Fisheries and Oceans Canada | Pêches et Océans Canada

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July 13, 2016

Your file *Votre référence*
CEAA: 80032

Our file *Notre référence*
13-HPAC-PA6-00004

Jillian Smith
Project Manager
Canadian Environmental Assessment Agency
Pacific and Yukon Regional Office
410-701 Georgia Street West
Vancouver, BC V7Y 1C6

Dear Ms. Smith:

Subject: DFO Comments on the Agencies March 18, 2016 Information Requests for the Pacific Northwest LNG Project.

Please refer to the Canadian Environmental Assessment Agency's (Agency) March 18, 2016 Information Request provided to Pacific Northwest LNG (Proponent) and subsequent June 17, 2016 response. On June 27, 2016 the Agency requested advice from Fisheries and Oceans Canada (DFO) on two specific issues of concern and nine questions. DFO has completed its review of the Proponent's June 17, 2016 Information Request response with detailed responses to the two Agency specific issues provided below and a response to the nine questions provided as an attachment to this letter (Appendix 1).

In undertaking the review of the Proponent's information, DFO Science was requested to provide specialist advice on the comments relating to the trestle alignment change and marine mammals. Conclusions of the Science advice are provided in Appendix 1. The full text of the science advice, including the context and analysis for issues relating to the trestle realignment are provided in Appendix 2; issues relating to marine mammals and the ability to detect them at night and/or low light conditions are provided in Appendix 3

The following provides DFO's response to the Agency's specific areas of concern.

1. **Potential effects of marine construction activities on fish, fish habitat and marine mammals.**

   Based on information provided by the Proponent to date, including the revised information within their June 17, 2016 Information Request submission on proposed

timing, mitigation measures, timing windows and monitoring, it is DFO's opinion that construction related impacts to fish and fish habitat can be mitigated and subsequently has a low probability of resulting in significant adverse effects to fish and fish habitat.

The Proponent has proposed a 1000 m radius marine mammal protection zone based on a 160 dB re 1 uPa threshold. This threshold and marine protection zone, if properly monitored and maintained will provide for the protection of large whales including humpback whales. However, for harbour porpoises which inhabit this area year round, pile driving noises in the range of 130 to 140 dB re 1 uPa have been shown to result in avoidance behaviours and displacement of animals from these ensonified areas. Based on the Proponent's sound modeling which indicates that the 140 dB isopleth could extend distances of up to >10 km from the pile driving sound source, it remains DFO's position that the displacement of individuals from concentrated areas adjacent to the proposed pile driving activities could have significant consequences for harbour porpoises at the population level. It is thus reasonable to conclude that the proposed pile driving works pose a high risk of significant adverse residual effects to harbour porpoise.

The Proponent's recommendation to use "proven" technologies to detect marine mammals at night and in low light conditions was due to the possibility that pile driving activities would begin at night. Originally, the Proponent had indicated that they might commence pile driving activities during the day and continue into the night. DFO's previous advice on this methodology was that this would be acceptable as prior to commencing any pile driving activities, visual observations could be made to ensure that the marine mammal safety zone was clear of marine mammals. Once pile driving commenced, it is not expected that marine mammals would advance into the ensonified areas to a point where harm or death would occur. DFO's review of the measures that the Proponent has proposed to detect marine mammals at night and in low light conditions has concluded that these technologies would be inadequate to determine with a reasonable level of confidence that cetaceans would be present or absent from the marine safety zone. As such, commencing pile driving activities at night represents a high risk to marine mammals. Consequently, DFO does not recommend that pile driving activities commence at night, until such time as the various mitigation measures outlined by the Proponent are implemented to the satisfaction of DFO and have been shown to effectively identify marine mammals within the safety zone prior to commencing any night time pile driving activities.

2. Potential effects of the marine structures on hydrodynamic and sediment conditions, including Flora Bank (e.g. 3D modelling)

As the proposed change in the orientation of the trestle and berths does not represent a major change in the overall design of the marine structures, DFO's January 13, 2016 advice to the Agency remains applicable. To summarize, the previous advice provided was that DFO concurred with the Proponent's conclusions that no significant effects were expected from the trestle pilings, with the SW Tower and

Anchor Block likely to cause the greatest disturbance. Impacts with these two large structures are predicted to be localized and can be mitigated.

Following the Environmental Assessment and prior to issuance of any *Fisheries Act* Authorizations , DFO recommends the need for a continued program of observational monitoring and modelling to better define the expected changes in currents and waves near the berths and along the trestle. Such modelling must take into account any changes in the orientation of the trestle, and in the position of the berths and carriers, and potential changes to currents in vicinity of Agnew Bank. With regard to the modelling effort, it would be desirable to incorporate greater realism in the representation of the carriers at berths. Specifically, rather than representing the carriers effectively as "islands" extending through the entre water column, refinements to the model should be made to allow for flows underneath the carriers.

While it has yet to be demonstrated with detailed modelling, it is anticipated that reorientation of the trestle and the associated relocation of the carrier berths away from Flora Bank will reduce the potential for morphological change to the southwest margin of Flora Bank. It may be remarked that a reorientation of the suspension bridge similar to that of the trestle would likewise reduce the potential impacts on Flora Bank of its supporting structures (the SW Tower and SW Anchor Block). Given that some scope exists for adjustments in the locations of the structures, it is recommended that during final bridge and trestle design stage, that a small clockwise rotation in the orientation of the suspension bridge be considered such that the position of the SW Tower is displaced away from the Bank. Such a change is likely to reduce the potential for morphological change of Flora Bank associated with this structure.

It should be noted that the advice provided here is in response to questions raised by the Agency as part of the federal environmental assessment process. Should the project proceed to the regulatory phase, then DFO will require additional detailed information as found in the *Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations*. DFO must take into account the factors described in Section 6 of the *Fisheries Act* before making any regulatory decision.

Should you have any questions or concerns regarding the contents of this letter or attached comment, please contact Mr. Alain Magnan at alain.magnan@dfo-mpo.gc.ca or by phone at 250-756-7021.

Yours Sincerely,
<original signed by>

Cheryl Webb
Regional Director
Ecosystems Management Branch
Fisheries and Oceans Canada

Attach:
Appendix 1: DFO response to CEAA's June 27, 2016 requests for information
Appendix 2: Centre for Science Advice Pacific: Science response to CEAA request re: trestle re-alignment and hydrodynamics modelling from PNW LNG in response to CEAA March 18th (Jul 5, 2016).
Appendix 3: Centre for Science Advice Pacific: Advice re: adequacy of PNW's proposed marine mammal monitoring during pile driving for the development of the PNW LNG terminal (July 5, 2016).

Cc: Carmel Lowe, DFO Science
Alain (Al) Magnan, DFO FPP
Jessica Coulson, NRCan

Appendix #1

DFO response to CEAA's June 27, 2016 Requests for Information

July 12, 2016

DFO Response to the June 27, 2016 Questions from CEAA:

The Canadian Environmental Assessment Agency (Agency) provided a written request to DFO on June 27th, 2016 for additional clarification on information received from Pacific Northwest LNG (Proponent). The following provides DFO's response to the Agency's nine questions. Information provided in some of these responses is supported by the following DFO Centre for Science Advice Pacific documents attached as follows:

- **Appendix 2:** Centre for Science Advice Pacific: Science response to CEAA request re: trestle re-alignment and hydrodynamics modelling from PNW LNG in response to CEAA March 18th (Jul 5, 2016); and
- **Appendix 3:** Centre for Science Advice Pacific: Advice re: adequacy of PNW's proposed marine mammal monitoring during pile driving for the development of the PNW LNG terminal (July 5, 2016).

CEAA Question #1:
For dredging at the MOF July 15 – April 15, what is DFO's advice regarding if and to what extent the Proponent should meet the CCME Water Quality Guidelines for long-term or for short-term exposure for TSS? The Proponent's updated modelling predictions indicate exceedances of the long-term exposure guideline in deeper waters up to ~400m from the dredging location.

DFO Response:
The Proponent should ensure that all applicable mitigation measures are employed during dredging activities to mitigate the release of suspended sediment including the use of a containment system to surround the dredging activities. Monitoring compliance points should then be measured outside of the isolated areas. If water quality monitoring identifies increased suspended sediment levels, a mitigation measure that can be employed is the temporary halting of works to ensure compliance with the CCME Water Quality Guidelines, following which the works can resume.

The Proponent should ensure that any increases of suspended sediment above background levels do not result in Serious Harm to fish as per S. 35(2) of the *Fisheries Act* and/or the release of a deleterious substance as per S. 36(3) of the *Fisheries Act*. In 2014, the Order Designating the Minister of the Environment Responsible for the Administration and Enforcement of Subsections 36(3) to (6) of the *Fisheries Act* (i.e. deleterious substances) was issued which delegated this authority from DFO to the Minister of ECCC.

CEAA Question #2:
With regard to effects to water quality as a result of construction along the bridge and trestle, the Proponent described several measures that would be taken to minimize increases to total suspended solids, and described the effects: "Elevated TSS levels and sediment deposition resulting from these nearshore vessel movements and removal of temporary piles are not expected to result in injuries or mortalities that would constitute a measurable change in the viability of local fish populations." What is DFO's advice regarding the need for any specific mitigation measures to ensure that any detrimental effects to water quality are minimized, e.g. should a water quality effects threshold be defined requiring the Proponent not to exceed the long-term exposure water quality guidelines at any point 100m or further SE of the construction area? Are any specific measures required?

DFO Response:
Any increases in total suspended sediments as a result of pile installation and removal are expected to be localized in nature and short in duration, resulting in a low risk of adverse effects to fish and fish habitat. Similarly for boat traffic, there is little to no vessel movement expected to occur on or adjacent to Flora Bank. Any vessels near Flora Bank will be travelling at reduced rates of speed which will mitigate any disturbance to the marine environment. As with the pile driving activities, any increases in suspended sediment as a result of vessel movement is expected to be short in duration and localized.

The Proponent should ensure that any increases of suspended sediment above background levels do not result in Serious Harm to fish as per S. 35(2) of the *Fisheries Act* and/or the release of a deleterious substance as per S. 36(3) of the *Fisheries Act*. In 2014, the Order Designating the Minister of the Environment Responsible for the Administration and Enforcement of Subsections 36(3) to (6) of the *Fisheries Act* (i.e. deleterious substances) was issued which delegated this authority from DFO to the Minister of ECCC.

CEAA Question #3:
For disposal at sea, does DFO have any updated advice regarding if and to what extent the Proponent should meet the CCME Water Quality Guidelines for long-term or short-term exposure for TSS? Please consider both disposal activities during the least-risk timing window (timing TBD), and disposal outside of such a window. E.g. should additional mitigation measures (e.g. less frequent disposal events) be required outside of a least-risk timing window in order to meet the water quality guidelines at the edge of the disposal site at medium to shallow depths? Please see below the wording used in the draft EA report:

"With respect to water quality, the Agency understands that the Project would re-suspend seabed sediments in the waters surrounding the Project area during construction (e.g. dredging) and operations (e.g. scour around marine infrastructure, propeller scour), likely introducing total suspended solids concentrations above the Canadian Water Quality Guidelines for the Protection of Aquatic Life, where chronic effects to aquatic life could

occur even with mitigation measures. Disposal of marine sediment at the disposal site at Brown Passage could result in total suspended solids concentrations that exceed the Canadian Water Quality Guidelines for the Protection of Aquatic Life, and could cause localized acute effects within the disposal site and chronic effects in the areas immediately surrounding the disposal site. The Agency agrees with Fisheries and Oceans Canada that the Proponent would need to modify the proposed construction activities to further mitigate effects of elevated total suspended solids outside of windows of least risk, that is, when fish are more likely to be using an area for sensitive life stages. With additional mitigation measures, exceedances of the guidelines are still likely, especially in deeper waters.

DFO Response:
DFO does not have any further comments to provide on Disposal at Sea as the Minister of Environment Canada and Climate Change (ECCC) administers Disposal at Sea Permits through the Canadian Environmental Protection Act (CEPA 1999). As part of the permitting process, ECCC will undertake a detailed review of the application and set conditions to protect marine and human health.

The Proponent should ensure that any increases of suspended sediment above background levels do not result in Serious Harm to fish as per S. 35(2) of the *Fisheries Act* and/or the release of a deleterious substance as per S. 36(3) of the *Fisheries Act*. In 2014, the Order Designating the Minister of the Environment Responsible for the Administration and Enforcement of Subsections 36(3) to (6) of the *Fisheries Act* (i.e. deleterious substance) was issued which delegated this authority from DFO to the Minister of ECCC.

CEAA Question #4:
Could effects to fish overall be considered reversible?

DFO Response:
Should the project be decommissioned and the aquatic habitat returned to its original condition, it would be expected that effects to fish would be reversible.

CEAA Question #5:
Does DFO have any updated advice for CEAA in light of the trestle realignment and associated 3D modelling results?

DFO Response:
Refer to Appendix 3 for full analysis and response to this issue. As the proposed change in the orientation of the trestle and berths does not represent a major change in the overall design of the marine structures, the advice that DFO previously provided to CEAA still holds. To summarize, the previous advice provided was that DFO concurred with the Proponent's conclusions that no significant effects were expected from the trestle pilings, with the SW Tower and Anchor Block likely to cause the greatest disturbance. Impacts with these two large structures are predicted to be localized and can be mitigated.

Following the Environmental Assessment and prior to issuance of any *Fisheries Act* Authorizations, there is need for a continued program of observational monitoring and modelling to better define the expected changes in currents and waves near the berths and along the trestle. Such modelling must take into account any changes in the orientation of the trestle, and in the position of the berths and carriers. With this reorientation, there is now need to consider the effects of potential changes to currents in vicinity of Agnew Bank. With regard to the modelling effort, it would be desirable to incorporate greater realism in the representation of the carriers at berths. Specifically, rather than representing the carriers effectively as "islands" extending through the entre water column, refinements to the model should be made to allow for flows underneath the carriers.

While it has yet to be demonstrated with detailed modelling, it is anticipated that reorientation of the trestle and the associated relocation of the carrier berths away from Flora Bank will reduce the potential for morphological change to the southwest margin of Flora Bank. Modelling results presented in the March 18 IR Response (e.g. Slide B13) indicate this is one of two areas most likely to see (relatively weak) erosional impacts due to their proximity to the structures and carriers. The other area is found near the SW Tower. In this regard, it may be remarked that a reorientation of the suspension bridge similar to that of the trestle would likewise reduce the potential impacts on Flora Bank of its supporting structures (the SW Tower and SW Anchor Block). Previous modeling studies conducted by the Proponent have consistently shown that there is potential for erosion of Flora Bank to occur about the SW Tower, due to its close proximity to the margin of Flora Bank. Specifically, high resolution modeling results presented in the Supplemental Modeling Report of 10 November 2015 demonstrated that vortices shed from the SW Tower lead to weak gradual erosion at the margin of Flora Bank (i.e., beyond the scour protection around the Tower). Moreover these vortices propagate onto the Bank, transporting uplifted sediment and producing episodic increases in levels of suspended solids in vicinity of the nearest eel grass beds.

Given that some scope exists for adjustments in the locations of the structures, it is recommended that during the final design of the bridge and trestle, a small clockwise rotation in the orientation of the suspension bridge be considered such that the position of the SW Tower is displaced away from the Bank. Such a change is likely to reduce the potential for morphological change of Flora Bank associated with this structure. For example, a clockwise rotation of the bridge that restores the linear arrangement of the bridge and trestle, would displace the SW Tower about 130 metres away from the Bank. The existing modelling results suggest that this would be sufficient to reduce the potential for erosion at the margin of the Bank.

CEAA Question #6:
In DFO comments provided to the Proponent April 29, 2016 DFO recommended that the threshold for mitigating impacts to marine mammals not exceed 160 dB at 500 m for pulse noise and not exceed 120dB at 500 m for continuous noise (ex. vibratory pile driving, pile drilling and dredging). During the meetings with PNW there was discussion related to the 160 dB threshold for impact pile driving (pulse noise) and a general

understanding that the Proponent committed to meeting that threshold at 1000 m. However, there was no discussion regarding the 120 dB threshold for continuous noise. Is DFO satisfied that a 160 dB threshold for both continuous and pulse noise at 1000 m is sufficient to mitigate behavioural effects to marine mammals?

DFO Response:
The previous information provided by DFO regarding the 120dB was in relation to harbour porpoises. It continues to be DFO's opinion that due to the length and intensity of construction of the marine structures, there remains a high risk of significant adverse effects to harbour porpoises occurring. For all other marine mammals, a 160 dB threshold during construction periods is recommended to avoid adverse behavioural effects.

CEAA Question #7:
In the Proponent's IR response it stated that it would commit to a 160 dB safety radius for marine mammals for all pile activities. It did not mention a safety radius for blasting or dredging. In the EIS addendum the Proponent had originally committed to a safety radius for blasting activities and January advice from DFO had indicated that you would also like a safety radius for dredging. Does DFO think that a safety radius for blasting and dredging activities is needed in the MOF given the fact that the Proponent has committed to not blasting or dredging during specific timing windows? Or are safety radii still required for these activities?

DFO Response:
DFO recommends that a safety radius for blasting be established. A safety radius for dredging activities is not required. However, should marine mammals come within 250 m of dredging activities, it is generally advised to temporarily cease works to avoid any impacts or injuries to marine mammals.

CEAA Question #8:
Outside of the April 15 to end of June window that limits how impact pile driving will be conducted at the MOF and along the trestle and bridge infrastructure, does DFO advise any mitigation measures to manage underwater noise other than the 207dB and 160dB thresholds?

DFO Response:
In its June 2016 submission to the Agency, the Proponent identified a suite of mitigation measures that will be used to meet the 160 and 207 dB thresholds. DFO supports the use of these mitigation measures to meet the agreed upon thresholds

CEAA Question #9:
The Proponent indicated that it would use additional proven technologies (in addition to the use of real-time passive acoustic monitoring) such as night vision, forward looking infrared and infrared binoculars to detect marine mammals during low visibility conditions including at night. During the meetings with the Proponent DFO indicated that

the use of radar might be a good method. Does DFO wish to require that the Proponent use specific methods, including radar for detecting marine mammals?

DFO Response:
The following provides DFO Centre for Science Advice Pacific response to the Proponent's use of "proven" technologies for detecting marine mammals under low visibility conditions (Appendix 3).

The Proponent's identify six complementary approaches for monitoring for the presence of marine mammals within the 1000 m safety zone consisting of:

1. Marine mammal observers (MMO) to monitor the marine mammal behavioural disturbances safety radius;
2. Use of additional proven technologies by the MMO's as appropriate for detecting marine mammals under low visibility (including darkness) such as night vision, FLIR, and infrared binoculars;
3. Sound verification monitoring to confirm that underwater noise levels do not exceed the injury threshold for fish during pile driving;
4. Sound verification monitoring to confirm the size of the marine mammal safety radius;
5. Passive acoustic monitoring to detect the presence and location of marine mammals during in water impacts pile driving along the trestle and berth; and
6. A hydrophone "gate" system to verify sound levels and detect marine mammals on Agnew Bank and in Porpoise Channel during construction of the MOF.

The following are comments on the likely efficacy of each of these six approaches with regard to the key species of concern in the development area, harbour porpoises, humpback whales and killer whales.

1. Trained marine mammal observers (MMO's) based on small vessels would be able to effectively monitor a 1000 m safety zone for the presence of the larger cetaceans, humpbacks and killer whales, during periods of good visibility (i.e. daylight hours, no fog). Visual monitoring for the presence of harbour porpoises, however, would be unreliable in sea states greater than Beaufort 3 (winds > 10 knots) because of their small size and inconspicuous surface behaviour. Such conditions are common in the development area, especially during winter.
2. Technologies to detect marine mammals under low visibility conditions (e.g. at night, in fog) such as night vision systems, FLIR and infrared binoculars, have a mixed track record of efficacy and cannot be considered to be "proven". Such systems can be effective for detection of large cetaceans at distances of several kilometres in low sea states. However, reliability of detection diminishes with sea state so that it would be unrealizable for even large whales in rough sea conditions. Infrared systems are "practically useless" in conditions with rain, fog

or haze. Given their small size and inconspicuous behaviour, there is a very low probability that harbour porpoises would be detected by infrared systems within the 1000 m safety zone in anything above Beaufort sea state 0 (calm) and clear conditions. Given that a safety zone of at least 10 km radius would be needed to avoid disturbance to harbour porpoises, these detection technologies would be entirely ineffective.

3. Harbour porpoises have very high metabolic rates and must feed on small schooling fish almost continuously day and night to survive. Thus, any reduction of forage fish availability would directly affect harbour porpoise feeding success. Verification of sound levels to mitigate potential injury to fish is important.
4. Sound verification monitoring is necessary to determine the true sound field surrounding pile driving activities. This should be undertaken at far greater distances than the 1000 m radius proposed (based on the estimated 160 db 1uPa isopleth) because of the vulnerability of harbour porpoises to disturbance and displacement from habitats ensonified at levels as low as 130-140 dB re 1uPa.
5. Passive acoustic monitoring is not a reliable method of detecting marine mammals to ensure absence from an impact area. Many cetaceans, including humpback whales and killer whales (especially transient killer whales), vocalize only occasionally and are silent during much of the time in British Columbia waters. harbour porpoises, which are the most vulnerable of the marine mammals to noise disturbance from pile driving, are particularly difficult to detect acoustically even when vocalizing. First, they only produce very short duration clicks at very high frequencies (~ 130 kHz), well above the hearing range of humans. Energy in these high frequency clicks attenuates very rapidly so they do not travel far underwater. Also, the clicks tend to be highly directional, so they cannot be detected outside of a narrow field directly in front of the animal. Studies using passive click detectors for monitoring harbour porpoises in European waters have shown that detections are limited to distances of about 100 m and only 10-30% of porpoises tracked visually were detected by an array of passive acoustic click detectors.
6. Comments above also apply to the proposed hydrophone "gate" system to detect marine mammals on Agnew Bank and Porpoise Channel.

In summary, in most cases the proposed methods to monitor marine mammals by visual and/or acoustical technologies would be inadequate to determine with a reasonable level of confidence that cetaceans would be present or absent from a safety zone of 1000 m surrounding pile driving activities. This is particularly true for harbour porpoises, which are small and cryptic, and are difficult to detect reliably in all but calm conditions with good visibility. During darkness or in reduced visibility due to fog, porpoises would have a very low probability of detection using enhanced visual (e.g. infrared imaging) or acoustical technologies over a safety zone of 1000 m radius.

The Proponent's recommendation to use these other technologies to detect marine mammals was due to the possibility that pile driving activities would begin during the night. Originally, the Proponent had indicated that they might commence pile driving activities during the day and continue into the night. DFO's previous advice on this methodology was that this would be acceptable because prior to commencing any pile driving activities, visual observations could be made to ensure that the safety zone was clear of marine mammals. Once pile driving commenced, it is not expected that marine mammals would advance into the ensonified areas to a point where harm or death would occur. Based on the information provided above, the ability to observe marine mammals at night is not considered "proven" technologies. As such, commencing pile driving activities at night represents a high risk to marine mammals. Consequently, DFO does not recommend that pile driving activities commence at night, until such time as the various mitigation measures outlined above by the Proponent are implemented to the satisfaction of DFO and have been shown to effectively identify marine mammals within the safety zone.

Appendix #2

Centre for Science Advice Pacific: Science response to CEAA request re: trestle re-alignment and hydrodynamics modelling from PNW LNG in response to CEAA March 18th

July 5, 2016

Centre for Science Advice Pacific

Non-CSAS Rapid Science Response

REQUEST INFORMATION

Request Contact:	**Al Magnan**	Project Type/Fishery:	**LNG**
Requesting Branch	**EMB**	Requesting Program	**FPP**
Advice Title	**Science response to CEAA request re: trestle re-alignment and hydrodynamics modelling from PNW LNG in response to CEAA March 18th**		
Date of request:	**June 21, 2016**	Project footprint:	
Region of proposed impact:	**Skeena Estuary**	Habitat Type:	**Estuarine/Shallow Marine**
Relevant species:			
Date required:	**July 5, 2016**	Request #:	**RSR2016-011_FPP_PNW**

OVERVIEW

(Please provide a brief overview of the issue or, for development projects, the nature of the works, location, scale, review type. Please also indicate the relational for the date required for this advice. Maps may be attached for clarification if necessary).

On June 17, 2016, Pacific NorthWest LNG Ltd. (the Proponent) submitted information to the Canadian Environmental Assessment Agency (CEAA) in response to CEAA's March 18, 2016 information request (IR) letter. The proponent's submission included information regarding a proposed realignment of the trestle structure.

FPP requested DFO Science review the trestle realignment and determine if it would have an impact on DFO Science's advice regarding the hydrodynamics modelling described by the proponent.

1ST QUESTION

Context:

In the June 17th response to CEAA's March 18, 2016 IR, the Proponent provided new information proposing a slight alignment change in the trestle (Chapter 9). There are no changes proposed to the Anchor Black and SW Tower. The Proponent has indicated that this slight alignment change will not affect the results of their modeling exercise: "PNW believes that the effects on marine sediment and hydrodynamic conditions potentially generated by the new proposed trestle alignment will be the same or less than predicted in the modelling for the previous alignment".

Question:

FPP is seeking DFO Science advice on whether or not this alignment change would change DFO's previous advice to CEAA.

Importance: ☒ Essential ☐ Important ☐ Desirable

SCIENCE RESPONSE

To prepare this response, DFO has reviewed the following documents:

Pacific NorthWest LNG March 18, 2016 Information Request Responses, Prepared for Canadian Environmental Assessment Agency, June 17, 2016, hereafter referred to as the "March 18 IR Response".

Background

DFO has provided advice to FPP and CEAA regarding a series of hydrodynamic modelling studies conducted by Pacific Northwest LNG to assess the impact of the introduction of marine structures near Flora Bank. In particular, the suitability of the modelled hydrodynamics for sediment transport was assessed. To date, all of the modelling of the hydrodynamics predicting impacts on Flora Bank conducted by the

Proponent and reviewed by DFO has been based on a particular configuration of the marine structures and carriers. In this configuration, the marine structures consist of a suspension bridge followed by a trestle, arranged in a straight line, and extending about 2.5 kilometres from Lelu Island. Berths for two LNG carriers are located at the end of the trestle. A modification in the design of the marine structures is now under consideration which involves a relatively small rotation in the orientation of the trestle such that the centre of the berth structure is displaced to the northwest, away from Flora Bank, by a distance of about 300 metres. This modification leaves unchanged the position of the suspension bridge and its two large supporting structures, the SW Tower and the SW Anchor Block.

Analysis

1) The proposed reorientation of the trestle and berths represents a relatively minor change in the overall design of the marine structures.
2) There is an inconsistency between the stated displacement of the berths (315 m) associated with reorientation of the trestle (page 2.14), and the stated rotation angle of 3 degrees (page 2.15). The latter would lead to a smaller displacement of approximately 60 metres in the position of the berth structure. It seems likely that the stated rotation angle is a typographical error as the figure illustrating the realignment of the trestle has it rotated by a larger angle (a clockwise rotation of about 15 degrees) with the berths displaced by about 300 m. However, regardless of which is correct, the advice given below holds for either case.
3) The modelling conducted by the Proponent has shown that introduction of marine structures and the presence of carriers at berth leads to changes in the hydrodynamics that produce relatively localized changes in bottom morphology. For example, results based on the Delft-3D modelling system and presented in Slide B13 of the March 18 IR Response show a comparison of morphological changes to Flora Bank in a baseline simulation (no marine structures or carriers) with that arising from (1) the introduction of marine structures (bridge, trestle and berth), and (2) the marine structures with the additional presence of carriers at the berths. These particular results are based on simulations representative of typical conditions encountered during early summer and include tidal currents and currents driven by freshwater discharge from the Skeena River under freshet conditions. It is evident from comparison of these three different cases that there are two areas for which the marine structures and carriers tend to produce weak erosion of Flora Bank. Specifically, the modelling results show erosion occurring in proximity of the SW Tower, which is one of the two large structures supporting the bridge. This occurs independently of the presence of the carriers. Secondly, the additional presence of the carriers leads to weak erosion of the southwest side of Flora Bank. It is notable that this is the area of Flora Bank that is located closest to the carriers.
4) Under the proposed reorientation of the trestle the berths and carriers are located further away from the margin of Flora Bank. Accordingly, it seems reasonable to expect that the potential for erosion of the southwest margin of Flora Bank is unlikely to increase with this modification. In fact, it is likely that the reorientation of the trestle will reduce the potential for erosion of the southwest margin of the bank. Thus the Proponent's statement on Page 9.1 that the effects on "hydrodynamic conditions potentially generated by the new proposed trestle alignment will be the same or less than predicted in the modelling for the previous alignment" is likely valid, but further modelling work is required to substantiate this statement.
5) This finding is consistent with advice that DFO had given to CEAA in its Science Response of 17 May 2016 in which it was noted that "A potential mitigation measure for the impact of the vessels is to use the northern berth as much as possible (it is further from Flora Bank)."
6) The proposed change in the orientation of the trestle will not change the potential for erosion about the SW Tower.

Advice:

As the proposed change in the orientation of the trestle and berths does not represent a major change in the overall design of the marine structures, the advice that DFO previously provided to FPP and CEAA still holds. In particular, there is need for a continued program of observational monitoring and modelling to better define the expected changes in currents and waves near the berths and along the trestle. Obviously, such modelling must take into account any changes in the orientation of the trestle, and in the position of the berths and carriers. With this reorientation, there is now need to consider the effects of potential changes to currents in vicinity of Agnew Bank. With regard to the modelling effort, it would be desirable to incorporate greater realism in the representation of the carriers at berths. Specifically, rather than representing the carriers effectively as 'islands' extending through the entire water column, refinements to the model should be made to allow for flows underneath the carriers.

While it has yet to be demonstrated with detailed modelling, it is anticipated that reorientation of the trestle and the associated relocation of the carrier berths away from Flora Bank will reduce the potential for morphological change to the southwest margin of Flora Bank. Modelling results presented in the March 18 IR Response (e.g., Slide B13) indicate this is one of two areas most likely to see (relatively weak) erosional impacts due to their proximity to the structures and carriers. The other area is found near the SW Tower. In this regard, it may be remarked that a reorientation of the suspension bridge similar to that of the trestle would likewise reduce the potential impacts on Flora Bank of its supporting structures (the SW Tower and SW Anchor Block). Previous modelling studies conducted by the Proponent have consistently shown that there is potential for erosion of Flora Bank to occur about the SW Tower, due to its close proximity to the margin of Flora Bank. Specifically, high resolution modelling results presented in the *Supplemental Modelling Report* of 10 November 2015 demonstrated that vortices shed from the SW Tower lead to weak, gradual erosion at the margin of Flora Bank (i.e., beyond the scour protection around the Tower). Moreover, these vortices propagate onto the Bank, transporting uplifted sediment and producing episodic increases in levels of suspended solids in vicinity of the nearest eel grass beds.

Given that some scope exists for adjustments in the locations of the structures, it is recommended that a small clockwise rotation in the orientation of the suspension bridge be considered such that the position of the SW Tower is displaced away from the Bank. Such a change is likely to reduce the potential for morphological change of Flora Bank associated with this structure. For example, a clockwise rotation of the bridge that restores the linear arrangement of the bridge and trestle, would displace the SW Tower about 130 metres away from the Bank. The existing modelling results suggest that this would be sufficient to reduce the potential for erosion at the margin of the Bank.

Responder: Patrick Cummins Responder: Charles Hannah

REVIEW & APPROVAL

This response does not constitute delivery of peer reviewed Science advice; it is intended as a rapid response to an immediate requirement for Science information or advice, from those experts able to contribute within the timeframes required.

Reviewed by: Lesley MacDougall, A/Coordinator, Centre for Science Advice Pacific

Signature: <original signed by> Date: July 7, 2016

Approved by: Carmel Lowe, Regional Director, DFO Science Pacific Region

Signature: by email Date: JUL 0 8 2016

Appendix #3

Centre for Science Advice Pacific
Advice re: adequacy of PNW's proposed marine mammal monitoring during pile driving for the development of the PNW LNG terminal

July 5, 2016

Centre for Science Advice Pacific

Non-CSAS Rapid Science Response

Request Information

Request Contact:	**Al Magnan**	Project Type/Fishery:	**LNG**
Requesting Branch	**EMB**	Requesting Program	**FPP**
Advice Title	**Advice re: adequacy of PNW's proposed marine mammal monitoring during pile driving for the development of the PNW LNG terminal**		
Date of request:	**June 21, 2016**	Project footprint:	
Region of proposed Impact:	**Skeena Estuary/**	Habitat Type:	**Estuarine/Shallow Marine**
Relevant species:	**Marine Mammals**		
Date required:	**July 5, 2016**	Request #:	**RSR2016-010_FPP_PNW**

Overview

(Please provide a brief overview of the issue or, for development projects, the nature of the works, location, scale, review type. Please also indicate the relational for the date required for this advice. Maps may be attached for clarification if necessary).

On June 17, 2016, Pacific NorthWest LNG Ltd. (the Proponent) submitted information to the Canadian Environmental Assessment Agency (CEAA) in response to CEAA's March 18, 2016 information request (IR) letter. The proponent's submission included more precise information on equipment that will be used, duration and staging of works, updated sound modeling and proposed mitigation measures.

FPP requested DFO Science review the marine mammal monitoring methods proposed by the Proponent and provide advice regarding their adequacy in low visibility situations to detect marine mammals (including but not limited to Harbour Porpoises) and thereby provide appropriate assurance that works commencing at night will not result in injury or death of marine mammals.

1ST Question

Context:

An original condition of operation from FPP was that all pile driving was to commence during day time conditions to allow the marine mammal observers an opportunity to identify marine mammals within the marine exclusion zone. The proponent has now indicated that there might be instances where pile driving may commence at night. However, to mitigate any adverse effects, they propose to use a suite of measures (radar, night vision system, infrared binoculars, etc) which will allow them to not only see marine mammals at night, but also in low light conditions such as rainy or foggy days. Consequently, they feel that with these additional mitigation measures that works can commence without injuring or killing marine mammals.

Question:

DFO FPP requests that DFO Science provide comments on PNW LNG's proposed underwater monitoring as documented in Section 3.3 of the "Pacific NorthWest LNG March 18, 2016 Information Request Responses" (June 17, 2016). Specifically, provide a review of the adequacy of PNW LNG's proposed use of "proven technologies for detecting marine mammals under low visibility conditions" (page 3.24).

Importance: ☒ Essential ☐ Important ☐ Desirable

Science Response

Response:

The proponents have several approaches to real-time *in situ* monitoring of a 'safety zone' of 1000 m from the source(s) of impulsive pile-driving noise. This safety zone is based on acoustic modelling exercises that predicted

the distance of a 160 dB re 1 µPa sound pressure level (SPL) isopleth from impulse pile driving noise. The 160 dB threshold is that used in the United States by NOAA in assessments noise impacts on cetaceans – levels in excess of this SPL can be assumed to cause behavioural disturbance and those below are assumed not to cause disturbance. This threshold was developed by NOAA more than 20 years ago and it is based largely on responses to bowhead whales and grey whales to impulsive sounds from underwater seismic testing. Although it may be valid for large whales including humpbacks, there is ample empirical evidence that harbour porpoises exhibit avoidance responses and displacement from habitats ensonified by pile driving noise at levels of 130–140 dB re 1 µPa (see DFO RSR2016-003FPP.PNW, March 14, 2016). Based on acoustic modelling presented in Appendix N of the PNW EIS, a 140 dB re 1 µPa isopleth could be at distances of > 10 km from a single impact pile driving source with bubble curtain sound attenuation (Figure 35 in Modelling of Underwater Noise for Pacific NorthWest LNG Marine Construction and Shipping Scenarios, prepared by JASCO Applied Sciences). Thus, the 1000 m safety zone would clearly be inadequate to mitigate acoustic disturbance to harbour porpoises from multiple pile driving sources.

The proponents identify six complementary approaches for monitoring for the presence of marine mammals within the 1000 m safety zone. These are:

1. Marine mammal observers (MMOs) to monitor the marine mammal behavioural disturbance safety radius
2. Use of additional proven technologies by MMOs as appropriate for detecting marine mammals under low visibility (including darkness) such as night vision, FLIR, and infrared binoculars
3. Sound verification monitoring to confirm that underwater noise levels do not exceed the injury threshold for fish during pile driving
4. Sound verification monitoring to confirm the size of the marine mammal safety radius
5. Passive acoustic monitoring to detect the presence and location of marine mammals during in-water impact pile driving along the trestle and berth
6. A hydrophone 'gate' system to verify sound levels and detect marine mammals on Agnew Bank and in Porpoise Channel during construction of the MOF

The following are comments on the likely efficacy of each of these six approaches with regard to the key species of concern in the development area, harbour porpoises, humpback whales and killer whales.

1. Trained marine mammal observers (MMOs) based on small vessels would be able to effectively monitor a 1000 m safety zone for the presence of the larger cetaceans, humpbacks and killer whales, during periods of good visibility (i.e., daylight hours, no fog). Visual monitoring for the presence of harbour porpoises, however, would be unreliable in sea states greater than Beaufort 3 (winds > 10 knots) because of their small size and inconspicuous surface behaviour. Such conditions are common in the development area, especially during winter.
2. Technologies to detect marine mammals under low visibility conditions (e.g. at night, in fog) such as night vision systems, FLIR and infrared binoculars, have a mixed track record of efficacy and cannot be considered to be "proven". Such systems can be effective for detection of large cetaceans at distances of several kilometres in low sea states. However, reliability of detection diminishes with sea state so that it would be unreliable for even large whales in rough sea conditions. Infrared systems are "practically useless" in conditions with rain, fog or haze (Baldacci et al. 2005). Given their small size and inconspicuous behaviour, there is a very low probability that harbour porpoises would be detected by infrared systems within the 1000 m safety zone in anything above Beaufort sea state 0 (calm) and clear conditions. Given that a safety zone of at least 10 km radius would be needed to avoid disturbance to harbour porpoises, these detection technologies would be entirely ineffective.
3. Harbour porpoises have very high metabolic rates and must feed on small schooling fish almost continuously day and night to survive (Wisniewska□et al. 2016). Thus, any reduction of forage fish availability would directly affect harbour porpoise feeding success. Verification of sound levels to mitigate potential injury to fish is important.
4. Sound verification monitoring is necessary to determine the true sound field surrounding pile driving activities. This should be undertaken at far greater distances than the 1000 m radius proposed (based on the estimated 160 dB 1 µPa isopleth) because of the vulnerability of harbour porpoises to disturbance and

displacement from habitats ensonified at levels as low as 130-140 dB re 1 µPa.

5. Passive acoustic monitoring is not a reliable method of detecting marine mammals to ensure absence from an impact area. Many cetaceans, including humpback whales and killer whales (especially transient killer whales), vocalize only occasionally and are silent during much of the time in British Columbia waters. Harbour porpoises, which are the most vulnerable of the marine mammals to noise disturbance from pile driving, are particularly difficult to detect acoustically even when vocalizing. First, they only produce very short duration clicks at very high frequencies (~130 kHz), well above the hearing range of humans. Energy in these high frequency clicks attenuates very rapidly so they do not travel far underwater. Also, the clicks tend to be highly directional, so they can not be detected outside of a narrow field directly in front of the animal. Studies using passive click detectors for monitoring harbour porpoises in European waters have shown that detections are limited to distances of about 100 m, and only 10-30% of porpoises tracked visually were detected by an array of passive acoustic click detectors (Kyhn et al. 2012).
6. Comments above also apply to the proposed hydrophone 'gate' system to detect marine mammals on Agnew Bank and Porpoise Channel.

In summary, in most cases the proposed methods to monitor marine mammals by visual and/or acoustical technologies would be inadequate to determine with a reasonable level of confidence that cetaceans would be present or absent from a safety zone of 1000 m surrounding pile driving activities. This is particularly true for harbour porpoises, which are small and cryptic, and are difficult to detect reliably in all but calm conditions with good visibility. During darkness or in reduced visibility due to fog, porpoises would have a very low probability of detection using enhanced visual (e.g. infrared imaging) or acoustical technologies over a safety zone of 1000 m radius.

References

Baldacci, A., Carron, M. and Portunato, N. 2005. Infrared detection of marine mammals. NATO Undersea Research Centre Technical Report SR-443. NATO Undersea Research Centre, New York, New York, USA.

Kyhn, L.A., Tougaard, J., Thomas, L., Duve, L.R., Stenback, J., Amundin, M., Desportes, G. and Teilmann, J. 2012. From echolocation clicks to animal density—Acoustic sampling of harbor porpoises with static dataloggers. The Journal of the Acoustical Society of America, 131(1), 550-560.

Wisniewska, D.M., Johnson, M., Teilmann, J., Rojano-Doñate, L., Shearer, J., Sveegaard, S., Miller, L.A., Siebert, U. and Madsen, P.T. 2016. Ultra-high foraging rates of harbor porpoises make them vulnerable to anthropogenic disturbance. Current Biology, 26(11), 1441-1446.

Responder: John Ford

Responder:

REVIEW & APPROVAL

This response does not constitute delivery of peer reviewed Science advice; it is intended as a rapid response to an immediate requirement for Science information or advice, from those experts able to contribute within the timeframes required.

Reviewed by: Lesley MacDougall, A/Coordinator, Centre for Science Advice Pacific

Signature: <original signed by> Date: 8 July, 2016

Approved by: Carmel Lowe, Regional Director, DFO Science Pacific Region

Signature: <original signed by> Date: JUL 0 8 2016