MEMORANDUM

To: Nicola Banton, EA/Permitting Manager **Date:** 8 July 2016

From: Todd Goodsell, Senior Permitting Specialist

Subject: **Response to Comment DFO-056 re: Instream Works**

Introduction

This memo has been prepared in response to the DFO Comment – 056 that contains multiple questions regarding proposed instream works. For the purposes of providing response each individual question is assigned a specific letter A – H.

DFO Comment 056

The information presented by KAM in the Instream Works section does not provide the reader with a clear understanding of the potential effects related to the construction of the four dams to Jacko Lake nor the construction of the sheetpile wall.

A. Specifically are any instream works or lake infilling required with the construction of the 4 dams?
B. What types of piles are to be used and what method of pile driving will be selected?
C. What is the number of piles that are required to be installed and what is the expected duration for these works to take?
D. What is the time period that pile driving will be undertaken and the expected behaviour responses to fish within Jacko Lake?
E. What mitigations are available to reduce these effects?
F. How will the site be isolated prior to construction of the sheetpile dam?
G. Will the sheetwall and piles be removed after operations are complete, if not, why?
H. What other options were considered other than a sheetwall?

KAM Responses

DFO-056 A: Specifically are any instream works or lake infilling required with the construction of the 4 dams?

The JLD2 embankment in the northeastern arm of Jacko Lake will require construction of an engineered fill embankment in an area which is currently part of Jacko Lake. The dam is required to allow mining of the open pit by containing Jacko Lake away from the pit area. Construction of the dam will require the installation of a temporary sheet pile cofferdam to the west of the dam footprint. The cofferdam is also required to allow for removal of a section of the Kinder Morgan pipeline which will no longer be required following the planned pipeline realignment to the west of Jacko Lake.

The remaining dams (JLD1, JLD3 and JLD4 are located outside the current lake footprint (beyond the 892m elevation contour) and therefore can be constructed in "dry" areas. There may be disturbance to vegetation within 50m of the lake however it is expected that the vegetation (grasses, shrubs) outside the immediate dam footprints can be replanted following completion of construction.

The existing Jacko Lake Dam will be removed once the new dams are constructed. Given the shallow water level immediately upstream of the existing dam, the removal work can be completed with temporary inflatable bladder dams and silt curtains over a period of 2-3 weeks.

DFO-056 B: What types of piles are to be used and what method of pile driving will be selected?

Detailed design of the sheet pile cofferdam will be completed once a geotechnical site investigation for the proposed dam has been completed to better understand foundation soil conditions where the sheetpile is proposed. Based on available foundation data nearest the proposed area, it is expected that interlocking steel Z-type piles will be required for the sheet pile wall along with steel piles (<0.5m diameter) to support the sheet pile wall. The pile driving method is influenced by the foundation soil conditions and it is expected the hammer-type pile driving will be required. However, if foundation conditions are suitable then vibratory or hydraulic press type pile driving will be considered as the noise produced by these latter two methods can be substantially less than hammer-type drivers. KAM understands that underwater noise / sound pressure can affect aquatic organisms and that this is likely the reason for the information request related to pile installation.

Underwater noise is typically described by three metrics and expressed in decibels (dB); peak sound pressure level (Peak SPL), root mean square sound pressure level (RMS), and sound exposure level (SEL) Typical sound levels associated with the installation of these pile types are presented in the following table.

Table 1 Site Data Pile Driving Noises – Typical Data (10 m from source)

Pile Type	Installation Method	SEL (dB re 1 $\mu Pa^2 \cdot s$)	RMS* SPL (dB re 1 μPa)	Peak SPL (dB re 1 μPa)
<0.5m steel pile[b]	Impact hammer	160 - 170	175 – 183	190 - 195

Z-type sheet pile (0.6m)[a]	Impact hammer	164 – 186	173 – 192	188 - 209
Z-type sheet pile (0.6m)[b]	Vibratory hammer	160 - 165	160 - 165	175 - 182

Note: * Root mean square (RMS) value based on impulse level - 35ms average.

a. Typical sound data from Caltrans 2015
b. Typical sound data from Caltrans 2007

DFO-056 C: What is the number of piles that are required to be installed and what is the expected duration for these works to take?

Specific pile configuration and width will be confirmed once additional site foundation information is available as part of permit level design. However for purposes of the Application/EIS, it has been assumed that Z-type sheet piles would be suitable and that a sheet pile width of approximately 600 mm (24 inch) could be used. The width of the Jacko Lake arm to be contained during construction is 220 m therefore approximately 370 sheet piles plus an estimated 120 supporting piles will be required. Based on the use of a impact hammer driving system, it is estimated that 1600-2400 blows per day would be required. Preliminary estimates indicate that construction of the cofferdam system would require 12 – 16 weeks using one hammer system and 6-8 weeks using two hammer systems (this duration does not include dewatering of the isolated northeast arm after sheet pile installation).

DFO-056 D: What is the time period that pile driving will be undertaken and the expected behaviour responses to fish within Jacko Lake?

The preferred timing for pile placement is during a period of lower lake levels but not during winter conditions as a frozen ice surface would make barge-based pile installation operations challenging. Therefore it is expected that the sheet pile cofferdam would be constructed in summer once the spring freshet had passed and higher lake levels had subsided. Piling activities will be coordinated with the overall Jacko Lake dam construction program to minimize impacts to the aboriginal and recreational fisheries on Jacko Lake and Peterson Creek at the outlet of the lake.

Little is known about the effects of pile driving on fish behavior, such as a startle response to noise or movement away from highly utilized habitats impacted by sound [(1)]. As noted in the Application / EIS, anthropogenic noise can result in avoidance behaviour and increased stress,

[1] ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009, Technical Guidance for Assessment and Final Mitigation of the Hydroacoustic Effectsof Pile Driving on Fish

which may affect fisheries productivity; however, the ecological significance of such effects is typically low, except where reproductive activity is involved (2).

Spiga et al. (3) also note the lack of detailed studies on fish behaviour in response to sound, citing the fact that studies on fish behaviour are difficult to perform under representative conditions. The primary concern with behavioural changes is whether the reaction to noise becomes biologically significant; behavioural changes that affect the ability of the fish to grow, survive, and reproduce may have consequences at the population level[3]. Pile driving noises may also cause stress in rainbow trout; stress may result in reduced appetite, feeding activity, food intake, and an increase in metabolic rate[3]. However, rainbow trout growth, survival, and disease responsiveness were found to not be affected by long-term exposure to noise levels up to 150 dB re 1 µPa[3].

As a conservative measure, NOAA Fisheries and USFWS generally have used 150 dB RMS as the threshold for behavioral effects on ESA-listed fish species (salmon and bull trout) for most biological opinions evaluating pile driving [4].

DFO-056 E: What mitigations are available to reduce these effects?

Sound pressure associated with pile driving is created by a propagating elastic compression wave that travels down the pile from the pile head to the pile toe. This compression wave is caused by the pile driving hammer striking the pile head. Associated with the compression wave is local pile expansion. The expansion, or diameter increase, is related to the type of pile material. This expansion of the pile displaces the local fluid and creates an acoustic wave front which then propagates downward and away from the pile. Peak sound pressure at the pile wall is directly related to the velocity of pile expansion. This velocity can be found from hammer energy, hammer geometry, pile geometry, and pile material properties.

In the Application/EIS KAM has committed to the implementation of mitigation measures to ensure the sound pressure levels from pile driving activities meet the National Oceanic and Atmospheric Administration (NOAA) interim criteria for the onset of physical injury to fish The interim criteria use two metrics – Sound Pressure Level (SPL) of 206 dB (re: 1 µPa) and Sound Exposure Level (SEL) of 187 dB (re: 1 µPa2•sec) for fishes larger than 2 g, and 183 dB for (re: 1 μPa^2•sec) for smaller fishes[5]. The document "Best Management Practices for Pile Driving and Related Operations" developed by BC Marine and Pile Driving Contractors Association and DFO

[2] Fisheries and Oceans Canada. 2014. A Science Based Framework for Assessing the Response of Fisheries Productivity to State of Species or Habitats. DFO Can. Sci. Advis. Sec. Sci.Advis. Rep. 2013/067.
[3] Spiga, I, Cheesman, S, Hawkins, A, Perez-Dominguez, R, Roberts, L, Hughes, D, Elliott, M, Nedwell, J, Bentley, M (2012). Understanding the Scale and Impacts of Anthropogenic Noise upon Fish and Invertebrates in the Marine Environment.SoundWaves Consortium Technical Review (ME5205)
[4] Caltrans. 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish.
[5] Fisheries Hydroacoustic Working Group. 2008. Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities. Memorandum. June 12. Available at: http://www.dot.ca.gov/hq/env/bio/files/fhwgcriteria_agree.pdf

in 2003 provides the following guidance for installation of steel piles and steel sheet piles to minimize/prevent impacts to fish habitat:

- Steel Piles Greater than 24 inches in diameter using impact or hydraulic hammers:
    - Hydrophone and visual monitoring of the effects of the shock waves on fish.
    - If a fish kill occurs, an effective means of reducing the level of the shockwave will be implemented.
    - Following implementation of additional mitigation measures, if a fish kill recurs or sound pressure over 30 kPa is recorded, work will stop immediately and the methods will be reviewed and corrected.
- Steel Sheet Piles and H-piles with a drop hammer, an impact hammer or a vibratory hammer:
    - If a fish kill occurs, an effective means of reducing the level of the shockwave or measures to prevent fish from entering the potentially harmful shock wave area (e.g. hazing or isolation of area) will be implemented.
    - Following implementation of additional mitigation measures, if a fish kill recurs or sound pressure over 30 kPa is recorded, work will stop immediately and the methods will be reviewed and corrected.

*30 kPa is approximately equivalent to a SPL of 209 dB.

There is a number of mitigation measures that could be used to mitigate the impact of hammer driving of the sheet pile walls in the event that NOAA criteria are not met and/or monitoring indicates significant effects to fish or the fishery. Potential additional mitigations to be considered if necessary include:

- Use of a double acting impact hammer system which will increase the number of total hammer strikes but will generate less noise per strike and provides faster install for lower duration of effects.
- Bubble curtains to attenuate sound in the water column would decrease the sound levels propagating beyond the construction zone due to pile driving. Field experience has shown bubble curtains can decrease sound levels up to 10dB.
- Cushion blocks would lower the sound levels from pile driving (however this will slow pile driving penetration rate and thus installation of the piles). Pile cushions reduce the rise time in pile stress by delaying the onset of force into the pile. This reduced rise time results in reduced fluid particle velocities, and reduced Peak SPL. Field experience has shown a decrease of 2-3dB with the use of cushion blocks.
- Driving pressures can be moderated and controlled depending on the soil types in order to mitigate sound levels during pile driving. The soft start method can reduce pile driving noise. The soft start method involves initially driving a pile with low hammer energy and as the pile is driven into the soil, the hammer energy is increased as necessary to achieve soil penetration. By utilizing the soft start method the relatively low sound

pressure level will be a warning mechanism for fish so that they can vacate the area before maximum hammer energy is reached.

- Temporary cofferdams (temporary inflatable dewatering/isolation of the immediate area where piles are being driven). Isolating the piles from the water body significantly decreases the submerged sound levels (up to 10 – 20dB).

Depending on the water level and time of construction, sheet piles may not be required for the full length of the coffer dam alignment and inflatable coffer dams or similar may be substituted if sound level and pressure criteria cannot be achieved and/or monitoring indicates unacceptable impacts to fish or the fishery on Jacko Lake.

DFO-056 F: How will the site be isolated prior to construction of the sheetpile dam?

The sheetpile dam construction area will be isolated via a double floating silt curtain to prevent entrained sediments from entering the main body of Jacko Lake. The silt curtains will be anchored on either side of the northeast arm during construction of the cofferdam.

DFO-056 G: Will the sheetwall and piles be removed after operations are complete, if not, why?

Yes, the sheetpile cofferdam is intended to be temporary and will be removed following completion of the dam construction on the northeast arm of Jacko Lake.

DFO-056 H: What other options were considered other than a sheetwall?

Alternative means of site isolation prior to construction of the dam on the northeast arm of Jacko Lake were considered. The use of water inflated Aqua-Dams® to create a temporary cofferdam was considered as a potential alternative but the water depth of up to 3-4 m of the construction area (after sub-excavation) is at or about the current size of aqua-dam structures and the maximum controlled water depth which is limited to 3 m for this type of coffer dam. Another alternative mitigation initially considered was drawdown of Jacko Lake water level so that the northeast arm was dewatered for construction because the arm is shallow relative to the rest of the lake. However drawdown of lake level to allow dam construction "in the dry" would result in unacceptable temporary reduction of Jacko Lake habitat as well as impacts to downstream habitat in Peterson Creek and impacts to downstream water rights. Finally, an alternative involving temporary crib or rockfill cofferdams west of the proposed JLD2 construction area was considered however this would result in greater disturbance to Jacko Lake and would be difficult to fully remove following completion of JLD2 dam construction resulting in greater impacts to the lake than the proposed sheet pile wall.