NRCan's Technical Comments – EIS – BHP Canada Exploration Drilling – Annex 1-4

ANNEX 1: Advice to the Agency

Table 1: Please use the table below to provide advice for the Agency's consideration in its recommendation to the Minister of Environment and Climate Change and preparation of draft conditions

Questions	Responses/Comments
• Has the Proponent described all project components and activities in sufficient detail to understand all relevant project-environment interactions? If not, identify what additional information is needed.	Geology and geohazard relevant to the project have not all been identified by the Proponent. This includes gas hydrates, steep slopes, slope instability, sediment failures, sediment preconditioning, fluid escape, diapirs and weak sediment layers. NRCan is of the opinion that current oil spill models do not adequately consider the fate of the heavier components in the oil. Please see Annex 4 for additional information.
• Were the study areas sufficient to predict potential effects from all relevant project-environment interactions, and to consider the effects within a local and regional context? • Is the baseline information sufficient to characterize the existing environment, predict potential effects and obtain monitoring objectives? If not, identify what additional information is needed.	Geological information is general and regional in nature. Well-site surveys for geohazards and geotechnical properties will be initiated by the Proponent in advance of drilling in the vicinity of the proposed drilling sites.
Alternatives Assessment	

Questions	Responses/Comments
• Has the Proponent adequately described the criteria it used to determine the technically and economically feasible alternative means? • Has the Proponent listed the potential effects to valued components (VCs) within your mandate that could be affected by the technically and economically feasible alternative means? • Has the Proponent adequately described why it chose each preferred alternative means? • Are there other alternative means that could have been presented? If so, please describe.	There are no alternative geophysical methods discussed. However, well-site surveys are standard practice and will be undertaken by the Proponent prior to drilling. Oil spill modelling is standard practice for exploratory drilling projects.
Environmental Effects Assessment	
• Has the Proponent clearly described all relevant pathways of effects to be taken into account under section 5 of CEAA 2012? • Has the Proponent identified all potential effects to VCs, including species at risk, within your mandate? • Were all potential receptors considered?	The Proponent has proposed well-site surveys for geohazards in advance of drilling. NRCan is of the opinion that current oil spill models do not adequately consider the fate of the heavier components in the oil. Please see Annex 4 for additional information on this.
• Were the methodologies used by the Proponent appropriate to collect baseline data and predict effects, why or why not? • Has the Proponent explicitly addressed the degree of scientific uncertainty related to the data and methods used within the assessment? If there are unaccounted for scientific uncertainties, describe them and indicate the options for increasing certainty in the predictions?	Standard industry site-survey techniques will be used. Scientific uncertainties are not mentioned and would lie within data interpretation.
• Are the predicted effects described in objective and reasonable terms (e.g. beneficial or adverse, temporary or permanent, reversible or irreversible)?	NRCan does not have any comments.

Questions	Responses/Comments
• Has the Proponent adequately assessed the potential cumulative environmental effects, including using appropriate temporal and spatial boundaries , examining physical activities that have been and will be carried out, and proposing mitigation and follow-up program requirements? Provide rationale.	Not all geohazards are identified or characterized. Other potential geohazards are; gas hydrates, steep slopes, sediment preconditioning, fluid escape, diapirs and weak sediment layers. NRCan is of the opinion that current oil spill models do not adequately consider the fate of the heavier components in the oil. Please see Annex 4 for additional information on this.
• Has the Proponent adequately described the potential for environmental effects caused by accidents and malfunctions, including the types of accidents and malfunctions, their likelihood and severity and the associated potential environmental effects? If not, identify what additional information is needed.	Not all geohazards have been identified. The consequences of geohazard accidents are not identified.
• Are you satisfied with the Proponent's assessment of effects of the environment on the Project? • Has the Proponent characterized the likelihood and severity appropriately? Provide rationale.	Not all geohazards have been identified. Consequences of geohazard accidents have not been identified.
• Has the Proponent sufficiently described and characterized the project activities and components as they relate to federal decisions within your mandate? If not, identify what additional information is needed. • Are changes to the environment, as they relate to federal decisions within your mandate, sufficiently described? If not, identify what additional information is needed.	Regional geology has been adequately described. Not all geohazards have been identified. Potential risks to the environment have not been fully examined.
Mitigation	

Questions	Responses/Comments
• Has the degree of uncertainty regarding the effectiveness of the proposed mitigation measures been described? If not, identify what information is needed. • Is it clear how each proposed mitigation measure links to each potential pathway of effect?	More details about geohazards in the region are needed. Additional mitigation measures may be needed following the well-site surveys.
• Would you propose different or additional mitigation measures? If so, provide a description of the mitigation measure(s), with rationale.	Well-site surveys for geohazards and geotechnical properties, in advance of drilling, are standard practice for the industry.
• Which of the proposed mitigation measures and/or project design elements do you consider to be necessary to reduce the likelihood of significant adverse environmental effects? Provide rationale.	Well site/geohazard/geotechnical surveys are necessary to identify the likelihood of effects from geohazards. These surveys will identify potential geohazards that could be present in the proposed drilling sites, allowing for detailed consideration in Project planning.
Residual Adverse Environmental Effects	
• Are the identification and documentation of residual environmental effects described by the Proponent adequate? If not, what are the aspects for which there is uncertainty and, where possible, indicate how these residual effects can be best described. If there is uncertainty, what are the options for increasing certainty?	NRCan does not have any comments.
• Did the Proponent provide a sufficiently precise, ideally quantitative, description of the residual environmental effects related to your mandate? Identify any areas that are insufficient.	NRCan does not have any comments.
Determination of Significance	
• Are the conclusions on significance in the EIS supported by the analysis that is provided?	NRCan does not have any comments.

Questions	**Responses/Comments**
• Are the Proponent's proposed criteria for assessing significance appropriate? This includes how the criteria were characterized, ranked, and weighted. Provide rationale. Where the Proponent has **not** used one of the Agency's recommended key criteria (magnitude, geographic extent, duration, frequency, reversibility, and social/ecological context), has a rationale been provided?	
• Were appropriate methodologies used in developing the conclusions on significance?	NRCan does not have any comments.
• Do you agree with the Proponent's analysis and conclusions on significance? Provide rationale.	NRCan does not have any comments.
Monitoring and Follow-up	
• Does the proposed monitoring and follow-up program verify the predictions of the environmental assessment as they relate to section 5? Please explain additional monitoring or follow-up needed to address uncertainty in the effects assessment.	The well site surveys for geohazards and geotechnical properties, initiated by the Proponent in advance of drilling, will be conducted. Additional follow-up may be necessary after the site survey. The geological and geotechnical properties of the sediment and their susceptibility to failure should be understood, before drilling takes place.

Questions	Responses/Comments
• Does the proposed monitoring and follow-up program verify the effectiveness of proposed mitigations as they relate to section 5? Please explain additional monitoring or follow-up needed to address uncertainty in the proposed mitigation.	The well site surveys for geohazards and geotechnical properties will be conducted in advance of drilling. These surveys will only identify potential geohazards in the vicinity of the proposed drilling sites. If geohazards are identified, these may require avoidance and/or special consideration in Project planning.
• Is the objective of the follow-up program clear and measurable? • Does the follow-up program include sufficient detail, and technical merit, for the Agency to achieve the stated objective through a condition (e.g. sufficient baseline dataset, monitoring plans, acceptable thresholds of change, contingency procedures)?	The objectives are clear and measurable with well-site surveys for geohazards and geotechnical properties initiated in advance of drilling. This should provide sufficient data to achieve stated objectives.
• Are you aware of any federal or provincial authorizations or regulations that will achieve the same follow-up program objective(s)? If so, how do these achieve the objective(s)?	The well site surveys for geohazards and geotechnical properties is a standard industry approach normally not done by government.
Additional comments, views, advice	
• Provide any other comments.	NRCan does not have any additional comments.

ANNEX 2: Information requirements directed to the Proponent

Table 2: Please use the table below to provide your department's comments and suggestions for information that should be required from the Proponent to ensure the information in the EIS is scientifically and technically accurate and is sufficient to make a determination of significance on environmental effects.

ID	Project Effects Link to CEAA 2012	Reference to EIS guidelines	Reference to EIS	Context and Rationale	Specific Question/ Request for Information
NRCan-01	Geohazards	16.Geohazards	16.1.1 Seismicity and Geohazards	The geomorphology within southern Orphan Basin is characterized by numerous canyons with steep side walls, numerous steep failure scarps, mass transport deposits and remnant slide blocks.	NRCan recommends that the Proponent provide a quantitative analysis of possible recurrence of submarine landslides based on literature within the region of the project, especially within Orphan Basin.
NRCan-02	Geohazards	16.2.1 Geohazards	16.1.1 Seismicity and Geohazards	EL1157 and EL1158 prospect licenses are located on the Newfoundland Slope on the south side of Orphan Basin. Water depths within the region of the project are between 300 and 2500 meters, with steep slope angles ranging between 4 and 30 degrees in the region.	The earthquake and tsunami of 1929 and other nearby regional seismicity should be discussed and its importance to regional earth stability assessment, given the very steep slopes and poorly understood sediment properties found in project area. This may be accomplished by reviewing

					relevant research literature from the region.
NRCan-03	Geohazards	16.2.1 Geohazards	16.1.1 Seismicity and Geohazards	Water depths within the project area are between 300 and 2575 meters, with steep slope angles in the region ranging between 4 and 30 degrees. The geomorphology within the region of the project is characterized by numerous canyons with steep side walls, numerous steep failure scarps, mass transport deposits and remnant slide blocks. These features are overlain by poorly understood stratified drift deposits in the nearby Sackville Spur.	NRCan recommends that the Proponent review the sediment failure risk (especially in the upslope direction) by uncontrolled well blowout given the very steep slopes and poorly understood sediment properties found in the region, and outline any contingency plan or mitigation measures in place for such an accident.
NRCan-04	Geohazards	16.2.1 Geohazards	16.1.1 Seismicity and Geohazards	Gas Hydrate occurrences have been identified on Northern Flemish Pass by Mosher (2008), near EL1157 and EL1158.	NRCan recommends that the Proponent should provide evidence of the presence and extent of gas hydrates in the Flemish Pass and Sackville Spur Area, and its likely presence in and potential impact on the project area. This includes how it could precondition and impact the stability of the sediments in the greater prospect area.
NRCan-05	Geohazards	16.2.1 Geohazards	16.1.1 Seismicity and Geohazards	Preconditioning of sediments in Flemish Pass and in the region of the project is not understood. Increased pore pressure may be possible because of the presence of gas	NRCan recommends the Proponent provide the role of preconditioning factors on sediment stability in the project area. Discussion of

				hydrates in the Flemish Pass/Orphan Basin area.	preconditioning factors should include the following: salt diapirs, shallow fluids and fluid escape features, gas hydrates, and their potential for excess pore pressure and stratigraphic weak layers from ice rafted debris as proposed by Rashid, (2019).
NRCan-06	Oil Spill Modelling	15.2 Fate and Behaviour of Potential Spills	15.2 Fate and Behaviour of Potential Spills	At the depths of 2,338 and 2,047 m and temperatures from 85°C in the reservoir to approximately 2°C in the ocean water for the proposed project, methane, ethane and propane would leave the well as supercritical fluids or liquids. It appears that the oil will have to ascend to approximately 453 m before the methane would become a gas and form bubbles.	Please explain how this delay in bubble formation would affect model results.
NRCan-07	Oil Spill Modelling	15.2 Fate and Behaviour of Potential Spills	15.2 Fate and Behaviour of Potential Spills	To aid in understanding the oil mass balance results, NRCan requested that Proponent suggest a crude whose assay is public to provide fuller details than currently available for the Bay du Nord crude. BHP suggested that Terra Nova crude be used for this purpose. However, upon inspection of the crude assay data for Terra Nova, NRCan does not agree that this crude is suitable. NRCan suggests that, from review of multiple crude assay results available on the web, the Equinor Copy of the Azeri BTC 2015 10 data be used. In particular, it is important to match the pour	NRCan suggests that from a review of multiple crude assay results available on the web, the Equinor Copy of the Azeri BTC 2015 10 data be used. In particular, it is important to match the pour point results for the crudes where both Bay du Nord and Azeri crudes have pour points of -9°C. As well, contents of the aliphatics, aromatics and residues are very similar.

				point results for the crudes where both Bay du Nord and Azeri crudes have pour points of -9°C. As well, contents of the aliphatics, aromatics and residues are very similar. Having this data to reference provides an estimate of the content of material that boils above 500°C (BP +500°C). For Azeri crude, the content of this fraction is 16.5 wt% or 14.5 vol%. The data also shows that 46.3 wt% of the material with boiling points greater than 200°C are ring structures (either naphthenes or aromatics). Oil molecules containing substituted rings larger than 15 carbons in size will be slow or resistant to degradation. This information together suggests that there would likely be at least 16 wt% of the initial crude released remaining for the entire period modelled. The quantity of the oil remaining at the end of the model run would also include "yet to be degraded" fresh oil (ie on the last day of the model run, the whole fresh crude would also be present. The fate of the degradation endpoint material (ie 16 wt%) could be variable as waxy aliphatic weathered material portions could remain in the water column indefinitely until it picks up sediment and sinks or finds a shore. More aromatic weathered material would be dense enough to sink, with or without sediment. These fates would be ongoing	

				processes beyond the model run period and region. Research continues to develop the data needed for inputs to add this level of complexity to current models.	

ANNEX 3: Advice to the Proponent

Table 3: Additional advice to the Proponent, such as guidance or standard advice related to your departmental mandate

ID	Reference to EIS	Context and Rationale	Advice to the Proponent
NRCan-1	16.2.1 Geohazards	Seafloor stability	EL1157 and EL1158 prospect licenses are located on the slope between 300 and 2500 meters, where there are steep slope angles ranging between 4 and 30 degrees found in the region. The geomorphology within the region of the project is characterized by numerous canyons with steep side walls, numerous steep failure scarps, mass transport deposits and remnant slide blocks. These features are overlain by poorly understood stratified drift deposits on Sackville Spur and regionally. The geological and geotechnical properties of the sediment and their susceptibility to failure should be understood before drilling takes place.

ANNEX 4: Additional Advice to the Agency

Table 4: Additional advice to the Agency, such as guidance or standard advice related to your departmental mandate

ID	Reference to EIS	Context and Rationale	Advice to the Proponent
NRCan-1	15.2. Fate and Behaviour of Potential Spills	Further to NRCan's comments in previous exploratory drilling projects, NRCan reiterates that current oil spill models do not adequately consider the fate of the heavier components in the oil. Consequently mass balance estimates will give estimates of biodegradation that will be high while those for sedimentation will be low. This would also impact the estimates of the amount of oil that would reach shores because heavier oil components in the water column would be carried towards shores and are less likely to resurface. Consequently this portion of the oil would not be "recoverable" until it lands on shore. However, NRCan acknowledges that this is an ongoing area of research and that other federal departments are of the view that current models provide sufficient information. NRcan will conduct simulations, publish data, and continue ongoing discussions	NRCan suggest that the following wording be included by the Agency in the EA Report when it is produced: NRCan advises that the current oil spill models do not consider the contents of the persistent portions of the crude oil and that biodegradation rates are therefore over-estimated; however, NRCan agrees that this is indeed on ongoing area of research and has indicated that it will conduct simulations, publish data, and continue ongoing discussions with industry to further advance existing models. Despite the potential shortcomings identified by NRCan, other federal departments are of the view that current models provide sufficient information.

		with industry to further advance existing models. As such, there is no need for NRCan to ask further information on this, however we ask that these views be reflected in the EA Report.	

Missing References applicable to Geohazards on Newfoundland Margin

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