Appendix G
Acoustic Environment

This Appendix G is organized as follows:

- Section G.1 provides descriptions of acoustical concepts, technical term and definitions used in the assessment
- Section G.2 shows the acoustic modelling parameters used
- Section G.3 presents the mitigation measures
- Section G.4 shows the key assumptions for modelling noise emissions during construction phase
- Section G.5 lists the equipment (and their sound power level) during construction of each compressor station
- Section G.6 presents the equipment (and their sound power level) during pipeline construction
- Section G.7 shows the key assumptions for modelling noise emissions during operation phase
- Section G.8 presents the noise sources included in the acoustic models developed for the compressor stations

G.1 NOISE TERMINOLOGY

Airborne Sound: Sound that reaches the point of interest by propagation through air.

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 subject to this directive, transportation sources, animals, and nature. Ambient noise is the same as background sound level.

Ambient Sound Level (ASL): The ASL consists of all noise in the area that is not related to regulated facilities. This noise includes sound from other non-regulated industrial facilities, transportation sources, animals and nature. The ASL does not include any energy-related industrial component and must be measured without it. The ASL can be measured when the sound level in an area is not felt to be represented by the BSLs. The ASL must be measured under representative conditions. As with comprehensive sound levels, representative conditions do not constitute absolute worst-case conditions (i.e., the quietest day in this case) but conditions that portray typical conditions for the area.

Attenuation: The reduction of sound intensity by various means (e.g., air, barrier, porous materials, silencers, enclosures).

Background Sound Level (i.e., Baseline): It includes noise from all sources other than the sound of interest (i.e., sound other than that being measured, for example, sound from other industrial noise not being measured, transportation sources, animals, and natures sound).

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.

Basic Sound Level (BSL): The A-weighted L_{eq} sound level commonly observed to occur in the designated land use categories with industrial presence. The BSL is assumed to be 5 dBA above the ASL and is set out in Table 1 of BC Noise Control Best Practices Guideline (BC OGC 2009).

Category: A classification of a dwelling unit in relation to transportation routes used to arrive at a BSL.

Class A Adjustment: Consists of the sum of adjustments that account for the adjustment seasonal nature of the noise source, absence of both tonal and impulse-impact components, and the actual ASL in an area. It cannot exceed +10 dBA. The Class A adjustment is added to the BSL, the daytime adjustment, and the Class B adjustment to arrive at a permissible sound level.

Class B Adjustment: An adjustment based on the duration of a noisy activity that recognizes that additional noise can be tolerated if it is known that the duration will be limited. An adjustment of B1, B2, B3, or B4 may be selected as applicable.

Comprehensive Sound Level (CSL): The sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The CSL does include industrial components and must be measured with them, but it should exclude abnormal noise events.

Daytime: Defined as the hours from 07:00 to 22:00.

Daytime Adjustment: An adjustment that allows a 10 dBA increase because daytime sound levels are generally about 10 dBA higher than nighttime values.

dB – Decibel: The logarithmic units associated with sound pressure level, sound power level, or acceleration level. See sound pressure level, for example.

dBA – Decibel, A-Weighted: The logarithmic units associated with a sound pressure level, where the sound pressure signal has been filtered using a frequency weighting that mimics the response of the human ear to quiet sound levels. The resultant sound pressure level is therefore representative of the subjective response of the human ear. 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 signal has been filtered using a frequency weighting that mimics the response of the human ear to loud sound levels. 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 SPL_1, SPL_2 … SPL_n) is done as follows:

$$SPL_1 + SPL_2 + \ldots SPL_n = 10 \log \left(10^{(SPL_1/10)} + 10^{(SPL_2/10)} + \ldots + 10^{(SPL_n/10)}\right)$$

As an example:

50 dB + 50 dB = 53 dB

50 dB + 47 dB = 52 dB

50 dB + 40 dB = 50 dB

Directivity Factor (Q) (also, Directional or Directionality Factor): A factor mathematically related to Directivity Index, used in calculating propagated sound levels to account for the effect of reflecting surfaces near to the source. For example, for a source in free space where the sound is radiating spherically, Q = 1. For a source located on or very near to a surface (such as the ground, a wall, rooftop), where the sound is radiating hemispherically, Q = 2. This accounts for the additional sound energy reflecting off the surface, and translates into a +3 dB addition.

Dwelling Unit: Any permanently or seasonally occupied residence with the exception of an employee or worker residence, dormitory, or construction camp located within an industrial project boundary. Trailer parks and campgrounds may qualify as a dwelling unit if it can be demonstrated that they are in regular and consistent use during the applicable season.

Dwelling Unit (most affected): The nearest dwelling unit may not necessarily be the one most adversely affected because of factors such as topography or anthropogenic features. For example, the nearest dwelling unit to a facility may be located behind an intervening ridge, while a more distant dwelling unit may be in direct line of sight with the facility. Care must be taken in determining the most affected dwelling unit.

Emergency: An unplanned event requiring immediate action to prevent loss of life or property. Events occurring more than four times a year are not considered unplanned.

Energy Equivalent Sound Level (L_{eq}): 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). Leq is usually A-weighted. An Leq value expressed in dBA is a good, single value descriptor of the annoyance of noise.

Far Field: Describes a region in free space where the sound pressure level from a source obeys the inverse-square law (the sound pressure level decreases 6 dB with each doubling of distance from the source). The far field is that area far enough away from the noise source that the noise emissions can be treated as if they come from a single point or line source and the individual components of the noise source are not apparent as separate sources. This is typically at a distance of at least three to five times the major dimensions of the noise sources.

Free Sound Field (Free Field): A sound field in which the effects of obstacles or boundaries on sound propagated in that field are negligible.

Frequency: The number of times per second that the sine wave of sound or of a vibrating object repeats itself. Now expressed in hertz (Hz), formerly in cycles per second (cps).

Frequent Aircraft Flyovers: Used in the assessment of categories as part of a site specific analysis for dwellings that lie within a contour area with a noise exposure forecast (NEF) 25 or greater, as designated by Transport Canada. In the absence of any NEF contours for local airport, Transport Canada is to be contacted for current air traffic statistics. In this case, to qualify for the BSL adjustment, a dwelling must be within 5 km of an airport that has a minimum of nine aircraft takeoffs or landings over the nighttime period.

Heavily Travelled Road: Generally includes highways and any other road where the average traffic count is at least 10 vehicles per hour over the nighttime period. It is acknowledged that highways are sometimes lightly travelled during the nighttime period, which is usually the period of greatest concern.

Heavy Truck: Any truck having a gross vehicle weight of 12,000 kg or more and having three or more axles.

Hertz (Hz): Unit of measurement of frequency, numerically equal to cycles per second.

Human Perception of Sound: The human perception of noise impact is an important consideration in qualifying the noise effects caused by projects. The typical threshold for an increase in sound level that is considered to be "barely perceptible" by the human ear in a controlled laboratory setting varies from 1 to 5 dBA, depending on the sound pressure level and frequency of the sound (Health Canada 2011).

Insertion Loss (IL): The arithmetic difference between the sound level from a source before and after the installation of a noise mitigation measure, at the same location. Insertion loss is typically presented as a positive number, i.e., the post-mitigation sound level is lower than the pre-mitigation level. Insertion loss is expressed in dB and is usually specified per 1/1 octave band, per 1/3 octave band, or overall.

Intensity: The sound energy flow through a unit area in a unit time.

Low Frequency Noise (LFN): Noise in the low frequency range, from infrasonic sounds (<20 Hz) up to 100 Hz. Where a clear tone is present below and including 250 HZ and the difference between the overall C-weighted sound level and the overall A-weighted sound level exceeds 20 dB.

Masking: a) the process by which the threshold of audibility for a sound is raised by the presence of another (masking) sound or b) the amount by which the threshold of audibility of a sound is raised by the presence of another (masking) sound.

Mitigation Noise Level (MNL): Short term (less than 12 months) construction noise level at which Health Canada (HC) normally advises mitigation. This level is calculated based on the community description, construction duration, and presence of tonal or impulsive noise and stems from the findings of the EPA (1974). Table G-1 below presents the applicable correction factors for calculating suggested MNL.

Table G-1: Calculating Suggested Construction Noise MNL (based on EPA 1974)

Suggested Basic MNL 47 dBA L_{dn} ***Suggested MNL for various scenarios***		
Community Description	**Applied Correction Factors**	**Suggested MNL**
Quiet suburban or rural community	+0 dBA L_{dn}	47 dBA L_{dn}
Normal suburban community	+5 dBA L_{dn}	52 dBA L_{dn}
Urban residential community	+10 dBA L_{dn}	57 dBA L_{dn}
Noisy urban community	+15 dBA L_{dn}	62 dBA L_{dn}
Very noisy urban community	+20 dBA L_{dn}	67 dBA L_{dn}
Additional Corrections ***If applicable, add any or all of the following corrections:***		
Construction Duration less than 2 months	+10 dBA L_{dn}	
Winter (or windows always closed)	+5 dBA L_{dn}	
Negligible tonal or impulsive noise	+5 dBA L_{dn}	

Near Field: The region or sound field very near to a source, where sound pressure does not obey the inverse-square law (i.e., 6 dBA loss per doubling of distance for a point source does not apply). Usually this region is located within a few wavelength of the source and is also controlled by the dimension of the source.

Nighttime: Defined as the hours from 22:00 to 07:00.

Noise: Generally associated with the unwanted portion of sound.

Noise Exposure Forecast (NEF): The NEF contours are site specific to each airport and take into account such factors as traffic levels, proximity to runways, flight paths, and aircraft type and size.

Noise Impact Assessment (NIA): An NIA identifies the expected sound level emanating from a facility as measured 15 m from the nearest or most impacted permanently or seasonally occupied dwelling. It also identifies what the permissible sound level is and how it was calculated.

Noise Level: Same as Sound Level, except applied to unwanted sounds.

Permanent Facility: Any existing or proposed facility that will be at a location longer than two months.

Permanently Occupied Dwelling: A fixed residence occupied on a full-time basis.

Permissible Sound Level (PSL): The maximum sound level that a facility should not exceed at a point 15 m from the nearest or most impacted dwelling unit. The PSL is the sum of the BSL, daytime adjustment, Class A adjustment, and Class B adjustment.

Pristine Area: A pure, natural area that might have a residence but no industrial presence, including energy, agricultural, forestry, manufacturing, recreational, or other industries that could make noise generation a consideration.

Representative Conditions: Those conditions typical for an area and/or the nature of a complaint. For ASLs, these are conditions that portray the typical activities for the area, not the quietest time. For CSLs, these do not constitute absolute worse-case conditions or the exact conditions the complainant has highlighted if those conditions are not easily duplicated. Sound levels must be taken only when representative conditions exist; this may necessitate a survey of extensive duration (two or more consecutive nights).

Seasonally Occupied Dwelling: A fixed residence that, while not being occupied on a full-time basis, is occupied on a regular basis. A regular basis does not imply a scheduled occupancy but implies use of six weeks per year or more. The residence must not be mobile and should have some sort of foundation or features of permanence (e.g., electrical power, domestic water supply, septic system) associated with it. Summer cottages or mobile homes are examples of seasonally occupied dwellings, while a holiday trailer simply pulled onto a site is not.

Sound: A dynamic (fluctuating) pressure.

Sound Level (SL): The A-weighted Sound Pressure Level expressed in dBA.

Sound Level Meter: An instrument comprised of a microphone, amplifier, output meter, and frequency-weighting networks, which is used for the measurement of noise and sound levels.

Sound Pressure Level (SPL): The logarithmic ratio of the RMS sound pressure to the sound pressure at the threshold of hearing. The sound pressure level is defined by equation (1) where P_{RMS} 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} Pascal.

$$SPL\ (dB) = 20 \log(P_{RMS}/P_0)$$

Sound Power Level (PWL): The logarithmic ratio of the instantaneous sound power (energy) of a noise source to that of an international standard reference power. The sound power level is defined by equation (2) where W is the sound power of the source in watts, and W_0 is the reference power of 10^{-12} watts.

$$PWL\ (dB) = 10 \log(W/W_0)$$

Inter-relationships between sound pressure level (SPL) and sound power level (PWL) depend on the location and type of source.

Spectrum: The description of a sound wave's resolution into its components of frequency and amplitude.

Tonal Components: Most energy industrial facilities typically exhibit a tonal component. Examples of tonal components are transformer hum, sirens, and piping noise. The test for the presence of tonal components consists of two parts.

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 2 bandwidths on the opposite side.

The second part is that the tonal component must be a pronounced peak clearly obvious within the spectrum.

Transmission Loss: A measure of the reduction in sound energy resulting from incident sound waves striking a wall, partition or enclosure, and radiating through to the other side. Mathematically, the transmission coefficient t is the ratio of transmitted acoustic power to the incident acoustic power, and in decibels, the Transmission Loss (TL) of the wall is:

$$TL = 10 \log (1/t)$$

The TL of a wall varies by frequency. The associated noise reduction (NR) due to the TL of the wall is a function of the TL and the acoustical parameters of the receiving space.

G.2 ACOUSTIC MODELLING PARAMETERS

The BC Noise Control Best Practices Guideline (BC OGC, 2009) does not endorse any specific international standard or computer acoustic modelling software program; however, international calculation standards are recommended.

The modelling of sound in this assessment is based on sound propagation methods prescribed by the ISO 9613-1 and ISO 9613-2 standards (ISO 9613-1&2 1993, 1996). These standards are commonly used by noise practitioners and are accepted by BC OGC and Health Canada. Sound propagation from the Project was calculated using Cadna/A computer program (Version 4.3.143) from DataKustik GmbH. CadnaA noise modelling software incorporates ISO 9613 algorithms.

Ground terrain information in the form of height points consistent with site conditions was used in the noise model. The terrain information is based on ASTER Global Digital Elevation Model (GDEM) Worldwide Elevation Data (1.5 arc second resolution). These data have a horizontal resolution of 50 m within 1 km of the

project footprint and 250 m horizontal resolution for the area outside of 1 km from the project footprint but within the assessment areas. The GDEM data was incorporated in Cadna/A to account for the terrain effect.

The model accounted for the following factors:

- geometric spreading
- barrier effects
- atmospheric absorption
- source size, location and elevation
- mild downwind from the project to the dwellings(s) and/or temperature inversion condition
- source directivity

See Table G-2 for the modelling parameters used in the assessment.

Table G-2: Acoustic Modelling Parameters

Item	Model Parameters	Model Setting
1	Temperature	10°C
2	Relative humidity	70%
3	Wind speed	Downwind condition, (as per ISO 1996-2)
4	Noise source type (area, line, point)	Refer to Section G.8
5	Noise source data in octave-band center frequency	Refer to Section G.6 and G.8
6	Noise Propagation Calculation Standard	ISO 9613
7	Ground attenuation	Ground absorption coefficient (G) of 0.3 within the Project facility boundary and 0.5 within the RAA
8	Terrain Parameters (terrain resolution)	Ground terrain incorporated in model with resolution of 50 m within 1 km of the project footprint and 250 m horizontal resolution for the area outside of 1 km from the project footprint but within the RAA
9	Order of Reflections	1 order of reflection

G.3 MITIGATION MEASURES

For areas where the construction noise exceeds the HC guidance, the following additional mitigation measures may be practical to address noise environmental effects during construction and decommissioning activities:

- replace backup beepers with a broad band or ambient adjustable noise alarm with proximity sensors

- use acoustical screening from temporary on-site buildings (construction phase related), temporary screen or barrier
- make changes to equipment schedules

For compressor station operation, a list of mitigation measures (included in the acoustic model to achieve compliance with the BC Noise Control Guideline) are found in Table G-3. In addition to these mitigation measures, aerial coolers that meet 50 dBA at 120 metres (400 feet) will be selected.

Table G-3: Acoustic Performance of Recommended Noise Mitigation Measures

Description	Sound Transmission Loss Rating (dB re 1 pW) by Octave Band (Hz)								
	31.5	63	125	250	500	1000	2000	4000	8000
Roof exhaust fan silencers	1	4	6	9	13	15	16	12	12
Building roofs and walls (STC 35)	12	14	19	23	30	36	39	40	40
Building ventilation inlet silencers	3	4	5	7	8	10	11	9	9
Acoustic (lined) weatherhood for building exhaust fan	3	3	4	2	4	8	10	9	9
Turbine 12' exhaust silencer	5	11	17	21	24	26	24	18	12
Turbine intake filterhouse (cross flow) and silencer	8	11	21	24	25	47	48	47	60
Generator sets radiator discharge silencer	2	5	8	14	19	22	21	15	15
Generator sets hospital grade exhaust silencer	8	14	24	32	30	26	22	21	22

G.4 KEY ASSUMPTIONS DURING CONSTRUCTION PHASE

Assumptions in modelling noise emissions from compressor station construction are:

- Equipment used during compressor station construction would be as provided by PRGT.
- Construction occurs only during the daytime hours.
- Equipment would be used at a utilization rate of 75%.
- Equipment listed as “spare”, or found to have a sound power level of less than 5 kW were deemed negligible and not modelled.
- When required, +5 dBA and +12 dBA adjustments are applied for tonal (back-up alarms) and highly impulsive (pile driving) activities, respectively.

Assumptions in modelling noise emissions during pipeline construction are:

- Information on each land-based pipeline construction activity equipment, including type and number of equipment used, were provided by PRGT.
- Each construction activity modeled area will be approximately 1 km long and 100 metres wide.
- Equipment utilization rate is set at 80%.
- During site preparation, the moved earth will be reused or kept on site and there will be no offsite road traffic associated with earth moving.
- The construction personnel will stay in the construction camp and therefore, minimum road transportation will be required for construction crews.
- Marine construction is expected to be a 24 hours a day operation.
- Marine construction was assumed to consist of one shallow water pipe-layer barge, one backhoe dredger, two tugboats, and one supply vessel operating at 100% power output during construction.

Table G-4 lists the duration assumed for each type of pipeline construction activity.

Table G-4: Activity Description and Expected Duration for Pipeline Construction

Type of Construction	Activity Description	Activity Duration	Daily Duration
Marine pipeline construction	Pipe-laying	300m to 500m per day for shallow water pipelay barge; 3 km to 5 km per day for deep water pipelay vessel	24 hours operation
	Pipe Trenching		
	Material Supply		
	Supporting Tugboats		
Land based pipeline construction	Early Construction Clearing	2 to 12 days per KP	Daytime operation only between 7.00 am to 10.00 pm
	Clearing	2 to 12 days per KP	
	Grading	2 to 12 days per KP	
	Mainline Welding	2 to 12 days per KP	
	Coating	2 to 12 days per KP	
	Ditching	2 to 12 days per KP	
	Lower In	2 to 12 days per KP	
	Backfill	2 to 12 days per KP	
	Tie In Main Line	2 to 12 days per KP	
	Back Fill Tie In	2 to 12 days per KP	
	Isolate Water Crossing	Depend on water crossing size but not more than 12 months	24 hours operation

G.5 SOUND POWER LEVELS FOR COMPRESSOR STATION CONSTRUCTION

Table G-5 lists the equipment (and their sound power level) specified by PRGT that will be required during construction of each compressor station.

Table G-5: Sound Power Levels for Individual Construction Equipment during Construction of Compressor Stations

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1000	2000	4000	8000		
F550 Crew Cab Deck Truck 1 ton	1	1	107	101	106	109	104	102	99	93	87	107	113
F550 Crew Cab Picker Truck 1 ton	1	1	107	101	106	109	104	102	99	93	87	107	113
F250 Super Cab Pick Up 3/4 ton	1	1	107	101	106	109	104	102	99	93	87	107	113
F550 Service Truck 2 ton	1	1	107	101	106	109	104	102	99	93	87	107	113
GMC 1500 Pick Up 1/2 ton	1	1	107	101	106	109	104	102	99	93	87	107	113
Cat 330 Track Hoe Excavator	1	2	109	109	108	108	111	110	107	104	101	114	118
12 Passenger Van	1	1	107	101	106	109	104	102	99	93	87	107	113
12 Passenger Van	1	1	107	101	106	109	104	102	99	93	87	107	113
Zoom Boom 9,000 lbs	1	2	106	109	106	104	102	100	97	92	84	105	113
Carry Deck Crane 10,000 lbs	1	2	108	108	104	99	91	92	91	84	78	98	112
Cat 320 Track Hoe Excavator	1	2	109	109	108	108	111	110	107	104	101	114	118
35 Ton Picker Truck	1	2	103	106	97	95	92	90	85	77	68	95	108
JD Rubber Tired Hoe	1	2	105	109	101	99	99	98	95	94	85	103	112
Gravel Truck	1	2	89	92	95	92	86	90	90	79	70	95	100
S185 Skid Steer Loader	1	2	102	102	111	106	102	102	98	95	90	107	114
8 kw Light Towers (2)	2	2	94	101	99	96	87	87	86	84	77	94	105
Sheeps Foot 66" Packer	1	2	100	100	103	109	106	102	98	91	83	107	113
45' Man Lifts (2)	2	2	96	96	91	92	91	87	88	86	79	94	101
60' man Lift	1	2	96	96	91	92	91	87	88	86	79	94	101
40' Scissor Lift	1	2	108	108	105	102	102	102	99	93	91	106	113

Table G-5: Sound Power Levels for Individual Construction Equipment during Construction of Compressor Stations (cont'd)

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overal l dB
			31.5	63	125	250	500	1000	2000	4000	8000		
F250 Deck Truck	1	1	107	101	106	109	104	102	99	93	87	107	113
F150 Pick Up	1	1	107	101	106	109	104	102	99	93	87	107	113
Cat Mini Excavator	1	2	107	107	109	96	97	94	93	89	80	100	113
GMC 1500 Pick Up	1	1	107	101	106	109	104	102	99	93	87	107	113
F550 Deck Truck	1	1	107	101	106	109	104	102	99	93	87	107	113
F250 Deck Truck	1	1	107	101	106	109	104	102	99	93	87	107	113
Pile Driver	1	2	111	111	110	107	110	112	110	105	95	116	119
Grader	1	2	113	116	115	111	107	112	106	102	93	114	121
Bulldozer	1	2	108	111	119	110	107	105	103	97	88	111	120
Rock Trencher	1	2	101	101	109	103	104	101	98	93	88	106	112

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*" (2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

G.6 SOUND POWER LEVELS FOR PIPELINE CONSTRUCTION

The modelling approach for pipeline construction assumes that each phase of construction is approximately 1 km long, 100 m wide, and occurs in sequence. Because construction typically involves many pieces of diesel-powered machinery continuously moving within a construction zone, each phase of construction is modelled as a separate area source with an equivalent sound power level equal to sum of the noise emissions from all equipment present. Table G-6 lists the total sound power level for each phase of construction and Table G-7 through Table G-16 list the equipment (and their sound power levels) for each construction activity. Table G-17 lists the equipment (and their sound power levels) for construction at watercourse crossings. Table G-18 lists the equipment (and their sound power levels) for marine-based pipeline construction

Table G-6: Total Sound Power Level for Each Phase of Pipeline Construction, Including Tonal Adjustments and Utilization Factors

Construction Phase	Noise Source	PWL (dBA)
Early Construction Clearing	• Truck, F-150 4x4, Crew Cab • Truck, F-250 4x4, Crew Cab • ATV, Foreman Quad, 475 cc • Mulcher, Gyro Track 25 • Dozer, D6T, LGP Ripper, VPAT • Excavator, 320DL c/w thumb • Excavator, 336DL c/w brushcutter • Chainsaw	123
Clearing	• Truck, F-150 4x4, Crew Cab • Truck, F-250 4x4, Extended Cab • Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • Truck, EMT Unit, F-250 4x4, Crew Cab • Truck, Mechanics Rig • Truck, Tandem Water • ATV, Foreman Quad, 475 cc • ATV, Honda Big Red Side by Side 675 cc • Mulcher, Hurricane 250 • Mulcher, Iron Wolf, D8R • Dozer, D6T, LGP Ripper, VPAT • Dozer, D7E, LGP, DAT, Angle Blade, Winch • Excavator, 336DL c/w thumb • Excavator, 336DL c/w brushcutter • Chainsaw	121

Table G-6: Total Sound Power Level for Each Phase of Pipeline Construction, Including Tonal Adjustments and Utilization Factors (cont'd)

Construction Phase	Noise Source	PWL (dBA)
Grading	• Truck, F-150 4x4, Crew Cab • Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • ATV, Foreman Quad, 475 cc • ATV, Honda Big Red Side by Side 675 cc • Bus, Bluebird 320C, 24 Passenger (4x2) • Articulated Dump Trk, 10.4 m^3 • Articulated Dump Trk, 12.5 m^3 • Dozer, D6T, XL, 3 Winch, VPAT • Dozer, D7E, LGP, DAT, Angle Blade • Dozer, D8T, LGP Ripper • Dozer, D8T, LGP Winch • Dozer, D9T, Ripper • Dozer, D10T, Ripper • Excavator, 336DL • Excavator, 345DL • Excavator, 365CL • Grader, 16M • Grader, 14M	127
Welding	• Truck, F-150 4x4, Crew Cab • Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • Truck, Welding Rig • Sideboom, 583T • Sideboom, Tac Rig • Sideboom, 572 Autoweld • Welder, Quad D7 Welding Tractor • Dozer, D6T, XL, 3 Winch, VPAT • Bus, Bluebird 321C, 36 Passenger (4x2)	122
Coating	• Truck, F-250 4x4, Extended Cab • Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • Truck, F-350 4x4, Crew Cab Mixing Unit • Truck, F-750 4x4, Flatdeck c/w Picker, Generator & Coli • Truck, T440 M/L SandBlasting Unit • Sideboom, 572R Series 2 • Compressor, 210 CFM • Bus, Bluebird 320C, 24 Passenger (4x2) • Bus, Mixing Unit	125

Table G-6: Total Sound Power Level for Each Phase of Pipeline Construction, Including Tonal Adjustments and Utilization Factors (cont'd)

Construction Phase	Noise Source	PWL (dBA)
Trenching	• Truck, F-150 4x4, Crew Cab • Truck, F-250 4x4, Crew Cab • Excavator, 345DL • Excavator, 365CL • Dozer, D6T, LGP Ripper, VPAT • Dozer, D8T, LGP Ripper • Dozer, D9T, Ripper • Dozer, D10T, Ripper • Bus, Bluebird 320C, 24 Passenger (4x2)	123
Lowering In	• Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • Truck, F-250 4x4, Extended Cab • Truck, Welding Rig • Sideboom, 587T • Skid Steer, 256 C • Dozer, D6T, XL, 3 Winch, VPAT • Dozer, D8T, LGP Ripper • Excavator, 336DL Long Stick • Pump, Ditch, 6" • Pump, Trash, 6" • Pump, 6" Flygt 460V Pumps, w/1000L Tank • Bus, Bluebird 320C, 24 Passenger (4x2) • Light Tower - 20 KW • Gen Set, 125 kW, c/w FT & Panels	123
Tie-In	• Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • Truck, Welding Rig • Sideboom, 587T • Sideboom, 594 • Dozer, D8T, LGP Ripper • Excavator, 365CL • Pump, Submersible, 3" • Pump, Ditch, 3" • Pump, Ditch, 4" • Pump, Trash, 4" • Pump, Ditch, 6" • Bus, Bluebird 320C, 24 Passenger (4x2) • Light Tower - 20 KW	121

Table G-6: Total Sound Power Level for Each Phase of Pipeline Construction, Including Tonal Adjustments and Utilization Factors (cont'd)

Construction Phase	Noise Source	PWL (dBA)
Backfilling	• Truck, F-150 4x4, Crew Cab • Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • Dozer, D6T, XL, 3 Winch, VPAT • Dozer, D8T, LGP Ripper • Excavator, 336DL Long Stick • Excavator, 345DL • Pump, Ditch, 3" • Pump, Submersible, 3" • Pump, Ditch, 4" • Pump, Trash, 4" • Compactor, CAT CS 583D • Light Tower - 20 KW	122
Hydro-Testing	• Truck, F-250 • Truck, F-350 • Water Truck • Pump, 6" • 1600 CFM Compressor • 2000 PSI Booster	112
Isolated water crossings (for typical Horizontal Directional Drilling)	• Truck, F-250 4x4, Crew Cab • Truck, F-350 4x4, Crew Cab Flatdeck • Truck, F-350 4x4, Crew Cab Mixing Unit • Truck, F-550 4x4, Tie-In Sandblasting Unit • Truck, Welding Rig • Truck, Tandem Water • Bus, Bluebird 320C, 24 Passenger (4x2) • Sideboom, 587T • Excavator, 365CL • Dozer, D8T, LGP Winch • Pump, Ditch, 3" • Pump, Trash, 4" • Boring Machine, Track NPS 42 • Light Tower - 20 KW	119

Table G-7: Sound Power Levels for Individual Construction Equipment during Early Construction Clearing Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-150 4x4, Crew Cab	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Crew Cab	10	1	107	101	106	109	104	102	99	93	87	107	113
ATV, Foreman Quad, 475 cc	4	2	110	112	119	114	106	101	99	100	101	111	122
Mulcher, Gyro Track 25	2	2	108	108	108	105	105	105	102	102	100	110	115
Dozer, D6T, LGP Ripper, VPAT	2	3	103	103	107	105	105	102	99	93	85	107	113
Excavator, 320DL c/w thumb	2	3	100	103	112	106	102	98	96	92	89	105	114
Excavator, 336DL c/w brushcutter	2	3	100	103	112	106	102	98	96	92	89	105	114
Chainsaw	4	2	114	114	114	111	111	111	107	107	105	116	121

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker's "*Handbook of Noise and Vibration Control*"(2007).

2. Based on manufacturer's data for equipment of similar power and performance rating.

3. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

Table G-8: Sound Power Levels for Individual Construction Equipment during the Clearing Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-150 4x4, Crew Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Extended Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Crew Cab	6	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Flatdeck	1	1	107	108	108	105	105	105	102	102	100	110	115
Truck, EMT Unit, F-250 4x4, Crew Cab	1	1	107	103	107	105	105	102	99	93	85	107	113
Truck, Mechanics Rig	1	1	107	103	112	106	102	98	96	92	89	105	115
Truck, Tandem Water	1	1	107	103	112	106	102	98	96	92	89	105	115
ATV, Foreman Quad, 475 cc	2	2	110	112	119	114	106	101	99	100	101	111	122
ATV, Honda Big Red Side by Side 675 cc	2	2	110	112	119	114	106	101	99	100	101	111	122
Mulcher, Hurricane 250	1	2	108	108	108	105	105	105	102	102	100	110	115
Mulcher, Iron Wolf, D8R	1	2	108	108	108	105	105	105	102	102	100	110	115
Dozer, D6T, LGP Ripper, VPAT	1	3	103	103	107	105	105	102	99	93	85	107	113
Dozer, D7E, LGP, DAT, Angle Blade, Winch	1	3	103	103	107	105	105	102	99	93	85	107	113
Excavator, 336DL c/w thumb	2	3	100	103	112	106	102	98	96	92	89	105	114
Excavator, 336DL c/w brushcutter	1	3	100	103	112	106	102	98	96	92	89	105	114
Chainsaw	2	2	114	114	114	111	111	111	107	107	105	116	121

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker's "*Handbook of Noise and Vibration Control*"(2007).

2. Based on manufacturer's data for equipment of similar power and performance rating.

3. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

Table G-9: Sound Power Levels for Individual Construction Equipment during the Grading Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-150 4x4, Crew Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Crew Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Flatdeck	1	1	107	101	106	109	104	102	99	93	87	107	113
ATV, Foreman Quad, 475 cc	2	2	110	112	119	114	106	101	99	100	101	111	121
ATV, Honda Big Red Side by Side 675 cc	2	2	110	112	119	114	106	101	99	100	101	111	121
Bus, Bluebird 320C, 24 Passenger (4x2)	2	3	114	117	112	108	110	108	106	100	92	113	120
Articulated Dump Trk, 10.4 m^3	1	3	112	115	110	106	108	106	104	98	90	111	118
Articulated Dump Trk, 12.5 m^3	1	3	114	117	112	108	110	108	106	100	92	113	120
Dozer, D6T, XL, 3 Winch, VPAT	4	3	103	103	107	105	105	102	99	93	85	107	112
Dozer, D7E, LGP, DAT, Angle Blade, MS Ripper	4	3	103	103	107	105	105	102	99	93	85	107	112
Dozer, D8T, LGP Ripper	6	3	114	117	118	109	101	102	98	96	92	108	121
Dozer, D8T, LGP Winch	10	3	114	117	118	109	101	102	98	96	92	108	121
Dozer, D9T, Ripper	1	3	108	111	119	110	107	105	103	97	88	111	120
Dozer, D10T, Ripper	1	3	108	111	119	110	107	105	103	97	88	111	120
Excavator, 336DL	2	3	100	103	112	106	102	98	96	92	89	105	114
Excavator, 345DL	4	3	100	103	112	106	102	98	96	92	89	105	114
Excavator, 365CL	2	3	100	103	112	106	102	98	96	92	89	105	114
Grader, 16 m	1	3	113	116	115	111	107	112	106	102	93	114	120
Grader, 14 m	1	3	110	113	112	108	104	109	103	99	90	111	117

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker's "*Handbook of Noise and Vibration Control*"(2007).

2. Based on manufacturer's data for equipment of similar power and performance rating.

3. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

Table G-10: Sound Power Levels for Individual Construction Equipment during the Welding Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-150 4x4, Crew Cab	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Crew Cab	4	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Flatdeck	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, Welding Rig	2	1	107	101	106	109	104	102	99	93	87	107	113
Sideboom, 583T	4	2	106	109	106	104	102	100	97	92	84	105	113
Sideboom, Tac Rig	4	2	106	109	106	104	102	100	97	92	84	105	113
Sideboom, 572 Autoweld	4	2	106	109	106	104	102	100	97	92	84	105	113
Welder, Quad D7 Welding Tractor	4	1	103	103	100	95	96	98	94	90	88	101	108
Dozer, D6T, XL, 3 Winch, VPAT	2	1	103	103	107	105	105	102	99	93	85	107	113
Bus, Bluebird 321C, 36 Passenger (4x2)	2	2	114	117	112	108	110	108	106	100	92	113	121

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*"(2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

Table G-11: Sound Power Levels for Individual Construction Equipment during the Coating Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-250 4x4, Extended Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Crew Cab	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Flatdeck	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Mixing Unit	4	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-750 4x4, Flatdeck c/w Picker, Generator & Coli	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, T440 M/L SandBlasting Unit	4	1	107	101	106	109	104	102	99	93	87	107	113
Sideboom, 572R Series 2	4	2	106	109	106	104	102	100	97	92	84	105	113
Compressor, 210 CFM	4	2	103	103	99	93	98	99	97	90	85	103	108
Bus, Bluebird 320C, 24 Passenger (4x2)	2	2	114	117	112	108	110	108	106	100	92	113	121
Bus, Mixing Unit	4	2	114	117	112	108	110	108	106	100	92	113	121

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*" (2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

Table G-12: Sound Power Levels for Individual Construction Equipment during the Trenching Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-150 4x4, Crew Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Crew Cab	2	1	107	101	106	109	104	102	99	93	87	107	113
Excavator, 345DL	4	2	100	103	112	106	102	98	96	92	89	105	114
Excavator, 365CL	8	2	100	103	112	106	102	98	96	92	89	105	114
Dozer, D6T, LGP Ripper, VPAT	2	2	103	103	107	105	105	102	99	93	85	107	113
Dozer, D8T, LGP Ripper	2	2	114	117	118	109	101	102	98	96	92	108	122
Dozer, D9T, Ripper	1	2	108	111	119	110	107	105	103	97	88	111	120
Dozer, D10T, Ripper	1	2	108	111	119	110	107	105	103	97	88	111	120
Bus, Bluebird 320C, 24 Passenger (4x2)	2	2	114	117	112	108	110	108	106	100	92	113	121

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*" (2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

Table G-13: Sound Power Levels for Individual Construction Equipment during the Lowering In Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-250 4x4, Crew Cab	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Flatdeck	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Extended Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, Welding Rig	2	1	107	101	106	109	104	102	99	93	87	107	113
Sideboom, 587T	12	2	106	109	106	104	102	100	97	92	84	105	113
Skid Steer, 256 C	1	2	96	98	100	95	91	93	89	83	75	96	104
Dozer, D6T, XL, 3 Winch, VPAT	1	2	103	103	107	105	105	102	99	93	85	107	113
Dozer, D8T, LGP Ripper	1	2	114	117	118	109	101	102	98	96	92	108	122
Excavator, 336DL Long Stick	2	2	100	103	112	106	102	98	96	92	89	105	114
Dragline, 3-Yard	1	3	109	111	111	104	106	108	110	91	75	114	118
Pump, Ditch, 6"	4	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Trash, 6"	4	2	95	95	93	93	92	91	91	88	82	97	102
Pump, 6" Flygt 460V Pumps, w/1000L Tank	1	2	95	95	93	93	92	91	91	88	82	97	102
Bus, Bluebird 320C, 24 Passenger (4x2)	2	2	114	117	112	108	110	108	106	100	92	113	121
Light Tower - 20 KW	1	3	94	101	99	96	87	87	86	84	77	94	105
Gen Set, 125 kW, c/w FT & Panels	1	4	90	93	94	94	94	92	90	87	82	97	101

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker's "*Handbook of Noise and Vibration Control*"(2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

3. Based on measured sound power level for similar equipment.

4. Theoretical estimation using formulae and spectrum from Hoover & Keith's "*Noise Control for Buildings, Manufacturing Plants, Equipment and Products*" (1981) based on provided equipment specifications.

Table G-14: Sound Power Levels for Individual Construction Equipment during the Tie-in Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-250 4x4, Crew Cab	1	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Flatdeck	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, Welding Rig	4	1	107	101	106	109	104	102	99	93	87	107	113
Sideboom, 587T	4	2	106	109	106	104	102	100	97	92	84	105	113
Sideboom, 594	4	2	106	109	106	104	102	100	97	92	84	105	113
Dozer, D8T, LGP Ripper	1	2	114	117	118	109	101	102	98	96	92	108	122
Excavator, 365CL	1	2	100	103	112	106	102	98	96	92	89	105	114
Pump, Submersible, 3"	1	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Ditch, 3"	1	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Ditch, 4"	1	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Trash, 4"	1	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Ditch, 6"	1	2	95	95	93	93	92	91	91	88	82	97	102
Bus, Bluebird 320C, 24 Passenger (4x2)	1	3	114	117	112	108	110	108	106	100	92	113	121
Light Tower, 20 kW	1	3	94	101	99	96	87	87	86	84	77	94	105

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*" (2007).
2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).
3. Based on measured sound power level for similar equipment.

Table G-15: Sound Power Levels for Individual Construction Equipment during the Backfilling Activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-150 4x4, Crew Cab	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-250 4x4, Crew Cab	2	1	107	101	106	109	104	102	99	93	87	107	113
Truck, F-350 4x4, Crew Cab Flatdeck	2	1	107	101	106	109	104	102	99	93	87	107	113
Dozer, D6T, XL, 3 Winch, VPAT	4	2	103	103	107	105	105	102	99	93	85	107	113
Dozer, D8T, LGP Ripper	4	2	114	117	118	109	101	102	98	96	92	108	122
Excavator, 336DL Long Stick	4	2	100	103	112	106	102	98	96	92	89	105	114
Excavator, 345DL	4	2	100	103	112	106	102	98	96	92	89	105	114
Dragline, 3-yard	2	3	109	111	111	104	106	108	110	91	75	114	118
Pump, Ditch, 3"	2	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Submersible, 3"	2	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Ditch, 4"	2	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Trash, 4"	2	2	114	117	112	108	110	108	106	100	92	113	121
Compactor, CAT CS 583D	2	2	96	98	100	95	91	93	89	83	75	96	104
Light Tower, 20 kW	2	3	94	101	99	96	87	87	86	84	77	94	105

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*" (2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

3. Based on measured sound power level for similar equipment.

Table G-16: Sound Power Levels for Individual Construction Equipment during the Hydro-testing activity

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-250	10	1	93	96	99	96	90	94	94	83	74	99	104
Truck, F-350	4	1	93	96	99	96	90	94	94	83	74	99	104
Water Truck	1	1	93	96	99	96	90	94	94	83	74	99	104
Pump, 6"	10	2	95	95	93	93	92	91	91	88	82	108	106
1600 CFM Compressor	8	3	107	94	97	104	99	98	89	85	86	102	106
2000 PSI Booster	2	2	103	103	99	93	98	99	97	90	85	103	106

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*" (2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

3. Based on specifications from manufacturer of similar equipment.

Table G-17: Sound Power Levels for Construction Equipment at Water Crossings

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									Overall dBA	Overall dB
			31.5	63	125	250	500	1K	2K	4K	8K		
Truck, F-250 4x4, Crew Cab	1	1	93	96	99	96	90	94	94	83	74	99	104
Truck, F-350 4x4, Crew Cab Flatdeck	1	1	93	96	99	96	90	94	94	83	74	99	104
Truck, F-350 4x4, Crew Cab Mixing Unit	1	1	93	96	99	96	90	94	94	83	74	99	104
Truck, F-550 4x4, Tie-In Sandblasting Unit	1	1	93	96	99	96	90	94	94	83	74	99	104
Truck, Welding Rig	2	1	86	89	92	89	83	87	87	76	67	91	96
Truck, Tandem Water	1	1	93	96	99	96	90	94	94	83	74	99	104
Bus, Bluebird 320C, 24 Passenger (4x2)	1	2	114	117	112	108	110	108	106	100	92	113	121
Sideboom, 587T	2	2	106	109	106	104	102	100	97	92	84	105	113
Excavator, 365CL	2	2	100	103	112	106	102	98	96	92	89	105	114
Dozer, D8T, LGP Winch	1	2	114	117	118	109	101	102	98	96	92	108	122
Pump, Ditch, 3"	2	2	95	95	93	93	92	91	91	88	82	97	102
Pump, Trash, 4"	2	2	95	95	93	93	92	91	91	88	82	97	102
Boring Machine, Track NPS 42	1	2	95	103	103	116	110	108	108	108	104	115	119
Light Tower, 20 kW	1	3	94	101	99	96	87	87	86	84	77	94	105

Reference:

1. Federal Highway Administration (FHWA) publication "*Construction Noise Handbook*" (2006) and Malcolm J. Crocker "*Handbook of Noise and Vibration Control*" (2007).

2. Department for Environment, Food and Rural Affairs (DEFRA) UK publication "*Update of Noise Database for Prediction of Noise on Construction and Open Sites*" (2005).

3. Based on measured sound power level for similar equipment.

Table G-18: Sound Power Levels for Individual Construction Equipment for Marine Based Pipeline Construction

Equipment	Quantity	Reference	Sound Power Level Per Unit										
			Sound Power Levels (dB re 1 pW) by Octave Band (Hz)									dBA	dB
			31.5	63	125	250	500	1000	2000	4000	8000		
Shallow water pipelay barge	1	1	124	114	121	112	109	106	102	102	93	112	126
Backhoe dredger	1	1	114	111	119	110	107	103	96	87	72	109	121
Tug Boat	2	1	109	106	113	105	102	98	90	81	66	104	116
Material Supply Vessel	1	1	109	106	113	105	102	98	90	81	66	104	116

Reference:

1. Based on measured sound power level for similar equipment.

G.7 KEY ASSUMPTIONS DURING OPERATIONS PHASE

In addition to the key modelling parameters used within CadnaA computer program in Section G.2, additional assumptions for compressor station operational noise modelling are:

- The modelling is based on compressor station design, location, and geographic footprint as provided by PRGT.
- Compressors are assumed to operate continuously (i.e., 24 hours a day).
- Standby equipment used in upset conditions is not included in the model because of the unpredictability of the event and is not required under BC Noise Control Guideline.
- Where specific equipment was not provided, noise emissions are based on equipment of a similar power rating.
- Road transportation required to operate the compressor station is assumed to be negligible and is not modelled.
- All buildings housing indoor noise-generating equipment will be sealed to grade specifications to prevent noise breakout between the building skid and the ground.
- All flanking paths and penetrations from plumbing, heating ducts and electrical wire in the buildings will be properly insulated and covered so that noise does not escape through them.

G.8 SOUND POWER LEVELS FOR COMPRESSOR STATION OPERATIONS

Table G-19 presents the noise sources included in the acoustic models developed for the compressor stations. The noise emission sources for each compressor station are identical. Each compressor station is composed of two approximately 30 MW ISO-rated natural gas fired turbo-compressor packages, two aerial coolers, and two Waukesha F3524 GSI generator sets for auxiliary power. The noise emission information for the gas turbine unit is based on Rolls-Royce RB211of similar power rating.

Table G-19: Sound Power Levels for Compressor Station Operations

Sources	Source Type	Quantity per Building	Sound Power Level (dB re 1 pW) by Octave Band (Hz)									Total PWL		Reference
			31.5	63	125	250	500	1K	2K	4K	8K	dB(A)	dB	
Power Generator Buildings (2)														
Roof	Area	1	99	106	106	99	93	87	84	79	75	96	110	1, 3
Walls	Area	1	101	109	107	103	93	88	83	77	74	98	112	1, 3
Skid	Area	1	92	103	101	97	93	91	83	79	70	96	106	1, 3
Roof ridge ventilator	Line	1	89	97	98	96	93	91	90	86	84	97	103	2
Radiator	Point	1	99	100	102	98	89	83	79	79	91	95	106	2, 3
Silenced exhaust (top of stack)	Point	1	109	112	98	87	92	100	95	90	88	102	114	1, 3
Exhaust muffler casing breakout	Point	1	113	113	95	83	90	102	98	94	88	105	116	1, 3
Wall supply fan	Point	4	86	96	96	94	90	90	87	82	79	95	101	2
Aerial Coolers (2)														
Discharge	Area	1	106	106	103	98	95	92	87	82	81	98	111	2, 3
Inlet	Area	1	108	106	104	100	98	95	91	87	88	101	112	2, 3
Plenum	Area	1	105	105	99	94	92	88	83	78	78	94	109	2, 3
Compressor Buildings (2)														
East and west walls	Area	2	105	105	99	94	92	88	83	78	78	87	110	1, 3
South and north walls	Area	2	106	101	94	88	74	74	67	67	73	84	108	1, 3
Roof	Area	1	111	106	99	93	79	79	72	72	78	89	113	1, 3
Rollup door	Area	1	99	90	91	90	84	83	81	82	81	90	101	1, 3
Double door	Area	1	97	91	81	77	72	78	70	69	68	81	98	1, 3
Man Door 1	Area	1	92	86	76	72	67	73	65	64	63	76	93	1, 3
Man Door 2	Area	1	92	86	76	72	67	73	65	64	63	76	93	1, 3
Man Door 3	Area	1	92	86	76	72	67	73	65	64	63	76	93	1, 3
Man Door 4	Area	1	91	85	75	71	66	72	64	63	62	75	92	1, 3
Man Door 5	Area	1	91	85	75	71	66	72	64	63	62	75	92	1, 3

Table G-19: Sound Power Levels for Compressor Station Operations (cont'd)

Sources	Source Type	Quantity per Building	Sound Power Level (dB re 1 pW) by Octave Band (Hz)									Total PWL		Reference
			31.5	63	125	250	500	1K	2K	4K	8K	dB(A)	dB	
Louvre 1	Area	1	93	94	89	90	84	84	78	84	91	92	99	1, 3
Louver 2	Area	1	93	94	89	90	84	84	78	84	91	93	99	1, 3
Louver 3	Area	1	94	95	90	91	85	85	79	85	92	93	100	1, 3
Louver 4	Area	2	93	94	89	90	84	84	78	84	91	93	99	1, 3
Wall Exhaust Fan 1	Point	2	86	83	81	85	87	78	69	67	62	85	92	2
Wall Exhaust Fan 2	Point	2	80	77	75	80	81	72	64	62	57	80	87	2
Building Ventilation Exhaust	Area	4	91	93	89	92	87	89	84	88	86	95	99	2
Roof relief fan	Point	4	101	101	96	92	82	83	76	81	90	92	105	2
Combustion air inlet	Point	1	104	101	93	90	87	84	89	102	89	103	107	1, 2
Turbine exhaust (top of stack)	Point	1	124	115	105	96	88	81	75	76	85	95	125	1, 3
Turbine exhaust Stack break-out	Point	1	120	113	109	102	96	89	84	80	74	99	121	1, 3
Discharge piping	Line	1	95	95	95	99	91	94	89	83	71	98	103	2
Suction piping	Line	1	97	97	97	101	93	96	91	85	73	100	105	2
Suction scrubber	Point	1	90	81	83	91	101	91	85	85	77	99	102	2

Reference:

1. Based on manufacturer's data for equipment of similar power and performance rating.

2. Based on measured sound power level for similar equipment.

3. Theoretical estimation using formulae and spectrum from D. A. Bies and C. H. Hansen, 2009, and I. L. Vér and L. L. Beranek 2006 based on provided equipment specifications.