Technical Data Report
Acoustics

Cedar LNG Project

February 2022

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Ward Prystay

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Cedar LNG Partners LP (Cedar), a Haisla Nation-led partnership with Pembina Pipeline Corporation, is proposing to construct and operate the Cedar LNG Project (the Project), a liquefied natural gas (LNG) export facility within the District of Kitimat, British Columbia. The Project will be located on Haisla Nation-owned land within the Nation's traditional territory, approximately 3 kilometres (km) west across Kitimat Arm from Kitamaat Village and approximately 10 km southwest of Kitimat's town centre.

This technical data report presents detailed noise assessment information associated with construction, operation, and decommissioning of the Project. Noise effects have been modelled in the combined local/regional assessment area (LAA/RAA) boundaries including noise sensitive receptors. These modelling results are based on information provided by Cedar and on assumptions where information is not yet available. Modelling incorporated internationally accepted sound propagation algorithms.

Noise effects were predicted at noise sensitive receptors during project construction and operation. While noise emissions are expected during the decommissioning phase, these emissions are expected to be similar or lower when compared to noise during the construction phase. Thus, noise emissions from construction are considered to be a conservative estimate of noise emissions from the decommissioning phase. This assessment is based on provincial noise guidelines and federal guidance.

Compliance with the British Columbia Oil and Gas Commission Noise Control Guideline (OGC 2021) noise thresholds (permissible sound level and low-frequency noise) was assessed for the operation phase at the residential noise sensitive receptors and locations along the Oil and Gas Commission 1.5 km criteria boundary within the LAA/RAA.

Model results from the construction and operation phases were also compared with the federal Health Canada Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise (Health Canada 2017) for change in percent highly annoyed (%HA) as well as sleep disturbance thresholds.

Key findings of the assessment were:

- Noise effects from the project operation phase in combination with cumulative noise effects from the LNG Canada Export Terminal and ambient sound level were predicted to comply with the British Columbia Oil and Gas Commission Noise Control Guideline.
- Low-frequency noise effects from the operation phases of the Project on the residential noise sensitive receptors are not expected.
- The modelled construction and operation noise levels do not exceed the Health Canada recommendations of %HA at all noise sensitive receptors.
- The modelled operation nighttime noise levels do not exceed the sleep disturbance targets by Health Canada at all residential noise sensitive receptors.

Abbreviations

%HA	percent highly annoyed
°C	degrees Celsius
dB	decibel
dBA	A-weighted decibel
dBC	C-weighted decibel
FLNG	floating liquefied natural gas
G	ground absorption factor
ha	hectare
ISO	International Organization for Standardization
km	kilometre
LAA	local assessment area
L_d	daytime equivalent sound level
L_{dn}	day-night equivalent sound level
L_{eq}	energy equivalent sound level
L_{max}	maximum sound level
LFN	low frequency noise
LNG	liquified natural gas
m	metre
OGC	Oil and Gas Commission
PSL	permissible sound level
PWL	sound power level
RAA	regional assessment area
SPL	sound pressure level

UTM	Universal Transverse Mercator
WHO	World Health Organization

Glossary

Acoustic Attenuation	Acoustic attenuation is a measure of the energy loss of sound propagation in media.
Ambient Noise	All noises that exist in an area and are not related to a facility. Ambient noise includes sound from other industrial noise not being measured, transportation sources, animals, and nature. Ambient noise is the same as background sound level
Bands (octave, 1/3 octave)	A series of electronic filters separate sound into discrete frequency bands, making it possible to know how sound energy is distributed as a function of frequency. Each octave band has a centre frequency that is double the centre frequency of the octave band preceding it
Project Area	The area to be utilized by the Project and includes District Lot 99 and marine waters extending approximately 500 m offshore
Daytime	The hours from 0700 to 2200
dB – Decibel	A logarithmic unit associated with sound pressure levels and sound power levels
dBA – Decibel, A-Weighted	A logarithmic unit where the recorded sound has been filtered using the A frequency weighting scale. A-weighting somewhat mimics the response of the human ear to sounds at different frequencies. A weighted sound pressure levels are denoted by the suffix ‘A’ (i.e., dBA), and the term pressure is normally omitted from the description (i.e., sound level or noise level)
dBC – Decibel, C-Weighted	The logarithmic units associated with a sound pressure level, where the sound pressure signals has been filtered using a frequency weighting. The C weighting approximates the sensitivity of human hearing at industrial noise levels (above about 85 dBA). C-weighted sound pressure levels are denoted by the suffix ‘C’ (i.e., dBC). C weighted levels are often used in low-frequency noise analysis, as the filtering effect is nearly flat at lower frequencies

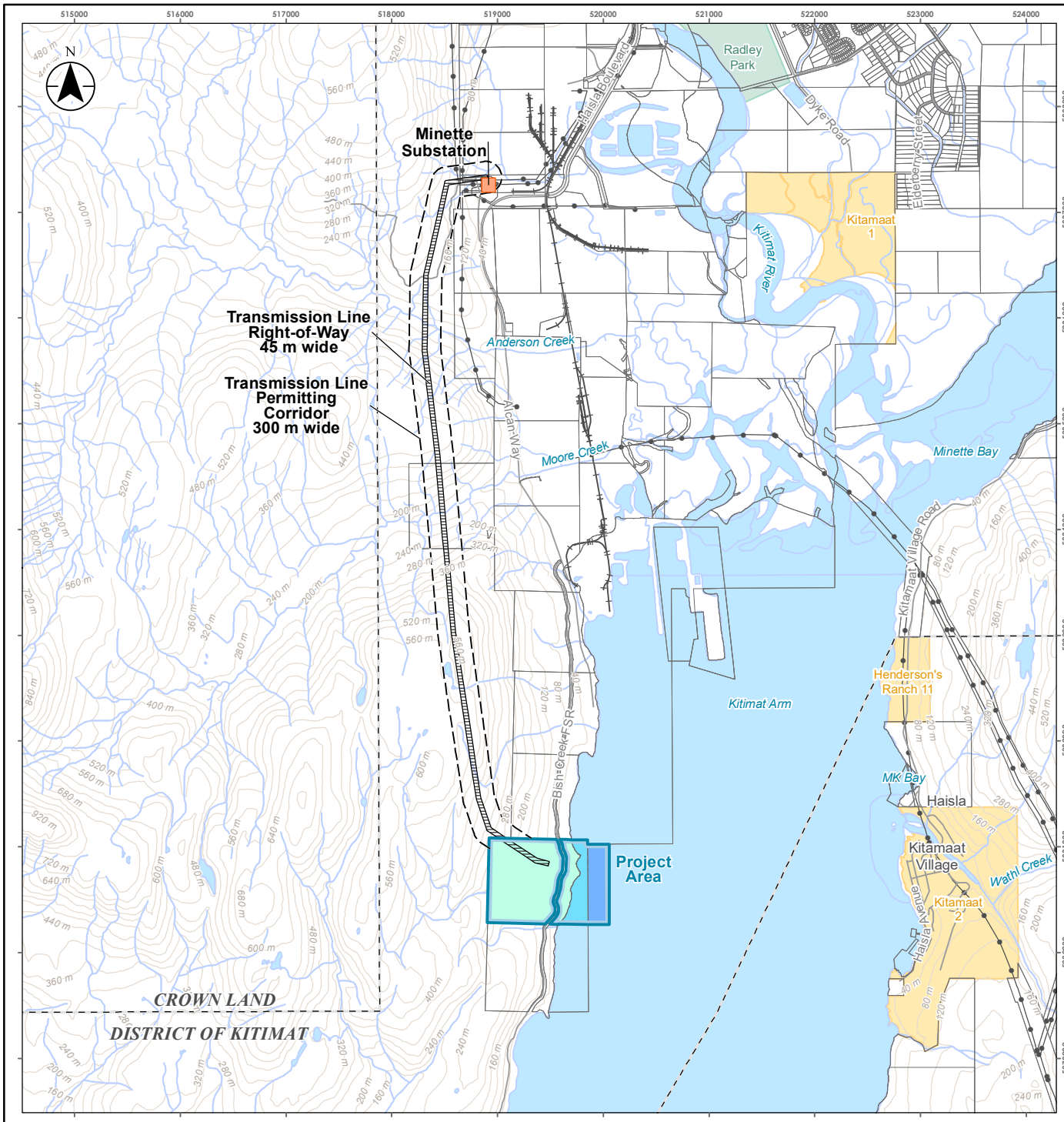
Decibel Addition	In acoustics, due to the logarithmic nature of the decibel scale, the addition of two or more sound pressure levels (denoted as SPL1, SPL2 … SPLn) is done as follows: SPL1 + SPL2 + …SPLn = 10 log (10 (SPL1/10) + 10(SPL2/10) + …+ 10(SPLn/10)) As an example: 50 dB + 50 dB = 53 dB
Energy-related facility	Energy-related facilities as per OGC noise guideline include a facility under the jurisdiction of the OGC or other regulatory agency, used for energy generation, transport (except by road or rail line) and resource extraction. These include mining, extraction, processing and transportation (except by road or rail line) as well as federally regulated electrical transmission lines and pipelines (OGC 2021).
Floating liquefied natural gas (FLNG) facility	A water-based liquefied natural gas production facility that is purpose-built to liquefy and store liquefied natural gas and transfer it to LNG carriers for global export.
Frequency	Number of cycles per unit of time. In acoustics frequency is expressed in hertz (Hz), i.e., cycles per second
Hertz (Hz)	Unit of measurement of frequency, numerically equal to cycles per second
L_{eq}	Energy Equivalent Sound Level. An energy-average sound level taken over a specified period of time. It represents the average sound pressure encountered for the period. The time period is often added as a suffix to the label (e.g., L_{eq} [24] for the 24-hour equivalent sound level). L_{eq} is usually A-weighted. A L_{eq} value expressed in dBA is a good, single value descriptor of the annoyance of noise
L_d	Daytime equivalent sound level from 0700 to 2200.
L_{dn}	Day-night equivalent sound level with an additional 10 dB penalty added to the nighttime period.
L_n	Nighttime equivalent sound level from 2200 to 0700.
Liquefied natural gas (LNG)	Natural gas that has been cooled to approximately -162°C where the methane and other components condense from gas to liquid form. In its liquid state, natural gas takes up 1/600 of the space that the gaseous phase occupies.

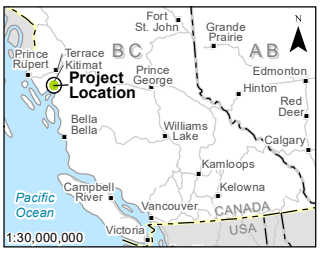
LNG carrier	A marine cargo ship with specialized cryogenic tanks that designed for transporting liquefied natural gas.
Natural gas	A naturally occurring hydrocarbon gas mixture consisting primarily of methane (typically >98%) plus varying amounts of ethane, propane, butanes, pentanes, higher molecular weight hydrocarbons, hydrogen sulfide, carbon dioxide, water vapor, and sometimes helium and nitrogen.
Nighttime	The hours from 2200 to 0700
Noise	Unwanted sound
Noise Level	Same as Sound Level, except applied to unwanted sounds
Sound	A dynamic (fluctuating) pressure
Sound Pressure Level (SPL)	The logarithmic ratio of the root mean square sound pressure to the sound pressure at the threshold of hearing. The sound pressure level is defined by equation below where P is the RMS pressure due to a sound and P_0 is the reference pressure. P_0 is usually taken as 2.0 × 10-5 Pascals. SPL (dB) = 20 log(P_{RMS}/P_0)
Sound Power Level (PWL)	The logarithmic ratio of the instantaneous sound power of a noise source to that of the reference power. The sound power level is defined by equation below where W is the sound power of the source in watts, and Wo is the reference power of 10^{-12} watts PWL (dB) = 10 log(W/W_0)
Spectrum	The description of a sound wave's resolution into its components of frequency and amplitude
Tonal Components	Often industrial facilities exhibit tonal components. Examples of tonal components are transformer hum, sirens, and piping noise. The test for the presence of tonal components consists of two parts (as per tonality prescribed in the OGC noise guideline (OGC 2021): The first part must demonstrate that the sound pressure level of any one of the slow-response, A-weighted, 1/3 octave bands between 20 and 16 kHz is 10 dBA or more than the sound pressure level of at least one of the adjacent bands within two 1/3-octave bandwidths. In addition, there must be a minimum of a 5 dBA drop from the band containing the tone within two bandwidths on the opposite side. The second part is that the tonal component must be a pronounced peak clearly obvious within the spectrum.

1.0 INTRODUCTION

Cedar LNG Partners LP (Cedar), a Haisla Nation-led partnership with Pembina Pipeline Corporation, is proposing to construct and operate the Cedar LNG Project (the Project), a liquefied natural gas (LNG) export facility within the District of Kitimat, British Columbia. The Project will be located on Haisla Nation-owned land within the Nation's traditional territory, approximately 3 kilometres (km) west across Kitimat Arm from Kitamaat Village and approximately 10 km southwest of Kitimat's town centre (Figure 1).

The Project is subject to environmental assessment requirements under the British Columbia *Environmental Assessment Act* and the federal *Impact Assessment Act*. This technical data report presents supporting material and detailed information to support the assessment of the acoustic environment in the Application for an Environmental Assessment Certificate (the Application) and permitting requirements.





Notes
1. Coordinate System: NAD 1983 UTM Zone 9N
2. Data Sources: DataBC, Government of British Columbia; Natural Resources Canada; Canadian Hydrographic Service

- Road
- Railway
- Transmission Line
- Topographic Contour (40 m)
- Watercourse
- Waterbody
- Cadastral (Legal Lot) Boundary
- Reserve Land
- Local Greenspace
- District of Kitimat Municipal Boundary
- Minette Substation
- Project Area
- Transmission Line Right-of-Way
- Transmission Line Permitting Corridor

Parcel Owned by Haisla Enterprise Ltd.
- District Lot 99, Plan 14740, PID 013-061-267
- Water Lot A, Plan EPP 14217, PID 029-462-142 (Portion)

Proposed Crown Lease
- Conceptual Water Lot

0 0.5 1 1.5 2 km
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Stantec

CEDAR LNG

Project Location: Kitimat, British Columbia

Project Number 123221953
Prepared by WWU on 20211126
Discipline Review by WPRYSTAY on 20211126
GIS Review by LTRUDELL on 20211126

Client/Project/Report
Cedar LNG Partners LP
Cedar LNG Project
Acoustic Technical Data Report

Figure No.
1

Title
Cedar LNG Project Location

2.0 STUDY AREA

The Project is located approximately 10 km southwest of Kitimat's town centre (Figure 1). The nearest residential area to the Project is Kitamaat Village, located approximately 3 km directly east across Kitimat Arm.

For the purposes of this noise assessment the project assessment area includes a combined local assessment area (LAA) and regional assessment area (RAA) of 3 km in all directions from the Project Area and marine shipping route. The LAA/RAA extends 3 km from the Project Area to encompass the nearest community of Kitamaat Village (Kitamaat 2 Indigenous Reserve).

The British Columbia Oil and Gas Commission Noise Control Guideline (OGC 2021) (referred to herein as OGC noise guideline) requires that environmental noise impacts be assessed at a distance of 1.5 km from the facility or at the nearest residential dwelling, whichever is closer (i.e., 1.5 km criteria boundary). Since there are no residential noise sensitive receptors within 1.5 km from the Project Area, the nearest residential noise sensitive receptor is near Kitamaat Village approximately 2.7 km from the Project Area (R13; see Table 1), the LAA/RAA is extended to 3 km. In addition, locations along the combined (Project and LNG Canada Export Terminal) 1.5 km criteria boundary are also assessed.

Figure 2 shows the LAA and RAA of 3 km and 1.5 km criteria boundary from the Project Area and transmission line corridor, and Figure 3 shows the LAA and RAA of 3 km from the shipping route. The identified noise sensitive receptors within the LAA/RAA are listed in Table 1, including a short description, location and distance to the Project.

Only the residential dwellings are considered noise sensitive receptors as per OGC noise guideline. The remainder are considered noise sensitive receptors as per Health Canada Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise (Health Canada 2017) (referred to herein as Health Canada noise guidance). Health Canada noise guidance includes a broader definition of noise sensitive receptor than just residential dwellings. Figure 4 shows the location of the noise sensitive receptor locations listed in Table 1.

Noise sensitive receptors outside the LAA/RAA of the facility, shipping route or transmission line are not assessed, as it is assumed that noise at a distance greater than 3 km from the Project Area and the shipping route will attenuate to a level that is below the ambient sound level.

Table 1 Noise Sensitive Receptors within the Assessment Areas

Receptor ID	Name	Description[1]	Universal Transverse Mercator (UTM)[2] Coordinates (m)		Approximate Distance (km) from Project Area	Approximate Distance (km) from Transmission line	Approximate Distance (km) from Marine Shipping Route
			Easting	Northing			
R01	Kitamaat Village childcare centre	Daycare center	523066	5980755	3.0	--	--
R02	Kitamaat Village school	School	523151	5980707	3.1[3]	--	--
R03	Kitamaat Village church	Place of worship	522957	5980687	3.1[3]	--	--
R04	Kitamaat Village Health Centre	Hospital	523179	5980675	3.1[3]	--	--
R05	Hartley Bay residence	Residential noise sensitive receptor	483667	5919585	--	--	2.6
R06	Gil Island	Traditional land use area, active and passive recreation areas	481423	5908389	--	--	1.4
R07	Fin Island		478990	5902839	--	--	0.6
R08	Otter Channel		460900	5896173	--	--	1.9
R09	Anger Island		432995	5928312	--	--	1.9
R10	Banks Island (North)		404163	5943106	--	--	2.6
R11	McCauley Island		408572	5946470	--	--	2.6
R12	Banks Island (South)		440131	5914969	--	--	2.2
R13	Kitimaat Village residence 1	Residential noise sensitive receptor	522774	5979712	2.8	--	--
R14	Kitimaat Village residence 2		522934	5980462	2.9	--	--
R15	Kitimaat Village residence 3		522869	5981030	2.8	--	--
R16	Kitimaat Village Residence 4 (Haisla)		523078	5981322	3.0	--	--

Table 1 Noise Sensitive Receptors within the Assessment Areas

Receptor ID	Name	Description[1]	Universal Transverse Mercator (UTM)[2] Coordinates (m)		Approximate Distance (km) from Project Area	Approximate Distance (km) from Transmission line	Approximate Distance (km) from Marine Shipping Route
			Easting	Northing			
R17	Jesse Lake	Traditional land use area, active and passive recreation areas	509425	5967551	--	--	2.8
R18	Anderson Creek 1		516262	5986538	--	2.0	--
R19	Anderson Creek 2		518978	5985696	--	0.6	--
R20	Moore Creek 1		519186	5984492	3.4[3]	0.7	--
R21	Moore Creek 2		519220	5984496	3.4[3]	0.8	--
R22	West Lake		509376	5967643		--	2.9
R23	C'Imo'Ca Child Care Centre	Daycare center	523016	5980749	2.9	--	--
R24	Haisla Recovery Centre	Hospital	522881	5980891	2.8	--	--
R25	Coste Island	Traditional land use area, active and passive recreation areas	516535	5968079	2.8	--	--
R26	SW dockyard		519911	5982474	1.4	1.2	--
R27	Half Moon Bay		519840	5981852	1.0	1.0	--
R28	Kitimat Service Area		520279	5989605	--	2.6	--
L1 [3]	Assessment Location	OGC noise guideline (1.5 km criteria boundary)	519106	5978779	1.5`	`	--

NOTES:

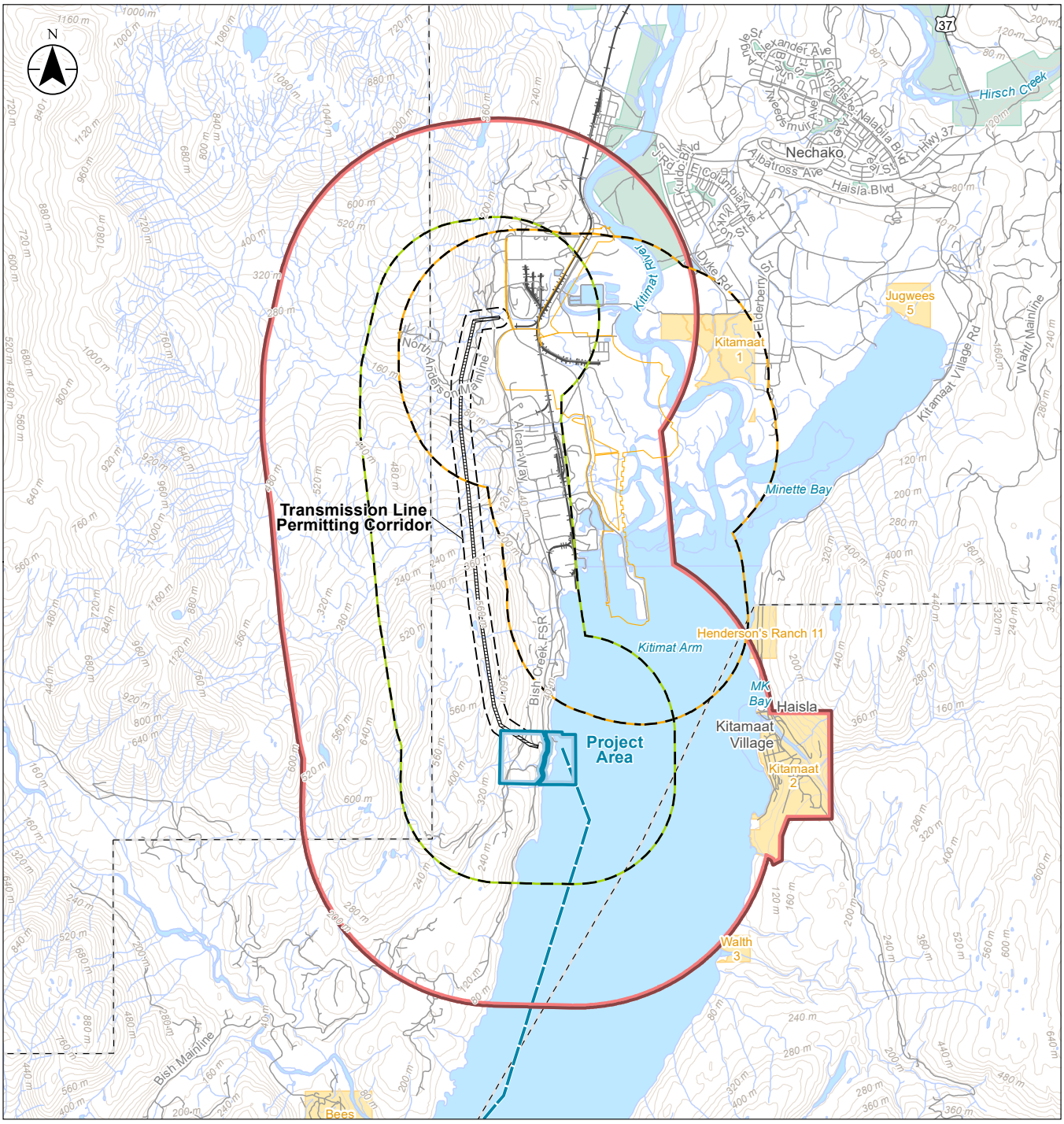
[1] The identified noise sensitive receptors are based on the definitions provided in the OGC noise guideline (residential noise sensitive receptors only) and the Health Canada guidance (noise sensitive receptors beyond just residential receptors

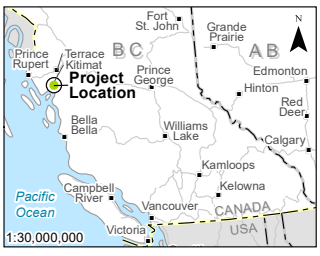
[2] Coordinate system: NAD 1983 UTM Zone 9

[3] These receptors are just outside the LAA/RAA but are included to be conservative

[4] Assessment location represents the highest noise effects along the 1.5 km criteria boundary

"—" outside the LAA/RAA, distance more than 3 km from Project Area or transmission line





Notes
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2. Data Sources: DataBC, Government of British Columbia; Natural Resources Canada; Canadian Hydrographic Service

- Highway
- Road
- Railway
- Topographic Contour (40 m)
- Watercourse
- Waterbody
- Reserve Land
- Local Greenspace
- District of Kitimat Municipal Boundary
- LNG Canada Project Footprint
- Project Area
- Transmission Line Right-of-Way
- Transmission Line Permitting Corridor
- Marine Shipping Route (Approximate Location)
- Cedar LNG Criteria Boundary (1.5 km)
- LNG Canada Criteria Boundary (1.5 km)

Acoustic
- Local Assessment Area
- Regional Assessment Area

0 1 2 3 4 km
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Project Location: Kitimat, British Columbia
Project Number 123221953
Prepared by WWU on 20211126
Discipline Review by SZABANI on 20211126
GIS Review by LTRUDELL on 20211126

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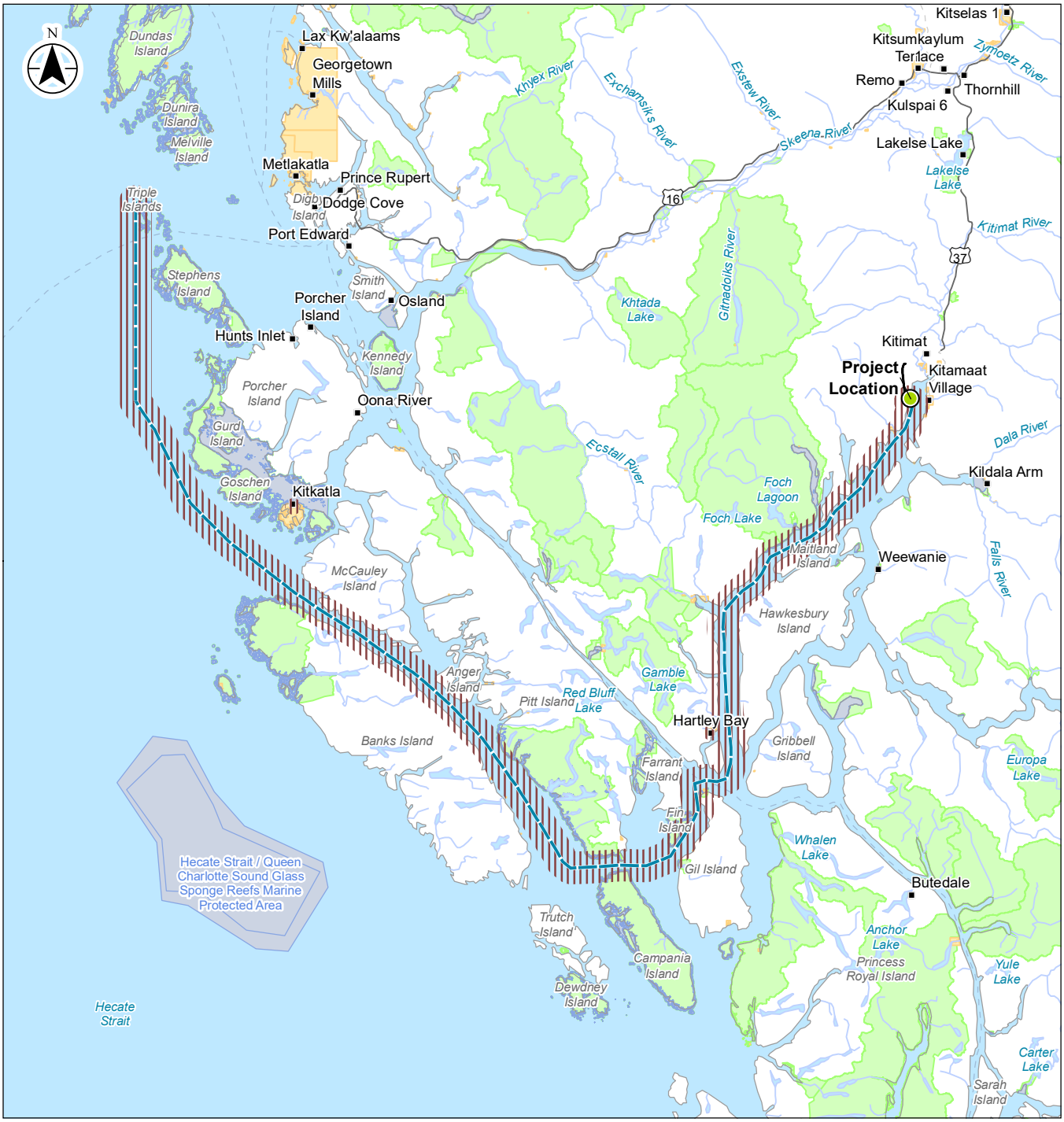
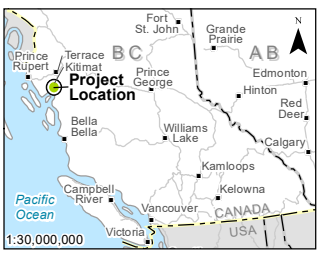
Figure No.
2

Title
Acoustic Local and Regional Assessment Areas





- Highway
- Resource Road
- Ferry Route
- Watercourse
- Waterbody
- Reserve Land
- Park or Protected Area
- Marine Park or Protected Area
- Project Location
- Marine Shipping Route (Approximate Location)

Acoustic (Shipping)

- Local and Regional Assessment Area

0 10 20 30 40 50 km

1:1,100,000 (at original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 UTM Zone 9N
2. Data Sources: DataBC, Government of British Columbia; Natural Resources Canada; Canadian Hydrographic Service

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Project Location:
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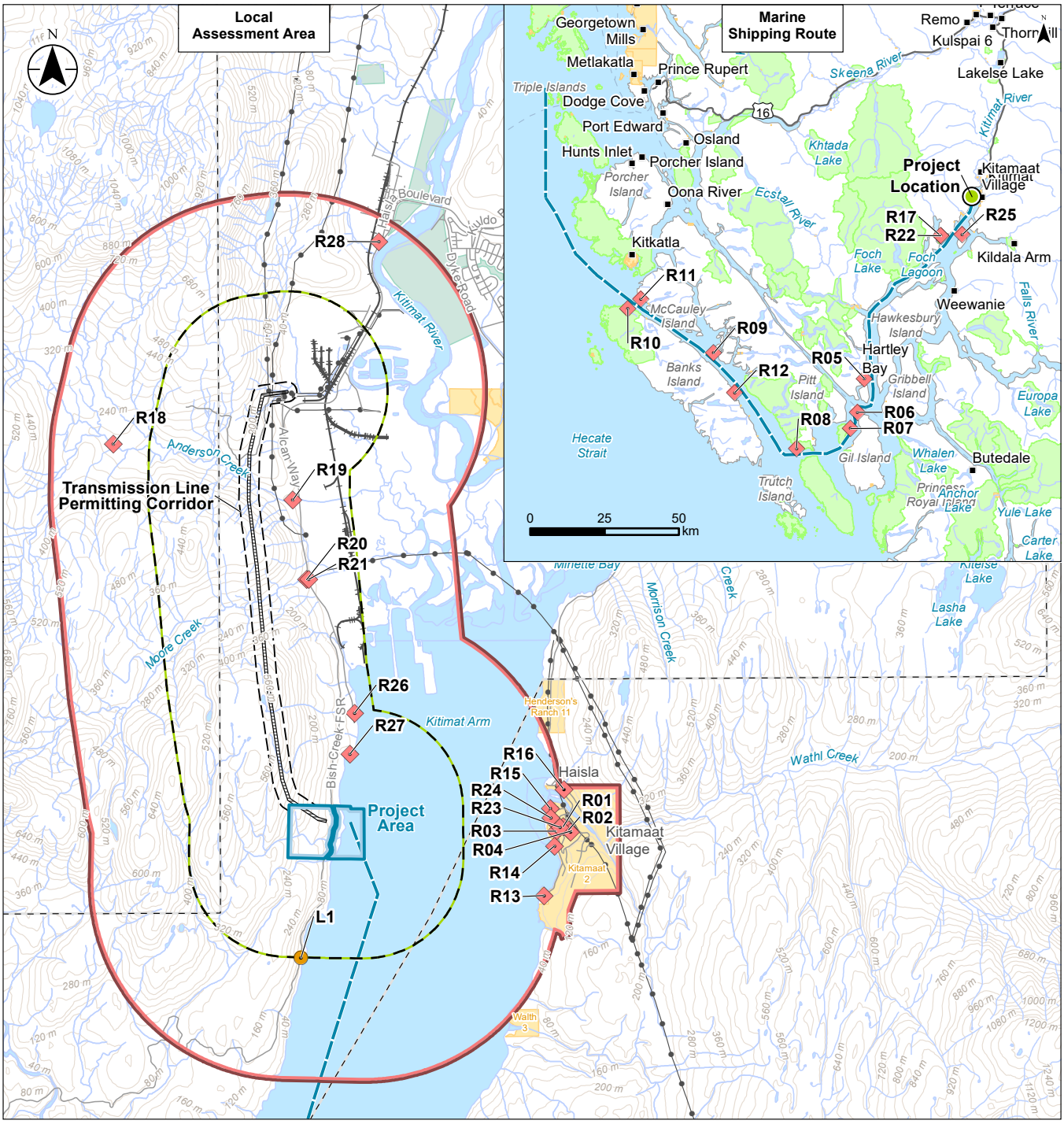
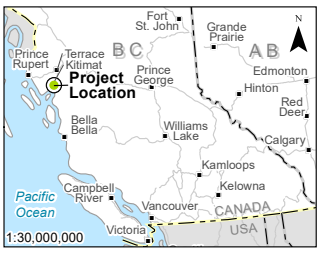
Acoustics Technical Data Report

Figure No.
3

Title
Acoustic (Shipping) Local and Regional Assessment Areas





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- Topographic Contour (40 m)
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- Waterbody
- Reserve Land
- Local Greenspace
- District of Kitimat Municipal Boundary
- Project Area
- Transmission Line Right-of-Way
- Transmission Line Permitting Corridor
- Marine Shipping Route (Approximate Location)
- Cedar LNG Criteria Boundary (1.5 km)
- Noise Sensitive Receptor
- Assesment Location

0 0.5 1 1.5 2 2.5 3 km

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CEDAR LNG

Project Location:
Kitimat,
British Columbia

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Cedar LNG Partners LP
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Figure No.
4

Title
Noise Sensitive Receptor Locations

3.0 ENVIRONMENTAL NOISE DESCRIPTORS

Environmental noise is rarely steady and typically varies over time. To account for this variation, a single number descriptor known as the energy equivalent sound level (L_{eq}) is used to describe environmental noise. Defined as the steady, continuous sound level over a specified time, L_{eq} has the same acoustic energy as the actual varying sound levels over the same time.

The recorded sound can be “frequency-weighted” with A and C scales being the most common. The corresponding weighted L_{eq} values would then be expressed in A-weighted decibels (dBA) or C-weighted decibels (dBC). The A-weighted scale is based on relative loudness of sound at different frequencies and is meant to reflect the human ear response to noise. The C-weighted scale is used to assess the low frequency content of noise. A-weighted and C-weighted L_{eq} are the main noise descriptors in assessing environmental noise effects.

Time periods commonly used for L_{eq} measurements and regulatory criteria are daytime (0700 to 2200) and nighttime (2200 to 0700). The daytime equivalent sound level (L_d) is the 15-hour A-weighted energy equivalent sound level. Similarly, the nighttime equivalent sound level (L_n) is a 9-hour A-weighted energy equivalent sound level. The day-night average sound level (L_{dn}) is a 24-hour time-averaged L_{eq}, with a 10-decibel (dB) penalty applied to nighttime hours. Most regulatory bodies use these environmental noise descriptors. Health Canada, in addition, uses the maximum sound level (L_{max}) and percent highly annoyed (%HA) to quantify noise effects (Section 4.0. and the Glossary for more information).

4.0 REGULATORY REQUIREMENTS

The below sections outline the various regulatory requirements and guidance documents considered and applied in this noise assessment.

4.1 MUNICIPAL NOISE GUIDELINE

The Kitimat Municipal Code (District of Kitimat 2021) is the only applicable municipal regulation in the study areas that pertains to noise. The code, as currently written, is a nuisance-based regulation, which specifies prohibitions on certain types of activities. It provides qualitative guidelines on noise but does not quantify sound level limits for any activities including industrial activities. Because municipal sound limits are not quantified, they are not used in this assessment.

4.2 PROVINCIAL NOISE GUIDELINE

4.2.1 Liquefied Natural Gas Facility Regulation and LNG Facility Permit Application and Operations Manual

The LNG Facility Regulation (Government of British Columbia 2014) and the LNG Facility Permit Application and Operations Manual (OGC 2014) provide guidance for the construction and operation of an LNG facility in British Columbia. With regards to noise, the LNG Facility Regulation outlines permit holders should ensure that mitigation measures are built into the design and operating procedures using the OGC noise guideline, stating that the LNG facility must ensure that the construction and normal operation of the LNG facility do not cause excessive noise, however, no quantitative limits are provided. The LNG Facility Permit Application and Operations Manual does not state any quantitative noise limits either, however, it recommends that noise impacts are assessed according to the OGC noise guideline (Section 4.2.2).

4.2.2 Oil and Gas Commission Noise Control Guideline

Limits on noise emissions from regulated energy-related facilities[1] (e.g., oil and gas) in British Columbia are specified in the Oil and Gas Commission Noise Control Guideline (OGC 2021), herein referred to as OGC noise guideline. This guideline is a receptor-oriented regulation, which specifies allowable sound levels from energy-related facilities at designated points of reception.

In accordance with the OGC noise guideline, all new regulated oil and gas facilities must meet a daytime (0700 to 2200) and nighttime (2200 to 0700) permissible sound level (PSL) at a distance of 1.5 km (criteria boundary) from the facility boundary or at the nearest receptor, whichever is closer. Only dwellings that are permanently or seasonally occupied are defined as receptors. Exceptions to this definition include any employee or worker residence, dormitory, or construction camp located within an industrial plant boundary. See Section 4.2.3 for how the PSL has been determined for the various residential noise sensitive receptors.

[1] For a definition of energy-related facility as per OGC (2021) see the glossary

The OGC noise guideline does not define a sound-level limit for construction and decommissioning activities of oil and gas facilities in British Columbia. However, the OGC noise guideline requires that reasonable measures be implemented to limit noise from these activities. Because provincial sound-level limits are not defined for construction activities, the assessment uses federal guidance (Section 4.3) to establish thresholds for construction and decommissioning activities.

4.2.3 Permissible Sound Level

The daytime and nighttime PSL at each residential noise sensitive receptor depends on dwelling density and proximity to transportation (i.e., proximity to heavily travelled roadways and rail lines). Daytime PSL is set at 10 dB above the nighttime value to reflect that daytime ambient sound levels are generally higher than nighttime ambient sound levels. The ambient sound level is 5 dB below the basic sound level. When there is no receptor within 1.5 km from a project fence line, the nighttime and daytime PSLs along the 1.5 km criteria boundary are set to 40 dBA and 50 dBA L_{eq}, respectively.

Table 2 summarizes the determination of PSLs for the residential noise sensitive receptors. In this noise assessment all identified residential noise sensitive receptors are located more than 500 metres (m) from heavily travelled roadways. Therefore, the transportation category for these residential dwellings is Category 1. The ambient sound level for residential noise sensitive receptors with the dwelling unit density between 1 and 8 per quarter section was set at 35 dBA. Correspondingly, the daytime PSL of 50 dBA and nighttime PSL of 40 dBA were determined for these receptors. The ambient sound level for residential noise sensitive receptors with a dwelling unit density between 9 to 160 per quarter section was set at 38 dBA. Correspondingly, the daytime PSL of 53 dBA and nighttime PSL of 43 dBA were determined for these receptors.

4.2.4 Low-Frequency Noise

Low frequency noise (LFN) is identified as a potential concern in the OGC noise guideline. Low frequency noise describes noise with frequency content in the range of 20 to 250 Hertz (Hz). When two conditions are met, LFN may exist:

- Isolated (i.e., non-facility noise, such as wind noise, has been removed) time-weighted average dBC – dBA value for the measured day- or nighttime period is equal to, or greater than, 20 dB
- A clear tonal component exists at a frequency below 250 Hz

Table 2 Calculated Daytime and Nighttime Permissible Sound Levels

Receptor ID	Dwelling Unit Density per Quarter Section[1] of land	Transportation Category, Proximity to Transportation[2]	OGC Ambient Sound Level[3] (dBA)		OGC Permissible Sound Level (PSL) (dBA)	
			Daytime Ambient Sound Level (dBA)	Nighttime Ambient Sound Level (dBA)	Daytime BSL (dBA)	Nighttime BSL (dBA)
R01	-	-	-	-	-	-
R02	-	-	-	-	-	-
R03	-	-	-	-	-	-
R04	-	-	-	-	-	-
R05	9–160	1 >500 m	48	38	53	43
R06	-	-	-	-	-	-
R07	-	-	-	-	-	-
R08	-	-	-	-	-	-
R09	-	-	-	-	-	-
R10	-	-	-	-	-	-
R11	-	-	-	-	-	-
R12	-	-	-	-	-	-
R13	1–8	1 >500 m	45	35	50	40
R14	9–160	1 >500 m	48	38	53	43
R15	9–160	1 >500 m	48	38	53	43
R16	9–160	1 >500 m	48	38	53	43
R17	-	-	-	-	-	-
R18	-	-	-	-	-	-
R19	-	-	-	-	-	-
R20	-	-	-	-	-	-
R21	-	-	-	-	-	-

Table 2 Calculated Daytime and Nighttime Permissible Sound Levels

Receptor ID	Dwelling Unit Density per Quarter Section[1] of land	Transportation Category, Proximity to Transportation[2]	OGC Ambient Sound Level[3] (dBA)		OGC Permissible Sound Level (PSL) (dBA)	
			Daytime Ambient Sound Level (dBA)	Nighttime Ambient Sound Level (dBA)	Daytime BSL (dBA)	Nighttime BSL (dBA)
R22	-	-	-	-	-	-
R23	-	-	-	-	-	-
R24	-	-	-	-	-	-
R25	-	-	-	-	-	-
R26	-	-	-	-	-	-
R27	-	-	-	-	-	-
R28	-	-	-	-	-	-
L1	-	-	45	35	50	40

NOTES:

[1] Refers to a quarter section, with the most likely affected dwelling at the centre (a 451 m radius). For quarter sections with various land uses or with mixed densities, the density chosen should be factored for the area under consideration. A quarter section is an area of one-fourth of a square mile.

[2] Definition of transportation proximity category as follows:
Category 1—dwelling units more than 500 m from heavily travelled roads and rail lines and not subject to frequent aircraft flyovers.
Category 2—dwelling units more than 30 m but less than 500 m from heavily travelled roads and rail lines and not subject to frequent aircraft flyovers.
Category 3—dwelling units less than 30 m from heavily travelled roads and rail lines and/or subject to frequent aircraft flyovers.

[3] Ambient sound level is 5 dB below the basic sound level, as prescribed in OGC noise guideline.

"-" These receptors are not considered residential noise sensitive receptors as per OGC noise guideline, hence they are not assessed against a PSL.

4.3 FEDERAL NOISE GUIDANCE

The provincial noise guideline (i.e., OGC 2021) does not provide quantitative noise thresholds for construction activities; the project construction noise assessment therefore refers to Health Canada noise guidance. The Health Canada Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise (Health Canada 2017) (referred to herein as Health Canada noise guidance) addresses noise effects as they relate to perceived annoyance as well as sleep disturbance when assessed at noise sensitive receptors. The Health Canada noise guidance uses daytime or nighttime equivalent sound levels (L_d and L_n, respectively), adjusted day-night average sound levels (L_{dn}), and %HA to quantify noise effects for activities with a duration of more than 12 months (i.e., the construction activities and normal operation) (Health Canada 2017).

4.3.1 Annoyance Targets

The Health Canada noise guidance recommends the use of %HA to quantify annoyance due to noise effects for activities with a duration of more than 12 months. The Health Canada %HA was used to quantify the construction and operation noise effect in the Application. The baseline %HA values are based on results from the Application. The cumulative case %HA values are determined from the cumulative noise effect from the baseline sound levels in Table 4 and construction noise level in Table 10, and project noise levels in Table 11. The difference between the baseline and cumulative case %HA values quantifies the change in %HA. The baseline and total (baseline + Project) %HA is calculated by the following equations with the L_{dn} corresponding to the baseline or project inclusion:

$$\%HA_{(baseline)} = \frac{100}{1+e^{[10.4-0.132*Ldn(baseline)]}}$$

$$\%HA_{(baseline+Project)} = \frac{100}{1+e^{[10.4-0.132*Ldn(baseline+Project)]}}$$

Receptors in rural areas could be considered to have a greater expectation of “peace and quiet” (i.e., quiet rural areas) than receptors in urban areas. Health Canada considers a “quiet rural area” to be an area with an L_{dn} of 45 dB or less due to human-made sounds. As a conservative approach, receptors with L_{dn} <45.5 dBA are considered for the +10 dB adjustment to account for its heightened sensitivity to any increases in noise levels. The effect of this +10 dB adjustment in quiet rural areas is to produce a greater change in %HA than would occur with unadjusted noise levels.

Health Canada noise guidance recommends the highest increase for change in %HA is 6.5% at a receptor for project activities with a duration of more than one year. If the change in %HA exceeds 6.5%, effects are of concern and may require mitigation. Health Canada also recommends mitigation of project noise if it exceeds L_{dn} of 75 dBA at a receptor, even if the change in %HA does not exceed 6.5%. Impulsive and tonal characteristics of source noise are accounted for in the %HA calculations because their presence can increase annoyance.

Change in %HA is quantified by determining the difference between %HA calculated for the baseline condition and %HA calculated with inclusion of the Project's noise contribution. The change in %HA is calculated by using the following equation:

$$\text{Change in \%HA} = \%HA_{(\text{baseline+Project})} - \%HA_{(\text{baseline})}$$

4.3.2 Sleep Disturbance

To assess sleep disturbance Health Canada recommends guidelines and recommendations of the World Health Organization (WHO) for community noise (WHO 1999). The WHO guideline recommends a target for sleep disturbance as being an indoor sound level of no more than 30 dBA L_{eq} for continuous noise during the sleep period (WHO 1999). Health Canada also recommends that indoor sound levels not exceed 45 dBA L_{max} more than 10 to 15 times per night to provide for a good sleep environment. As per Health Canada noise guidance, the recommended outdoor-to-indoor transmission loss with windows at least partially open is 15 dBA and fully closed windows are assumed to reduce outdoor sound levels by approximately 27 dBA. Therefore, the equivalent outdoor levels should not be more than 60 dBA. The outdoor noise level of 45 dBA L_{eq} was also used as the threshold for continuous noise (Health Canada 2017).

5.0 METHODOLOGY

The objective of the noise assessment is to quantify the noise effect during construction, operation and decommissioning phases of the Project. Effects associated with the project decommissioning are predicted to be the same or less than the construction phase. Therefore, when referred to construction in this assessment, the same results apply to the decommissioning phase. Noise models are used to predict the noise level at noise sensitive receptors near the construction and operation activities. The noise model considers noise emission from mobile and stationary equipment. The noise prediction results are compared to applicable noise guidelines and guidance. If the noise effects exceed the recommended thresholds, mitigation measures are recommended to reduce noise to acceptable levels.

5.1 ASSESSMENT APPROACH

The approach used to assess the potential noise effects during construction/decommissioning and normal operation is summarized as follows:

1. Determine the assessment area and receptor location(s) within the LAA/RAA
2. Establish the applicable regulatory threshold (e.g., PSL, change in %HA, and sleep disturbance threshold for noise sensitive receptors)
3. Quantify the baseline sound levels at the noise sensitive receptors in accordance with the applicable noise guidelines
4. Predict the project noise effects for the “predictable worst case” land clearing phase during the construction phase of the Project
5. Predict the project-only noise effects during the operation phase of the Project (for the facility itself as well as for shipping activities)
6. Assess compliance by comparing the noise effect at the receptors to the applicable noise threshold for both construction and operation

5.2 MODELLING

The OGC noise guideline or the Health Canada noise guidance do not endorse any specific standards or modelling software; however, international calculation standards are recommended.

Noise modelling in this assessment was completed using the latest version of the Cadna/A software (DataKustik 2019), which incorporates International Organization for Standardization (ISO) Standard 9613 (ISO 1993, 1996) algorithms. These ISO standards are commonly used by noise practitioners and are accepted by OGC and Health Canada. The Cadna/A software model accounts for the following factors:

- Geometric spreading
- Screening effects

- Atmospheric absorption
- Ground condition
- Source size, location, and elevation
- Mild downwind conditions from the Project to the dwelling(s) and or temperature inversion condition
- Source directivity

The values of 10°C temperature and 70% relative humidity are used in the model settings to represent summer nighttime conditions that enhance noise propagation. The wind speed is based on ISO 9613-2 standard (ISO 1996), which assumes 1 to 5 m/s downwind condition from the source to the receptor in the sound propagation calculation. Ground absorption factor (G) is an index with value ranges from 0 to 1 where 0 represents reflective surface and 1 represent absorptive surface. Waterbodies are assigned the G value of 0. The Project Area as well as developed areas are assigned G = 0.3. All remaining surrounding area is assigned the G value of 0.8. Ground terrain information is based on the Canadian Digital Elevation Model Product from Natural Resources Canada (NRCan 2013). The reflection parameter of one represents the order of reflection when the sound emission incident ray hits a structure.

Table 3 lists the modelling parameters used in the models for this assessment in more detail.

Table 3 Acoustic Modelling Parameters

Item	Model Parameters	Model Setting
1	Temperature[1]	10°C
2	Relative humidity[1]	70%
3	Wind speed	Downwind condition, wind speed of 1 m/s to 5 m/s (based on ISO 9613-2 standard)
4	Noise source	Refer to Section 7.0
5	Acoustic modelling software	Cadna/A (DataKustik 2019)
6	Noise propagation standard	ISO 9613
7	Ground conditions and attenuation factor[2]	Ground absorption (G): • Waterbody G = 0 • Project Area and industrial areas G = 0.3 • Surrounding area (vegetated) G = 0.8 (G varies between 0-1, where 0 represents reflective ground surface and 1 represents absorptive ground surface condition)
8	Terrain parameters (terrain resolution)	50 m by 50 m for around the Project Area and 200 m by 200 m for the area around the shipping route (NRCan 2013)
9	Reflection parameters [3]	1 order of reflection

NOTES:

[1] The Values of 10°C temperature and 70% relative humidity are used in the model settings to represent summer nighttime conditions that enhance noise propagation. The wind speed is based on ISO 9613-2 standard (ISO 1996), which assumes 1 to 5 m/s downwind condition from the source to the receptor in the sound propagation calculation.

[2] Ground terrain information is based on the Canadian Digital Elevation Model Product from Natural Resources Canada (NRCan 2013).

[3] The reflection parameter of one represents the order of reflection with the sound emission incident ray hits a structure.

6.0 BASELINE SOUND LEVEL

The baseline sound level characterizes the existing acoustic environment within the LAA/RAA. The baseline sound level can vary between noise sensitive receptors depending on where they are located. If noise monitoring results from the LAA/RAA are available from previous published environmental assessments, then these baseline sound levels are incorporated. If no monitoring results are available, then recommended sound levels from OGC noise guideline or the Health Canada guidance are used.

Present projects and activities within the LAA/RAA that are likely to interact on acoustics with the Project are characterized by a combination of residential, industrial and commercial activities (e.g., MK Bay Marina, Rio Tinto Aluminum Smelter) as well as the natural environment. There are future projects and activities that are likely to interact on acoustics with the Project (e.g., LNG Canada Export Terminal). These and other future projects could possibly overlap either spatially or temporally with the noise effects of the Project. However, present or future projects that are not regulated by the British Columbia Oil and Gas Commission are not subject to the same provincial quantitative operation noise threshold (i.e., PSL). Estimating noise effects from non-regulated projects can be difficult due to the unavailability of public information. In addition, Health Canada noise guidance (Health Canada 2017) only considers the noise effects from the Project against the existing sound level. According to Health Canada noise guidance foreseeable future projects are not required to be included in the assessment. The LNG Canada Export Terminal (an OGC regulated facility), once it is in operation, is the only project that has been included in the cumulative assessment. Note that only projects located within the LAA/RAA are assumed to be likely to interact with the Project on acoustics.

Since the planned LNG Canada Export Terminal Project is located within the LAA/RAA, its published operation noise levels are added to the baseline sound levels for the noise sensitive receptors. Information on the expected operation noise levels was based on the LNG Canada Export Terminal published Acoustic Environment Technical Data Report (LNG Canada 2014).

Table 4 provides the predicted operation noise levels from the planned LNG Canada Export terminal, the OGC noise guideline recommended ambient sound levels (based on population density and proximity to transportation) and the resulting combined baselines sound levels as used in the compliance assessment against the PSL thresholds from the OGC noise guideline.

Table 4 Baseline Sound Levels at Noise Sensitive Receptors (OGC Guideline)

Receptor ID	LNG Canada Export Terminal Sound Level[1]		OGC Ambient Sound Level		Baseline Sound Level (dBA)[2]		PSL	
	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)
R01	29.2	28.6	-	-	-	-	-	-
R02	28.8	28.3	-	-	-	-	-	-
R03	29.3	28.8	-	-	-	-	-	-

Table 4 Baseline Sound Levels at Noise Sensitive Receptors (OGC Guideline)

Receptor ID	LNG Canada Export Terminal Sound Level[1]		OGC Ambient Sound Level		Baseline Sound Level (dBA)[2]		PSL	
	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)
R04	28.7	28.2	-	-	-	-	-	-
R05	9.7	14.7	48	38	48.0	38.0	53	43
R06	17.2	22.2	-	-	-	-	-	-
R07	14.8	19.7	-	-	-	-	-	-
R08	11.0	16.0	-	-	-	-	-	-
R09	11.4	16.4	-	-	-	-	-	-
R10	10.7	15.7	-	-	-	-	-	-
R11	9.3	14.3	-	-	-	-	-	-
R12	12.3	17.3	-	-	-	-	-	-
R13	27.7	27.2	45	35	45.1	35.7	50	40
R14	28.5	28.0	48	38	48.0	38.4	53	43
R15	32.2	31.7	48	38	48.1	38.9	53	43
R16	30.4	29.9	48	38	48.1	38.6	53	43
R17	7.2	12.2	-	-	-	-	-	-
R18	27.3	27.2	-	-	-	-	-	-
R19	39.9	39.9	-	-	-	-	-	-
R20	37.5	37.3	-	-	-	-	-	-
R21	37.6	37.5	-	-	-	-	-	-
R22	7.1	12.0	-	-	-	-	-	-
R23	29.3	28.8	-	-	-	-	-	-
R24	31.8	31.3	-	-	-	-	-	-
R25	15.2	20.2	-	-	-	-	-	-
R26	40.6	39.9	-	-	-	-	-	-
R27	37.1	36.5	-	-	-	-	-	-
R28	29.8	29.8	-	-	-	-	-	-
L1	25.0	25.7	45	35	45.0	35.5	50	40

NOTES:

[1] SOURCE: LNG Canada (2014)

[2] The combined baseline noise level is based on the logarithmic addition of the LNG Canada Export Terminal modelled noise values during operation (LNG Canada 2014) and the OGC noise guideline default ambient sound level.

"-" These receptors are not considered residential noise sensitive as per OGC noise guideline, hence they are not assessed against a PSL and no baseline level is provided.

A recent noise monitoring program has been conducted in the Kitimat area as part of an environmental assessment for the neighboring LNG facility (i.e., LNG Canada Export Terminal [LNG Canada 2014]). These surveys followed the OGC noise guideline. Ambient noise monitoring surveys were conducted in 2013 and 2014 as part of the environmental assessment for LNG Canada Export Terminal to quantify the existing acoustic environment (LNG Canada 2014). Multiple-day measurements were collected within the area of the proposed project facility and along the shipping route (which is the same shipping route as the Project). The average A-weighted sound levels for measurements taken in proximity to Kitamaat Village were approximately 43 dBA (daytime) and 39 dBA (nighttime); around Kitimat were 46 to 48 dBA (daytime) and 40 to 41 (nighttime); in proximity to Promise Island and Douglas Channel were 47 dBA (daytime) and 39 dBA (nighttime); and in proximity to McCauley Island were 44 dBA (daytime) and 43 dBA (nighttime) (see Table 5).

Results for the LNG Canada Export Terminal monitoring location M1 are used as the ambient sound level for representative noise sensitive receptors at Kitamaat Village (i.e., R01, R02, R03, R04, R14, R15, R16, R23 and R24). Results for monitoring location M6 are used as the ambient sound level for representative noise sensitive receptor R11.

Table 5 Monitored Baseline Sound Levels from LNG Canada (2014)

Receptor ID	Location	Daytime[1] (L_d) (dBA)	Nighttime[1] (L_n) (dBA)	Day-nighttime L_{dn} (dBA)	UTM Coordinates[2]	
					Easting	Northing
M1	Residential area in Kitamaat Village	43.2	39.4	46.6	522857	5980903
M2	Residence in town of Kitimat	46.9	41.3	49.1	521856	5989630
M3	Residence in town of Kitimat	48.3	40.6	49.3	523710	5991180
M4	Rural dwelling south of town of Kitimat	39.9	40.2	59.2	523546	5986268
M5	Promise Island near Hartley Bay	47.7	39.0	48.2	484253	5918123
M6	McCauley Island	44.9	43.9	50.5	410634	5942757

NOTES:
[1] SOURCE: LNG Canada 2014
[2] UTM – Universal Transverse Mercator UTM Zone 9 NAD 83

Table 6 lists the baseline sound levels as used in the compliance assessment against the %HA threshold from the Health Canada guidance. Receptor locations with a resulting combined day-night baseline sound levels of L_{dn} <45.5 dBA have been adjusted by +10 dB to account for the “peace and quiet” requirement by Health Canada.

Table 6 Baseline Sound Levels at Noise Sensitive Receptors (Health Canada)

Receptor ID	Ambient Sound Levels			LNG Canada Export Terminal Operation Sound Level		Combined Baseline Sound Level (dBA)[1]			
	Daytime L_d (dBA)	Nighttime L_n (dBA)	Reference	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)	Day-nighttime L_{dn} (dBA)	$L_{dn,\ adjusted}$ [2] (dBA)
R01	43.2	39.4	LNG Canada (M1)	29.2	28.6	43.4	39.7	46.9	46.9
R02	43.2	39.4	LNG Canada (M1)	28.8	28.3	43.4	39.7	46.9	46.9
R03	43.2	39.4	LNG Canada (M1)	29.3	28.8	43.4	39.8	46.9	46.9
R04	43.2	39.4	LNG Canada (M1)	28.7	28.2	43.4	39.7	46.9	46.9
R05	48.0	38.0	OGC Noise Guideline	9.7	14.7	48.0	38.0	48.0	48.0
R06[2]	45.0	35.0	OGC Noise Guideline	17.2	22.2	45.0	35.2	45.1	55.1
R07[2]	45.0	35.0	OGC Noise Guideline	14.8	19.7	45.0	35.1	45.1	55.1
R08[2]	45.0	35.0	OGC Noise Guideline	11.0	16.0	45.0	35.1	45.0	55.0
R09[2]	45.0	35.0	OGC Noise Guideline	11.4	16.4	45.0	35.1	45.0	55.0
R10[2]	45.0	35.0	OGC Noise Guideline	10.7	15.7	45.0	35.1	45.0	55.0
R11[2]	44.9	43.9	LNG Canada (M6)	9.3	14.3	44.9	43.9	50.5	50.5
R12[2]	45.0	35.0	OGC Noise Guideline	12.3	17.3	45.0	35.1	45.0	55.0
R13[2]	45.0	35.0	OGC Noise Guideline	27.7	27.2	45.1	35.7	45.3	55.3
R14	43.2	39.4	LNG Canada (M1)	28.5	28.0	43.3	39.7	46.9	46.9
R15	43.2	39.4	LNG Canada (M1)	32.2	31.7	43.5	40.1	47.2	47.2
R16	43.2	39.4	LNG Canada (M1)	30.4	29.9	43.4	39.9	47.0	47.0
R17[2]	45.0	35.0	OGC Noise Guideline	7.2	12.2	45.0	35.0	45.0	55.0
R18[2]	45.0	35.0	OGC Noise Guideline	27.3	27.2	45.1	35.7	45.3	55.3
R19	45.0	35.0	OGC Noise Guideline	39.9	39.9	46.2	41.1	48.7	48.7
R20	45.0	35.0	OGC Noise Guideline	37.5	37.3	45.7	39.3	47.4	47.4

Table 6 Baseline Sound Levels at Noise Sensitive Receptors (Health Canada)

Receptor ID	Ambient Sound Levels			LNG Canada Export Terminal Operation Sound Level		Combined Baseline Sound Level (dBA)[1]			
	Daytime L_d (dBA)	Nighttime L_n (dBA)	Reference	Daytime L_d (dBA)	Nighttime L_n (dBA)	Daytime L_d (dBA)	Nighttime L_n (dBA)	Day-nighttime L_{dn} (dBA)	$L_{dn, adjusted}$ [2] (dBA)
R21	45.0	35.0	OGC Noise Guideline	37.6	37.5	45.7	39.4	47.5	47.5
R22[2]	45.0	35.0	OGC Noise Guideline	7.1	12.0	45.0	35.0	45.0	55.0
R23	43.2	39.4	LNG Canada (M1)	29.3	28.8	43.4	39.8	46.9	46.9
R24	43.2	39.4	LNG Canada (M1)	31.8	31.3	43.5	40.0	47.1	47.1
R25[2]	45.0	35.0	OGC Noise Guideline	15.2	20.2	45.0	35.1	45.1	55.1
R26	45.0	35.0	OGC Noise Guideline	40.6	39.9	46.3	41.1	48.8	48.8
R27	45.0	35.0	OGC Noise Guideline	37.1	36.5	45.7	38.8	47.1	47.1
R28	45.0	35.0	OGC Noise Guideline	29.8	29.8	45.1	36.1	45.5	45.5

NOTES:

[1] The combined noise levels is based on the logarithmic addition of the LNG Canada modelled values and the Health Canada default peace and quiet adjusted L_{dn} values.

[2] Receptor locations with a L_{dn} <45.5 have been adjusted by +10 dB to account for the “peace and quiet” requirement by Health Canada

7.0 PROJECT NOISE EFFECTS

The sound power level (PWL) for noise emitting equipment associated with the construction and operation phase are required for the noise modelling. The estimated PWL values are based on the following:

- Information provided by Cedar or the equipment vendor
- Equipment specifications and referenced formula from acoustic literature (Crocker 2007; Bies and Hansen 2004)
- Publication that provides reference PWL and sound pressure levels for common construction equipment (DEFRA 2005 and FTA 2018)
- Noise measurement data of similar equipment from Stantec's acoustic database

The following sections summarize the noise emitting equipment included in the construction and operation phase.

7.1 CONSTRUCTION PHASE NOISE EMISSION

Construction of the Project is estimated to last up to approximately four years. Construction will include the following two main components, the construction of the 8 km long transmission line from BC Hydro's Minette Substation to the Project Area and the construction of the marine terminal. Noise sensitive receptors farther away from the marine terminal (e.g., R19, R18) may not be affected by its construction noise, however, since these receptors are located closer to the transmission line, they might be affected by construction noise from the transmission line. Therefore, this assessment includes both, the construction noise of the marine terminal as well as the transmission line. The floating LNG (FLNG) facility will be constructed overseas and will be towed to the Project Area, construction noise of the FLNG has therefore note been included in the assessment.

The construction of the transmission line includes the following activities:

- Access road construction
- Land clearing
- Foundation installation
- Tower erection
- Conductor installation

The transmission line construction activities will occur sequentially at different times (e.g., land clearing before foundation installation). Therefore, the noise assessment only considered the predictable worst-case scenario based on highest PWL with consideration of the type and quantity of equipment associated with each construction phase. Table 7 presents the overall PWL for each transmission line construction phase. The land clearing activities during the transmission line construction is assumed the worst-case scenario.

Table 7 Overall Sound Power Level Transmission Line Construction Phase

Construction Phase	Noise Source	Sound Power Level (dBA)
Access road construction	Crawler tractor, backhoe, compactor, tracked tank drill, excavator	101.9
Land clearing	Chainsaw, feller buncher, skidder, excavator, dozer, logging truck	114.8
Foundation installation	Mini-hoe, excavator, concrete truck, low-bed / equipment hauler, forklift, rock drill	114.5
Tower erection	Crane, low-bed / equipment hauler, road grader, crawler tractor	108.2
Conductor installation	Tensioner, crane, low-bed / equipment hauler, generator for puller on trailer, generator for rope machine, forklift, skidder, backhoe, crawler tractor	108.9

The marine terminal will include access roads, a substation, warehouse, security building, the strut mooring system for the FLNG facility and the small craft jetty. Helicopter may be required for the construction of 3 out of 22 transmission line towers. The use of helicopter is expected to be temporary and short-term during the daytime only. Therefore, noise effects from the helicopter use were not included in the assessment. The construction of the marine terminal includes preparation and installation of these components. Based on the information available, all equipment associated with the preparation and installation of the marine terminal is assumed to occur in one phase in the noise assessment. A detailed listing of equipment type, quantity, rated power, acoustic usage factor, and PWL for both the marine terminal construction and the transmission line land clearing activities (worst-case construction phase of the transmission line construction) is presented in Table 8.

Table 8 Sound Power Level Summary of Construction Phase

Item	Equipment	Number of Units	Power (HP)	Acoustic Usage Factor		Sound Power Level [1] (dBA)
				Daytime	Nighttime	
Marine Terminal						
1	Bulldozer	3	303	75%	0%	108
2	Excavator	5	345	75%	0%	108
3	Concrete truck	3	380	75%	0%	106
4	Concrete pump truck	1	505	75%	0%	105
5	Scraper	2	408	75%	0%	116
6	Compactor	5	157	75%	0%	97
7	Crane	3	270	75%	0%	95
8	Fuel and Water truck	3	385	75%	0%	106
9	Front End Loader	2	276	75%	0%	103
10	Grader	1	238	75%	0%	114
11	Articulated Truck	5	496	75%	0%	117

Table 8 Sound Power Level Summary of Construction Phase

Item	Equipment	Number of Units	Power (HP)	Acoustic Usage Factor		Sound Power Level [1] (dBA)
				Daytime	Nighttime	
12	Track drill	2	540	75%	0%	116
13	Paving Machine	1	142	75%	0%	103
14	Welding Trailer/Rig	2	385	75%	0%	101
15	Gensets	5	84	75%	0%	90
16	Tower Light Plant	4	11	75%	0%	93
17	Backup Alarm [2]	16	--	10%	0%	114
18	Pick-up trucks	10	400	75%	0%	106
19	Crew Bus	4	260	50%	0%	103
20	Diesel Hammer [3]	2	186	75%	0%	134
21	Vibro Hammer	2	--	75%	0%	116
22	Drilling Rig	4	--	25%	0%	114
23	SPUD Barge Crane	1	818	75%	0%	106
24	Tugboat	8	4000	75%	0%	107
25	Floating Crane Barge	1	898	75%	0%	117
26	Work boat	1	250	75%	0%	81
Transmission Line Construction						
Land clearing						
27	Chainsaw	1	5	55%	0%	117
28	Feller Buncher	1	330	32%	0%	111
29	Skidder	1	193	64%	0%	109
30	Excavator	1	311	96%	0%	105
31	Dozer	1	303	32%	0%	108
32	Logging truck	1	630	9%	0%	117

NOTES:
[1] Sound power level represents each unit of equipment
[2] Additional tonality adjustment of +5 dB included in the model (Health Canada 2017)
[3] Additional impulsive adjustment of +12 dB included in the model (Health Canada 2017)
"—" Not applicable

The following assumptions are used in the construction noise model:

- FLNG facility will be constructed overseas; therefore, no construction activities associated with the facility were included
- FLNG facility feed gas pipeline construction is not included in this assessment
- The noise effect from the helicopter use for the three transmission line towers was not included in this assessment as the use of helicopter is expected to be temporary and short-term during the daytime only
- Construction activities are limited to daytime hours for a total duration of 10 hours per day
- Construction activities are expected to occur over a span of up to approximately four years
- Pilling activities are expected to occur for the construction of the strut mooring system and the small craft jetty
- Pilling activities are expected to occur for the construction of substation, warehouse, and security buildings at the onshore marine terminal
- No pilling is anticipated for the construction of the transmission line
- Decommissioning noise effects are the same or less than the construction phase based on usage of similar construction equipment, but with lesser quantities

7.2 OPERATION PHASE NOISE EMISSION

The operation phase noise model includes noise sources from the LNG processing facility, substation, and also noise from the LNG carriers and tugboats while travelling along the shipping route through the Principe Channel from Triple Islands to the Project Area. Noise emissions from operation of the transmission line are negligible. A detailed listing of equipment type, quantity, and PWL for the operation phase is presented in Table 9.

Table 9 Sound Power Level Summary of Operation Phase

ID	Equipment	Number of Units [1]	Sound Power Level (dBA)
1	Amine Cooler	4	105
2	Amine Regenerator Reflux Condenser	2	102
3	Amine Booster Pumps	2	101
4	Amine Circulation Pumps	2	101
5	Regenerator Reflux Pumps	2	103
6	Regen Compressors	2	98
7	Regen Gas Cooler	2	104
8	LNG Expander	1	97
9	Heavies Surge Cooler	1	104
10	Heavies Fractionator Reflux Pumps	2	94

Table 9 Sound Power Level Summary of Operation Phase

ID	Equipment	Number of Units [1]	Sound Power Level (dBA)
11	BOG Compressor	1	108
12	Offloading Compressor	1	110
13	BOG Interstage Cooler	2	105
14	Offloading Interstage Cooler	1	105
15	Offloading Discharge Cooler	1	105
16	Auxiliary Boiler	1	86
17	Process Condensate Pumps	1	97
18	Topsides Water Cooler	12	105
19	Hull Water Cooler	4	105
20	Topsides Water Pumps	1	97
21	Thermal Oxidizer Package	1	97
22	Refrigerant Compressor	2	107
23	Refrigerant Compressor	2	107
24	Refrigerant Interstage Pump	2	93
25	Refrigerant Compressor	2	93
26	Refrigerant Interstage Pump	2	93
27	Refrigerant Discharge Pump	2	93
28	Refrigerant Interstage Condenser (32 fans)	14	105
29	Refrigerant Interstage Condenser (32 fans)	16	105
30	Refrigerant Discharge Condenser (32 fans)	16	105
31	Refrigerant Discharge Condenser (32 fans)	16	105
32	Machinery space ventilation fan	1	108
33	Exhaust for welding space	1	91
34	Exhaust fan for Purifier room	1	103
35	Ballast Water Intake	1	98
36	Ballast Water Intake	1	98
37	Ballast Water Discharge	1	98
38	283 MVA Transformer	2	108
39	5 MVA Transformer	1	82
40	LNG Carrier Propulsion	1	109
41	LNG Carrier Idling	1	95
42	Harbor Tugboat (1715 kw) Propulsion	2	105
43	Harbor Tugboat (1715 kw) Idling	2	105
44	Shipping Route Assistance Tugboat (1268 kw) Propulsion	2	104

NOTE:
[1] Sound power level represents each unit of equipment

The following assumptions are used in the operation noise model:

- Modelled noise sources represent continuous normal operation during both daytime and nighttime
- All operating stationary equipment was assumed to run at 100% capacity. This is conservative as it can be expected that equipment will not operate at 100% capacity throughout the year. For example, during colder months cooling fan loads will be lower as not as much cooling will be required.
- Spare or stand-by equipment (e.g., backup power generator, spare pumps) that operate intermittently during upset or emergency conditions were not included in the noise model
- LNG carriers while travelling along the shipping route were assumed to be supported by two assistance tugboats. Assumed LNG carrier and assistance tugboat travelling speed is 8 knots or 14.8 km/hr. Total travelling time along the shipping route from Triple Islands to the Project Area is assumed to take 19 hours.
- To model the “worst-case” scenario associated with the noise from LNG carriers and assistance/harbor tugboats on a 24-hour basis, LNG carriers and assistance tugboats are assumed to be travelling along the shipping route for 19 hours and then LNG carriers spend an additional five hours at the marine terminal berthed, while being assisted by harbor tugboats for three hours during the daytime. To be conservative of the 19 hours travel along the channel nine hours are assumed to occur during the nighttime (2200 to 0700) with the remaining ten hours occurring during the daytime (0700 to 2200). Even though, loading of the LNG carrier is taking more than five hours, only five hours are included in the noise model to complete the worst-case 24-hour scenario. During loading, only the idling noise of the LNG carrier is present, which is quieter than the LNG propulsion noise during travelling, which is why the travelling noise has been assumed to occur during the nighttime to be conservative.

8.0 MODEL RESULTS

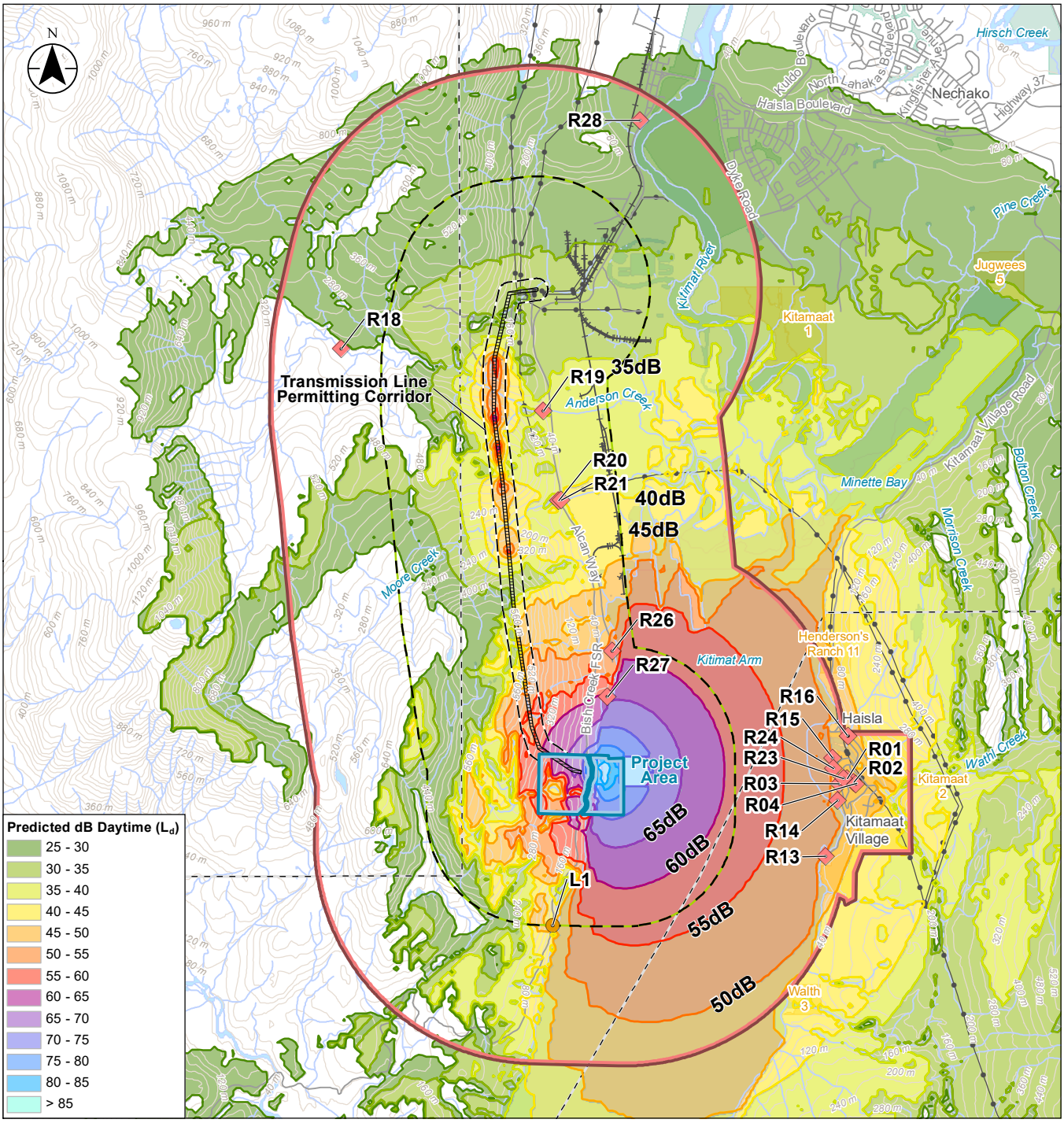
8.1 CONSTRUCTION

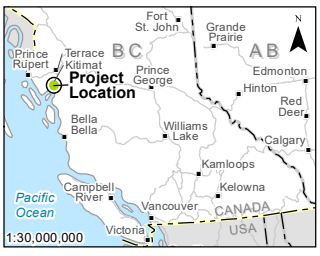
Modelled construction noise levels at the noise sensitive receptors are shown in Table 10 as daytime, nighttime, and day-night average sound levels. The modelled results are also shown in Figure 5.

Table 10 Construction Phase Sound Levels

Receptor ID	Description	Project Construction Daytime Sound Level, L_d (dBA)	Project Construction Nighttime Sound Level, L_n (dBA)	Project Construction Day-Night Sound Level, L_{dn} (dBA)
R01	Kitamaat Village childcare centre	48.9	--	46.9
R02	Kitamaat Village school	48.6	--	46.6
R03	Kitamaat Village church	49.5	--	47.5
R04	Kitamaat Village Health Centre	48.5	--	46.5
R05	Hartley Bay residence	--	--	--
R06	Gil Island	--	--	--
R07	Fin Island	--	--	--
R08	Otter Channel	--	--	--
R09	Anger Island	--	--	--
R10	Banks Island (North)	--	--	--
R11	McCauley Island	--	--	--
R12	Banks Island (South)	--	--	--
R13	Kitimaat Village residence 1	46.6	--	44.6
R14	Kitimaat Village residence 2	49.5	--	47.5
R15	Kitimaat Village residence 3	49.9	--	47.9
R16	Kitimaat Village Residence 4 (Haisla)	45.8	--	43.8
R17	Jesse Lake	--	--	--
R18	Anderson Creek 1	17.1	--	15.5
R19	Anderson Creek 2	35.9	--	33.9
R20	Moore Creek 1	29.6	--	27.6
R21	Moore Creek 2	30.1	--	28.1
R22	West Lake	--	--	--
R23	C'Imo'Ca Child Care Centre	49.2	--	47.2
R24	Haisla Recovery Centre	49.9	--	47.9
R25	Coste Island	--	--	--
R26	SW dockyard	52.1	--	50.1
R27	Half Moon Bay	61.0	--	59.0
R28	Kitimat Service Area	26.5	--	24.5

NOTE:
"--" Noise effects are negligible because there are no construction activities during nighttime period or because the receptor is located at far distance from the noise sources





Notes
1. Coordinate System: NAD 1983 UTM Zone 9N
2. Data Sources: DataBC, Government of British Columbia; Natural Resources Canada; Canadian Hydrographic Service

- Road
- Railway
- Transmission Line
- Topographic Contour (40 m)
- Watercourse
- Waterbody
- Reserve Land
- Local Greenspace
- District of Kitimat Municipal Boundary
- Project Area
- Transmission Line Right-of-Way
- Transmission Line Permitting Corridor
- Regional Assessment Area
- Local Assessment Area
- Cedar LNG Criteria Boundary (1.5 km)
- Noise Sensitive Receptor
- Assesment Location

0 0.5 1 1.5 2 2.5 3 km

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Stantec

CEDAR LNG

Project Location:
Kitimat,
British Columbia

Project Number 123221953
Prepared by WWU on 20211126
Discipline Review by SZABANI on 20211126
GIS Review by LTRUDELL on 20211126

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Cedar LNG Partners LP
Cedar LNG Project
Acoustics Technical Data Report

Figure No.
5

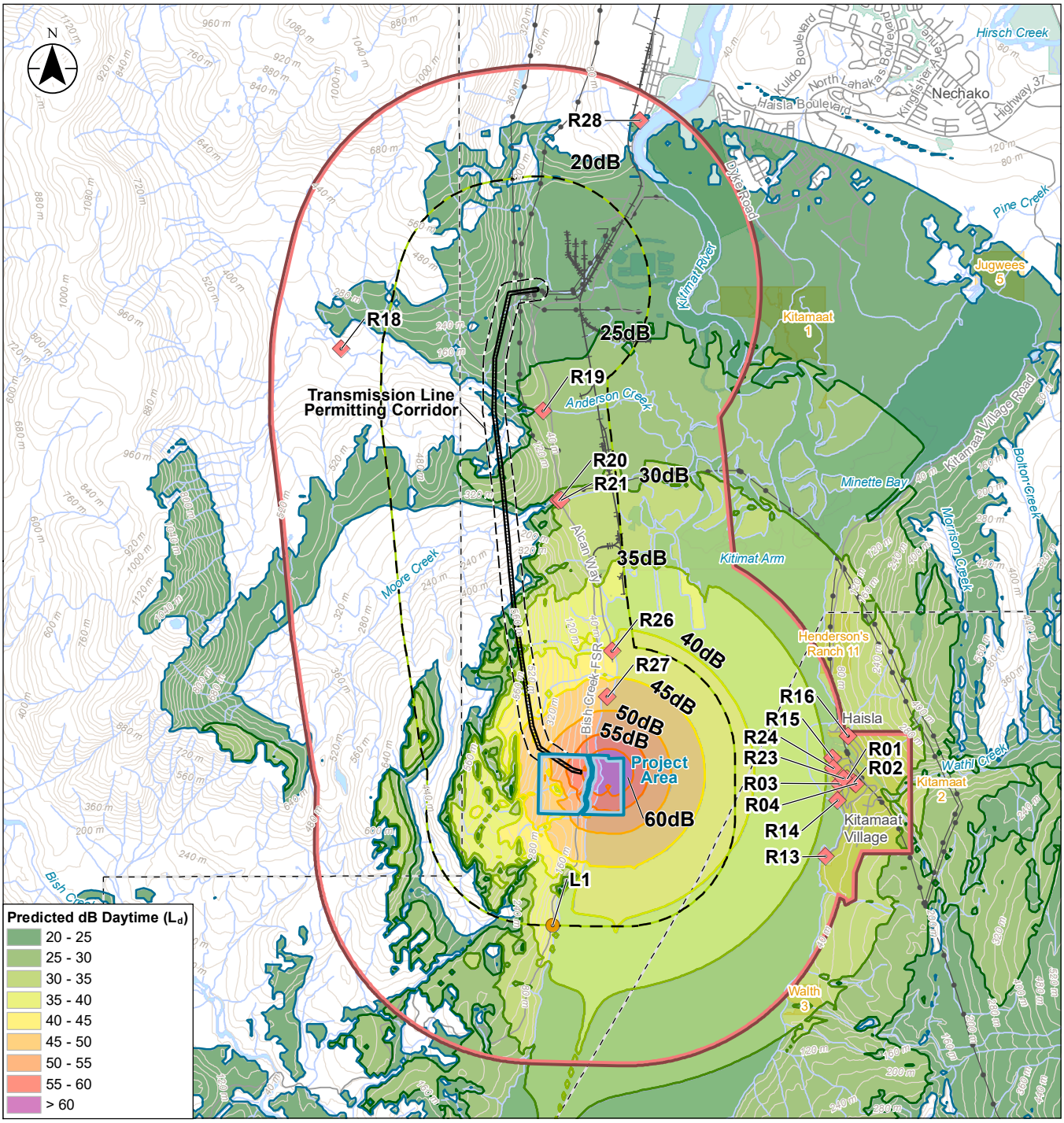
Title
Construction Phase Daytime (L_d) Predictive Noise Contour Map

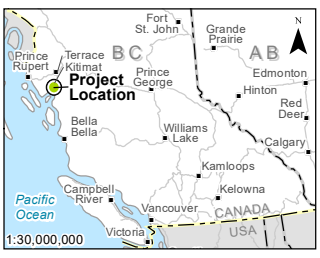
8.2 OPERATION

Modelled operation noise levels at the various noise sensitive receptors are shown in Table 11 as daytime, nighttime, and day-nighttime average sound levels. The average sound levels presented are based on operation noise from the Project Area but also from shipping activities. The modelled L_{max} values are based on the potential usage of the marine air horn of the LNG carrier while it is travelling along the shipping route at a location nearest to the noise sensitive receptors. Figure 6 and Figure 7 show the modelled daytime and nighttime sound levels graphically for the operation phase at the marine terminal area, respectively. Figure 8 and Figure 9 show the modelled daytime and nighttime sound levels graphically for the marine shipping route.

Table 11 Operation Phase Sound Level

Receptor ID	Description	Project Operation Daytime Sound Level, L_d (dBA)	Project Operation Nighttime Sound Level, L_n (dBA)	Project Operation Day-Night Sound Level, L_{dn} (dBA)
R01	Kitamaat Village childcare centre	33.8	33.7	40.1
R02	Kitamaat Village school	33.4	33.4	39.8
R03	Kitamaat Village church	34.2	34.2	40.6
R04	Kitamaat Village Health Centre	33.3	33.3	39.7
R05	Hartley Bay residence	9.6	11.3	17.5
R06	Gil Island	16.8	18.6	24.8
R07	Fin Island	20.6	22.4	28.6
R08	Otter Channel	15.3	17.1	23.3
R09	Anger Island	15.0	16.8	23.0
R10	Banks Island (North)	13.4	15.2	21.4
R11	McCauley Island	12.3	14.1	20.3
R12	Banks Island (South)	14.1	15.8	22.0
R13	Kitimaat Village residence 1	34.1	34.1	40.5
R14	Kitimaat Village residence 2	34.2	34.2	40.6
R15	Kitimaat Village residence 3	34.6	34.5	40.9
R16	Kitimaat Village Residence 4 (Haisla)	33.6	33.5	39.9
R17	Jesse Lake	12.3	14.0	20.2
R18	Anderson Creek 1	2.4	2.3	8.7
R19	Anderson Creek 2	26.7	26.6	33.0
R20	Moore Creek 1	25.4	25.3	31.7
R21	Moore Creek 2	30.5	30.5	36.9
R22	West Lake	11.3	13.1	19.3
R23	C'Imo'Ca Child Care Centre	34.0	34.0	40.4
R24	Haisla Recovery Centre	34.5	34.5	40.9
R25	Coste Island	12.8	14.5	20.7
R26	SW dockyard	40.4	40.4	46.8
R27	Half Moon Bay	47.7	47.7	54.1
R28	Kitimat Service Area	20.0	20.0	26.4
L1	Assessment Location	37.4	37.4	43.8





Notes
1. Coordinate System: NAD 1983 UTM Zone 9N
2. Data Sources: DataBC, Government of British Columbia; Natural Resources Canada; Canadian Hydrographic Service

- Road
- Railway
- Transmission Line
- Topographic Contour (40 m)
- Watercourse
- Waterbody
- Reserve Land
- Local Greenspace
- District of Kitimat Municipal Boundary
- Project Area
- Transmission Line Right-of-Way
- Transmission Line Permitting Corridor
- Regional Assessment Area
- Local Assessment Area
- Cedar LNG Criteria Boundary (1.5 km)
- Noise Sensitive Receptor
- Assesment Location

0 0.5 1 1.5 2 2.5 3 km

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Stantec

CEDAR LNG

Project Location:
Kitimat,
British Columbia

Project Number 123221953
Prepared by WWU on 20211126
Discipline Review by WPRYSTAY on 20211126
GIS Review by LTRUDELL on 20211126

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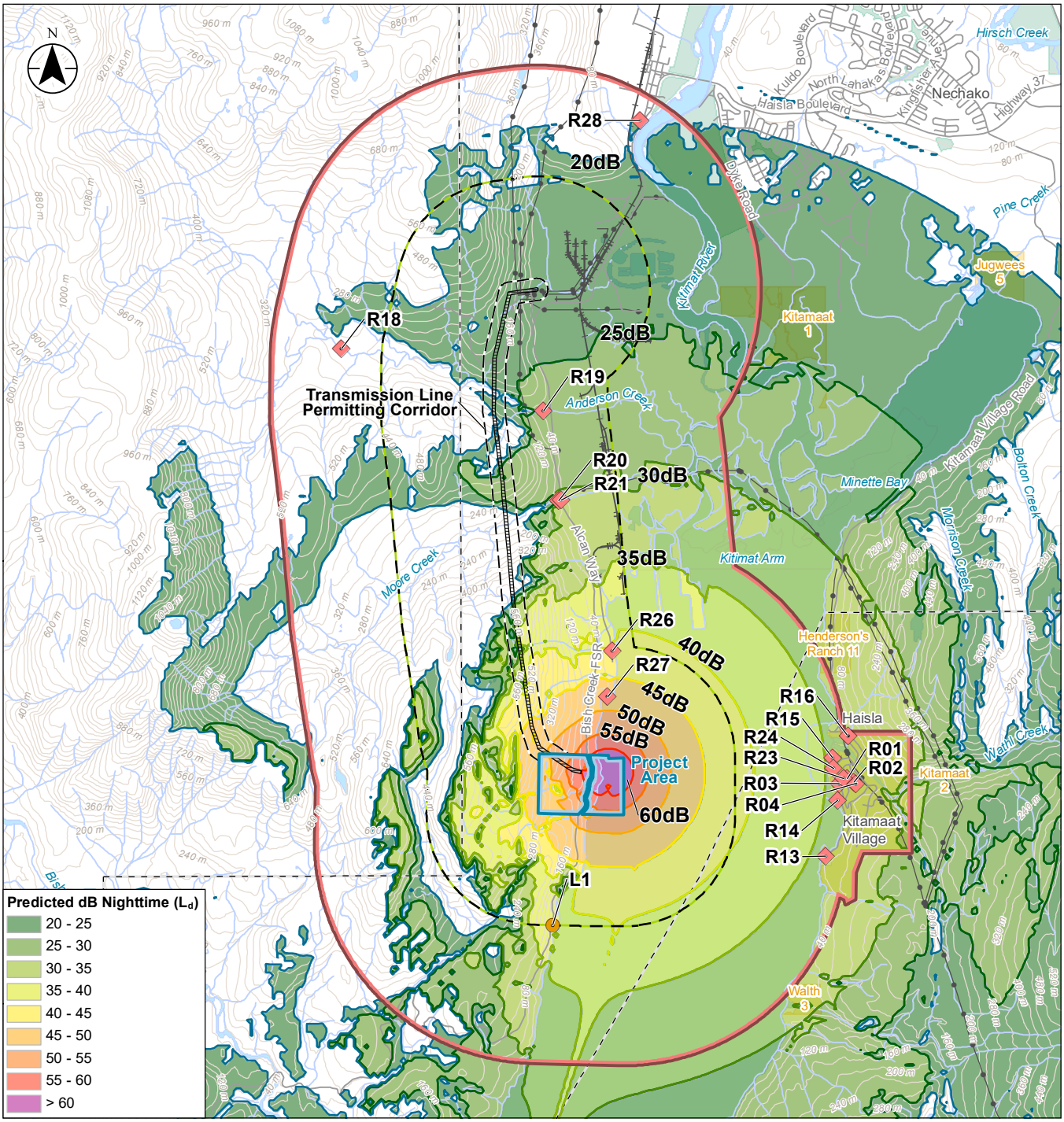
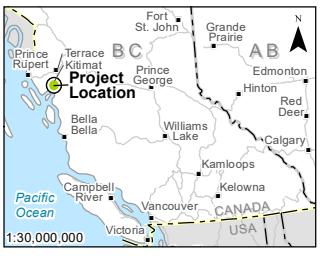
Figure No.
6

Title
Operation Phase Predictive Daytime (L_d) Noise Contour Map





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- Road
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- Cedar LNG Criteria Boundary (1.5 km)
- Noise Sensitive Receptor
- Assesment Location

0 0.5 1 1.5 2 2.5 3 km

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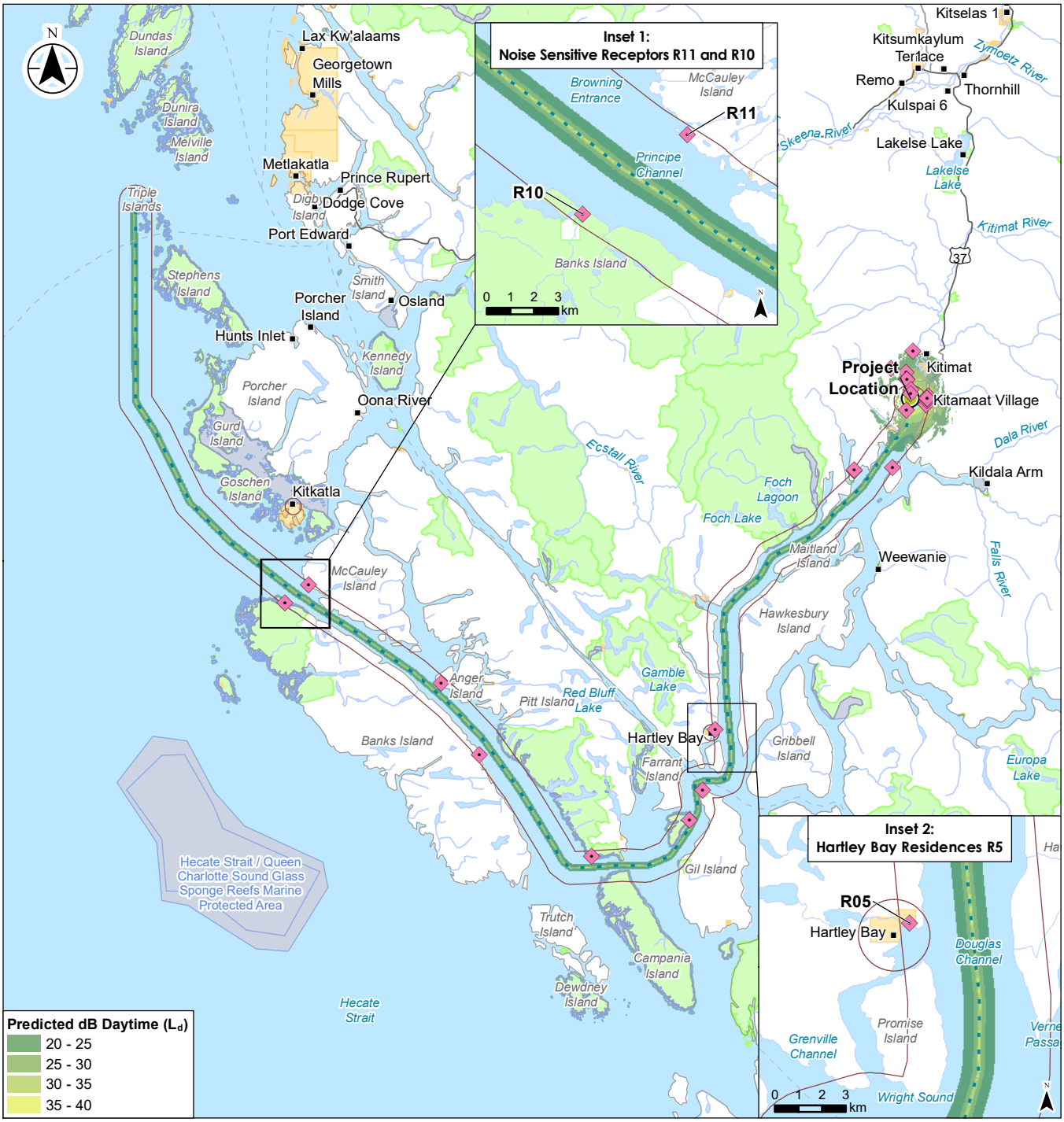
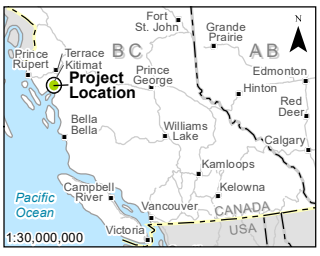
Cedar LNG Project
Acoustics Technical Data Report

Figure No.
7

Title
Operation Phase Predictive Nighttime (L_n) Noise Contour Map





Highway
Road
Ferry Route
Watercourse
Waterbody
Reserve Land
Park or Protected Area
Marine Park or Protected Area

Project Location
Marine Shipping Route (Approximate Location)
Noise Sensitive Receptor

Acoustic (Shipping)

Local and Regional Assessment Area

0 10 20 30 40 50 km

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Notes
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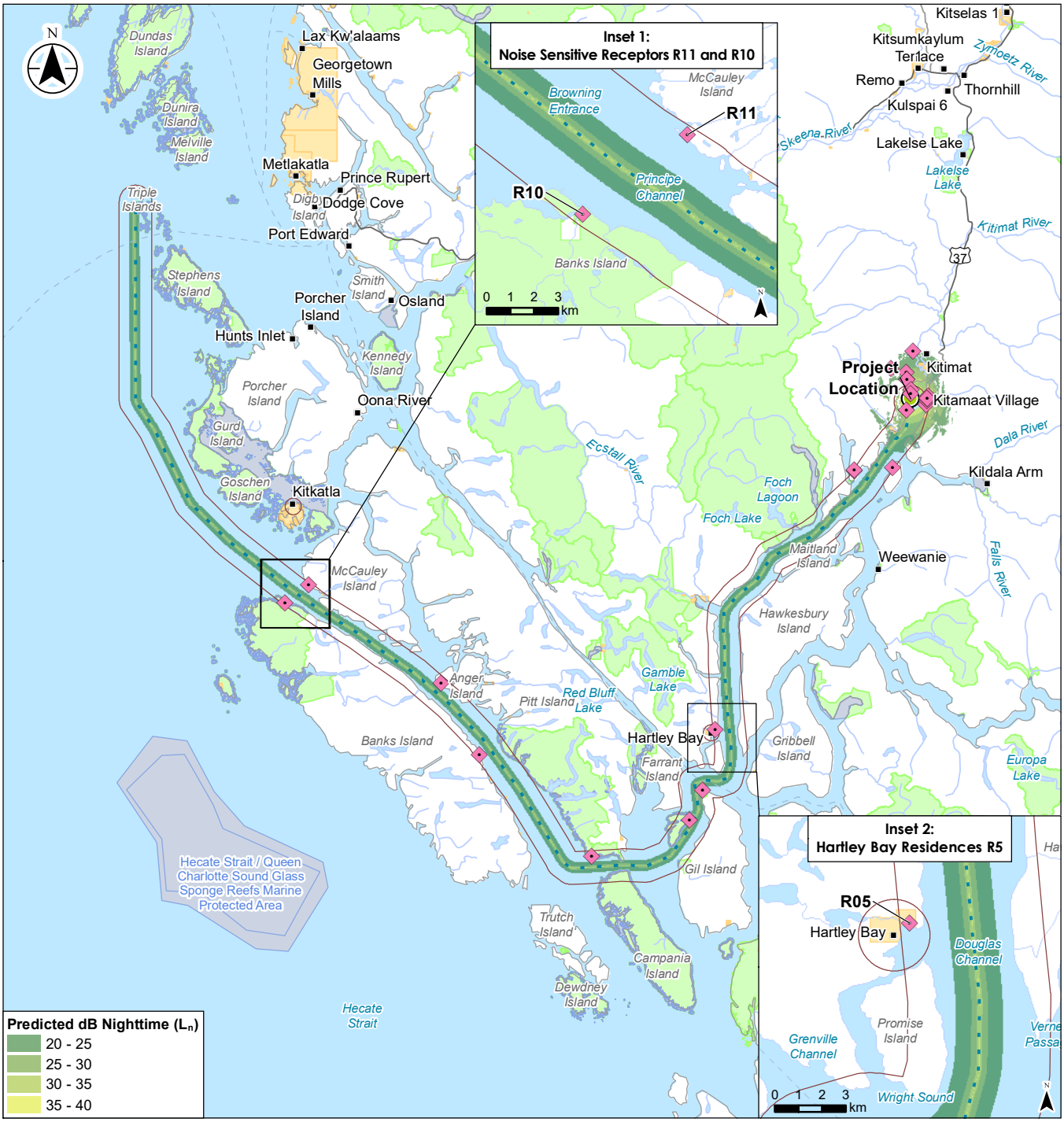
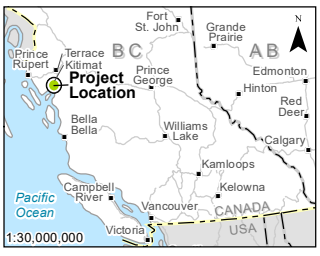
Figure No.
8

Title
Operation Phase Predictive Daytime (L_d)
Marine Shipping Route Noise Contour Map





Highway
Road
Ferry Route
Watercourse
Waterbody
Reserve Land
Park or Protected Area
Marine Park or Protected Area

Project Location
Marine Shipping Route (Approximate Location)
Noise Sensitive Receptor

Acoustic (Shipping)

Local and Regional Assessment Area

0 10 20 30 40 50 km

1:1,100,000 (at original document size of 8.5x11)

Notes
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2. Data Sources: DataBC, Government of British Columbia; Natural Resources Canada; Canadian Hydrographic Service

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Figure No.
9

Title
Operation Phase Predictive Nighttime (L_n)
Marine Shipping Route Noise Contour Map

9.0 COMPLIANCE SUMMARY

9.1 COMPLIANCE WITH OGC NOISE LIMITS

Table 12 summarizes the modelling results at the residential dwellings and at the 1.5 km criteria assessment location against the PSL as per the OGC noise guideline (OGC 2021). Table 9 summarizes the project-only noise levels from the facility and the shipping activities. The project-only levels are then added to the baseline levels (which include the predicted noise levels from the planned LNG Canada Export Terminal) to obtain the cumulative sound levels. The cumulative sound levels are compared against the PSL levels to assess compliance. The results indicate that predictive noise levels are below the PSL limits.

Table 12 Compliance Assessment - OGC PSL

Receptor ID	Project Case (Facility) Sound Level		Baseline Sound Level		Cumulative Sound Level		Site-Specific Permissible Sound Level[2]		Meets PSLs?
	Daytime (dBA)	Nighttime (dBA)	Daytime (dBA)	Nighttime (dBA)	Daytime (dBA)	Nighttime (dBA)	Daytime (dBA)	Nighttime (dBA)	
R01	--	--	--	--	--	--	--	--	--
R02	--	--	--	--	--	--	--	--	--
R03	--	--	--	--	--	--	--	--	--
R04	--	--	--	--	--	--	--	--	--
R05	9.6	11.3	48.0	38.0	48.0	38.0	53	43	Yes
R06	--	--	--	--	--	--	--	--	--
R07	--	--	--	--	--	--	--	--	--
R08	--	--	--	--	--	--	--	--	--
R09	--	--	--	--	--	--	--	--	--
R10	--	--	--	--	--	--	--	--	--
R11	--	--	--	--	--	--	--	--	--
R12	--	--	--	--	--	--	--	--	--
R13	34.1	34.1	45.1	35.7	45.4	38.0	50	40	Yes
R14	34.2	34.2	48.0	38.4	48.2	39.8	53	43	Yes
R15	34.6	34.5	48.1	38.9	48.3	40.3	53	43	Yes
R16	33.6	33.5	48.1	38.6	48.2	39.8	53	43	Yes
R17	--	--	--	--	--	--	--	--	--
R18	--	--	--	--	--	--	--	--	--
R19	--	--	--	--	--	--	--	--	--
R20	--	--	--	--	--	--	--	--	--
R21	--	--	--	--	--	--	--	--	--

Table 12 Compliance Assessment - OGC PSL

Receptor ID	Project Case (Facility) Sound Level		Baseline Sound Level		Cumulative Sound Level		Site-Specific Permissible Sound Level[2]		Meets PSLs?
	Daytime (dBA)	Nighttime (dBA)	Daytime (dBA)	Nighttime (dBA)	Daytime (dBA)	Nighttime (dBA)	Daytime (dBA)	Nighttime (dBA)	
R22	--	--	--	--	--	--	--	--	--
R23	--	--	--	--	--	--	--	--	--
R24	--	--	--	--	--	--	--	--	--
R25	--	--	--	--	--	--	--	--	--
R26	--	--	--	--	--	--	--	--	--
R27	--	--	--	--	--	--	--	--	--
R28	--	--	--	--	--	--	--	--	--
L1	37.4	37.4	45.0	35.5	45.7	39.6	50	40	Yes

NOTE:
"—" These receptors are not considered residential noise sensitive receptors as per OGC noise guideline, hence they are not assessed against a PSL.

Table 13 shows the predicted day and night sound levels in dBC and dBA for the residential noise sensitive receptors only. This table also shows the LFN assessment results by assessing the difference between the dBC and dBA levels. The difference between the C-weighted and A-weighted sound levels is greater than 20 dB for receptor R5 (which is further assessed in Table 14). Low frequency tonality at other residential locations from the Project is below 20 dB and therefore not expected.

Table 13 Compliance Assessment - OGC LFN

Receptor ID	Project Case Sound Level		Project Case Sound Level		Difference dBC-dBA		Above 20 dB?
	Daytime (dBA)	Nighttime (dBA)	Daytime (dBC)	Nighttime (dBC)	Daytime (dBA)	Nighttime (dBA)	
R05	9.6	11.3	40.5	42.2	30.9	30.9	Yes
R13	34.1	34.1	52.4	52.2	18.3	18.1	No
R14	34.2	34.2	52.4	52.2	18.2	18	No
R15	34.6	34.5	52.5	52.3	17.9	17.8	No
R16	33.6	33.5	52.0	51.7	18.4	18.2	No

At receptor R05, the difference between C-weighted and A-weighed sound levels is greater than 20 dB. Under the OGC noise guideline, a presence of low frequency tones is required for there to be an LFN issue. However, information on low frequency tonality is not available from the manufacturer of the noise sources included in the operation phase. As an alternative guidance for the LFN issue for receptors with dBC minus dBA value greater than 20 dBA with limited information on low frequency tonality, Health Canada noise guidance recommends that the energy sum of the linear sound levels in the 16, 31.5 and 63 Hz octave bands at a receptor location should not exceed 70 dBL.

Table 14 summarizes the predicted octave band sound level at 16, 31.5, and 63 Hz for R5 during the operation phase. Assessment of the 16 Hz sound pressure level is not possible because no sound power data is available for the proposed equipment and this octave band is outside of the ISO 9613-2 calculation standard; however, Stantec's professional experience suggests that the 16 Hz octave band sound pressure level will be similar to that of the 31.5 Hz octave band. The sound levels at 16 Hz octave band were assumed to be the same as the sound levels at 31.5 Hz octave band. Potential for LFN noise effect is low at R5 because the predicted sum of the sound level results are below the Health Canada target of 70 dBL.

Table 14 Sound Level at 16, 31, and 63 Hz Octave Band Frequency

Receptor ID	Description	Operation Phase Predicted Nighttime Sound Level, L_d (dB)				Operation Phase Predicted Nighttime Sound Level, L_n (dB)			
		16 Hz	31.5 Hz	125 Hz	Sum of 16 Hz, 31.5 Hz, and 125 Hz	16 Hz	31.5 Hz	125 Hz	Sum of 16 Hz, 31.5 Hz, and 125 Hz
R05	Hartley Bay residence	42.6	42.6	33.9	45.9	44.3	44.3	35.6	47.6

Therefore, this assessment concludes that a LFN effect, based on the OGC noise guideline and Health Canada noise guidance criteria, is not expected for the Project at all identified residential noise sensitive receptors.

9.2 COMPLIANCE WITH HEALTH CANADA NOISE GUIDANCE

9.2.1 Change in Percent Highly Annoyed and Mitigated Noise Level

For the construction and operation phases, change in %HA associated with the Project is compared with the threshold of 6.5% as advised by Health Canada. The change in %HA at a receptor is based on the difference between the baseline %HA and total (project plus baseline) %HA (Health Canada 2017).

The %HA is determined from the adjusted baseline sound level or the adjusted total sound level, based on an equation from the Health Canada guidance. The adjusted baseline sound level and adjusted total sound level is calculated by adding the 10 dB “peace and quiet” adjustment to the baseline sound level (Section 4.3.1) and total sound level for applicable receptors. The total sound level is the combined noise effect of the baseline sound level and project sound level (see Sections 8.1 and 8.2).

The changes in %HA associated with the project construction phase are summarized in Table 15. The predicted changes in %HA are compared to the 6.5% target as stated in the Health Canada noise guidance. The change in %HA at all receptors is below the 6.5% target for the construction phase and hence indicate compliance with the Health Canada guidance.

Table 15 Construction Phase – Change in %HA

Receptor ID	Description	Baseline		Project Construction L_{dn} (dBA)	Total (Baseline and Project)		Change in %HA (Between Total and Baseline)
		$L_{dn, adjusted}$ (dBA)	%HA		$L_{dn, adjusted}$ (dBA)	%HA	
R01	Kitamaat Village childcare centre	46.9	1.5	46.9	49.9	2.2	0.7
R02	Kitamaat Village school	46.9	1.5	46.6	49.7	2.1	0.7
R03	Kitamaat Village church	46.9	1.5	47.5	50.2	2.2	0.8
R04	Kitamaat Village Health Centre	46.9	1.5	46.5	49.7	2.1	0.6
R05	Hartley Bay residence	48.0	1.7	--	48.0	1.7	0.0
R06[1]	Gil Island	55.1	4.2	--	55.1	4.2	0.0
R07[1]	Fin Island	55.1	4.2	--	55.1	4.2	0.0
R08[1]	Otter Channel	55.0	4.2	--	55.0	4.2	0.0
R09[1]	Anger Island	55.0	4.2	--	55.0	4.2	0.0
R10[1]	Banks Island (North)	55.0	4.2	--	55.0	4.2	0.0

Table 15 Construction Phase – Change in %HA

Receptor ID	Description	Baseline		Project Construction L_{dn} (dBA)	Total (Baseline and Project)		Change in %HA (Between Total and Baseline)
		$L_{dn, adjusted}$ (dBA)	%HA		$L_{dn, adjusted}$ (dBA)	%HA	
R11	McCauley Island	50.5	2.3	--	50.5	2.3	0.0
R12[1]	Banks Island (South)	55.0	4.2	--	55.0	4.2	0.0
R13[1]	Kitimaat Village residence 1	55.3	4.3	44.6	55.7	6.0	1.7
R14	Kitimaat Village residence 2	46.9	1.5	47.5	50.2	2.2	0.8
R15	Kitimaat Village residence 3	47.2	1.5	47.9	50.5	2.3	0.8
R16	Kitimaat Village Residence 4 (Haisla)	47.0	1.5	43.8	48.7	1.8	0.4
R17[1]	Jesse Lake	55.0	4.2	--	55.0	4.2	0.0
R18[1]	Anderson Creek 1	55.3	4.3	15.5	55.3	4.3	0.0
R19	Anderson Creek 2	48.7	1.9	33.9	48.9	1.9	0.0
R20	Moore Creek 1	47.4	1.6	27.6	47.5	1.6	0.0
R21	Moore Creek 2	47.5	1.6	28.1	47.6	1.6	0.0
R22[1]	West Lake	55.0	4.2	--	55.0	4.2	0.0
R23	C'Imo'Ca Child Care Centre	46.9	1.5	47.2	50.0	2.2	0.7
R24	Haisla Recovery Centre	47.1	1.5	47.9	50.5	2.3	0.8
R25[1]	Coste Island	55.1	4.2	--	55.1	4.2	0.0
R26	SW dockyard	48.8	1.9	50.1	52.5	3.0	1.1
R27	Half Moon Bay	47.1	1.5	59.0	59.2	7.0	5.5
R28	Kitimat Service Area	45.5	1.2	24.5	45.6	1.2	0.0

NOTE:
[1] The + 10 dB “peace and quiet” adjustment is included

The changes in %HA associated with the project operation phase are summarized in Table 16. The changes in %HA are compared to the target for change in %HA of 6.5% advised in the Health Canada noise guidance. The change in %HA at all receptors is below the 6.5% target for the operation phase and hence indicate compliance with the Health Canada guidance.

Table 16 Operation Phase - Change in %HA

Receptor ID	Description	Baseline		Project L_{dn} (dBA)	Total (Baseline and Project)		Change in %HA (Between Total and Baseline)
		$L_{dn, adjusted}$ (dBA)	%HA		$L_{dn, adjusted}$ (dBA)	%HA	
R01	Kitamaat Village childcare centre	46.9	1.5	40.1	47.7	1.6	0.2
R02	Kitamaat Village school	46.9	1.5	39.8	47.7	1.6	0.2
R03	Kitamaat Village church	46.9	1.5	40.6	47.8	1.7	0.2
R04	Kitamaat Village Health Centre	46.9	1.5	39.7	47.6	1.6	0.2
R05	Hartley Bay residence	48.0	1.7	17.5	48.0	1.7	0.0
R06[1]	Gil Island	55.1	4.2	24.8	55.1	4.2	0.0
R07[1]	Fin Island	55.1	4.2	28.6	55.1	4.2	0.1
R08[1]	Otter Channel	55.0	4.2	23.3	55.0	4.2	0.0
R09[1]	Anger Island	55.0	4.2	23.0	55.0	4.2	0.0
R10[1]	Banks Island (North)	55.0	4.2	21.4	55.0	4.2	0.0
R11	McCauley Island	50.5	2.3	20.3	50.5	2.3	0.0
R12[1]	Banks Island (South)	55.0	4.2	22.0	55.0	4.2	0.0
R13[1]	Kitimaat Village residence 1	55.3	4.3	40.5	55.5	5.0	0.7
R14	Kitimaat Village residence 2	46.9	1.5	40.6	47.8	1.6	0.2
R15	Kitimaat Village residence 3	47.2	1.5	40.9	48.1	1.7	0.2
R16	Kitimaat Village Residence 4 (Haisla)	47.0	1.5	39.9	47.8	1.6	0.2
R17[1]	Jesse Lake	55.0	4.2	20.2	55.0	4.2	0.0
R18[1]	Anderson Creek 1	55.3	4.3	8.7	55.3	4.3	0.0
R19	Anderson Creek 2	48.7	1.9	33.0	48.8	1.9	0.0
R20	Moore Creek 1	47.4	1.6	31.7	47.5	1.6	0.0
R21	Moore Creek 2	47.5	1.6	36.9	47.9	1.7	0.1
R22[1]	West Lake	55.0	4.2	19.3	55.0	4.2	0.0
R23	C'Imo'Ca Child Care Centre	46.9	1.5	40.4	47.8	1.6	0.2

Table 16 Operation Phase - Change in %HA

Receptor ID	Description	Baseline		Project L_{dn} (dBA)	Total (Baseline and Project)		Change in %HA (Between Total and Baseline)
		$L_{dn, adjusted}$ (dBA)	%HA		$L_{dn, adjusted}$ (dBA)	%HA	
R24	Haisla Recovery Centre	47.1	1.5	40.9	48.1	1.7	0.2
R25	Coste Island	55.1	4.2	20.7	55.1	4.2	0.0
R26	SW dockyard	48.8	1.9	46.8	50.9	2.5	0.6
R27	Half Moon Bay	47.1	1.5	54.1	54.9	4.1	2.6
R28	Kitimat Service Area	45.5	1.2	26.4	45.6	1.2	0.0

NOTE:
[1] The + 10 dB “peace and quiet” adjustment is included

9.2.2 Sleep Disturbance

Table 17 shows the sleep disturbance assessment results based on the Health Canada noise guidance recommendations. The results included the L_{max} values based on the marine air horn on the LNG carriers during shipping activities and the L_n from facility continuous operation during the nighttime. The results indicate that all residential receptors are below the outdoor threshold of 60 dBA L_{max} and 45 dBA L_n.

Note that construction (and decommissioning) activities are not anticipated during the nighttime, so a sleep disturbance assessment has not been completed for the construction phase.

Table 17 Operation Phase Sound Level

	Marine Horn - Sleep Disturbance[1]		Facility Operation - Sleep Disturbance[1]	
Receptor ID	**L_{max}**	**L_{max} Exceeds 60 dBA**	**Nighttime L_n Outdoor[1] (dBA)**	**L_n Exceeds 45 dBA**
R01	--	--	--	--
R02	--	--	--	--
R03	--	--	--	--
R04	--	--	--	--
R05	51.3	No	11.3	No
R06	--	--	--	--
R07	--	--	--	--
R08	--	--	--	--
R09	--	--	--	--
R10	--	--	--	--
R11	--	--	--	--
R12	--	--	--	--
R13	56.6	No	34.1	No
R14	59.1	No	34.2	No
R15	58.7	No	34.5	No
R16	54.3	No	33.5	No
R17	--	--	--	--
R18	--	--	--	--
R19	--	--	--	--
R20	--	--	--	--
R21	--	--	--	--
R22	--	--	--	--
R23	--	--	--	--
R24	--	--	--	--
R25	--	--	--	--
R26	--	--	--	--
R27	--	--	--	--
R28	--	--	--	--

NOTES:

"--" Location indicates the receptor is not a residential noise sensitive receptor

[1] Continuous nighttime and daytime noise level during the operation phase only assessed where sleeping may occur

10.0 SUMMARY

The noise assessment focused on the potential project noise effects during the construction/ decommissioning and operation phases. Sound power levels were calculated for the Project based on information provided by Cedar, equipment information, published literature and Stantec's database. Noise models were generated to predict the noise effects of construction/decommissioning and the operation case at identified residential noise sensitive receptors (i.e., dwellings).

The cumulative sound levels were found to be below the PSLs at all identified residential dwellings and at the 1.5 km criteria boundary (1.5 km from the LNG Canada Export Terminal and Cedar LNG Project boundary). Cumulative sound levels included noise effects of the Project, ambient sound levels, and the LNG Canada Export Terminal. In addition, no low frequency noise concerns for the Project are anticipated at the identified residential noise sensitive receptors.

Community annoyance was assessed for all noise sensitive receptors. The potential noise effects of project construction and operation activities are predicted to comply with the Health Canada change in %HA threshold for all noise sensitive receptors. Furthermore, sleep disturbance noise effect was assessed for residential noise sensitive receptors during the nighttime period for operation activities. Project operation activities were predicted to comply with the sleep disturbance thresholds during the nighttime period at the residential noise sensitive receptors. No construction activities are expected during the nighttime period and hence no sleep disturbance assessment was completed for the construction phase.

11.0 REFERENCES

Bies, D.A. and C.H. Hansen. 2003. Engineering Noise Control Theory and Practice. Third Edition.

Crocker, Malcolm J. 2007. Handbook of Noise and Vibration Control. John Wiley & Sons, Inc.

DataKustik. 2019. DataKustik GmbH Cadna/A Computer Aided Noise Abatement (CadnaA) Model, Version 2019 MR2 (build:173.4950), Munich, Germany.

DEFRA (Department for Environment Food and Rural Affairs). 2005. Update of Noise Database for Prediction of Noise on Construction and Open Sites. United Kingdom. 2005

District of Kitimat. 2021. Complete Kitimat Municipal Code. Available online at: https://www.kitimat.ca/en/municipal-hall/bylaws.aspx#Kitimat-Municipal-Code. Accessed on: July 2021.

FTA (United States Federal Transit Administration). 2018. Transit Noise and Vibration Impact Assessment Manual (FTA Report No. 0123). Prepared by John A. Volpe National Transportation Systems Center. September 2018.

Government of British Columbia. 2014. Liquefied Natural Gas Facility Regulation. *Oil and Gas Activities Act*. Last amended March 4, 2021. Available online at: https://www.bclaws.gov.BC.ca/civix/document/id/complete/statreg/146_2014. Accessed on: June 2021.

Health Canada. 2017. Evaluating Human Health Impacts in Environmental Assessment: Noise, published by Health Canada. January 2017.

ISO (International Organization for Standardization). 1993. International Standard ISO 9613-1, Acoustics – Attenuation of Sound during Propagation Outdoors. Part 1: Calculation of Absorption of Sound by the Atmosphere. Geneva, Switzerland.

ISO. 1996. ISO 9613, 9613-2:1996, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation.

LNG Canada. 2014. Environmental Assessment of the LNG Canada Export Terminal. Acoustic Environmental Technical Data Report. October 2014. Available online at: https://projects.eao.gov.BC.ca/api/public/document/5886905fe036fb0105768ab7/download/Acoustic%20Environment%20Technical%20Data%20Report.pdf. Accessed: July 2021.

NRCan (Natural Resources Canada). 2013. Canadian Digital Elevation Model Product Specifications, Edition 1.1., from Natural Resources Canada (NRCan), Open Government, Canadian Digital Elevation Model, 1945-2011. Available at: https://ftp.maps.canada.ca/pub/nrcan_rncan/elevation/cdem_mnec/doc/CDEM_product_specs.pdf.

OGC (British Columbia Oil and Gas Commission). 2021. British Columbia Noise Control Best Practices Guideline. Version 2.2. July 2021.

OGC. 2014. Liquefied Natural Gas Facility Permit Application and Operations Manual. Available online at: https://www.bcogc.ca/energy-professionals/application-documentation/lng-application-and-operations-manual/. Accessed on: June 2021.

WHO (World Health Organization). 1999. Guidelines for Community Noise. Berglund, B., Lindvall, T. and Schwela, D.H (Eds.). Available online at: www.who.int/docstore/peh/noise/guidelines2.html.