Marine Mammal Management and Monitoring Plan

Woodfibre LNG Project: Rev 2

August 15, 2023

Prepared By:
Woodfibre LNG General Partner Inc.

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Woodfibre LNG

Preamble

The Woodfibre Liquefied Natural Gas Project (the Project) is a liquefied natural gas export facility being constructed on the former Woodfibre Pulp and Paper Mill site in Átl'ḵa7tsem (Howe Sound), approximately seven kilometres south of Sḵwx̱wú7mesh (Squamish). The Project is on the historical location of a Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) village known as Swiẏát. Swiẏát and Átl'ḵa7tsem (Howe Sound) are tied to the cultural well-being of Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) members, their ancestors, and their descendants, and to other Indigenous groups as defined in the Project's Environmental Assessment Certificates. The Project is also operating within the traditional, ancestral, and unceded territory of the səlilwətaɬ (Tsleil-Waututh) Nation. Woodfibre LNG General Partner Inc. recognizes the importance of these areas to the Sḵwx̱wú7mesh stélmexw (Squamish People), and other Indigenous groups. Woodfibre LNG General Partner Inc. seeks to construct and operate the Project in a manner that is respectful of Indigenous values. This Marine Mammal Management and Monitoring Plan is primarily written in English with important place names, species, phrases, and passages provided in the Squamish language.

Temíxwiẏiḵw chet wa naantem chet ti temíxw Swiẏát
Chet wa sméṅhemswit kwis ns7éyx̱nitas chet ti temíxw
We7ú chet kwis t'íchimwit iy íẇas chet eḵ' I tti.

Our ancient ancestors named this place Swiẏát
We, as their descendants safeguard these lands
We will continue to swim and fish in these clear waters.

Limitations and Sign-off

This document entitled Marine Mammal Management and Monitoring Plan was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Woodfibre LNG General Partner Inc. (the "Client").[1] Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Qualified Professional Sign-off:

_____
Signature

_____
Andrea Ahrens, M.Sc., R.P.Bio

[1] A draft version of this Estéteýwilhs iy Ínexwantas ta Sekw'ekw'inexw (Marine Mammal Management and Monitoring Plan) was prepared by Hemmera, a subsidiary of Ausenco. The draft version has been revised and updated by Stantec Consulting Limited (Stantec) at the request of Woodfibre LNG General Partner Inc.

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Squamish-English Translations

Squamish	English
asxw	harbour seal
Átl'ka7tsem	Howe Sound
Estéteýwilhs iy Ínexwantas ta Sekw'ekw'inexw tla Shkweń	Marine Mammal Mitigation and Monitoring Plan
ínexwantas	monitoring
kw'únut'	porpoise/dolphin
kwenís	grey whale/minke whale
kwexnís	Steller sea lion/California sea lion
cháyilhen	salmon
sekw'ekw'inexw	wildlife
skwúmechn	humpback whale
Skwxwú7mesh	Squamish
Skwxwú7mesh stélmexw	Squamish people
Skwxwú7mesh Úxwumixw	Squamish Nation
slhawt'	herring
sts'úkwi7	fish
yéwyews	orca (southern resident and transient) killer whale

Abbreviations

µPa	micropascal
Application	Application for an Environmental Assessment Certificate
BC	British Columbia
BC EAO	British Columbia Environmental Assessment Office
BCCSN	British Columbia Cetacean Sightings Network
BMP	best management practice
CEMP	Construction Environmental Management Plan
CPA	Certified Project Area
dB	decibel
DFO	Fisheries and Oceans Canada
EAC	Environmental Assessment Certificate
ECHO	Enhancing Cetacean Habitat and Observation
FDS	Federal Decision Statement
FSO	floating storage and offloading
km	kilometre
kPA	kilopascal
LAA	Local Assessment Area
LNG	liquefied natural gas
MMMMP	Marine Mammal Management and Monitoring Plan
MMO	Marine Mammal Observer
NOAA Fisheries	National Marine Fisheries Service of the National Oceanic and Atmospheric Administration
the Project	Woodfibre Liquefied Natural Gas Project
QP	Qualified Professional
RAA	Regional Assessment Area
rms	root mean square
SARA	*Species at Risk Act*

SNEAA	Squamish Nation Environmental Assessment Agreement
SPL	sound pressure level
TERMPOL	Technical Review Process of Marine Terminal Systems and Transshipment Sites
Woodfibre LNG	Woodfibre LNG General Partner Inc.

1.0 INTRODUCTION

Woodfibre LNG General Partner Inc. (Woodfibre LNG) will construct and operate the Woodfibre Liquefied Natural Gas Project (the Project), which is located on the former Woodfibre Pulp Mill site approximately seven kilometres (km) southwest of Sḵwx̱wú7mesh (Squamish), British Columbia (BC) (Figure 1). The Project will have capacity to liquefy up to 2.1 million tonnes per year of natural gas, have a storage capacity of 250,000 cubic metres (m^3), and export the liquefied natural gas (LNG) via tankers.

The Project underwent a comprehensive environmental assessment process from 2013 to 2015 and Woodfibre LNG received:

- an environmental assessment certificate (EAC) for the Certified Project Area (CPA) under the British Columbia *Environmental Assessment Act* (EAC #E15-02) in 2015;
- an environmental assessment approval from Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) through the Squamish Nation Environmental Assessment Agreement (SNEAA) in 2015, and;
- a positive federal Decision Statement under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) in 2016.

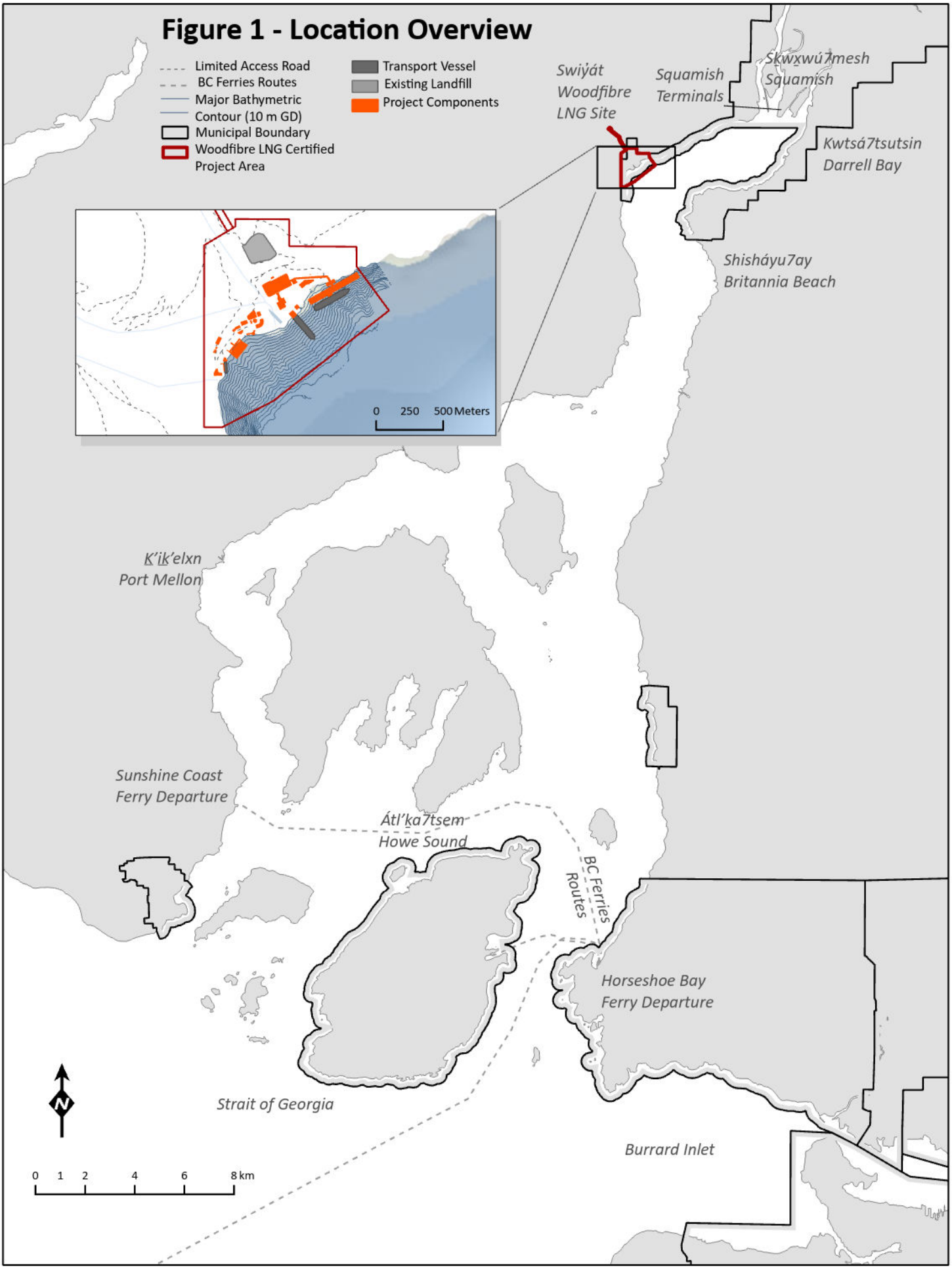
Two EAC amendments were granted by the BC Environmental Assessment Office (EAO) in 2017 and 2019, and the federal Decision Statement was reissued in 2018 in response to changes to the Designated Project. Woodfibre LNG also received an extension on EAC#15-02 from the BC EAO in October 2020. The provincial, Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), and federal environmental assessment processes have each yielded conditions of approval that Woodfibre LNG must address.

Most of the Project is on fee simple, industrially zoned, brownfield lands with more than 100 years of industrial use. There is no road access to the CPA, and all personnel, equipment, and supplies for the Project will be brought in by vessel via Átl'ḵa7tsem (Howe Sound). The Project will use electrical power sourced from BC Hydro, and gas will be supplied to the facility by Fortis BC.

The CPA and key project components are illustrated in Figure 2. Key project components are:

- land-based natural gas processing and liquefaction facilities
- a floating storage and offloading unit
- construction worker accommodation
- supporting infrastructure

The supporting infrastructure includes buildings (e.g., administration, control rooms, maintenance, dry storage and chemical, fire house, first aid, safety and guardhouse), fencing (temporary and permanent), material storage and laydown areas, utility and loading lines, and boil off gas vapour lines.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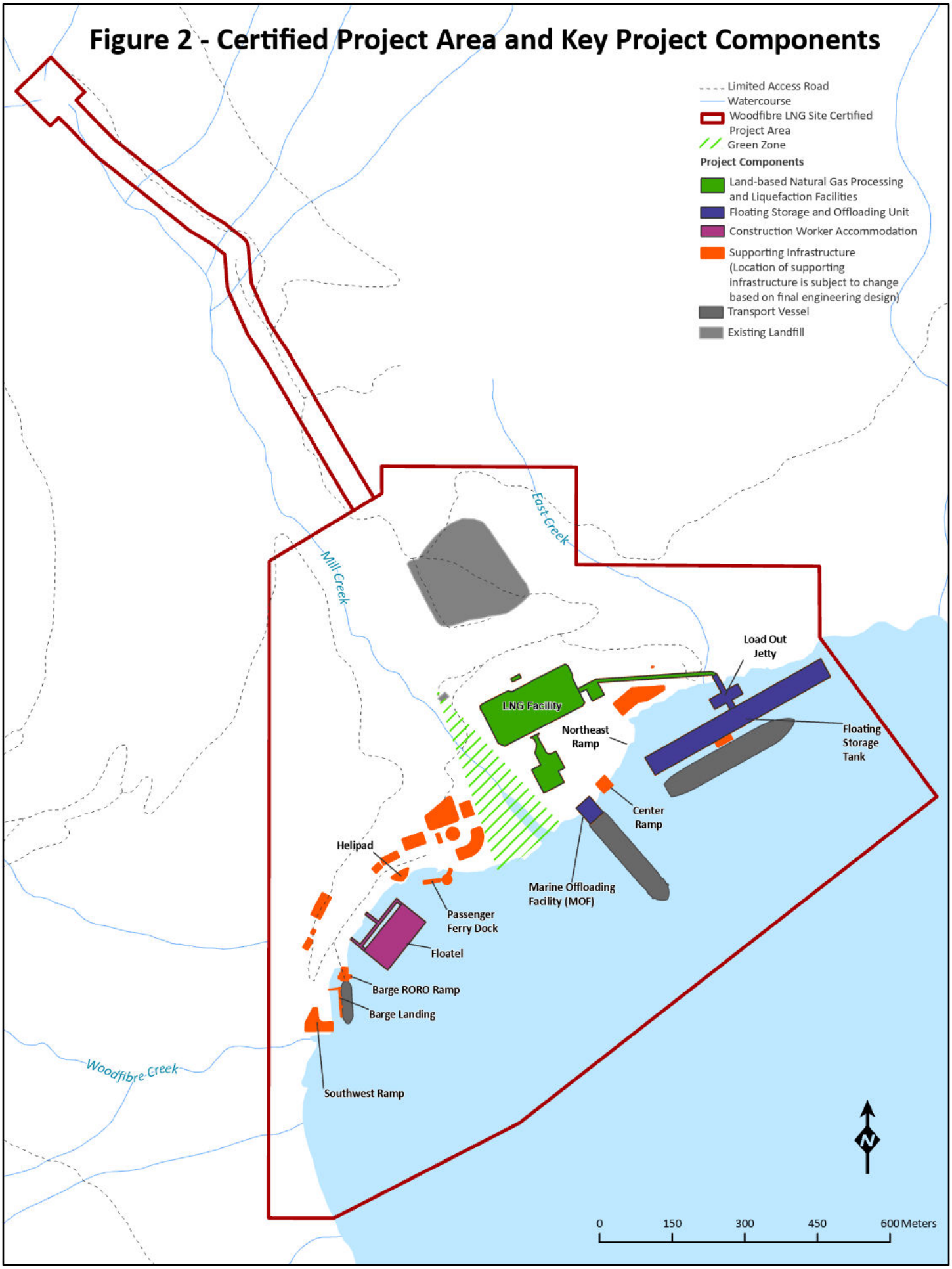
Woodfibre LNG Site
Squamish Terminals
Sḵwx̱wú7mesh Squamish
Kwtsá7tsutsin Darrell Bay
Shishá̱yu7ay Britannia Beach
0 250 500 Meters
K'ik'elxn Port Mellon
Sunshine Coast Ferry Departure
Átl'ka7tsem Howe Sound
BC Ferries Routes
Horseshoe Bay Ferry Departure
Strait of Georgia
Burrard Inlet
N
0 1 2 4 6 8 km

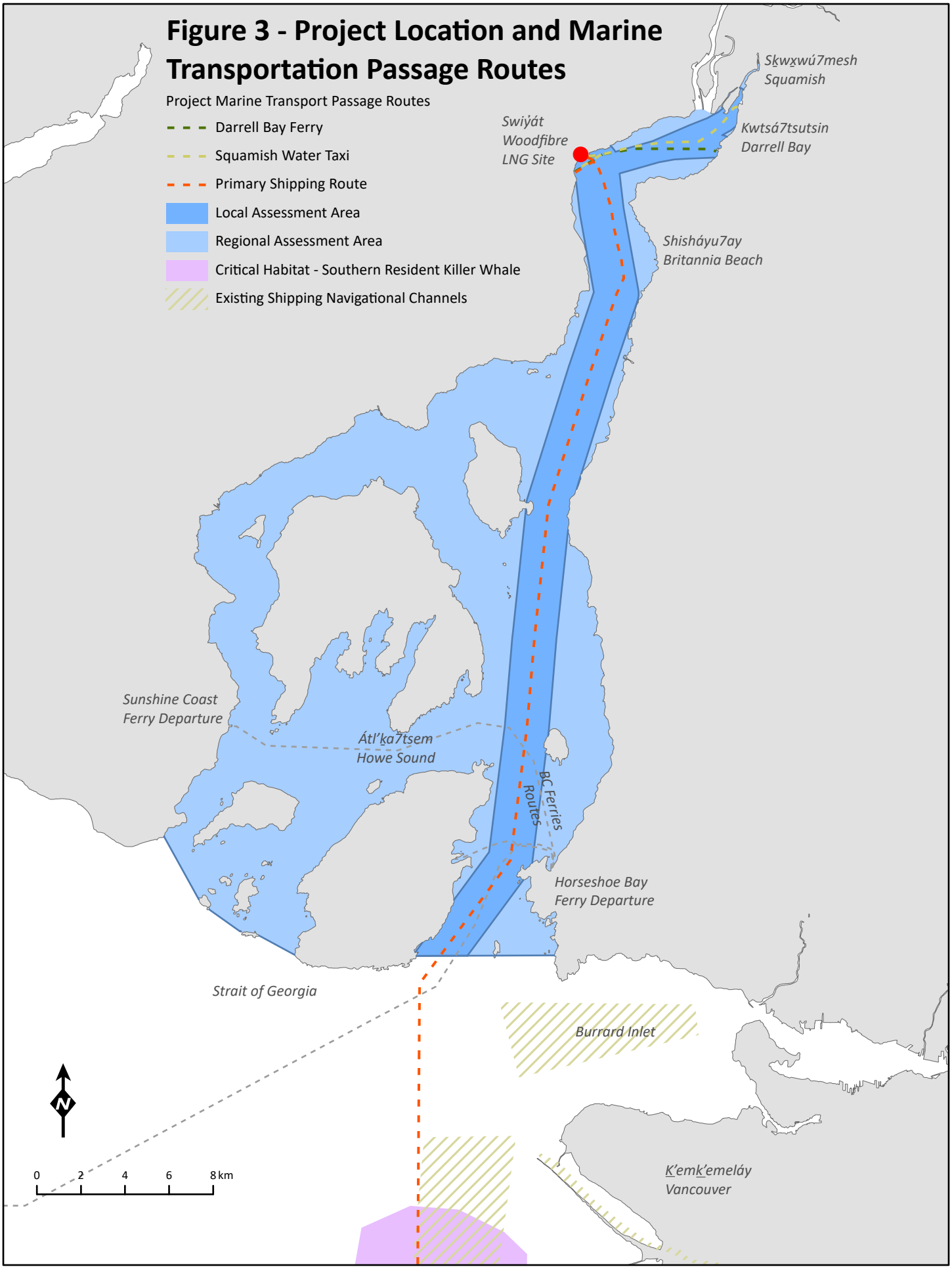
Figure 2 - Certified Project Area and Key Project Components



The works and activities that will occur as part of construction include, but are not limited to:

- marine early works (e.g., shoreline improvements and armoring, dock replacement or repairs), including improvements to the existing in-service (east and south) barge landing
- clearing vegetation and grubbing
- stripping and grading
- drilling and blasting, including excavation, crushing, screening, and hauling
- grouting and rock stabilization
- road, culvert, and bridge works
- construction of land-based natural gas processing and liquefaction facility
- construction support structures, services, and equipment
- construction of the floating storage and offloading unit
- marine facility construction of mooring dolphin supports and connecting trestles and gangways
- dredging if required

Figure 3 shows the Project location and primary shipping routes.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Existing Shipping Navigational Channels
Sḵwx̱wú7mesh Squamish
Swiýát Woodfibre LNG Site
Kwtsá7tsutsin Darrell Bay
Shisháyu7ay Britannia Beach
Sunshine Coast Ferry Departure
Átl'ka7tsem Howe Sound
BC Ferries Routes
Horseshoe Bay Ferry Departure
Strait of Georgia
Burrard Inlet
K'emḵ'emelay Vancouver
N
0 2 4 6 8 km

1.1 OBJECTIVE

The primary objective of this Estéteýwilhs iy Ínexwantas ta Sekw'ekw'inexw tla Shkweń (Marine Mammal Management and Monitoring Plan [MMMMP]) is to detail mitigation measures and ínexwantas (monitoring) protocols that will be employed to reduce the potential for adverse effects on marine mammals during construction and operation of the Project. This includes information on requirements for:

- ínexwantas (monitoring) activities
- procedures for reporting Project interactions with marine mammals
- implementation of best management practices (BMPs) and mitigation measures identified in the environmental assessment and provincial and federal environmental assessment conditions.

This MMMMP is a living document and revisions will be made if relevant new information becomes available through the progression of the detailed engineering design of the Project, changes in legislation or regulation, if performance objectives are not met, or as required by Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), Tsleil-Waututh Nation, and/or regulatory agencies. If the MMMMP requires updating, Woodfibre LNG will prepare a red-line version identifying the changes that are made. The red-line version will be issued to Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), Tsleil-Waututh Nation, and regulatory agencies for a 30-day review and comment period. After comments are received, the document will be updated and issued as a clean final revision for approval by Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and for submittal to the BC EAO. As standard practice, the latest version of the MMMMP will be implemented.

Annual tracking of updates to the status of listed species identified by the Government of British Columbia through the British Columbia Conservation Data Centre, Committee on the Status of Endangered Wildlife in Canada, or the *Species at Risk Act* (SARA) will be completed by Woodfibre LNG. Updates to the status of listed species will be included in annual ínexwantas (monitoring) reports. As necessary, additional BMPs or mitigation measures will be implemented to reduce or avoid effects of the Project on the affected species in accordance with species recovery plans should the status of a listed species change during construction of the Project.

1.2 PROJECT APPROVAL AND CONDITIONS

The following are the Project's marine mammal-related conditions:

- EAC Conditions 9 and 17
- FDS Conditions 3.3, 3.8, 3.9, 3.10, and 3.14
- SNEAA Condition 4.10(a)(iv) and 4.12
- Project commitments presented in Sections 5.19 and 13.0 of Woodfibre LNG's EAC Application (Application).

Concordance tables that cross-reference the sections of this MMMMP to the specific conditions are provided for the provincial (Table 1), and federal (Table 2) environmental assessment decisions. The Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) assessment process and conditions are discussed in Section 1.3. Project construction-related marine mammal commitments from the Application are provided in Section 1.4. Consistent with the commitments made during the environmental assessment, the BMPs and standards were used to inform this MMMMP, as described below.

Comments received during consultation on the development of this MMMMP, and Woodfibre LNG's responses, are provided in a Consultation Record, as required by EAC Condition 2.

Table 1: EAC Conditions Relevant to the Marine Mammal Management and Monitoring Plan

Condition Number	Condition	MMMMP Reference
EAC Condition 9	The Holder must develop, in consultation with DFO, OGC and Aboriginal Groups, a marine mammal management and monitoring plan for Construction that must at a minimum: a) Set out the means by which the mitigation measures related to Construction in the Application Table 22-1 under the heading "Marine Mammals" will be implemented; b) Identify the geographic areas where, and periods of time when, Construction could cause injury to marine mammals; c) Identify the geographic areas where, and periods of time when, Construction could cause behavioural change to marine mammals; d) Identify the time periods when elevated marine mammal occupancy is anticipated within the areas of potential injury to marine mammals or areas of potential behavioural change; e) Specify the role of a Qualified Professional in observing and reporting marine mammals in the areas of potential injury to marine mammals during Construction; f) Specify the Construction activities (e.g., blasting, pile driving) which must stop or not start if a marine mammal is sighted in the areas of potential injury to marine mammals, and not re-start until the marine mammal has moved out of the relevant area, to the satisfaction of the Qualified Professional; g) Specify mitigation measures for Construction underwater noise that will prevent or reduce behavioural change or injury to marine mammals; and h) A Qualified Professional must develop the plan and supervise the implementation of the plan. The Holder must provide the plan to EAO no less than 60 days prior to the Holder's planned date to commence Construction in the marine environment. The Holder must provide the plan to EAO, DFO, OGC and Aboriginal Groups no less than 30 days prior to the Holder's planned date to commence Construction in the marine environment. The Holder must implement the plan to the satisfaction of EAO.	Section 1.2 Section 5.0 Section 7.0 Section 4.0 Section 3.0

Table 1: EAC Conditions Relevant to the Marine Mammal Management and Monitoring Plan

Condition Number	Condition	MMMMP Reference
EAC Condition 17	The Holder must develop, in consultation with TC, CCG, Pacific Pilotage Authority, DFO and Aboriginal Groups, a marine transport management and monitoring plan for Operations. The plan must identify at a minimum: a) The means by which the marine transportation mitigation measures related to Operations in the Application Table 22-1 under the heading "marine transportation & use" (section 7.3, M5.19-3, M6.3-1, M7.3-1 – M7.3-17) will be implemented; b) Operations activities that have the potential to interfere with marine navigation; c) Existing and traditional navigational routes, fishing areas, habitat areas, harvesting areas, commercial shipping use, recreational and tourism use, Aboriginal Groups' use, and any associated timing windows; d) Methods to inform affected stakeholders and Aboriginal Groups of potential interference with marine navigation as a result of Operations activities; e) Mitigation measures to reduce disruption of marine navigation in Howe Sound as a result of Operations activities; f) Practices to reduce disruption and collision risk with marine mammals along the shipping route in Howe Sound; g) Methods to inform the public, commercial marine user groups, and Aboriginal Groups about the results of the Technical Review Process of Marine Terminal Systems and Transshipment Sites (TERMPOL) process respecting the Project; and h) Methods to monitor the effects of the Holder's shipping activities during Operations. The Holder must provide the plan to EAO no less than 60 days prior to the Holder's planned date to commence Operations. The Holder must also provide the final plan to TC, CCG, Pacific Pilotage Authority, DFO, the DOS, BC Ferries, Squamish Terminals and Aboriginal Groups. The Holder must implement the plan to the satisfaction of EAO.	Section 5.4 Section 6.0
The regulator name in the conditions reflect the names that were in place when the conditions were written. OGC (Oil and Gas Commission) is now BC Energy Regulator		

Table 2: FDS Conditions Relevant to the Marine Mammal Management and Monitoring Plan

Condition Number	Condition	MMMMP Reference
FDS Condition 2.4	The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement: 2.4.1 Undertake monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure(s); 2.4.2 Determine whether additional mitigation measures are required based on the monitoring and analysis undertaken pursuant to condition 2.4.1; and 2.4.3 If additional mitigation measures are required pursuant to condition 2.4.2, implement the additional mitigation measures and monitor them pursuant to condition 2.4.1.	Section 7.0
FDS Condition 2.5	Where consultation with Aboriginal groups is a requirement of a follow-up program, the Proponent shall discuss with each Aboriginal group opportunities for the participation of that Aboriginal group in the implementation of the follow-up program as set out in condition 2.4.	Section 7.0
FDS Condition 3.3	The Proponent shall implement measures to mitigate adverse environmental effects of the Designated Project on fish, including mortality, physical injury, and behavioral change, during all phases of the Designated Project. The mitigation measures shall include: 3.3.5 Taking into consideration the British Columbia Marine and Pile Driving Contractors Association's Best Management Practices for Pile Driving and Related Operations 2003 when conducting pile installation; and 3.3.6 Implementing low-noise methods or sound dampening technologies to reduce the intensity of the sound generated or the level of sound propagation through the water column if underwater pressure pulse levels exceed 30 kilopascals during pile installation.	Section 5.1
FDS Condition 3.8	The Proponent shall establish and maintain marine mammal underwater noise impact areas[2] for all construction activities to avoid adverse behavioural change in or injury to marine mammals. In doing so, the Proponent shall: 3.8.1 Identify each construction activity that generates underwater noise levels greater than 160 decibels and 190 decibels at a reference pressure of one micropascal and the periods of time when each activity occurs; 3.8.2 For all marine mammals except pinnipeds, establish the boundary of the underwater noise impact area for each construction activity identified in condition 3.8.1 at the distance from the activity where the underwater noise level is predicted to reach 160 decibels;	Section 5.2 Section 7.0

[2] The term 'underwater noise impact area' referenced in the FDS conditions is used synonymously with 'exclusion zone', 'exclusion area', and 'safety area', in this and other conditions and commitments made in this MMMMP.

Table 2: FDS Conditions Relevant to the Marine Mammal Management and Monitoring Plan

Condition Number	Condition	MMMMP Reference
FDS Condition 3.8 (cont'd.)	3.8.3 For pinnipeds, establish the boundary of the marine mammal underwater noise impact area for each construction activity identified in condition 3.8.1 at the distance from the activity where underwater noise levels reach 190 decibels or at a distance of 150 metres, whichever is the greater distance; 3.8.4 Employ a marine mammal observer, who is a qualified individual, and require that person to detect and report the presence of marine mammals in the marine mammal underwater noise impact areas identified in conditions 3.8.2 and 3.8.3 during construction activities identified in condition 3.8.1; 3.8.5 Stop or not start the construction activities identified in condition 3.8.1 if marine mammal(s) are detected in their respective marine mammal underwater noise impact areas identified in condition 3.8.2 or condition 3.8.3, and only begin or continue the construction activities identified in condition 3.8.1 once the marine mammal(s) have moved out of their respective underwater noise impact area; 3.8.6 Implement mitigation measures, including sound dampening technology such as bubble curtains and soft-start procedures, to reduce construction noise levels in the underwater noise impact areas identified in conditions 3.8.2 and 3.8.8. 3.8.7 Monitor continuously the levels of underwater noise at the boundaries of both marine mammal underwater noise impact areas while the construction activities identified in condition 3.8.1 are ongoing. The Proponent shall immediately halt the construction activities if hydroacoustic monitoring indicates that noise levels at either boundary exceed their respective threshold, and not resume without implementing sound attenuation measure(s), which could include increasing the distance of the underwater noise impact areas, to reduce noise levels below the thresholds.	Section 5.2 Section 7.0
FDS Condition 3.9	The Proponent shall require that liquefied natural gas (LNG) vessels associated with the Designated Project respect speed profiles applicable to the operation of the Designated Project, subject to navigational safety, to prevent or reduce the risks of collisions between LNG vessels and marine mammals.	Section 5.4
FDS Condition 3.10	The Proponent shall require that LNG vessels and tug operators associated with the Designated Project report collisions with marine mammals in Howe Sound to the Canadian Coast Guard within two hours of a collision occurrence, and notify Aboriginal groups in writing.	Section 5.4.1
FDS Condition 3.14	The Proponent shall, in consultation with Fisheries and Oceans Canada and Aboriginal groups, develop, prior to construction, and implement, during all phases of the Designated Project, a follow-up program to verify the accuracy of the environmental assessment and to determine the effectiveness of the mitigation measures identified under conditions 3.1 to 3.10.	Section 8.0

1.3 SQUAMISH NATION ENVIRONMENTAL ASSESSMENT AGREEMENT

The Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) environmental assessment process for the Project was designed to parallel the provincial and federal environmental assessment processes, whereby Project effects on the Sḵwx̱wú7mesh stélmexw (Squamish people's) rights and title interests are identified, understood, and properly avoided or mitigated. The process for the Project ultimately resulted in the Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) issuing an EAC (#2015-001), which includes conditions described in the SNEAA that was issued on October 14, 2015. Per SNEAA, "*Squamish Nation has agreed that Woodfibre may proceed with carrying out the Project, subject to Woodfibre LNG meeting, and (as applicable) continuing to meet, the Squamish Nation Conditions as provided for in this Agreement*."

The SNEAA Condition 12, which has applicability to the MMMMP, states

4.12 Binding Mitigation Measures - Squamish Condition #12

(a) Woodfibre LNG identifies approximately 119 distinct mitigation measures in Table 22-1 of Woodfibre LNG's EA application. If Squamish Nation determines that it wishes to monitor any of the mitigation measures, then Squamish Nation will issue a notice to Woodfibre LNG identifying which mitigation measures it intends to monitor ("Monitored Mitigation Measures") and the manner it proposes to undertake such monitoring.

(b) Where Squamish Nation is of the opinion that any Monitored Mitigation Measure is not being followed, it will notify Woodfibre LNG. Woodfibre LNG will respond to the notification with one of the following (the "'Response"):

(i) Woodfibre LNG's explanation of how the mitigation measure is being followed;

(ii) a written explanation why the mitigation measure is not being followed, and the measure that replaces it (with an explanation of how the new measure provides equal or greater levels of environmental protection);

(iii) A written explanation of why the mitigation measure is not being followed, with justification for:

a. why it has not been replaced with another measure, or

b. why it has been replaced with a measure that provides less levels of environmental protection

(c) Woodfibre LNG will develop a Monitored Mitigation Measures plan with the Squamish Nation that will include the frequency of guided tours for the Squamish Nation during construction and operations and a budget to implement the plan, which plan will be fully funded by Woodfibre LNG.

(d) Should Squamish Nation not be satisfied with the Response, then the Squamish Nation may submit the matter to the dispute resolution process set out in section 8.1 and if the reasonableness of the Response is at issue the expert or expert panel shall consider the following when making its decision: whether the mitigation measure has a material impact on constructability, cost, operability, safety, environment, or schedule; whether the mitigation measure creates unacceptable risk or legal liability for the Project; whether the mitigation measure conflicts with any legal, regulatory, or pre-existing contractual obligations of Woodfibre LNG; whether the Woodfibre LNG response to the proposed mitigation measure(s) conforms to Good Industry Practice; and any other information the expert or expert panel considers relevant.

Per Condition 6 (Section 4.6) of the SNEAA, the MMMMP is considered a Regulated Environmental Management Plan, meaning that it is an Environmental Management Plan requiring approval from Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) in accordance with Section 4.6(e) of the SNEAA.

The SNEAA Condition 10, which has applicability to the MMMMP, states

4.10 Marine Mammals - Squamish Condition #10

(a) Woodfibre LNG agrees to conduct a noise monitoring program that will involve collecting data from a hydrophone deployed within the Project area, the purpose of which program will be:

(iv) to collect local data on underwater sound levels;

(v) to supplement existing data on presence, frequency and seasonality of use by marine mammals;

(vi) to establish baseline data against which to compare ambient underwater sound levels and marine mammal use throughout the life of the Project; and

(vii) prior to commencement of construction, prepare, for approval by Squamish Nation in accordance with section 4.6, an Underwater Noise Management Plan and a Marine Mammals Management Plan that include mitigation measures and monitoring programs designed to address potential residual adverse effects on marine mammals from underwater noise.

(b) Woodfibre LNG will participate in studies of sub-lethal acoustic impacts on marine mammals by sharing its noise monitoring data and marine mammal monitoring data collected in respect of the Project, where and when such data are requested by qualified and reputable researchers. Woodfibre LNG also agrees to adopt in its adaptive management framework progressive strategies to minimize cumulative impacts on underwater noise on marine mammals. Woodfibre LNG's funding commitment for this work will be as set out in the IBA.

Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) is not an author of the MMMMP, nor does Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) hold any liability for implementation of this plan as it relates to more general marine navigation and commercial or recreational activities. In respect of the MMMMP being a Regulated Environmental Management Plan, and in accordance with Condition 6 of the SNEAA, a draft of the MMMMP was reviewed by a Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) Working Group representative. That draft review clarified Sḵwx̱wú7mesh Úxwumixw (Squamish Nation's) expectations for final approval of this plan. A key condition of Sḵwx̱wú7mesh Úxwumixw (Squamish Nation's) approval of the MMMMP is the living nature of this document; it is anticipated that through the construction period, unforeseen conflicts may occur between Project marine traffic and Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) members' marine activities. The protocols included in this MMMMP are intended to identify and respond to evolving or unforeseen concerns.

1.4 APPLICATION TABLE 22-1 COMMITMENTS

A concordance table that cross-references the sections of this MMMMP to the construction-related marine mammal commitments in Table 22-1 of the Application[3] is provided in Table 3. The mitigation measures in Table 3 are provided as proposed in Table 22-1 of the Application; further detail on how these mitigation measures will be implemented is described in the respective MMMMP sections referred to in the table.

Table 3: Marine Mammal Mitigation Measures Related to Construction in Table 22-1 of the Application

Mitigation Number	Mitigation Name and Proposed Mitigation	Concordance with the MMMMP
M5.17-6	**Underwater Noise Management Plan** Woodfibre LNG Limited will prepare and implement an Underwater Noise Management Plan as a component of the Marine Works Management Plan (M5.10-1) to mitigate potential mortality and behavioural changes to birds, fish and marine mammals. The plan will reference DFO's BMP for Pile Driving and Related Operations (BCMPDCA and DFO 2003), and will contain the following measures: Pile Driving and Related Activities: • Multiple underwater noise generating activities will be minimized when practicable (e.g., avoid multiple pile driving activities at the same time). Where multiple underwater noise generating activities are planned, they will be sequenced to minimize construction duration. • Works in the marine environment will be conducted during the least risk fisheries work window specified by DFO for the region unless otherwise agreed upon by DFO. The prescribed work window for Howe Sound is August 16–January 31 (DFO 2014b).	Section 5.1 Section 5.2 Section 7.0

[3] At the time the Application, including Table 22-1 was submitted, the company name was Woodfibre LNG Limited but it is now Woodfibre LNG General Partner Inc. The commitments as written and presented herein remain unchanged from the Application.

Table 3: Marine Mammal Mitigation Measures Related to Construction in Table 22-1 of the Application

Mitigation Number	Mitigation Name and Proposed Mitigation	Concordance with the MMMMP
M5.17-6 (cont'd.)	• Where possible, pile driving activities will avoid impacting hard substrates to prevent disturbance to fish habitat. • The use of vibrational pile driving will be used where practical and feasible as impact pile driving is associated with louder sound pressure levels underwater. The use of vibro-hammers for pile installation minimizes the effects on fish by decreasing the anticipated noise levels. • A ramp up or soft start technique will be used. Where equipment allows, power will be built up slowly from a low energy start-up to give adequate time for marine wildlife to leave the vicinity before exposure to the maximum sound pressure level. There will be a soft start every time pile driving is resumed following an interval of no pile driving. • Underwater noise from pile driving activities will be monitored in accordance with the following: – Sound will not exceed 30 kPa at a distance of 1 m to 2 m from pilings; or – If the sound exceeds 30 kPa at a distance of 1 m to 2 m from pilings, measures will be taken to reduce either the intensity of the sound generated or the level of sound propagation through the water column. – The appropriate measures will be chosen based on practicality to the Project and effectiveness and may include: • Silt curtains around pile driving activities • Bubble curtains around pile driving activities • A vibratory hammer in place of an impact hammer for pile driving. Prior to pile driving, the perimeter of the pile driving area will be identified, so that work occurs within the confines of the pile driving area. Monitoring: The Environmental Monitor will be responsible for monitoring underwater noise and potential effects to wildlife, and implementing corrective mitigation measures if necessary (e.g., establishing safety zones in the event underwater noise levels exceed injury thresholds).	Section 5.1 Section 5.2 Section 7.0
M5.19-1	**Avoidance of Pile Driving on Hard Substrates** In addition to the mitigation measures described in M5.17-6, Woodfibre LNG will prevent pile driving activities from impacting hard substrates, where possible. During impact pile-driving activities, a qualified specialist marine mammal observer will monitor for marine mammals and will communicate presence or absence to the Contractor.	Section 7.1

Table 3: Marine Mammal Mitigation Measures Related to Construction in Table 22-1 of the Application

Mitigation Number	Mitigation Name and Proposed Mitigation	Concordance with the MMMMP
M5.19-2	**Marine Mammal Management Plan** Woodfibre LNG Limited will produce a Marine Mammal Management Plan for the Project. This plan will include vessel speed reductions and avoidance of marine mammals: • LNG carrier and other deep-sea vessel speeds will be kept at a maximum of 8 to 10 knots when operating in the LAA [Local Assessment Area, per the Application]. • All Project vessels will follow established shipping lanes/navigational routes typically used in the area. • All Project vessels will maintain a constant course and constant speed, to the extent practical, when operating in the RAA [Regional Assessment Area, per the Application]. • Under no circumstances, other than in the case of an emergency, will vessels approach within 200 m of any marine mammal. • If marine mammals approach within 200 m of a vessel, the vessel will reduce its speed and, if possible, cautiously move away from the animal. If it is not possible for a vessel to move away from or detour around a stationary marine mammal or group of marine mammals, the vessel will reduce its speed and wait until the animal(s) moves at least 200 m from the vessel prior to resuming speed. • During impact pile driving activities, a qualified specialist marine mammal observer will monitor for marine mammals and will communicate presence/absence to the Contractor.	Section 5.1 Section 5.4
M5.19-3	**Planning for Future Marine Traffic** Woodfibre LNG Limited will undertake additional passage planning concerning the interaction of future traffic in studies as part of the Technical Review Process under TERMPOL Code of Recommended Standards for the safety and Prevention of Pollution for Marine Transportation Systems and Related Assessment Procedures.	Section 5.4.1

2.0 REGULATORY FRAMEWORK

2.1 REGULATORY REQUIREMENTS

Regulation and management of marine mammals occurs primarily through the Marine Mammal Regulations (SOR/93-56) of the *Fisheries Act*, R.S.C. 1985, c. F-14, and SARA, S.C. 2002, c. 29. These Acts are administered by Fisheries and Oceans Canada (DFO) in partnership with other federal departments and are the main federal statutes that pertain to the conservation and protection of marine mammals.

2.2 FEDERAL REGULATIONS

2.2.1 Marine Mammal Regulations (SOR/93-56) of the Fisheries Act

Regulation and management of marine mammals in Canada occurs primarily through the *Fisheries Act*, R.S.C. 1985, c. F-14 (under which marine mammals are classified as 'fish' for regulatory purposes), and the associated Marine Mammal Regulations (SOR/93-56). Section 7 of the Marine Mammal Regulations prohibits disturbance of marine mammals, except under a limited number of circumstances (e.g., when fishing for them under the authority of the Regulations; when carrying out authorized activities under the *Fisheries Act*; or, when acting in a manner authorized under SARA).

2.2.2 Species at Risk Act

The *Species at Risk Act* is a federal Act that applies to certain sek̲w'ek̲w'inexw (wildlife) species in Canada. Species listed on Schedule 1 as extirpated, endangered, or threatened are afforded protection under SARA. Species listed as special concern on Schedule 1 are managed to prevent them from becoming extirpated, endangered, or threatened. It is prohibited to kill, harm, harass, capture, or take an individual of those Schedule 1 species. It is also prohibited to damage or cause destruction to any part of the designated critical habitat of any listed endangered, threatened, or extirpated (if its reintroduction was recommended) species (Government of Canada, 2002). The conservation status of marine mammal species in Átl'k̲a7tsem (Howe Sound) is presented in Section 4.0 (Table 4). The federal government is required to develop a recovery strategy for those Schedule 1 species. Recovery strategies identify critical habitat and SARA prohibits the destruction of critical habitat on federal land. Recovery strategies that apply to this Project are listed in Section 5.1.

3.0 ROLES AND RESPONSIBILITIES

The Construction Environmental Management Plan (CEMP) outlines the roles and responsibilities of the Environmental Manager, Contractor, Qualified Professional (QP), and Environmental Monitor. Specific to the MMMMP, the QP is responsible for:

- developing the MMMMP and supervising its implementation
- providing discipline-specific expertise in underwater noise and marine mammals
- determining the most effective implementation of the Marine Mammal Observers (MMOs)
- supporting Woodfibre LNG representatives in annual review and, where required, updating the MMMMP
- reviewing results of the underwater noise verification program and identifying additional mitigation measures, if required
- supporting training of contractors, MMOs, and vessel operators

4.0 MARINE MAMMAL SETTING

A comprehensive literature review (desktop study) was completed to characterize existing marine mammal baseline conditions in the CPA, with an emphasis on seasonal residency/abundance and habitat use patterns (see Application Appendix 5.10-1 Marine Resources Baseline Study).

4.1 MARINE MAMMALS

Many marine mammal species are commonly sighted in Átl'ka7tsem (Howe Sound), including (Golder Associates, 2014):

- kw'únut' (any of: harbour porpoise [*Phocoena phocoena*]; Pacific white-sided dolphin [*Lagenorhynchus obliquidens*]; Dall's porpoise [*Phocoenoides dalli*])
- yéwyews (killer whale [*Orcinus orca*]; northern and southern residents, Bigg's [transient], and offshore ecotypes)
- skwúmechn (humpback whale [*Megaptera novaeangliae*])
- kwenís (minke whale [*Balaenoptera acutorostrata*])
- asxw (harbour seal [*Phoca vitulina richardsi*])
- kwexnís (either of: California sea lions [*Zalophus californianus*] or Steller [Loughlin's northern] sea lion [*Eumetopias jubatus monteriensis*])
- sea otter (*Enhydra lutris*)

Less commonly sighted whales have also been observed in the general regional area, including:

- false killer whale (*Pseudorca crassidens*)
- kwenís (grey whale [*Eschrichtius robustus*])
- pilot whale (*Globicephala macrorhynchus*)

Several species are listed as being of conservation concern on either a provincial or national level (Table 4). Marine mammals are important to Skwxwú7mesh Úxwumixw (Squamish Nation) and coastal Indigenous groups in the CPA. The most common marine mammal species reported in the upper reaches of Átl'ka7tsem (Howe Sound) near the CPA are asxw (harbour seals), kw'únut' (Pacific white-sided dolphins), and yéwyews (killer whale).

No critical habitat for marine mammals is designated in Átl'ka7tsem (Howe Sound); however, critical habitat for the endangered population of yéwyews (southern resident killer whales) has been designated approximately 11.5 km south of the entrance to Átl'ka7tsem (Howe Sound), near the mouth of the Fraser River, and extending through the Salish Sea to west coast of Vancouver Island (DFO, 2018; Figure 3).

Of the marine mammal species known to frequent Átl'ka7tsem (Howe Sound), asxw (harbour seals) were the only species observed to establish predictable haulout sites, typically located on nearshore islands, islets, reefs, or sandbars (Miller et al., 2020). Asxw (harbour seal) haulout sites have been studied since 1973 to better understand site location, general abundance, and population variations within

Átl'ḵa7tsem (Howe Sound) (Miller et al., 2020). Multiple sites have been observed along the shipping routes south of the Project, ranging as far as Burrard Inlet. In 2019, three main haulout sites; South Watts Point, Watts Point Logbooms, and Northwest St'a7mes (Squamish Harbour), were observed to be in close proximity to the Project. Haulouts in these locations ranged from 1 to 25 individuals (Miller et al., 2020).

Marine mammals at the species level vary greatly in their seasonal occurrence in Átl'ḵa7tsem (Howe Sound) (Table 4; Figure 3). Marine mammal sightings data from the British Columbia Cetacean Sightings Network (BCCSN) shows the use of habitats in Átl'ḵa7tsem (Howe Sound) by cetaceans to change seasonally, and the number of observations declines with distance from the Strait of Georgia. Asxw (harbour seal) are year-round residents in Átl'ḵa7tsem (Howe Sound), while ḵwex̱nís (California and Steller sea lions) and kw'únut' (harbour and Dall's porpoises) are considered occasional visitors throughout the year. Other cetacean species have generally been absent from Átl'ḵa7tsem (Howe Sound) over the last few decades until recently, with sightings of kw'únut' (Pacific white-sided dolphin), yéwyews (killer whale), ḵwenís (grey whale), and sḵwúmechn (humpback whale) notably increasing since 2009 (BCCSN 2022, pers. comm.). The recent rise in cetacean sightings in Átl'ḵa7tsem (Howe Sound) has been linked with improved water quality in the area and associated return in prey sts'úḵwi7 (fish) numbers, including slhawt' (herring) and cháyilhen (salmonids). K̲wenís (minke whale) and false killer whales are historically rare in Átl'ḵa7tsem (Howe Sound) and would be considered vagrant sightings in this area. A detailed overview of each species is provided in the Application Appendix 5.10-1 Marine Resources Baseline Study.

Table 4: Marine Mammal Species Potentially Occurring in Átl'ḵa7tsem (Howe Sound)

Common Name	Seasonal Occurrence	Conservation Status	
		SARA Schedule 1	BC
Killer whale (*Orcinus orca*)—Southern Resident	Year-round	EN	Red
Killer whale (*Orcinus orca*)—Northern Resident	Year-round	TH	Red
Killer whale (*Orcinus orca*)—Transient	Year-round	TH	Red
Killer whale (*Orcinus orca*)—Offshore	Year-round	TH	Red
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)	Year-round	N/A	Yellow
Dall's porpoise (*Phocoenoides dalli*)	Year-round	N/A	Yellow
Harbour porpoise (*Phocoena phocoena*)	Year-round	SC	Blue
Humpback whale (*Megaptera novaeangliae*)	Year-round	SC	Blue
Grey whale (*Eschrichtius robustus*) - Pacific Coast Feeding Group population	Spring, summer, fall	EN	Red
Minke whale (*Balaenoptera acutorostrata*)	Spring, summer	N/A	Yellow
Steller sea lion (*Eumetopias jubatus monteriensis*)	Year-round	SC	Blue
California sea lion (*Zalophus californianus*)	Year-round	N/A	Yellow
Harbour seal (*Phoca vitulina*)	Year-round	N/A	Yellow

Notes:
EN—endangered; SC—special concern; TH—threatened.
"N/A" Denotes no SARA Schedule 1 status

4.2 UNDERWATER NOISE

Ambient underwater noise levels were measured near the CPA in Átl'ka7tsem (Howe Sound) on July 5, 2013, to inform the environmental assessment. This information served as a baseline for comparison to anticipated underwater noise levels from proposed Project activities (e.g., pile installation, vessel operations). Broadband ambient noise levels ranged from 112.0 decibels (dB) to 126.8 dB re 1 µPa (micropascal[4]), with a median (50th percentile) of 116 dB re 1 µPa. A detailed summary of the ambient underwater noise assessment is provided in the Application Appendix 5.10-1 Marine Resources Baseline Study.

The JASCO Applied Sciences Woodfibre LNG Marine Acoustic Baseline Monitoring study was conducted in 2022 to better understand marine mammal presence, seasonality, and variability at the terminal site within St'a7mes (Squamish Harbour) (Lawrence et al. 2022). The program spanned one year and comprised two six-month deployments. The soundscape data retrieved was analyzed to distinguish between natural ambient sounds, anthropogenic noises, and marine mammal presence. Results from the study indicate that the main contributor of acoustic noise was from marine vessel and construction activities; however, several marine mammal species were detected amongst the data sets. Species detected along with their acoustic characteristics, behavioural attributes, and other physiological tendencies supporting the detection and confirming presence is summarized below.

Yéwyews (Bigg's killer whales), one of the four distinct transient population which frequents the Strait of Georgia and Howe Sound, was sporadically detected throughout the recording period. Similarly, kw'únut' (harbour porpoises), distinguishable by narrowband high-frequency clicks, were also frequently detected throughout the period. Kw'únut' (harbour seals) and kwexnís (California sea lions) were less frequently detected; however, acoustic detection was confirmed through vocalizations associated with mating and seasonal migratory behaviours respectively. Other species known to have previously visited the general area, such as kwexnís (Steller sea lions), kwenís (grey whales, minke whales), yéwyews (southern resident killer whale), kw'únut' (Dall's porpoises, or Pacific white-sided dolphins) were not detected amongst the data. Marine mammal vocalizations mainly from kwexnís (California sea lions) coincided with sounds that suggested skwúmechn (humpback whale) presence, but confirmation was nullified because of overlapping acoustic patterns.

4.3 VESSEL TRAFFIC LEVELS

Approximately 80 deep-sea vessels call at the Squamish Terminal per year. An additional three BC Ferries' routes from Horseshoe Bay provide daily large vessel activities in the region (Application Figure 5.19 1). BC Ferries accounts for nearly 75 percent of large vessel marine traffic in Átl'ka7tsem (Howe Sound). Tugs and barges also transit the route, although tug and barge traffic density in Montagu Channel is 13 percent of that in Thornbrough Channel. According to anecdotal reports, there are approximately 10 water taxi movements to the CPA per day (WFP 2014a,b, pers. comm.). Additional details regarding shipping are presented in the Application, Section 7.3 Marine Transport.

[4] An international system of units (SI) unit of pressure and stress equal to 10−6 pascals (using one-third octave percentile band levels of the 5th to 95th percentile, respectively).

5.0 MARINE MAMMAL MITIGATION MEASURES

This section describes the marine mammal mitigation measures that are applicable to the construction and operations phases of the Project. The mitigation measures are based on Project conditions of approval, Project commitments, and industry and government BMPs and guidelines. In addition to the CEMP, other management plans relevant to marine mammals include the Water Management Plan, the Marine Transport Management Plan, and the Marine Fish and Fish Habitat Management and Monitoring Plan. The CEMP and Emergency Response Plan include spill prevention and mitigation measures.

The mitigation of adverse project effects on marine mammals outlined in the MMMMP will be achieved through adherence to best practices and guidelines, project design, site-specific mitigation measures, and environmental training/education. Details are provided in the following sections.

The BC EAO environmental assessment report concluded that unmitigated underwater noise generated during Project construction may potentially injure marine mammals or result in behavioural disturbance. The approval also concluded that unmitigated transit of Project vessels during construction and operations could result in injury or mortality to marine mammals. Mitigation measures were proposed to reduce adverse effects.

The following sections:

- summarize the conclusions of the Application regarding the potential effects of underwater noise and vessel strikes from the Project on marine mammals
- provide relevant background information describing effects of underwater noise and vessel strikes on marine mammals
- describe mitigation measures to be implemented during Project construction and operations to reduce or eliminate potential effects of underwater noise and vessel strikes on marine mammals

5.1 BEST MANAGEMENT PRACTICES AND GUIDELINES

5.1.1 Acoustic Thresholds

Canada does not currently have formal regulatory acoustic thresholds for underwater sound levels that should not be exceeded, nor are there standardized national or provincial guidelines outlining mitigation measures or protocols to protect marine mammals exposed to noise from in-water pile installation (impact, vibratory, rotary drilling) or other marine construction activities. Environmental assessments and management plans in Canada therefore frequently rely on regulatory thresholds and guidance in place in the United States, which are provided by the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA Fisheries). NOAA Fisheries provides guidance for assessing the potential for underwater sound levels to injure or disturb marine mammals. This guidance includes the provision of thresholds that can be used to assess both behavioural disruption and injury (where onset of permanent threshold shift is used as the threshold for injury). With respect to behavioural disruption, NOAA Fisheries has historical (2005) interim guidance that sets thresholds for broadband underwater

root mean square (rms) sound pressure levels[5] (SPLs) predicted to cause behavioural disruption (NOAA, 2022). NOAA Fisheries has released updated regulatory guidance for assessing the potential for underwater noise to cause injury (i.e., permanent threshold shift) (NOAA Fisheries, 2018); however, these more recent recommendations do not update the (2005) interim guidance for disturbance (NOAA, 2022). In the absence of formal Canadian thresholds, and based on recent guidance on other Canadian projects on the west coast (e.g., Pacific Northwest LNG [CEA Agency, 2016], Aurora LNG [Aurora LNG, 2016]), and as required in FDS condition 3.8, an rms SPL threshold of 160 dB re 1 µPa will be used to establish the area encompassing potential injury and sensory disturbance to cetaceans relevant to Project construction activities and the geographic size of the area where mitigation measures will be implemented. Woodfibre LNG will also establish and maintain a separate pinniped-specific exclusion area a (set at the greater of either a 150-m radius from underwater noise producing activities, or 190 dB re 1 µPa) to avoid injury to pinnipeds. The 150-m boundary is conservative based on two facts:

- Woodfibre LNG will be required to meet an underwater noise threshold of 207 dB re 1 µPa at approximately 10 m from the pile installation to prevent injury or mortality of sts'úḵwi7 (fish)—this is necessary to be compliant with paragraph 34.4(1) of the *Fisheries Act*. Ínexwantas (Monitoring) is required to demonstrate that mitigation measures for attenuation of underwater noise from pile installation (e.g., bubble curtains) achieves this threshold.
- The scientific and United States' regulatory standard peak thresholds for injury are 218 dB re 1 µPa for seals and 232 dB re 1 µPa for sea lions, for impulsive sounds from activities such as pile installation (NOAA Fisheries, 2018).

Since the underwater peak sound level threshold to protect sts'úḵwi7 (fish) is well below the injury level for pinnipeds, the proposed 150-m boundary (verified as being below 190 dB re 1 µPa) is protective of injury to pinnipeds from both underwater noise and from any potential direct interactions with construction activities.

5.1.2 In-Water and Near-shore Land-Based Blasting

DFO has developed a policy document—*Guidelines for the use of explosives in or near Canadian fisheries waters* (Wright and Hopky, 1998)—that outlines methods and practices for the conservation and protection of sts'úḵwi7 (fish), marine mammals, and fish habitat from the potential effects arising from the destructive forces of explosives. Among these guidelines is the directive that no explosive is to be knowingly detonated within 500 m of a marine mammal (or no visual contact from an MMO using 7 x 35-power binoculars). The ultimate spatial extent of the Project in-water and near-shore land-based blasting exclusion zone will be verified in the field but will not be less than 500 m. Project-specific blasting mitigation measures are detailed in Table 5.

[5] Sound pressure level: a metric, measured in dB units that is commonly used to describe the magnitude of sound.

5.1.3 Pile Installation

The BC Marine and Pile Driving Contractors Association and DFO have developed a policy document—*Best Management Practices for Pile Driving and Related Operations*—that identifies the BMPs for pile installation activities that occur on the water in BC (BC Marine and Pile Driving Contractors Association, 2003). These include recommended practices for installing piles of varying materials, styles, and sizes, and using a variety of methods (e.g., drop, impact, or vibratory hammer). While these guidelines were designed primarily to prevent sts'úḵwi7 (fish) mortality (predicted to occur at underwater pressure levels in excess of 30 kPa [kiloPascals])[6], they provide a basis point from which to prioritize activities that may require mitigation for marine mammals as well.

Vibratory installation of steel piles is not explicitly identified in the BC BMPs as an activity requiring mitigation or ínexwantas (monitoring); this method of pile installation is frequently selected over impact pile installation as a mitigation measure in itself, as it does not produce the high impulse sound signatures of impact pile driving that can result in hearing injury to marine mammals. In contrast, the BC BMPs recommend that impact pile installation of steel pipe piles with a diameter greater than 24 inches requires ínexwantas (monitoring) and mitigation measures, such as bubble curtains.

While noise levels produced during pile installation are highly situation-specific, on average, use of a vibratory driver produces sound pressure levels (peak and rms) that are lower than those produced by an impact hammer in a comparable setting (California Department of Transportation, 2020; McCauley and Salgado Kent, 2008). The Project's preferred pile installation method is therefore vibratory driver, and these will be used wherever such methods are possible based on local substrate composition.

5.2 GENERAL MITIGATION MEASURES

Mitigation measures in Table 5 are designed to reduce displacement and direct mortality of marine mammals. The measures are intended to fulfill project conditions and commitments relating to marine mammals, as described in Section 1.0. If recommended setbacks cannot be followed, a QP will be engaged to determine setback adjustments or to outline additional mitigation measures, as needed.

During near-shore and in-water construction activities that generate underwater noise, Woodfibre LNG will adopt a precautionary approach for exclusion zones until otherwise confirmed through continuous Project-specific sound source verification measurements. Woodfibre LNG will set the initial exclusion zone at 1,000 m for cetaceans and at 500 m for pinnipeds. Continuous underwater noise measurements at both of these distances will determine whether the initial exclusion zones can be modified. If noise level measurements are greater than 160 dB SPLrms at 1,000 m (for cetaceans) or are greater than 190 dB at 500 m (for pinnipeds), the exclusion zones will be increased accordingly to reflect the measured distances. Conversely, if the distances to the respective noise thresholds are less than the planned initial distances referred to above, the exclusion zones may be reduced accordingly as determined by the QP. This approach will limit the potential effect of underwater noise on cetaceans and pinnipeds until such time that replicate sound source verification data is available to the QP. The QP will review the sound source verification information and, as required, recommend appropriate adaptive exclusion zones or

[6] Equivalent to 206 peak decibels (dB_{peak}).

additional mitigation measures to comply with the thresholds. The verification and adaptation processes described above are also replicated when construction activities change and/or the location or number of work fronts change. The change in activity will also reset the initial exclusion zones described above until the sound source verification is complete.

General mitigation measures outlined in Table 5 apply to all underwater noise generating activities, which Woodfibre LNG understands to be the following, based on Project-specific modelling (Kanu and Quijano, 2023):

- General shoreline works
- Pile installation
- In-water blasting
- Near-shore land-based blasting
- In-water or near-water drilling

Vessel movements, marine infilling and other activities in or near the marine environment are not expected to individually produce underwater noise to a level that requires management. The continuous underwater sound source verification will identify if these noise sources cumulatively generate underwater noise above the thresholds identified above.

Table 5: Mitigation Measures for Marine Mammals During Construction and Operations

Category	Mitigations	Application Mitigation Number
Underwater Noise		
General	• Multiple underwater noise-generating activities will be limited, when practical (e.g., avoid multiple pile installation activities at the same time). Where multiple underwater noise generating activities are planned, they will be sequenced to limit construction duration, if practical, with exclusion zones confirmed and adjusted based on monitoring data (see Section 7.1.1). • Transiting vessels will follow Fisheries and Oceans Canada's guidance (DFO 2023) for minimum distance between a vessel and yéwyews (killer whale), i.e., 400 m, when possible to do so while maintaining safe transit. • The use of vibratory pile installation and down-the-hole rotary drill methods will be preferentially used, where practical and feasible, as impact pile installation is associated with louder sound pressure levels underwater. The Contractor will determine when substrate conditions and Project design require the use of impact pile installation. The Environmental Monitor, or designate, will record changes in hammer type, size, and use. • A ramp up or soft start technique will be used. Where equipment allows, power will be built up slowly from a low energy start-up to give adequate time for marine sek̲w'ek̲w'inexw (wildlife) to leave the vicinity before exposure to the maximum sound pressure level. There will be a ramp up or soft start every time pile installation is resumed following an interval of no pile installation.	M5.17-6

Table 5: Mitigation Measures for Marine Mammals During Construction and Operations

Category	Mitigations	Application Mitigation Number
General (cont'd.)	• Where technically feasible, given topographical and hydrological conditions (i.e., water depth, current speed, and wave climate), bubble curtains (or other feasible sound attenuation method) will be used in conjunction with in-water blasting and in-water impact pile installation activities to attenuate SPLs. Bubble curtains (or other feasible sound attenuation methods) will be regularly inspected by the Contractor to verify the equipment is functioning properly. Bubble curtains reduce SPLs and pressure waves and, therefore, reduce the radius around the source within which injury or behavioural disturbance can occur. Exclusion zone radii (based on 160 dB re 1 µPa rms for cetaceans and set at 150-m/190 dB re 1 µPa for pinnipeds) will be appropriate, whether or not bubble curtains are employed; larger exclusion zones will be monitored for the presence of cetaceans when bubble curtains are not feasible, again based on the results of underwater noise ínexwantas (monitoring). • Underwater noise ínexwantas (monitoring) and/or recording will be conducted during in-water construction and near-shore blasting by the Environmental Monitor under the direction of the QP. This will be carried out on a continuous basis or until Woodfibre LNG and the QP can reduce the scope following analysis of replicate sound source verification data. The MMMMP incorporates the use of MMOs to maintain a visual watch of the exclusion zones during in-water blasting and pile installation activities and implement shutdown procedures in the event of a cetacean sighting within the 160 dB re 1 µPa rms exclusion zone or a pinniped sighting within the 150-m/190 dB re 1 µPa rms exclusion zone (minimum 500 m for in-water blasting). An MMO will be a QP that has undergone training in marine mammal observation methods and protocols and is specifically trained in: sighting and identifying local marine mammal species, recording and reporting observations, and implementing the correct procedures in the event of sightings. The QP will have the discretion to identify the number and locations of MMOs required to perform the visual Ínexwantas (monitoring), and this number will be dependent on multiple factors, including the scope of construction activities, viewing conditions, and the presence of viewing obstructions (e.g., vessels and barges) within the cetacean and pinniped exclusion zones. The designated and qualified MMOs will be responsible for ínexwantas (monitoring) the cetacean and pinniped exclusion zones and will work with the Woodfibre LNG Construction Manager and/or the Woodfibre LNG Environmental Representative during all activities requiring ínexwantas (monitoring). Detailed ínexwantas (monitoring) procedures are outlined below (Section 7.0).	

Table 5: Mitigation Measures for Marine Mammals During Construction and Operations

Category	Mitigations	Application Mitigation Number

General (cont'd.)	Prior to in-water construction activities and near-shore blasting, MMOs will implement the following protocols in relation to enforcement of the exclusion zones:
	• The entire cetacean and pinniped exclusion zones will be visually monitored with binoculars and naked eye for 30 minutes prior to commencement of in-water blasting or in-water pile installation (referred to herein as the pre-scan).
	• The visual ínexwantas (monitoring) of the exclusion zones during the 30-minute pre-scan will only be completed when the full extent of the exclusion zones can be surveyed by one or more MMOs and when visibility is sufficient for detecting marine mammals (i.e., must be completed during daylight hours, when the Beaufort sea state [a standard, semi-quantitative method for describing sea conditions] is 3 or less, and with no prohibitively thick fog or heavy rain impeding ínexwantas (monitoring) of the exclusion zone).
	• If visibility becomes compromised during the 30-minute pre-scan, the activity must be delayed until visibility increases and the exclusion zones can be fully monitored for a continuous 30-minute period.
	• If a cetacean or pinniped is detected within an exclusion zone during the 30-minute pre-scan, MMOs will:
	  • Notify the Woodfibre LNG Environmental Representative and/or Woodfibre LNG Construction Manager to delay start-up of the activity.
	  • Continue to monitor the exclusion zone until the sighted cetacean or pinniped has been observed to leave its exclusion zone and the initial 30-minute pre-scan period has been completed without additional sightings of any marine mammal, or,
	  • The cetacean or pinniped has not been re-sighted within its exclusion zone and a full additional 30 minutes has elapsed following the last sighting.
	• Once the exclusion zones have been deemed clear of marine mammals as per the directives above, the MMO will communicate to the Woodfibre LNG Environmental Representative and/or Woodfibre LNG Construction Manager (depending on who is on site) using an agreed and clear communication signal to indicate whether the relevant activity may proceed.
	• The number and location of ínexwantas (monitoring) stations will be selected by the QP to provide the best practical vantage point to observe the exclusion zones, considering safety limitations. Stations may be located on land, a small vessel, or on a barge in proximity to the noise-producing activity being monitored. A minimum of 3 boats will be used at the outset of ínexwantas (monitoring) to allow coverage of the entire exclusion zone; this may be modified, as required, following in-field hydrophone verification.
	• The pinniped exclusion zone is specific to the marine area and does not apply to pinnipeds that are hauled-out (i.e., out of the water) within a similar distance from the sound source. That said, Woodfibre LNG expects that hauled-out pinnipeds may retreat to the water to avoid shore-based activity associated with construction.
	• The construction activity shall only proceed upon positive confirmation with the MMO and following the activity-specific procedures outlined below.	

Table 5: Mitigation Measures for Marine Mammals During Construction and Operations

Category	Mitigations	Application Mitigation Number
Pile Installation	Prior to pile installation (impact, vibratory, rotary drilling), MMOs will follow the pre-scan protocol outlined above. Specific mitigation measures and protocols during pile installation activities include the following: • Pile installation will follow the BMPs developed by DFO and the BC Marine and Pile Driving Contractors Association (BC Marine and Pile Driving Contractors Association, 2003). • For pile installation, following the 30-minute pre-scan (detailed above) and where equipment allows, underwater acoustic energy output should commence from a lower energy level and build steadily and gradually to full output. This ramp-up period is designed to reduce risk to any marine mammals that may not have been identified by the MMO, prior to the generation of peak pressure and noise levels for pile installation. • As long as pile installation has been initiated under the appropriate conditions (i.e., following the complete 30-minute pre-scan), then it may continue throughout daylight hours and into the night provided adequate monitoring for marine mammals can continue as per QP recommendations (e.g., weather conditions are favourable, thermal imagery equipment is deployed, passive acoustic monitoring is deployed). If pile installation ceases during the daylight hours for a period longer than 30 minutes, piling activity may resume when needed following the pre-scan protocol being completed. MMOs will stop the activity in question if: • a cetacean is observed in the cetacean exclusion zone where underwater noise levels exceed 160 dB re 1 µPa rms or • a seal or sea lion is observed in the pinniped exclusion zone, set at a minimum of 150-m/190 dB re 1 µPa rms.	M5.17-6 M5.19-1

Near-shore Land-Based Blasting	Prior to near-shore land-based blasting, MMOs will follow the same pre-scan protocol outlined above. Specific mitigation measures and protocols during land-based blasting include the following:
	• Near-shore blasting will be phased such that areas further from shore are blasted first as a precautionary principle, allowing site-specific field measures to inform adaptive measures for subsequent works.
	• Charges should not exceed 3.17 kg TNT equivalent charge
	• Blasting mats will be used, as required, to control fly-rock.
	• During the initial blast, the exclusion zone will be set to 1,000 m.
	• Two hydrophones will be installed prior to near-shore blasting, one at 1,000 m and one at 500 m from the source, to directly measure or back-calculate the exact location of the exclusion zones. The zones will then be adjusted accordingly but will not be less than 500 m.
	• Underwater noise ínexwantas (monitoring) will be conducted at the commencement of land-based blasting activities, as directed by the QP, to verify that underwater pressure levels do not result in adverse effects to marine mammals. Similar to pile installation (as described above), MMOs will stop land-based blasting if:
	  • a cetacean is observed in the cetacean exclusion zone where underwater noise levels exceed 160 dB re 1 µPa rms or a minimum of 500 m
	  • a seal or sea lion is observed within the 500 m pinniped exclusion zone.
		M5.17-6

Table 5: Mitigation Measures for Marine Mammals During Construction and Operations

Category	Mitigations	Application Mitigation Number
Near-shore Land-Based Blasting (cont'd)	• Noisemakers (e.g., bangers, air horns) may be used prior to detonation to deter marine mammals from occurring in the "blast zone" and to prevent harm. Noisemakers will be used sparingly and only after a visual scan is used to confirm that marine mammals are present. • The hydrophones will also be used to passively monitor for marine mammal presence. • Prior to any available on-site noise data becoming available during the initial blasting, a bubble curtain will be deployed around the immediate blasting area and at 5 m below the water level. Once peak pressure levels are confirmed, the bubble curtain may be discontinued at the discretion of the QP. Land-based nearshore blasting can only be undertaken during daylight and in conditions of good visibility and sightability (as defined above).	
Dredging	The following mitigation measures only apply to suction dredging or other non-clamshell or non-backhoe dredging methods. No mitigations are required for clamshell or backhoe dredging. Prior to dredging, MMOs will follow the pre-scan protocol outlined above. If, during non-clamshell or non-backhoe dredging, a cetacean or pinniped is observed within 100 m of the dredging, work will not be started or work will be stopped. Dredging activities may only start or resume once the marine mammal has been confirmed by the MMO to have left the 100-m zone or has not been sighted by the MMO for 30 minutes. If pinnipeds cause regular delays to start of dredging or regular shutdown of dredging activity, Woodfibre LNG will work with DFO and Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) to develop alternative protocols to allow work to continue while providing appropriate protection to marine mammals.	M5.17-6
Operations within Átl'ḵa7tsem (Howe Sound)	The MMMMP will be implemented during the construction phase and continued in the operations phase. Additional measures that will be required during operations include the following (EAC Condition 13.2.3.8): • To the extent possible, vessel engines and propellers will be shut down while moored at the floating storage and offloading (FSO) jetty to reduce unnecessary underwater noise during LNG transfer operations. • Subject to safety considerations, machine-based equipment, engines, and propellers will be turned off when not in use to minimize unnecessary noise. • All Project vessels will follow established shipping lanes typically used in the area. • All Project vessels will maintain a constant course and constant speed, to the extent practical, when operating in Átl'ḵa7tsem (Howe Sound). • Other than in the case of an emergency, vessels will not intentionally approach within 200 m of a cetacean. • If a cetacean approaches within 200 m of a vessel, the vessel will reduce its speed and, if possible, cautiously move away from the animal. If it is not possible for a vessel to move away from or detour around a stationary cetacean or group of cetaceans, the vessel will reduce its speed and wait until the animal(s) moves at least 200 m from the vessel prior to resuming speed.	M5.19-2

Table 5: Mitigation Measures for Marine Mammals During Construction and Operations

Category	Mitigations	Application Mitigation Number
Above Water Noise		
General	Hauled out marine mammals will be exposed to construction generated noise. The following mitigation measures will be applied to limit potential effects of this exposure. • The MMO will confirm there are not hauled out marine mammals within 500 m of loud and impulsive noise generating activities (e.g., blasting or impact pile driving). Work will temporarily stop and resume only after being cleared to proceed by the QP or the marine mammals have left the area. • If kwexnís (Steller sea lion(s)) are observed above water within 500 m of construction noise, work will temporarily stop and resume only after being cleared to proceed by the QP with the application of modified work activity, noise reduction, or monitoring for behavioural disturbance. Work may also resume if the kwexnís (Steller sea lion(s)) have left the area.	N/A
Vessel Strikes		

	The geographic area within which the movement of construction-related vessels could result in injury or mortality to marine mammals is adjacent to the construction area and along Woodfibre LNG vessel transit areas in the LAA, as defined in the Application. Similarly, direct contact to a marine mammal may occur during dredging. Both of these activities (i.e., vessel strike or direct contact with a marine mammal during dredging) will be mitigated in the same way.
	• Other than in the case of an emergency,
	  • Vessels will not intentionally approach within 200 m of a cetacean, or within 400 m of a yéwyews (killer whale).
	  • If a cetacean approaches within 200 m of a vessel, the vessel will reduce its speed and, if possible, cautiously move away from the animal.
	  • If it is not possible for a vessel to move away from or detour around a stationary cetacean or group of cetaceans, the vessel will reduce its speed and wait until the animal(s) moves at least 200 m from the vessel prior to resuming speed.
	  • Marine vessel operators during construction activities will practice caution when cetaceans are observed within the Project Area, including reducing boat speed to minimize wake/wash and not intentionally approaching cetaceans.
	• The Contractor will provide marine mammal observation and identification training to vessel operators employed by the Contractor or who provide recurring vessel service to the Contractor. The Contractor will maintain records of staff and sub-contractors who have taken this training.
	• During the Project's marine construction phase, vessel operators will practice caution when pinnipeds (seals and sea lions) are observed by vessel operator within the CPA, including reducing boat speed to minimize wake/wash and not intentionally approaching pinnipeds.
		M5.19-2

Table 5: Mitigation Measures for Marine Mammals During Construction and Operations

Category	Mitigations	Application Mitigation Number
Operations within Átl'ka7tsem (Howe Sound)	Woodfibre LNG committed to implementing the recommendations from TERMPOL as they become available, as per EAC commitment M5.19-3. TERMPOL is a process for marine terminal or transshipment facilities operations phase and, in the case of Woodfibre LNG, relating to LNG carriers travelling to/from the Project Area. The TERMPOL technical review process appraises the safety of vessels, the transit route to/from the entrance of Juan de Fuca Strait (J Buoy) to its berth, and the cargo transfer operations. Woodfibre LNG submitted its TERMPOL report at the end of 2015 and is currently in the review phase. Woodfibre LNG will make public and comply with the technical review process findings and recommendations and incorporate them into applicable management plans. This is expected to include the development of a Port Information and Terminal Operations Manual to be reviewed by TERMPOL at least six months prior to start of operations. The MMMMP will be continued in the operations phase. Mitigation measures that will be required during operations include the following: • All Project vessels will follow established shipping lanes typically used in the area.	M5.19-2 M5.19-3
Operations within Átl'ka7tsem (Howe Sound) (cont'd.)	• All Project vessels will maintain a constant course and constant speed, to the extent practical, when operating in Átl'ka7tsem (Howe Sound). • Deep-sea Project vessels (vessels >65 m, excluding barges) and LNG carriers will travel at a maximum speed of 10 knots when operating in the Átl'ka7tsem (Howe Sound) marine corridor and will be directed not to exceed 6 knots within the CPA, unless the vessel operator determines that this speed limit poses a safety risk. • Other than in the case of an emergency, vessels will not intentionally approach within 200 m of any cetacean. • If cetaceans approach within 200 m of a vessel, the vessel will reduce its speed and, if possible, cautiously move away from the animal. If it is not possible for a vessel to move away from or detour around a stationary cetacean or group of cetaceans, the vessel will reduce its speed and wait until the animal(s) moves at least 200 m from the vessel prior to resuming speed. LNG carriers will respect speed profiles applicable to the operations, subject to navigational safety, to prevent or reduce the risks of collisions between LNG vessels and cetaceans. Project LNG vessels and tugs will report collisions with cetaceans in Átl'ka7tsem (Howe Sound) to the Canadian Coast Guard and DFO within two hours of a collision occurrence, and Woodfibre LNG will notify Indigenous groups in writing.	

5.3 UNDERWATER NOISE

5.3.1 Importance of Sound to Marine Mammals

Marine mammals use sound to communicate, forage, orient, and respond to perceived threats (Ketten, 1998; Southall et al., 2007; Ellison et al., 2012). Baleen whales (e.g., sḵwúmechn [humpback whale], ḵwenís [grey whale]) use sounds primarily for social functions, including reproductive behaviours and maintaining contact over great distances (hundreds of kilometres). Toothed whales (e.g., yéwyews [killer whale], kw'únut' [porpoise, dolphin]) communicate primarily over middle to short distances (tens of kilometres) and use specialized clicks (echolocation) to detect prey and navigate. Pinnipeds (e.g., asxw [seals] and ḵwex̱nís [sea lions]) also produce sounds but predominantly in social functions and during reproductive behaviours. As asxw (seals) and ḵwex̱nís (sea lions) spend time on land and at sea, they are sensitive to sound both in air and in water, but generally are not as susceptible to disturbance as cetaceans.

Given the importance of a functional acoustic environment to most marine mammal life functions, the introduction of anthropogenic underwater noise, if unmitigated, can result in behavioural disturbance. Disturbance can range from overt and visually observable responses such as displacement or avoidance behaviours and changes in activity state (e.g., swim speed or direction, surfacing interval) to less obvious changes such as increases in stress hormones. Behavioural disturbance in response to underwater noise depends on a number of variables, including the magnitude, duration, and wavelength of the noise, distance of the animal from the sound source, species, and the context (e.g., activity of the animal at the time). Amidst the additional anthropogenic background noise, relevant biological sound signals may also become undetectable (i.e., masked) to marine mammals (Ketten 1998). Marine mammals subject to high intensity SPLs, such as in-water blasting and impact pile installation, may experience a temporary or permanent decreased hearing sensitivity (i.e., temporary or permanent threshold shift) (Richardson et al., 1995; Southall et al., 2007; Popper and Hawkins, 2012).

5.3.2 Environmental Assessment Effects Summary

Most in-water marine Project construction activities produce underwater noise[7]; however, SPLs for most Project activities are unlikely to injure marine mammals. The Application considered that underwater noise effects from pile installation could occur during the construction of the FSO (i.e., floating storage tank) jetty, including pile installation and shoreline modifications to accommodate structural infrastructure, and possibly during dredging and permanent mooring of the FSO, and carried this Project interaction forward to determine mitigation measures and residual effects. Vibratory methods will be the preferred method (over impact methods) to install piles and sheet-piles and will be used wherever such methods are practical and feasible based on local substrate composition and construction requirements. Use of vibratory installation techniques is expected to reduce sound levels below those capable of causing injury.

[7] Effects to marine mammals from in-air noise were determined to be negligible in the Application given the absence of established asxw (seal) or ḵwex̱nís (sea lion) haulout sites proximal to the CPA.

While efforts will be made to reduce the need for and scale of marine blasting and in-water impact pile installation to the extent feasible, mitigation measures and ínexwantas (monitoring) protocols for these activities are addressed in Table 5 and Section 7.1. Mitigation measures to limit effects of marine construction are also detailed in the CEMP. The MMMMP details those mitigation measures for potential effects that are specific to marine mammals.

The Application concluded that marine mammal behavioural disturbance could occur due to underwater noise during pile installation during construction and from underwater noise associated with vessel operations. These activities were predicted to be short-term and localized, and any associated disturbance effects are expected to be reversed when construction stops. Mitigation measures to reduce potential for sensory disturbance to marine mammals are summarized in Table 5.

The Application also concluded that during Project operations, underwater noise could result in behavioural disturbance from the following activities: mooring of LNG carriers at the FSO for LNG transfer; marine shipping within Átl'ka7tsem (Howe Sound) (approximately 40 LNG carriers per year) in established shipping lanes; patrolling of Control Zone around LNG facility, FSO, and LNG carriers; and transport of employees through private passenger ferry terminal, transport of supplies using barges, site administration, safety facilities, and emergency transportation via helicopter. Mitigation measures to reduce potential effects on marine mammals during project operations are summarized in Table 5.

5.3.3 Underwater Acoustic Noise Modelling

An underwater acoustic modelling study was conducted for potential noise-producing activities associated with the construction of the Project (Kanu and Quijano, 2023). The goal of the study was to predict the potential extent of underwater noise exposure to marine mammals and sts'úkwi7 (fish) during construction of the terminal, materials offloading facility (MOF), floatel mooring infrastructure, and FSO facilities. The model considered installation of piles through impact and vibratory piling (with mitigation), land-based near-water rock blasting at the FSO, and rock coring using a rotary/cluster drill (down-the-hole). Conservative ranges for the extent of ensonification were calculated from the model to define exclusion zones to limit potential effects on marine mammals during construction of the Project. The following 10 scenarios were considered in the modelling study:

1. Six scenarios for impact and vibratory piling (i.e., both methodologies at the terminal, floatel, and FSO locations)
2. Three scenarios for rock coring (i.e., one at each of the MOF, terminal, and FSO locations)
3. One scenario for rock blasting at the east end of the modelling area

The geographical and environmental conditions were conservatively selected for the underwater noise model (e.g., water depths were modelled at the higher high water level, which is the most conservative depth). Construction activities were also conservatively modelled for the worst-case scenario of underwater noise production. For example, blasting was modelled at a 3.17 TNT charge, 1.5 m below the surface, and 5.4 m inland from the bedrock face; however, the actual blast locations will be 3 m above the high water mark and 23 m inland, with an actual vertical distance from the nearest water blast to low tide of 8.7 m (Keystone, 2023). These supporting noise modelling studies are available upon request.

The resulting distances for marine mammal disturbance threshold criteria based on the underwater noise model are summarized in Table 6.

Table 6: Construction Activity-based Estimated Distances To SPL Threshold Criteria

Construction Activity	SPL_{rms} Threshold (dB re 1µPa)	Ranges (km)
Impact pile installation with noise mitigation (confined bubble curtains)	160	Floatel: 1.11 All three locations (terminal, floatel, and FST): 0.64–1.11
Vibratory pile installation with noise mitigation (confined bubble curtains)	120	Terminal: 12.14 All three locations (terminal, floatel, and FST): 10.85–12.14
Land-based rock blasting	-	~13 (land-limited)
Rock coring	120	~14 (land-limited)

Note:
Kanu and Quijano (2023) used FST for the floating storage tank, which is referred to as the FSO in this MMMMP.

Source: Kanu and Quijano, 2023 (available upon request)

Mitigation measures to reduce potential effects on marine mammals are summarized in Table 5. Additional contingency measures may be implemented based on the underwater noise ínexwantas (monitoring) results; options include the following:

- Land-based rock blasting would be scheduled to occur during lower tides, when the tide is within 2 m of the lowest tide.
- Additional bubble curtains would be installed to further limit potential effects of underwater noise. Curtains would be installed at least 2 m apart to spread out the bubbles. The first curtain would be installed 5 m below the water, and the second would be around 6 m below the water.
- Amounts of charge in blast holes would be reduced.

5.4 VESSEL STRIKES

Records of vessel–collisions from the late 1800s to 1998 compiled by Laist et al. (2001) demonstrate that vessel strikes typically involve large baleen whales (Mysticetes). Toothed whales (Odontocetes) and pinnipeds (seals) are more agile and smaller and therefore rarely struck by vessels (Laist et al., 2001). However, DFO has recently identified vessel strikes as an emerging threat to yéwyews (killer whale) due to reported injuries and mortalities of both southern and northern resident yéwyews (killer whale) (DFO, 2017, 2018). Sḵwúmechn (humpback whale) are particularly sensitive to effects from vessel strikes (DFO, 2013), with a moderate risk to individuals and a low risk to the population. The Humpback Whale Recovery Strategy (DFO, 2013) indicates some high-risk potential, but further studies are required to clarify uncertainties. In BC waters, sḵwúmechn (humpback whale) is the most common cetacean struck by vessels, with 21 reports between 2001 and 2008; the rate of mortality from vessel strikes in BC waters, however, is largely unknown.

5.4.1 Environmental Assessment Effects Summary

An increase in the number of vessels operating in the proposed Woodfibre LNG carrier route, as well as project vessels operating between St'a7mes (Squamish Harbour) and the CPA, may cause a change in the health and mortality risk for marine mammals. All Project vessels during construction, operations, and decommissioning have potential for a collision with cetaceans. The BC EAO concluded in its environmental assessment report that in consideration of the mitigation measures proposed in the Application, the likelihood of a fatality or injury of a cetacean from an accidental vessel strike would be rare and the long-term viability of marine mammal populations in Átl'ka7tsem (Howe Sound) would unlikely be affected (BC EAO, 2015).

The Application stated that low vessel speeds (less than 14 knots) have been found to greatly reduce the likelihood of ship strikes on cetaceans by providing time for these animals to avoid oncoming vessels, as well as time for crew to detect and avoid cetaceans during transits. Furthermore, the potential for a vessel-cetacean collision would be limited to the proposed Woodfibre LNG carrier route.

6.0 MARINE SHIPPING ASSOCIATED WITH THE PROJECT OUTSIDE OF ÁTL'ḴA7TSEM (HOWE SOUND)

Woodfibre LNG will explore voluntary participation in regional initiatives to address potential effects of marine shipping on cetaceans from vessels associated with the Project (i.e., the Salish Sea from Buoy J to the mouth of Átl'ḳa7tsem [Howe Sound]). Woodfibre LNG is exploring participation in initiatives related to the programs, such as the federal Oceans Protection Plan and the Vancouver Fraser Port Authority Enhancing Cetacean Habitat and Observation (ECHO) Program. Woodfibre LNG is also committed to working collaboratively with Indigenous groups to determine ways to understand and reduce potential effects of marine shipping on cetaceans. Addressing the cumulative effects of marine shipping in the Salish Sea is a regional, multi-stakeholder, and multi-jurisdictional issue, with multiple contributors required to collaborate in the effort to effectively address the issue. Potential initiatives that Woodfibre LNG may participate in include:

Education and Awareness

- Woodfibre LNG carrier captain or designated personnel complete *Whales in Our Waters*[8] tutorial developed by the Vancouver Fraser Port Authority ECHO Program, BC Ferries, and Ocean Wise
- Woodfibre LNG carriers have *Mariner's Guide to Whales, Dolphins, Porpoises of Western Canada*[9] on the bridge

Regional Vessel Strike Risk Reduction

- Woodfibre LNG carriers will utilize the WhaleReport Alert System[10] developed for commercial ship operators to receive real-time notifications when whales are in range of vessel to take corrective action to avoid vessel strikes

Ongoing Research and Ínexwantas (Monitoring)

- Contribution of cetacean sightings to the BCCSN[11] to help build understanding of baseline conditions
- Potential collaboration with industry and Indigenous groups on marine mammal studies and initiatives

Participation in Regional Underwater Noise Reduction Initiatives

- Woodfibre LNG participation in Vancouver Fraser Port Authority ECHO Program[12] initiatives in the southern waters of BC (e.g., voluntary ship slowdowns, voluntary shipping lane route modifications, measuring underwater noise levels of individual ships at ECHO Listening Station)
- Consideration of offering incentives to Woodfibre LNG carriers/or encouraging that they meet Green Marine[13] or other underwater noise reduction criteria

[8] https://echolearn.portvancouver.com/
[9] https://www.portvancouver.com/wp-content/uploads/2017/07/Mariners-Guide-to-Whales-Dolphins-Porpoises-of-Western-Canada.pdf
[10] https://wildwhales.org/wras/
[11] https://wildwhales.org/
[12] https://www.portvancouver.com/environment/water-land-wildlife/echo-program/
[13] https://green-marine.org/certification/

7.0 MARINE MAMMAL ÍNEXWANTAS (MONITORING) AND ADAPTIVE MANAGEMENT

Marine mammal and underwater noise ínexwantas (monitoring) data collected will be used to inform and adaptively refine the mitigation measures described in the MMMMP with input from DFO and Indigenous groups. If additional mitigation measures are required and implemented, ínexwantas (monitoring) will be conducted to confirm their effectiveness and to verify the conclusions of the environmental assessment. Furthermore, in agreement with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), ínexwantas (monitoring) will contribute to the understanding of marine mammal distributions and underwater noise levels in Átl'ḵa7tsem (Howe Sound).

7.1 ÍNEXWANTAS (MONITORING)

7.1.1 Pile Installation and Blasting

Underwater noise ínexwantas (monitoring) will be conducted at the commencement of marine pile installation and near-shore blasting to inform mitigation measures, primarily by defining the boundary of the cetacean exclusion zone, which will be set at the radial extent where sound levels dissipate to 160 dB re 1 µPa rms. A component of this acoustic field verification will be to confirm the predicted sound levels presented in Woodfibre LNG's environmental assessment (Section 5.19.3.2; Table 5.19-12) for underwater blasting and pile installation. Resulting data will be used on-site to verify that the initial exclusion zones are appropriate for these activities under site-specific conditions (i.e., that received sound levels within the cetacean exclusion areas are below 160 dB re 1 µPa rms). Should measured hydroacoustic data indicate that sound levels extend further than predicted by modelling, the size of the cetacean exclusion zones and any ínexwantas (monitoring) techniques applied therein will be adjusted to reflect the site-specific data obtained during the field trial. Similarly, if underwater noise levels at this distance are below the 160 dB re 1 µPa rms cetacean threshold, then the cetacean exclusion zone radius may be reduced. Results of acoustic field verification and updated cetacean exclusion zones (as needed) will be provided to BC EAO and Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and can be provided to Indigenous groups upon request.

Underwater noise will be monitored continuously during pile installation and blasting activities where those activities or combination of activities have not been previously monitored, or where Project-specific monitoring data has identified that the specific activities and combination of activities generate underwater noise levels greater than 160 dB rms and 190 dB rms at a reference pressure of one micropascal (FDS Condition 3.8.1 and 3.8.7). Continuous monitoring will provide information to better understand if changes in concurrent activities, near-shore activities (e.g., blasting), pile installation methods (e.g., change in equipment, additional rig, change in pile diameter, change in pile material) and/or environmental conditions (e.g., water depth, water temperature, substrate type) at the noise source

influence the established cetacean and/or pinniped exclusion zone boundaries. If necessary, the exclusion zones may be modified under the direction of the QP.

Underwater noise levels during land-based blasting will also be monitored at the anticipated boundary of the exclusion zones. The location of ínexwantas (monitoring) and distance for the blast and from the shore will be recorded by the Environmental Monitor, as well as the results of ínexwantas (monitoring). Ínexwantas (monitoring) for marine mammals will commence 30 minutes prior to the blast. If cetacean thresholds are exceeded, underwater noise ínexwantas (monitoring) will continue for land-based blasting and additional mitigation will be applied (e.g., change in the blast design), until confirmed by the QP that underwater noise ínexwantas (monitoring) is no longer needed.

A quality assurance and quality control program will be implemented to evaluate the precision of underwater noise measurements (e.g., hydrophones) and verify instrument calibration and field procedures. This program will include instrument inspections and calibrations, collection of multiple readings at each sampling location, and inclusion of reference site measurements.

7.1.2 Shoreline Revetment Work

Underwater noise will be monitored continuously during shoreline revetment work and dredging activities to establish and modify, if necessary, the boundary of the 160 dB re 1 µPa rms cetacean exclusion zone. If underwater noise levels are consistently below the 160 dB re 1 µPa rms threshold for either shoreline work and/ or dredging activities, underwater noise ínexwantas (monitoring) may no longer be required for these activities (FDS Condition 3.8.1 and 3.8.7), at the discretion of the QP. As described in the mitigation measures, the sound source verification process will be replicated for these activities and will support adaptive management of potential effects to marine mammals.

7.1.3 Project Operations

Ínexwantas (monitoring) during the operations phase will be undertaken by shipping contractors during all Project-related shipping activities to avoid interactions with marine mammals. Ínexwantas (monitoring) programs related to underwater noise during operations (e.g., during transit of the LNG carriers and associated tugs within Átl'ka7tsem (Howe Sound) will be discussed and developed as appropriate by Woodfibre LNG in collaboration with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) and Tsleil-Waututh Nation.

7.1.4 Adaptive Management

To meet Condition 10 of the SNEAA, Woodfibre LNG will use an adaptive management process to evaluate performance objectives and to guide management actions. The adaptive management process comprises seven steps: assess, design, implement, monitor, evaluate, adapt, and update the MMMMP. These steps are described as follows:

1. Assess: This consists of an assessment of the potential effects of the Project on marine mammals and the identification of mitigation measures. This was completed through the federal, provincial, and Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) environmental assessment processes.
2. Design: This consists of the development of the mitigation and ínexwantas (monitoring) plans for construction, engineering design of the Project, and scheduling of construction activities. The MMMMP is a core element of this step.
3. Implement: This consists of implementing the MMMMP during construction and operations.
4. Monitor: This consists of implementing the Ínexwantas (monitoring) programs described in Section 7.1.
5. Evaluate: Results of ínexwantas (monitoring) will be reviewed to inform whether mitigation measures are functioning as intended and if additional mitigations are required. Woodfibre LNG will develop, in consultation with a QP, ínexwantas (monitoring) performance measures (e.g., targets, thresholds, and site objectives) to evaluate effectiveness of mitigations during construction and operations.
6. Adapt: If marine mammal conflicts and interactions occur, or if mitigations implemented are shown to be ineffective (i.e., where there is evidence of harm or a strong behavioural reaction [e.g., violent lobtailing, flipper slapping, irregular jumping out of the water, etc.] observed during construction activities), adaptive management measures will be identified and implemented. A QP will work with the Woodfibre LNG Environmental Representative and construction team to improve the mitigations and reduce the number of incidents. If compensation and offsetting are warranted, Woodfibre LNG will work with Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) to determine appropriate measures.
7. Update MMMMP: When adaptive management strategies necessitate an update to this MMMMP, Woodfibre LNG will prepare a red-line version of the document that identifies what triggered the need for improvement (i.e., which target, threshold, or site objective was not met) and the changes that were made to address a concern. The red-line version will be issued to Indigenous groups and regulatory agencies for a 30-day review and comment period. During this review period, the QP, Woodfibre LNG Environmental Representative, and MMOs or other relevant personnel will be responsible for working with the applicable contractor(s) to implement appropriate measures that continue to limit potential effects to marine mammals. After comments are received, the document will be updated and issued as the next revision.

8.0 REPORTING AND COMMUNICATIONS

8.1 ÍNEXWANTAS (MONITORING) REPORTS

Woodfibre LNG MMOs will actively monitor the in-water blasting and in-water pile installation exclusion zones to support implementation of mitigation measures (e.g., shutdowns). Sightings of pinnipeds and cetaceans will be documented, and cetacean sightings will be reported to the BCCSN for research purposes. Example underwater noise data sheets and marine mammal observation forms are presented in Appendices A and B, respectively.

The following information will be collected during ínexwantas (monitoring) periods:

- date and time that construction activity starts and ends
- weather and sea conditions
- date and time of marine mammal sighting, species, the number of individuals, location, orientation, and the time at which the individual(s) entered and left the exclusion zone (if applicable)
- the marine mammal(s)' behaviour at time of sighting (e.g., resting, foraging, travelling or surface-active behaviour [breaching, tail-slapping, etc.])
- any mitigation measures enacted (i.e., if there is a delayed start or stop in the activity)
- estimated distance of marine mammal from MMO and from construction activity when first sighted
- other human activity in the area, such as other vessel activity, including fishing
- underwater noise measurements using the form provided in Appendix A**,** or a similar form that provides the equivalent information
- the MMO will record marine mammal sightings using the form provided in Appendix B**,** or a similar form that provides equivalent information.
- monthly reporting during construction regarding compliance with EAC conditions

Annual reporting to BC EAO and the Impact Assessment Agency of Canada will be submitted on or before March 31 for the previous calendar year and posted on the Woodfibre LNG website, and will include:

- activities undertaken to be compliant with the FDS, fulfilled FDS condition 2.1, results of consultation (where required)
- results of follow-up programs
- reports of any additional mitigation measures applied
- as part of the FDS, annual report of marine observations and collisions

This information will be collated into ínexwantas (monitoring) reports, which will be sent to DFO, BC EAO, the Impact Assessment Agency of Canada, Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), and Tsleil-Waututh Nation upon completion of construction. Woodfibre LNG will provide a copy of these ínexwantas (monitoring) reports to other Indigenous groups, upon request.

Records of cetacean sightings will be provided to the BCCSN (www.wildwhales.org) to help inform their research programs, and to Indigenous groups upon request, upon completion of construction.

For the duration of construction, the Construction Monitors from respective Indigenous groups will, while working alongside Woodfibre LNG Environmental Monitors, have the opportunity to observe construction activities and report back to their community on the implementation and success of mitigation measures from the MMMMP.

Woodfibre LNG will report observations and sightings of marine mammals in annual FDS compliance reports and, if determined necessary by a QP (based on trends, frequency, timing or location of observations, and/or vessel-whale collisions), apply additional mitigation measures. Any additional mitigation measures will include consideration of marine safety and navigation and will be monitored for effectiveness.

8.2 ENVIRONMENTAL INCIDENT REPORTS

MMOs will immediately report any observations of injured, sick, or dead marine mammals to the Woodfibre LNG Environmental Representative or Woodfibre LNG Construction Manager (depending on who is on site), who will in turn contact the whale emergency hotline (1-800-465-4336), operated by DFO's BC Marine Mammal Response Program.

Project LNG vessels and tugs will report collisions with marine mammals in Átl'ka7tsem (Howe Sound) to the Canadian Coast Guard within two hours of a collision occurrence and to Woodfibre LNG. Woodfibre LNG will notify all ten Indigenous groups (as defined by FDS) in writing. Woodfibre LNG will also notify Indigenous groups of any incident of injury of significance with a marine mammal.

Any non-compliance with the EAC, as amended, will be reported by Woodfibre LNG within 72 hours of becoming aware of any such non-compliance, or immediately for any non-compliance that may cause a significant adverse effect.

8.3 RECORDS OF INFORMATION

Monthly ínexwantas (monitoring) reports completed during construction to comply with the EAC will be retained through the construction phase and for five years after commencing operations. Woodfibre LNG will maintain a record of information related to the implementation of the conditions set out in the most current Decision Statement issued under Section 54 of the *Canadian Environmental Assessment Act, 2012*, and the results of all associated ínexwantas (monitoring).

This information will be made available for 25 years following the end of operations or until the end of decommissioning of the Project, whichever comes first, and includes:

- training records retained by those providing training on this MMMMP; Woodfibre LNG and the Contractor
- records of consultation regarding the development of this MMMMP
- marine mammal observations and results of underwater noise ínexwantas (monitoring), including quality assurance / quality control results
- reports of cetacean collisions and notifications to Indigenous groups

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APPENDIX A
UNDERWATER NOISE DATA SHEET

APPENDIX A UNDERWATER NOISE DATA SHEET

Acoustic Monitoring Log

Project:								
Date:		**Start time:**		**End Time:**		**Monitor:**		**Crew:**
Weather:								
Construction and Other Anthropogenic Activities Nearby:								
General Notes:								

Time	Monitoring Site No.	Depth (m)	Peak Sound Pressure Level (dB)	RMS Sound Pressure Level (dB)	Stop Works (Y/N; if Y, duration)	Photo (Y/N, number)	Noise Type	Notes

APPENDIX B

Marine Mammal Observation Form

Woodfibre LNG

APPENDIX B MARINE MAMMAL OBSERVATION FORM

MARINE MAMMAL OBSERVATION FORM

Date (dd/mm/yyyy)	**Observation Start Time** (hh:mm)	**Observation End Time** (hh:mm)	**Sighting no.**
Observer location		**Observer name** (full name)	
Initial sightings cue (blow, back, head, footprint, splash, behaviour, birds)			
Species (see list of options on back)		**Certainty of identification** (percentage)	
Reticle (yes or no)	**Distance (m)** determine using reticles or range finder.	**Location of sighting re: pile**	
Number of mammals sighted		**Travel direction** (unknown, no direction, N, NE, E, SE, S, SW, W, NW)	
Behaviour(s) (see list of options on back)		**Blow** (None seen, V-shaped, low blow, medium blow, high blow; answer N/A for pinniped sighting)	
Appearance (Black, grey, brown, spots, snout - short, narrow, bump on head, fluke - small, fluke - large, relative body size, other - provide details)		**Dorsal fin** (None, position - middle of back, closer to fluke, height - short, medium, tall, size - small, medium, large, shape - triangular, curved, pointy, etc.)	
Video taken (yes or no) Provide video Numbers:		**Photos taken (yes or no)** Provide Photo Numbers:	
Work delay or stoppage? Why or why not?			
Sightings Comments (notes on the sighting, more details on appearance or behaviours observed, whether sightings made at close intervals are thought to be of the same individual or not)			

Species

- Killer whale
- Harbour porpoise
- Dall's porpoise
- Unidentified porpoise
- Pacific white-sided dolphin
- Unidentified dolphin or porpoise
- Minke whale
- Grey whale
- Humpback whale
- Unidentified large whale
- Unidentified whale
- Harbour seal
- Unidentified seal
- Steller sea lion
- California sea lion
- Unidentified sea lion
- Unidentified pinniped
- Other (provide species name)

Behaviours

- Blow
- Bow or wake riding
- Breaching
- Diving
- Feeding
- Fluking
- Lobtailing
- Looking
- Milling
- Pectoral/flipper slaps
- Porpoising
- Resting/logging
- Sinking
- Socializing
- Spyhopping
- Thrashing
- Traveling – slow or fast
- Hauled out
- Other – explain