indicate the number of profiles used. Clarification is also suggested on the chosen depth layers, as the chosen depth layers of 300–900 m and 1,000–3,000 m appear thick considering that the seawater properties change across the slope.

Page 5.94 - Figure 5.47 – There are significant inaccuracies or inconsistencies in the analysis of the upper ocean layers. For example, in Figure 5.47 the February surface salinity value dropped and then recovered in March. It would be expected that the salinity would be higher in February as deepening mixing is underway. Table 5.32 implies that the set of February values come from a single profile, possibly in the shelf (fresh and cold) side of the Orphan Basin.

Page 5.86 - Figure 5.45 – It appears that the positions are of shipboard CTD stations, rather than moorings as the EIS indicates.

5.4.5 – Tides

Page 5.103 – *"There are no tidal measurements for the Orphan Basin."* This statement is incorrect since tidal currents are measured (and discussed on page 5.49); however, it may be true for tidal elevations. Tidal elevations and currents are not likely to be an issue in the Orphan Basin, beyond the possibility of large internal tides in slope regions.

5.5 – Ice Conditions

5.5.1 – Sea Ice

Page 5.115 - Table 5.48 and Figure 5.55 – The median concentration reached its maximum during the week of March 12, not March 19.

Page 5.120, line 5 – Should be 7/10^{ths} "or greater" ice.

5.5.2 – Icebergs

Page 5.122 – It is important to consider the limitations of the iceberg sightings database. According to Anderson (1993), *"The primary objective (of Ice Patrol's aerial reconnaissance) is to maintain accurate information concerning the southwest, southern, and southeastern limits of the ice. A secondary objective is to fix the location of as much of the ice within the limits as is consistent with the accomplishment of the primary objective."* Using the above philosophy as the basis of accomplishing its mission, Ice Patrol does not and has never conducted a complete census of icebergs or surveyed the entirety of the Grand Banks for icebergs. The presence or absence of icebergs in areas removed from the extreme limits of the region of iceberg danger does not affect the performance of the Ice Patrol mission. Generally, areas of the Grand Banks removed from the limits of iceberg danger can have significant concentrations of icebergs and because of the nature of the mission, the icebergs located there may not be included in the data set.

Since the Project Area may or may not occur along the southwest, southern and southeastern limits of the ice, it is not clear to what extent icebergs occurring in the Project Area have been included in the data set.

Page 5.124 – "*Positions of all icebergs*" should be "positions of all iceberg sightings."

Page 5.124 – "*Icebergs on the field*" should be "iceberg sightings in the field."

Page 5.126 – "*January to September*" should be "January to December."

Page 5.126 – "*Large icebergs occur 11.3% of the time*" should be "Large icebergs account for 11.3% of the observed icebergs." This change should also be made for "*very large icebergs*."

Page 5.126 – The EIS should clarify what is meant by "*very few*."

Pages 5.127-5.130 - Captions of Figures 5.63 to 5.66: "*Icebergs*" should be "Iceberg Sightings."

5.6 – Climate Change

5.6.2 – Oceanographic Changes

Pages 5.137–5.138 – The Northwest Atlantic has significant natural variability on yearly to multi-decadal time scales. This should be considered in discussions of climate change and in inferences from observations in particular years or decades.

Ocean current and circulation changes in the Northwest Atlantic associated with increasing greenhouse gases in the atmosphere can be expected to occur via changes in atmospheric circulation and ocean salinity (e.g. from melting sea ice and ice sheets), as well as via changes in atmospheric and ocean temperatures.

Page 5.138 – The statement "*Recent regional downscaled results predict that sea level will rise by 0.11 m at the St. John's tidal gauge station from 2011 to 2069 (Han et al. 2018)*" should be clarified. In the paper, it says "*The sea level at St. John's is projected to rise by 0.11 m because of ocean steric and dynamic changes*." According to the Bedford Institute of Oceanography, total sea level rise at St John's from 2020 to 2070 is 0.35 m for RCP8.5 scenario.

Chapter 6.0 – Existing Biological Environment

Shrimp habitat is not largely overlapped by the Project Area; this is reiterated by the fact that the drilling will occur at depths 1,000–3,000 m. However, the RAA covers a large area in which there would be many species important to fisheries and the ecosystem which are rarely mentioned in Section 6 of the EIS. The maps displaying the Project Area, RAA, and overlapping Shrimp Fishing Areas (SFAs), is located in Section 7 (Figure 7.18).

Clarification is suggested on whether the absence of shrimp in Section 6 of the EIS was due to the low prevalence in the Study Area, as the data used was from 2016. Shrimp may be a key invertebrate species if data from another year were studied in the EIS.

Frequent use of the word "abundance" when discussing weights is inappropriate; typically abundance refers to numbers rather than weights.

Page 6.2 – *"Within the Project Area, habitats transition from Newfoundland slope to abyssal."* The text following this sentence describes the importance of the Newfoundland slope areas, however the "abyssal" habitat is not referenced. Also, there is no section of the report which examines the predominant characteristics of the "Newfoundland slope" areas and the "abyssal" areas. A reoccurring theme within the EIS is that the ecosystem beyond the slope, and specifically the 200-mile limit, is insufficiently characterized, referenced, and researched.

6.1 – Marine Fish and Fish Habitat

6.1.1 – Approach and Key Information Sources

"The Project falls within the geographical scope of the Eastern Newfoundland SEA (Amec 2014), which provides a regional overview of the offshore marine ecosystem that includes the Grand Banks, Flemish Cap, Orphan Basin, and adjacent slope and abyssal habitats." A summary of this regional habitat overview within the specific context of the Project Area should be included.

The distinction between Relative Abundance (%) and Average Occurrence (%) is unclear. It should be noted that in fisheries stock assessment terminology "abundance" is generally employed when discussing numbers of fish with respect to numbers per tow, etc. The use of "abundance" in this context should be replaced with "biomass" terminology.

6.1.4 – Plankton, Plants and Macroalgae

Table 6.1 – Although the principle reference is listed as AMEC 2014, the data references are back-dated approximately 20 years (Dalley and Anderson 1988, Dalley et al. 1999) and are based on Pelagic 0-Group surveys conducted in 1997–98. If available, recent sources of literature should be included.

Table 6.1 indicates its source as AMEC 2014 (modified from Dalley et al. 1999 and Dalley and Anderson 1998). It is unclear how the results have been "modified" from the original Dalley references to the results presented in Table 6.1.

In addition, neither Dalley and Anderson 1988 or Dalley et al. 1999 are included in the References Section of the EIS.

6.1.6 – Benthic Invertebrates and Habitat

The combined term 'cold water corals and sponges' is used inconsistently throughout the EIS and should be clarified. References are usually for corals and not sponges in the EIS.

Clarification is suggested on why the presented survey bycatch data for corals was restricted to two years (2014 and 2015). A patchily distributed faunal group and more data points (i.e. years) would provide a better description of broad spatial distributions.

Table 6.2's title (Dominant Invertebrate Taxa in Photographic Surveys within the Orphan Basin) suggests it is relevant for all invertebrates; however, only benthic invertebrates are represented in the Table.

Page 6.13 – The first paragraph in Section 6.1.6 should be linked with the Fish and Fish Habitat Section. The paragraph should also be expanded and discuss additional available literature.

Page 6.14 – The statement *"The survey will provide baseline data for coral and sensitive benthic habitat that may be present"* should be expanded to provide a description of the survey's methods.

The statement "*Surficial sediment in the Orphan Basin ranges from fine muds and clays to extremely coarse including boulders and bedrock 0.1 to 1.1 m thick"* should be clarified to explain whether 'thick' refers to particle size.

Primary literature on benthic community composition should be used in addition to LGL Limited 2013. Recent literature on benthic invertebrates in the Study Area should be used as the Carter et al.1979 reference is insufficient to characterize the benthic fauna in 2018. The EIS should also examine how the sediments were collected during the Carter study and provide an analysis to support four habitat designations.

Page 6.16 – Pertaining to the following text: *"There were no sponge grounds identified within the Project Area. While Geodia spp. may be observed within the Project Area (Figure 6.5), dense aggregations such as those found in sponge grounds are unlikely."* It would be more appropriate to say "there have been no sponge grounds identified within the Project Area to date." The second sentence in the above statement should be explained and a reference should be provided. Sponge significant benthic areas (SBAs) have been identified within the Study Area boundaries (Kenchington et al. 2016).

Page 6.17 – Figure 6.5 provides records of coral and sponges based on the DFO RV data. It should be noted however that these RV surveys extend only into the extreme east of the Study Area and include only a few sets in the eastern most ELs. See for example, Gullage et al. 2017 Figure S1 which provides set locations for the RV surveys between 2004 and 2011.

Page 6.17 – It difficult to discern the various habitat types (SBAs) and closures (marine refuges and Northwest Atlantic Fisheries Organization [NAFO] closures) in the RAA within Figure 6.5. Furthermore, sponge SBAs (Kenchington et al. 2016) and vulnerable marine ecosystem (VME) habitats, as identified by the Working Group on Ecosystem Science and Assessments (NAFO 2015; see ToR 1.1) have not been indicated on the map nor are described within the EIS. While the VME closures have been acknowledged and mapped, it is suggested that additional published information on VME habitats that have not been closed to fishing be included.

6.1.7 – Finfish (Demersal and Pelagic Species)

Page 6.19 – The text states "*The 2016 DFO RV survey data was analyzed for the Project Area (DFO 2016a). The results of the RV survey indicate deepwater redfish, Greenland halibut, roughhead grenadier, scyphozoan (marine jellyfish), roundnose grenadier, witch flounder and northern wolffish make up 91% of the catch by weight, with redfish contributing 41% of the abundance by weight. Distribution of the six most abundant fish species in the Project Area are shown in Figures 6.6 to 6.11."* The terminology in this section is confusing as seven species are listed as making up 91% of the catch by weight, while redfish are listed as contributing 41% of the abundance by weight. Clarification is suggested on whether the distribution of the six most "abundant" fish species in the area is based upon weight or numbers. It should also be noted that marine jellyfish (Scyphozoan) are invertebrates, not finfish.

Table 6.4 – If the table (Column 4) is referring to the potential for the species to occur within the RAA then most of the species should be designated as "high" as the timing of their presence is universally deemed to be "year round" and the "RAA" is sufficiently large enough that representatives of these species can always be found (with sufficient effort).

A more detailed explanation of "Potential for Occurrence" within both the RAA and Project Area should be provided to avoid misinterpretation.

It would appear from the Table and preceding text that information from Spanish, Portuguese, and European Union (EU) Research Vessel (RV) surveys that have been conducted outside of the 200 mile Canadian EEZ in NAFO Subdivisions 3L and 3M have not been included. This information is readily available from the NAFO Secretariat. For example, a Canadian RV survey was conducted on the Flemish Cap from 1978–85, which was subsequently replaced by an EU-Flemish Cap survey that has occurred annually since 1988. In 2003 the EU survey was extended to the Flemish Pass in Div. 3L. The EU Surveys include the following: EU in Div. 3M (1988–2017), EU-Spain in Div. 3NO (1995–2017) and EU-Spain in Div. 3L (2003–17).

It is suggested that information from RV surveys conducted outside the EEZ be utilized to inform the information presented in Table 6.4 and in Figures 6.6-6.11.

Page 6.19 – It is suggested to reword the following sentence "*The RV survey includes sampling of fish and invertebrates using a bottom otter trawl"* to the following statement "*The RV survey includes sampling of fish and invertebrates using a bottom otter trawl (Engel Hi-Lift) from 1971-1994 and a bottom shrimp trawl (Campelen) from 1995-present."*

The statement "*These surveys are the primary data source for monitoring trends in species distribution, abundance, of finfish in the regio*n" is misleading. It is suggested that the sentence be replaced with the following statement "*These surveys are the primary data source for monitoring trends in invertebrate and finfish species distribution, biomass and abundance in the region."*

Pages 6.22, 6.23, 6.24, 6.25, 6.26, and 6.27; **Figures 6.6, 6.7, 6.8, 6.9, 6.10, and 6.11 –** The figures do not have the RAA as indicated.

Pages 6.22-27 – Maps are based on 2015–16 DFO RV data only. It would be more appropriate to use an accumulation of several years of survey data (e.g. all data collected using Campelen trawl, 1995–present). 2015–16 could potentially be an anomalous year for one or more species.

6.4 – Special Areas

Pages 6.108-109 – The EIS does not provide a reference for the NAFO VME data.

A re-evaluation of the Placentia Bay-Grand Banks (PBGB) area to identify Ecologically and Biologically Significant Areas (EBSAs) took place in January 2017. Publications from this process are now available on the CSAS website (DFO 2019, Wells et al. 2019). Information regarding EBSAs relevant to the scope of the Proponent's EIS are provided within this Science Response Report.

Chapter 7.0 – Existing Socio-Economic Environment

Table 7.7 differentiates Northern Prawn and Pink (pandalid) Shrimps, however these are very similar shrimp. There should not be any catches from 3L in 2017 as the fishery was closed starting in 2015.

Figure 7.18 does not accurately represent the boundaries of the SFAs.

There are species minimally mentioned in Section 6, but then discussed thoroughly in Section 7. If there is sufficient fishery data to do an analysis, then biological properties of the species along with survey results should be discussed as well.

Chapter 8.0 – Assessment of Potential Effects on Marine Fish and Fish Habitat

8.2 – Project Interactions with Marine Fish and Fish Habitat

Page 8.8 – Clarification is suggested on when the abandonment program will be defined for the Project.

8.3 – Assessment of Residual Environmental Effects on Marine Fish and Fish Habitat

8.3.2 Mitigation

Page 8.11 – The text states "*BP will conduct an imagery-based seabed survey at the proposed wellsite(s) to confirm the absence of shipwrecks, debris on the seafloor, unexploded ordnance, and sensitive environmental features, such as habitat-forming corals or species at risk. The survey will be carried out prior to drilling and will encompass an area within a 500-m radius from the wellsite. If any environmental or anthropogenic sensitivities are identified during the survey,* *BP will notify the C-NLOPB immediately to discuss an appropriate course of action*." Clarification is suggested on whether the pre-drilling site survey will include plankton sampling throughout the water column such that sensitive larvae or fish eggs would be identified prior to CNLOPB notification/drilling commencement. Avoidance of sensitive periods of planktonic presence/production is a simple and effective mitigation measure. Additional information on the justification of restricting surveys to 500 m radius from a well, and also on the methods to be used is suggested.

Page 8.12 – The text states *"Where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly properties within muds and cements will be used. The chemical components of drilling fluids, where feasible, will be those that have been rated as being least hazardous under the Offshore Chemical Notification Scheme (OCNS) and Pose Little or No Risk to the Environment by the Convention for the Protection of the Marine Environment of the North-East Atlantic (refer to Section 2.9 for more information on chemical selection)."* It is unclear from this section what scenario would make it not feasible to use less toxic drilling muds and cements. There is no description provided with respect to the types/properties of higher toxicity materials mentioned. There is also no indication of mitigation measures that would be employed in the drilling process to counteract the potential adverse effects of utilizing more toxic materials.

8.3.3 – Characterization of Residual Project-Related Environmental Effects

Page 8.14 – *"Metals, including barium, and organic ingredients of drilling fluids and cuttings, other than Polycyclic Aromatic Hydrocarbons (PAHs), are not usually bioaccumulated from drill cuttings on the seafloor (IOGP 2016)."* Clarification on whether the bioaccumulation of metals, including barium, and organic ingredients of drilling fluids will not occur within the drill site vicinity is suggested. In addition, the EIS should explain whether PAHs are always bioaccumulated.

The EIS states *"The lack of bioaccumulation and low toxicity of cuttings substances indicates that direct toxicity of water-based (drilling) mud (WBM) or synthetic-based (drilling) mud (SBM) to benthic fauna is unlikely (IOGP 2016). However, it is difficult to distinguish between cuttings toxicity and the indirect effects on benthic communities caused by sediment alteration and organic enrichment (IOGP 2016)."* The first sentence indicates that direct toxicity of WBM or SBM to benthic fauna is unlikely. The second sentence indicates that it is difficult to distinguish between cuttings toxicity (which the previous sentence indicated is unlikely) and the indirect effects caused by sediment alteration and organic enrichment. The juxtaposition within the same paragraph should be addressed. In addition, it could also be argued that sediment alteration and organic enrichment are direct (not indirect) effects upon benthic fauna.

There are few studies that have tested the effect of seismic testing on marine mammals (Gomez et al. 2016) and the early life stages of fish and invertebrates, specifically its effect on the physiological and biological processes of larval development and settlement (Carroll et al. 2017). This uncertainty should be stated more clearly in the final sentence of penultimate paragraph on page 8.14.

Page 8.16 – The EIS states *"It has been found during production drilling that WBM cuttings may seriously affect biomarkers in filter feeding bivalves and cause elevated sediment oxygen consumption and mortality in benthic fauna; effects levels occur within 0.5-1 km of the discharge point (Bakke et al. 2013)."* The EIS should explain how this statement relates to the previous conclusion of low toxicity of cuttings (IOGP 2016). For example, are the scenarios being compared the same with respect to scale, environmental factors, and testing detection limits? In addition, the "*effects levels that occur within 0.5 to 1 km of the discharge point"* encompass larger linear distances (ha estimates are not provided) than the depositional models for the proposed project predict in Section 2.8.2 (100 mm or greater were confined to a maximum distance of 14 m from the discharge point). These findings may indicate that the toxic effects of cutting deposition may be related to factors other than the thickness of sediment deposited.

The EIS states *"When considering the bioaccumulation of chemicals from drill cuttings in marine organisms, several bioaccumulation bioassays using WBM cuttings found that metal concentration in the tissues of exposed animals were very similar to those in the tissues of unexposed animals (IOGP 2016)."* Clarification is suggested on whether similar studies were conducted with respect to bioaccumulation of SBM.

The following statement in the EIS is unclear *"Ellis et al. (2012) reviewed the results of sediment sampling from 72 production and exploration drilling platforms to assess the zone of influence of sediment contamination and biological effects on benthic communities."* It is unclear if the following discussion refers to data from production or exploration drilling scenarios. The zones of influence presented for WBM ranged from 2–20 km while those for SBM ranged from 200 m to 2 km. These zones of influence ranges are substantially higher than those predicted by dispersion modelling for the proposed project in Section 2.8.2.

Page 8.17 – It is noted that there is very little information on the effects of drilling waste on sea pens. Sub-lethal effects are also unknown. As such, sea pen behaviour and conclusions should be made with caution.

The statement "*The survey will be carried out prior to drilling and will encompass an area within a 500-m radius from the wellsite*" should be expanded. Additional information is suggested to provide a description of the surveys methods and an explanation of why a 500 m radius was selected.

8.3.5 – Summary of Project Residual Environmental Effects

Page 8.33 - Table 8.5 – It is suggested to change the magnitude of residual effects for discharges from Low (L) to Moderate (M) with respect to both change in risk of mortality or physical injury and change in habitat quality and use.

8.4 – Determination of Significance

Section 8.4 was examined but no comments were submitted during the review process.

8.5 – Follow-Up and Monitoring

Page 8.34 – It is not possible to comment upon the proposed Follow-Up Program as no details are provided with respect to the methodologies. It is suggested that at a minimum a detailed sediment sampling for chemical and grain size-analysis, and benthic fauna (including finfish and invertebrates) sampling for chemical and population analysis, occur prior to and after the drilling of an individual well. The planned visual monitoring indicated will provide valuable information with respect to sediment deposition and benthic fauna distributions; however, quantitative chemical and toxicity analysis methodologies should also be incorporated.

Chapter 11.0 – Assessment of Potential Effects on Special Areas

Sections 11.2–11.4 were not evaluated due to the unavailability of designated subject matter experts during the review period.

Chapter 15.0 – Accidental Effects

15.4 – Fate and Behaviour of Potential Spills

15.4.3 – Model Scenarios

For the oil spill blow out scenario, the oil produced is unknown. However, the oil is assumed to be a very light crude oil (Table 15.5). It appears that natural attenuation is the only oil spill countermeasure considered in this case. If so, the expected oil degradation (considering dissolution, evaporation once oil reaches the surface, biodegradation, photo-chemical weathering) rates, should be clarified (e.g. days, weeks or months). It should be noted that a longer degradation period may be occur, since the model blow out scenario indicates a 120-day unmitigated release as a worst case scenario.

There is an oil mass balance calculator in section 7.2.2.2 (Figure 7.7) in Appendix D. This information should be linked to Chapter 15.

New regulations establishing a list of spill-treating agents (Canada Gazette 2015) are in place that may permit the use of chemical dispersant to treat oil spilled offshore. This should be considered an option as an oil spill countermeasure.

The EIS should clarify whether attempts would be made to recover surfaced oil (booms and skimmers) or whether the sea conditions are unfavorable for such operations. In situ burning should be at least mentioned as a countermeasure along with potential impacts to the marine environment. It is suggested that the EIS be updated to explain whether the use of herding agents would be considered an option to thicken oil slicks when recovering or burning oil at the surface.

15.5 – Effects Assessment

15.5.1 – Marine Fish and Fish Habitat

This section is well researched and written. However, a number of studies conducted by R.A. Khan in the late-1980s and 1990s should be included. These studies investigated the effects of exposure to Hibernia Crude Oil upon a number of marine fish and seabird species from the Newfoundland area (e.g. see Khan and Kiceniuk 1984, Kiceniuk and Khan 1987, Khan and Ryan 1991, Khan and Nag 1993, and Dey et al. 1983).

15.5.2 – Marine and Migratory Birds

"*The use of dispersants during oil spills has been promoted as a means of reducing effects to birds.*" The EIS should explain whether dispersant may be considered to treat oil that has reached the surface of the sea. If dispersant would be used, more information should be added in the EIS to consider the impacts on the marine ecosystem (marine organisms and mammals) from the application of dispersant to treat oil spilled in the Orphan Basin and surrounding areas that may be impacted.

Chapter 16.0 – Effects of the Environment on the Project

16.1 – Key Environmental Considerations

16.1.2 – Oceanographic Conditions

Pages 16.5 - 16.8 – This subsection concisely repeats information provided in Section 5 on circulation, currents, and waves in the region; however, little additional information is added. The deficiencies identified in Section 5 regarding vertical structure of currents, strong upper-ocean currents including inertial oscillations, and tall eddies also apply to this subsection.

The 2014 Eastern Newfoundland SEA is not referenced in this subsection, but it is referenced (once) in the subsection on Weather Conditions (16.1.1, page 16.4).

Page 16.14 - Table 18 – The planned implementation of a physical environment monitoring program is important, although details are not provided in the EIS. It is suggested to include telemetry of upper-ocean current and wave measurements to the rig if feasible.

Appendix B – Drill Cuttings Modelling Report

In the EIS the transport and dispersion of drill cuttings is simulated with a tracer model of ParTrack based on current fields of HYCOM plus webtide tidal currents. The HYCOM data is daily and the tidal current is 3-hourly.

Pages 1 and 7 – Information on the currents from the HYCOM model simulation should be provided, particularly on the extent to which the model simulation is representative of the various current components in Orphan Basin. It is unlikely that the model simulation would resolve some of the observed strong current features in the region (e.g. upper-ocean inertial oscillations). Further information on the HYCOM model simulations is provided in Appendix D but this is not apparent from Appendix B.

It would seem more appropriate for the Dose related Risk and Effect Assessment Model (DREAM) simulations to use a time series of observed current profiles such as those available at the Lona O-55 site, at least as a complement to the HYCOM currents and possibly as the primary source of currents information.

The discussion of drilling discharge fate could benefit from consideration of the results of DFO studies of drilling waste drift and dispersion (e.g. Hannah et al. 2006), although the Orphan Basin Project Area is in deeper water than (at least) most past applications of the Benthic Boundary Layer Transport (BBLT) discharge dispersion model.

It is useful to have a brief description of model validation and model uncertainties of HYCOM and webtide. Moreover, the model performance of HYCOM in the Study Area should be presented.

On page 1, the report mentioned that daily data are used. However, 3-hourly HYCOM currents are used in 5.2.4. This should be clarified.

The report does not explain whether horizontal diffusion is used in the dispersion. The EIS should be updated accordingly.

There should be a more thorough discussion of the uncertainties in the model results.

In general, there is a reliance on a reanalysis run of HYCOM 1/12th for 2005–10 in the EIS.

There is no verification of features in HYCOM compared to what was said in the literature review.

There is no verification of HYCOM reanalysis against available moored observations.

There is no other reference model used to provide an idea of the accuracy of ocean models in the area (see Figure 1).

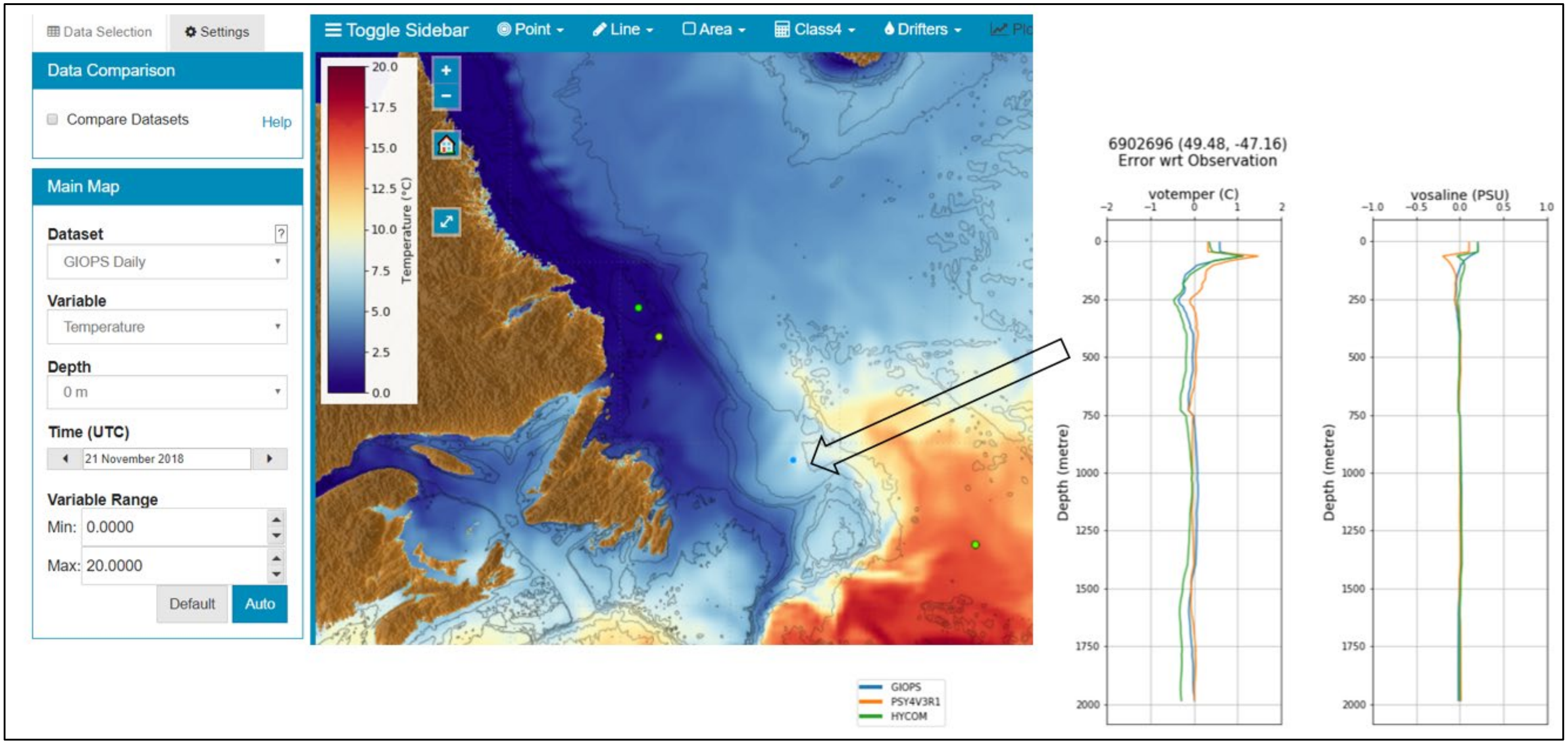

Figure 1: Example of HYCOM performance against ARGO float.

There are other more up-to-date reanalysis available: IE GLORYS 12 (Mercator Ocean International) CMEMS, 1993-2017. These include more recent times and can look at evolving trends in the environment in the Orphan Basin.

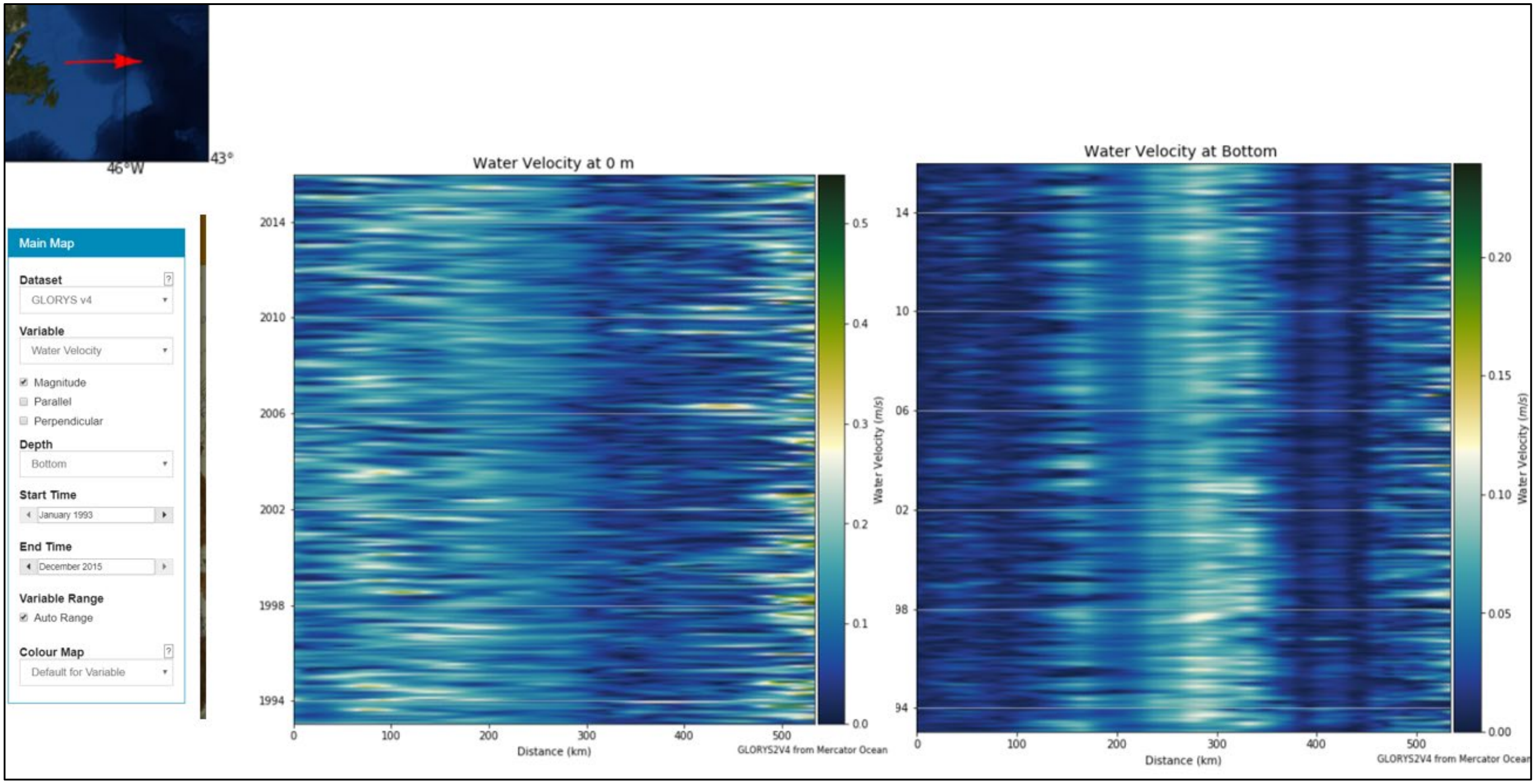

Figure 2: 1993–2015 Current Variability OB from Reanalysis.

The EIS should explain why HYCOM is not used to provide a typical annual stratification.

The GLORYS4 reanalysis shows a warming of bottom temperature in WOA area of 1°C. This suggests changing stratification/density in the area over 20 years.

The EIS should explain how such a change would affect (if any) the suspension of oil/drilling fluid in the water column, or change the distribution pattern of thick drilling muds (see Figures 3 and 4).

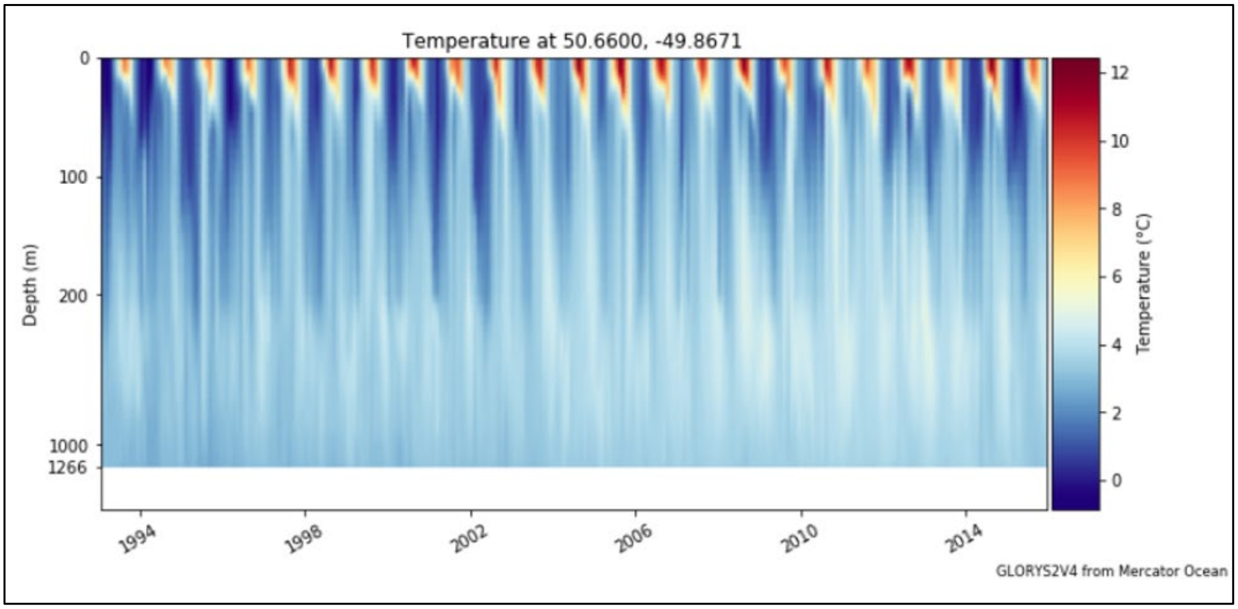

Figure 3: Temperature evolution in WOB from GLORYS 4.

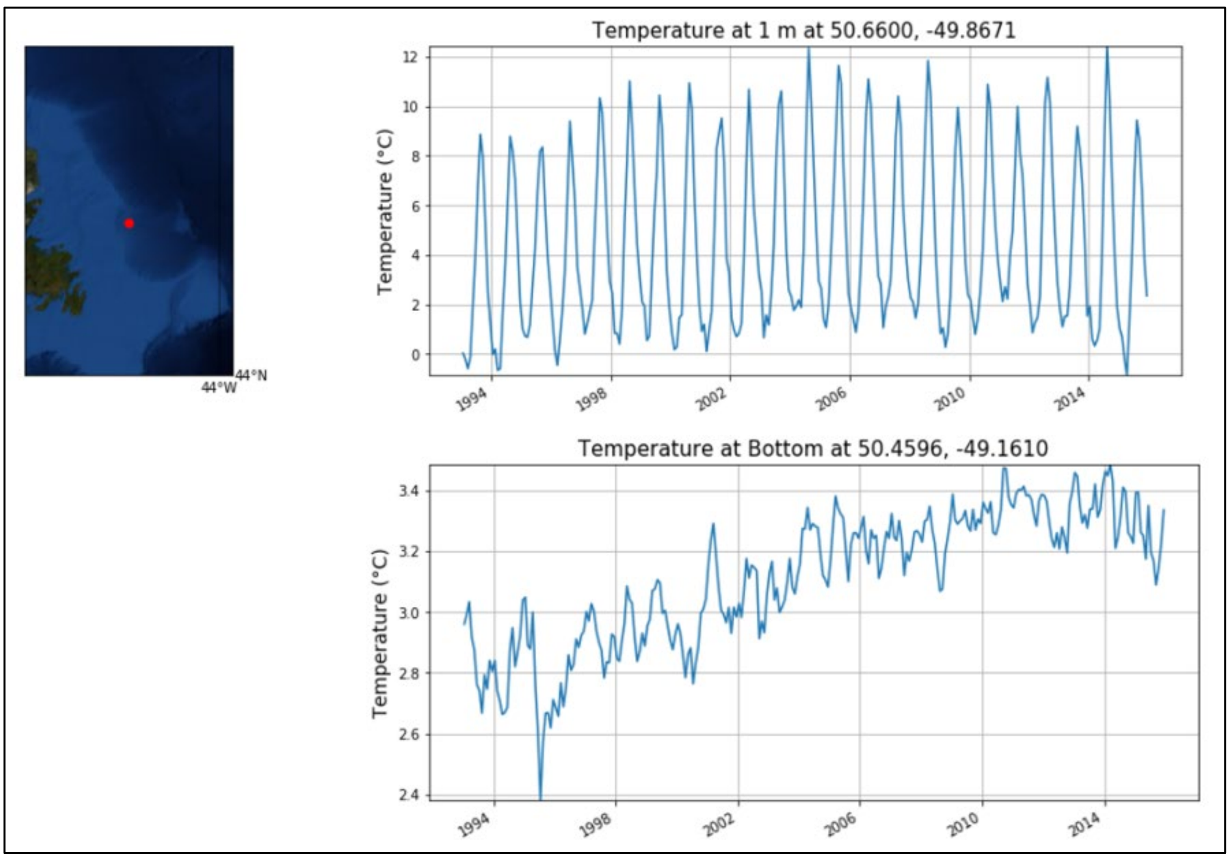

Figure 4: Monthly averaged temperature time series from GLORYS 4 reanalysis at 50.67N, -49.8671W from 1992–2016 for surface and bottom layer.

Clarification is suggested on why surface velocity is used to indicate an area of high surface energy for events that happen at 1,300 m or more. The EIS should also clarify why the HYCOM output used with currents at the bottom did not determine high or low energy situations.

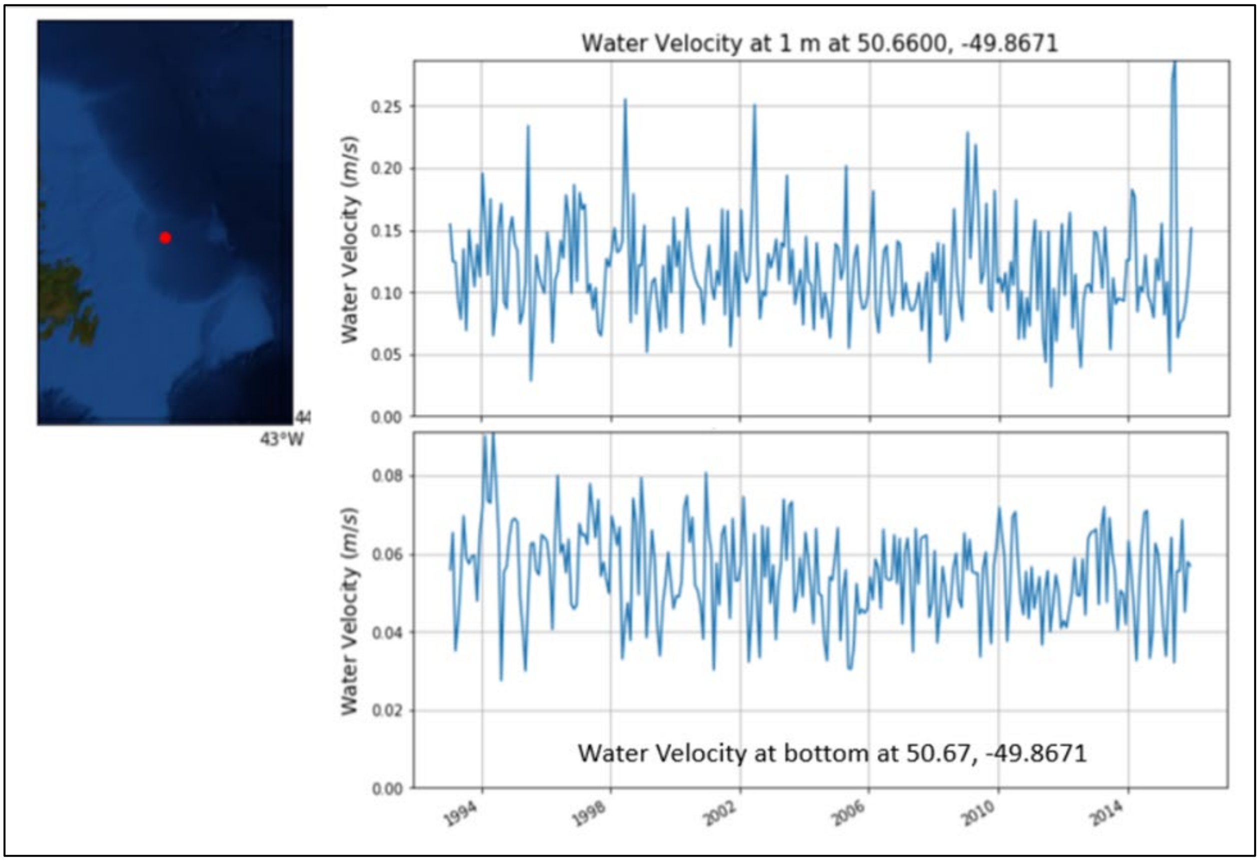

Figure 5: Monthly averaged water velocity from GLORYS 4 reanalysis at 50.67N, -49.8671W from 1992–2016 for surface and bottom layer.

The information provided about the drilling waste dispersion model in Appendix B is not adequate for evaluation of the validity of the predicted potential environmental effects. The models described in the DREAM package relate to the fate and effects of oil and other chemicals associated with liquid discharges (oil spills, produced water etc.) and mostly consider surface effects (currents and winds). Appropriate references for the ParTrack model are not provided. The model description also appears to be incorrect.

In addition to lacking model structure specifics for this application, the information used to parameterize the model is not complete in Appendix B. The types and amounts of drilling wastes are specified for the two model wells and two periods of current data (low and high in the upper 100 m water column) are simulated. The models use five years of HYCOM data (2006–10) in depth bins of 100 m (40 bins over 5,000 m). What is not specified is the time step for the current inputs. It may be inferred from the text (Section 5.2.5) that only the 45 day average values from the upper 100 m are used for the exercise. The EIS should clarify whether it is the three hour time step shown in the current figures and is it the entire current profile (Fig 5.7 and 5.8). The rationale for using the top 100 m of current records to select the low and high current periods is not provided. This depth may be relevant for initial release of SBM cuttings (at 15 m) but does not capture current behavior for the WBM releases (near bottom) or the later fate of SBM particles.

It can be assumed that there is no strong argument for coherence of the currents throughout the water column in the Orphan Basin (Carter and Schafer 1983, Zantopp et al. 2017). In the EIS, salinity and temperature needed for water mass density calculations are extracted from the World Ocean Atlas on a monthly basis. This EIS should be updated to explain whether this means that one value per depth bin is used for the entire modelled period. In addition, the World Ocean Atlas has different depth bins for the temperature and salinity data (World Ocean Data 2018). Further information pertaining to how these reconciled with the HYCOM data bins is suggested. The particle size distributions are provided for barite, bentonite and drill cuttings (Figure 5.4) but the use of these in the model is not described. The ParTrack model uses size categories and because of the short duration of the model (30 days) only the largest four or five size categories of particles will actually settle out (Rye et al. 1998, 2006). As a significant portion of the wastes are fines, they are assumed to remain in suspension and their eventual fate which may include deposition at considerable distance (Lepland et al. 2000, NGU 1997) possibly with low current areas on the upper rise or the “zone of no motion” (Carter and Schafer 1983 or focusing within nepheloid zones of the Orphan Basin [Carter and Schafer 1983]).

The ParTrack model does not consider resuspension (Rye et al. 1998). The reported near bottom currents are variable (Carter and Schafer 1983, Zantopp et al. 2017) and certainly have the potential for significant resuspension at times.

The drilling waste dispersion modeling was completed using a suite of software developed for the Norwegian offshore. The particle tracking model used to make drilling waste deposition predictions within this suite is ParTrack (Rye et al. 1998). The DREAM model also referenced in the report predicts dispersion and potential effects of dissolved waste components. Although the DREAM model is explained in detail in Appendix B, it is not used to predict and assess the potential for effects of drilling wastes since soluble components are not considered in this analysis. It should be noted that ParTrack does have the capacity to assess soluble components of drilling wastes that may be considered harmful such as glycol (Rye et al. 1998) but this has not been completed and should be addressed.

Within the EIS the Proponent modelled two wells: one in the east (EL 1145) in relatively shallow water and one in the west (EL 1149) in deeper water. The rationale for selection of the two drilling sites is not provided. In addition, each well is modelled separately. In consequence the effects of each of the 20 wells that may be drilled in the Study Area during the study period is evaluated separately and no effort is made to assess the potential for cumulative effects among wells for this Project. ParTrack does have the capacity to model multiple wells (Rye et al. 2006) and this is identified as a deficiency. It is further noted that the potential for cumulative effects among exploratory drilling programs is not modelled for assessment even though there may be up to 100 wells proposed in the Newfoundland offshore between now and 2030 (Government of Newfoundland and Labrador 2018). By only assessing the potential effects from two wells, which are deemed limited and negligible, the Proponent does not consider the cumulative effects of the many anticipated activities. The fragmented approach perpetuates the potential for habitat destruction as “death by a thousand cuts” (Laurence 2010).

The environmental effects assessment for benthic effects of drilling waste deposition considers only smothering as a significant and short-term effect with a threshold at 6.5 mm (Smit et al. 2006). It does not take into account the recent literature on effects on sensitive benthic species and the potential for interference with feeding etc. or the recent studies of Trannum et al. (2010) where benthic communities were affected by 3 mm of WBM. In addition to effects on sediment oxygen, the authors suggest that the observed effects may be also related to the sharpness of WBM particles when compared to natural sediments and recommend a reconsideration of attributing WBM effects to purely physical (smothering) processes. Schafer et al. (1981) reports significant abundances of benthic foraminifers in parts of the Orphan Basin particularly on the upper slope rise the where deposition of fine material is expected to occur (Carter and Schafer 1983). There is very little information in the sensitivity of benthic foraminifers to drilling wastes; however, they do show reduced activity when drilling wastes are present and Denoyelles et al. (2012) have suggested that they would be suitable as test organisms and indicators of benthic effects.

Details of the currents in the Study Area are not adequately presented. This is particularly the case for deep water currents which may affect benthic boundary layers and resuspension. Carter and Schafer (1983) provide an excellent summary of the currents across the Study Area and of their potential effects on sedimentation and resuspension as well as on the substrates and associated fauna. They also summarize available data on current direction and strength for the larger area which indicates that the deep water currents are also subject to intermittent reversal of direction (Carter and Schafer 1983). As the summary figures of the currents used to parameterize the model are not provided, it cannot be determined if these features are adequately represented by the model.

As only the largest particles settle out during the modelled period, and because fine particles make up the majority of particles, the majority of the drilling wastes are predicted to remain in the water column and advect elsewhere. Appendix B states that approximately 50% of the waste material will be transported outside the study boundary, and because it is dispersed, will only eventual settle to thicknesses of 1 um or less and therefore will not have any significant effects. The estimate of 50% is not supported by either the data provided (Figure 5.4) or the model descriptions (Rye et al. 1998, 2006). A figure of approximately 75% may be more appropriate (Table 1). This means that for the proposed 20 wells, assuming that the information used for the two modelled well simulations is applicable across the Study Area, there will be a total of between 75,000 and 108,000 t of waste materials that are not accounted for in the modelling exercise. The fate and potential effect of these particulate wastes is not considered in the assessment.

Table 1: Calculation of the amount of fine material not captured in the contour plots of drilling waste sedimentation.

-	-	-	**Discharge amounts per well (tonnes)**					**Total not captured by ParTrack (tonnes)**					-
Parcel	Z (m)	wells	cuttings	mud	Ba/Be	SBM	total	cuttings	mud	Ba/Be	SBM	total	% wastes discharged
EL1145	1,360	5	1,938	4,298	1,061	288	7,585	3,876	18,696	4,987	72	27,631	0.73
EL1146	-	5	1,938	4,298	1,061	288	7,585	3,876	18,696	4,987	72	27,631	0.73
EL1148	-	5	1,938	4,298	1,061	288	7,585	3,876	18,696	4,987	72	27,631	0.73
EL1149	2,780	5	1,844	4,159	787	288	7,078	3,688	18,092	3,699	72	25,551	0.72
Proportion not deposited	-	-	.4	.87	.94	.05	-	-	-	-	-	-	0.73
Total	**-**	**-**	**-**	**-**	**-**	**-**	**29,833**	**-**	**-**	**-**	**-**	**108,444**	**-**

Appendix D - Oil Spill Trajectory Modelling Report

5.3 – Environmental Data

The extent to which the HYCOM model simulation has been validated with observational currents data is unclear. This potential deficiency could have significant implications for the reliability of the results presented elsewhere in Appendix D.

Figures B.1.5 – B.1.6 – The displays of current speed indicate that the upper-ocean currents in the HYCOM simulation may be significantly weaker than those indicated by the moored current measurements at the Lona O-50 site in Section 5. A comparison of the model currents with observed currents is suggested.

7.2 – Deterministic Simulation Results

The mass balance (including Figure 7.7) does not take into consideration the photo-chemical weathering of oil at the surface of the sea. A recent lab study has shown that exposure of oil to sunlight can cause photo-chemical weathering of oil, thus causing significant changes in the chemical composition of light crude oil within a few days (Ward et al. 2018). In addition, Appeli et al. (2018) reported that the partial photo-oxidation of oil on the water surface led to 50% of the weathered saturates and aromatics being transformed to oxygenated hydrocarbons within 10 days during the Deepwater Horizon oil spill based on photo-oxidation of oil using ultraviolet irradiation conducted in the lab. However, given that a spill will occur offshore of Newfoundland and that there will most likely be significant wave energy and dilution over a large spatial area, the production of oxidized chemicals from the photo-chemical weathering of oil should have negligible impact on the marine environment. This EIS should be updated to reflect this information.

Conclusions

The sufficiency of baseline data and appropriateness of methodologies to predict effects

- There is a deficiency of information pertaining to data beyond the deep waters (e.g. off continental shelf and slope) which represent those of the Project Area that remain relatively understudied and undefined. Therefore, the distribution and diversity of deep water habitats and biota that they support are poorly described, which makes it difficult to comment on potential impacts and effective mitigation strategies.
- Information from Spanish, Portuguese, and European Union (EU) RV surveys conducted outside of the 200 mile Canadian EEZ in NAFO Divisions 3L and 3M have not been included in the EIS. This information is readily available from the NAFO Secretariat's website.
- More attention to extreme environmental conditions in the EIS is considered necessary.
- It is suggested to include error estimates on the drift methodologies as well as better use of the available physical oceanographic analysis systems with more up to date study time frames (i.e. 2015 or later) in the EIS.
- Oceanographic trends from HYCOM and GLORYS systems over the last 25 years would be useful to provide a perspective on how stratification and currents could change over time.
- The information provided about the drilling waste dispersion model in Appendix B and in Section 2 is not adequate for evaluation of the validity of the predicted potential environmental effects.

- The ParTrack model used does not consider the fate of fine particulates which may be transported over considerable distances.

The mitigation measures proposed by the Proponent

- The mitigation measures are generally well described and are reasonable based on current knowledge.
- There is no capacity indicated on which oceanographic systems and which oil spill models would be used in real time in the event of a spill or for monitoring potential discharge areas of drilling muds. Such a system could be run on a continuous basis during drill operations, and would provide readily available drift predictions should an incident arise.

The level of certainty in the conclusions reached by the Proponent on the effects

- There are few studies that have tested the effect of seismic testing on marine mammals (Gomez et al. 2016) and the early life stages of fish and invertebrates, specifically its effect on the physiological and biological processes of larval development and settlement (Carroll et al. 2017). This uncertainty should be stated more clearly in the final sentence of penultimate paragraph on page 8.14.
- The quality/accuracy of the drift predictions are not estimated. It would be beneficial to have a comparison of drifter systems against actual observations of drift. This would help qualify the results.
- As the description of the oceanographic parameters for the drilling waste model is inadequate, it cannot be determined if the currents used in the model adequately represent the hydrographic environment of the Study Area. The level of certainty of the conclusions regarding fate and effects of the wastes can therefore not be assessed.

The manner in which significance of the environmental effects, as they pertain to DFO's mandate, have been determined (i.e., the scientific merit of the information presented and the validity of the Proponent's methodologies and conclusions)

- The conclusions are generally supported by the literature review although the EIS should more strongly state that the effect of seismic testing on marine species has significant knowledge gaps due to the lack of standardization of both terminology and measurements of sound exposure which makes comparisons among studies difficult and precludes single species studies from reaching general conclusions on other regions and taxa (reviewed in Carroll et al. 2017).
- The assessment of the potential effects of drilling wastes on fish and fish habitat could not be evaluated because the description of the model is inadequate. Further, the fate of fine particulates (<65 um) are not considered in the assessment. This is a significant oversight since fine particulates make up the majority of the drilling wastes (up to 85% or more).
- The EIS deals only with the fate and effects of drilling wastes from a single well and does not assess the potential for cumulative effects of multiple wells (up to 20 in seven years).

The follow-up program proposed by the Proponent

- It is not possible to comment on the proposed follow-up program as no details are provided with respect to methodologies.

- The EIS does not include a follow-up or routine underway component with respect to drift projections of a variety of discharged fluids.

Whether additional information is required from the Proponent to complete the technical review

- Adequate description of the model parameterization for the drilling waste dispersion is required.
- Assessment of the fate of the fine particulates from the drilling wastes should also be included in the assessment.
- Assessment of the potential effects of multiple wells is required.
- A comparison of results with models other than HYCOM in the area would be useful as well as using a more modern approach than only WOA climatology for evaluating the impact of stratification on results.
- Information from Spanish, Portuguese, and EU RV surveys conducted outside of the 200 mile Canadian EEZ in NAFO Divisions 3L and 3M is required.
- Sponge SBAs (Kenchington et al. 2016) and vulnerable marine ecosystem (VME) habitats, as identified by the Working Group on Ecosystem Science and Assessments (NAFO 2015; see ToR 1.1) should be described and mapped within the EIS. In some cases, VMEs and SBAs are identified using predictive models.
- Habitat suitability models for corals have been developed for the Newfoundland and Labrador shelf region by Gullage et al. (2017). The project area and the Study Area overlap suitable habitat for multiple coral species, and this should be considered within the EIS.
- Standardized scales for RV catch weight (kgs) on maps (Figure 6.6 to 6.11) bias species distributions. The figures should be scaled based on the biomass of the particular species to allow for the visualization of important areas or “hotspots” for all fish species (e.g. small or rare fish).

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Sources of Information

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This Report is Available from the:

Center for Science Advice (CSA)
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Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-3769
ISBN 978-0-660-45215-9 Cat. No. Fs70-7/2022-041E-PDF

Correct Citation for this Publication:

DFO. 2022. Review of the Environmental Impact Statement for the BP Canada Energy Group Newfoundland Orphan Basin Exploration Drilling Program. DFO Can. Sci. Advis. Sec. Sci. Resp. 2022/041.

Aussi disponible en français :

MPO. 2022. Examen de l'énoncé des incidences environnementales du projet de forage exploratoire dans le bassin Orphan de Terre-Neuve de BP Canada Energy Group. Secr. can. des avis sci. du MPO. Rép. des Sci. 2022/041.