Australia Pacific LNG Project

Volume 2: Gas Fields

Chapter 15: Noise and Vibration Study

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15. Noise and Vibration

15.1 Introduction

15.1.1 Purpose

The purpose of this noise and vibration assessment is to describe the potential effects of construction and operation of the Australia Pacific LNG Project (the Project) gas fields on the environment, and to identify suitable mitigation and management measures to reduce the risk of these impacts to an acceptable level. The assessment of the potential impact of noise and vibration from activities associated with development of the Walloons gas fields has been conducted in accordance with the environmental impact statement (EIS) terms of reference for the Project.

The construction and operation of gas production wells, gas processing facilities and associated infrastructure will result in emissions of noise and vibration to the surrounding environment.

Australia Pacific LNG's sustainability principles will be applied to the planning, design, construction and operation of the gas fields to ensure noise and vibration emissions do not significantly adversely impact the qualities of the acoustic environment or cause environmental harm.

Of Australia Pacific LNG's 12 sustainability principles, the following two are most relevant for noise and vibration in the gas fields:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas
- Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.

The ambient noise levels over the Walloons gas fields is relatively quiet, given that most of the region is predominantly rural in nature. The sustainability principles as applied to noise and vibration mean that Australia Pacific LNG will seek to locate gas fields' infrastructure away from sensitive receptors, where feasible, and to control emissions from project activities to minimise environmental harm or loss of amenity.

Australia Pacific LNG will manage noise emissions and ground vibration associated with all construction and operational activities through the design and location of key infrastructure, using practical noise attenuation measures and complying with the environmental management plan (EM Plan) to meet the acoustic quality objectives set down in the Queensland Environmental Protection (Noise) Policy 2008.

15.1.2 Scope of work

The impact of potential noise and vibration emissions from the gas fields' development was assessed by:

- Conducting baseline noise level surveys at representative locations throughout the project area
- Measuring noise emissions from existing CSG wells and production facilities similar to that proposed for the Project

- Applying Queensland noise and vibration regulations, guidelines and policies to the measured and predicted noise levels of the Project's construction and operations
- Predicting the cumulative noise levels resulting from the Project in addition to the noise of other nearby coal seam gas producers, where appropriate.

Gas field activities assessed for noise included:

- Drilling and completion of gas production wells
- Construction of gas and water pipelines
- Construction of gas processing facilities (GPFs), water treatment facilities (WTFs) and other key infrastructure
- Operation of producing gas wells, GPFs, WTFs and associated infrastructure.

More detailed information on construction and operational noise criteria, the baseline survey and noise modelling methodology is presented in the technical report in Volume 5 Attachment 32.

15.1.3 Legislative framework

Environment Protection (Noise) Policy 2008

The Queensland Environmental Protection (Noise) Policy 2008 (EPP Noise) identifies the acoustic environmental values to be enhanced or protected within Queensland under the *Environmental Protection Act 1994* (EP Act).

The environmental values are identified as the qualities of the acoustic environment conducive to:

- Protecting the health and biodiversity of ecosystems
- Ensuring a suitable acoustic environment for individuals to sleep, study or learn, or be involved in recreation including relaxation and conversation
- Protecting the amenity of the community.

Gas well development and plant construction will address the building work construction requirements of the EP Act and the sleep disturbance criteria of the Department of Environment and Resource Management's 'Planning for noise control' guideline. Well development (drilling and completion) is considered similar to construction in that the noise is transient and the duration is temporary.

Construction noise and vibration

Construction noise and vibration is generally managed by local government under the EP Act. The EP Act specifies building work that creates an audible noise may only occur between 6.30am and 6.30pm on any day except Sundays and public holidays. There are no guidelines for noise limits within or outside of these hours for building or other similar works, such as well development.

The Project work will be regulated by an environmental authority issued for petroleum activities, which will be supported by an EM Plan with suitable construction and well development policies.

Acceptable levels of ground vibration and air-blast over-pressure for buildings are specified in the EP Act, if blasting is necessary for construction of gas fields' infrastructure. Vibration criteria for human comfort are not applicable to pipeline or other infrastructure construction because construction vibration is transient and a minimum separation distance of 100m is proposed between such infrastructure and the nearest sensitive locations.

Maximum vibration levels for prevention of damage in structures are recommended in British Standard (BS) 7385.2 1993 'Evaluation and measurement for vibration in buildings Part 2, Guide to damage levels from ground-borne vibration' and are presented in Volume 5 Attachment 32. BS 7385.2 sets out maximum vibration levels to prevent cosmetic or structural damage from 'transient' vibration sources such impact piling, dropping of heavy objects, or irregular vibration from excavator buckets stalling/releasing during digging through uneven ground. Similarly, BS 7385.2 sets vibration levels to prevent cosmetic damage from 'cyclic' vibration sources, such as vibratory rolling, vibratory pile driving, rock-hammering and rapid air-hammer impact piling.

Operational noise

The Queensland Government approved planning guideline for determining noise emission limits for new major industrial noise sources is the Department of Environment and Resource Management's planning for noise control guideline (the Guideline).This guideline prescribes methods and procedures for setting environmental authority conditions relating to noise and vibration.

The Guideline is intended to manage three aspects of the acoustic environment that may be affected by new developments, namely:

- The control and prevention of 'background noise creep' (the gradual cumulative increase in minimum noise levels generated by continuously operating equipment)
- The containment of variable noise levels and short term noise events to an 'acceptable level' above the background noise levels
- The setting of noise limits for transient noise events to avoid 'sleep disturbance'.

The night period is generally the most critical daily period to meet noise emissions criteria associated with continuously operating GPFs, WTFs and gas well equipment. Compliance with the night period criteria for continuous operations will generally ensure compliance in the day and evening periods.

All gas field noise sensitive locations may be classified according to two simplified representative categories that relate the background noise level (termed the rating background noise level, RBL) and the proximity to significant road corridors, as follows:

- Night RBL < 15dB(A) (sites remote from significant transport corridors)
- Night RBL = 16dB(A) (sites within 1000m of significant transport corridors).

Planning noise levels recommended for the Project are adjusted levels ($L_{Aeq\ 1\ hour,\ adj}$)[1] in accordance with the Guideline. Planning noise levels for the two representative location categories are shown in Table 15.1.

[1] See glossary of acoustic terminology and abbreviations in Volume 5 Attachment 32.

Table 15.1 Outdoor planning noise levels for residential locations

Residential location	Design planning noise level ($L_{aeq,1hour,adj}$ – dB(A))		
	Day (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
Residences with negligible transportation noise	28	28	28
Residences within 1km of major transportation corridor	35	28	28

Noise emissions levels from operational gas field plants typically require adjustment for noise character (tonality or impulsiveness) when assessed at sensitive locations.

Due to the very quiet background noise levels, gas field noise may be audible at some receptors under specific meteorological conditions, such as low winds with temperature inversion, for noise propagation, even though the noise emission levels meet the design planning noise level criteria.

The sleep disturbance noise limit for non-continuous, infrequent noise events (such as flaring) resulting from normal operations will be L_{Amax} 47dB(A) for residential dwellings with natural ventilation and partially closed windows. Sleep disturbance at residential locations is not expected for normal continuous plant operations.

A low frequency noise limit of 60dB(C) will be applied to the Project.

For detailed information about how construction noise criteria and adjustments, potential noise audibility, sleep disturbance or low frequency noise, were determined refer to the technical report in Volume 5 Attachment 32, which includes a glossary of acoustic terminology and abbreviations.

15.2 Methodology

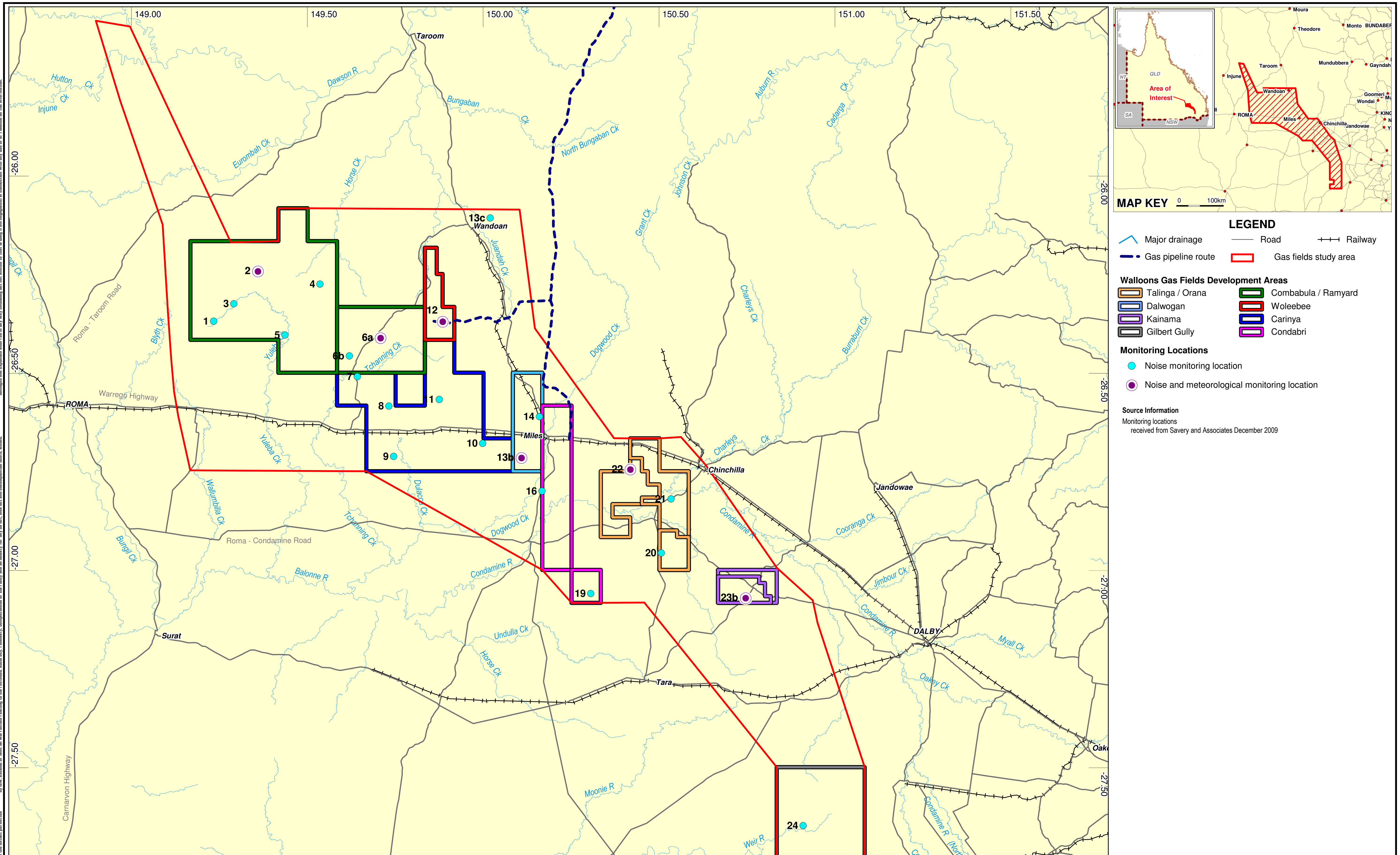
15.2.1 Baseline noise survey

Baseline noise levels were monitored for a minimum period of seven days at 25 sites throughout the gas fields' area. Figure 15.1 shows the gas fields' tenements and the monitoring locations. The monitoring sites were selected to represent the range of typical noise sensitive residential sites found within the gas fields. The sites were generally rural residential, located within areas that could be in the vicinity of future gas processing facilities and remote from major roadways, industrial facilities or urban infrastructure.

Noise levels and spectra were measured continuously and sampled each one-second in frequency bands from 20 hertz (Hz) to 10kHz in accordance with the requirements of Australian Standard AS 1055 (Acoustics – Description and measurement of environmental noise, Part 1: General procedures). The noise data was post-processed in 15 minute intervals to obtain statistical acoustic parameter levels, such as L_{A01}, L_{A10} and L_{A90}[2], for day, evening and night-time periods.

Simultaneous monitoring of wind-speed, direction, temperature, pressure and humidity conditions was conducted in the vicinity of baseline noise monitoring locations. Noise data that was affected by excessive wind speed or precipitation was excluded from the noise level results..

[2] See appendix on glossary of acoustic terminology and abbreviations in Volume 5 Attachment 32



AUSTRALIA PACIFIC LNG PROJECT

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Figure 15.1 - Noise and Meteorological Monitoring Locations

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The presence of insect noise was determined from inspection of the spectrograms (a noise level, frequency spectra and time history plot) for the noise-monitoring period at each site. When significant evening or night-time insect noise was detected, it was filtered during post-processing so that background noise levels with and without insect noise was reported.

15.2.2 Noise prediction modelling

Environmental noise models of nominal flat gas fields' areas were constructed using ISO 9613-2 (1996), Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, as implemented in SoundPLAN software. The method predicts A-weighted sound pressure levels under meteorological conditions (mild temperature inversion or slight downwind) favourable to sound propagation from noise sources to receivers.

The graphical noise contours generated by the models represent the predicted noise levels in all directions from the source. Where predictions were presented in the form of distance versus level curves, the curves represent the predicted level in the down-wind direction.

The calculation of sound propagation from the source to the receiver locations was calculated with specific algorithms for geometrical divergence, atmospheric absorption, ground effects, reflection from surfaces, screening by obstacles and attenuation by dense vegetation. The receiver locations were assumed to be 2m above the local ground level. The ground around GPF sites was assumed to be hard-packed and acoustically reflective, all other terrain is assumed to be acoustically soft.

The noise modelling for this EIS is based on generic situations with no allowance made for topographic features, such as hills, bushland or forested areas. Hence the results are expected to be conservative or higher than the actual noise levels likely to be experienced.

15.2.3 Vibration

No baseline ground vibration assessment was undertaken, as there are no recognised sources of background vibration in the vicinity of proposed gas fields' infrastructure. It is recognised that some existing activities within the general area of the gas fields might generate localised ground vibration emissions, such as coal mining

15.3 Existing environment

15.3.1 Background noise levels

Background noise levels determined in accordance with the Guideline are presented in Table 15.2.

The results indicate background noise levels are consistently very low across the study area, with evening and night-time background noise levels typically at or below 15dB(A). Only sites within 1km of major highway routes or other local sources have higher night time background noise levels.

Daytime rating background levels show greater variability than at night due to the varying proximity of instrumentation to vegetation and at some sites, proximity to stock and transportation routes. Noise from vegetation normally follows a diurnal cycle associated with daytime breezes and still conditions at night.

Table 15.2 Background noise levels[3]

Measurement location	Background noise level (RBL, minLA90 – dB(A))		
	Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Site 1 – 'Waverly'	21	<15	<15
Site 2 – 'Hillside'	20	<15	<15
Site 3 – 'Waipiro'	20	<15	<15
Site 4 – 'Nullin'	22	16	16
Site 5 – 'Seaside'	16	<15	<15
Site 6a – 'Woodview'	17	<15	<15
Site 6b – 'Cypress Downs'	25	<15	<15
Site 7 – 'Kamilaroi'	20	<15	<15
Site 8 – 'Dulacca North Road'	19	<15	<15
Site 9 – 'Ellerslie'	20	<15	<15
Site 10 – 'Sandlewood Grove' [4]	33	33	33
Site 11 – 'Devoncourt'	27	16	<15
Site 12 – 'Woodlands'	25	<15	<15
Site 13b – 'The Pines'	22	15	15
Site 13c –Middle Creek Rd	23	17	<15
Site 14 – '4 Mile Homestead'	27	17	16
Site 16 – 'Stoorallyn'	28	20	18
Site 19 – 'Drildool'	25	<15	<15
Site 20 – 'Haywen'	20	<15	<15
Site 21 – 1389 Tara-Chinchilla Rd	30	20	18
Site 22 – 'Gavindale'	23	<15	<15
Site 23 – Tara-Kogan Road	29	17	16
Site 24 – 'The Meadows'	22	<15	<15
Site 27 – 92 Bark Road	23	22	21
Site 28 – 'Western Creek'	23	<15	<15

[3] Corrected for instrumentation noise floor

[4] Background levels for the day evening and night periods were contaminated by water feature noise.

15.3.2 Equivalent continuous noise levels

A representation of the average noise level per time period (T) is the equivalent continuous level ($L_{Aeq,T}$).

The minimum equivalent continuous noise levels (L_{Aeq},1hour) data for the day, evening and night periods existing at each monitoring location are presented in Table 15.3.

Table 15.3 Minimum equivalent continuous noise levels[5]

Measurement Location	Minimum equivalent noise level (minLAeq,1hour – dB(A))		
	Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Site 1 – 'Waverly'	37	30	<15
Site 2 – 'Hillside'	35	24	18
Site 3 – 'Waipiro'	36	28	15
Site 4 – 'Nullin'	39	22	20
Site 5 – 'Seaside'	35	18	15
Site 6a – 'Woodview'	33	17	15
Site 6b – 'Cypress Downs'	39	19	16
Site 7 – 'Kamilaroi'	37	27	<15
Site 8 – 'Dulacca North Road'	33	20	18
Site 9 – 'Ellerslie'	35	21	16
Site 10 'Sandlewood Grove' [6]	41	38	36
Site 11 – 'Devoncourt'	41	24	22
Site 12 – 'Woodlands'	42	27	21
Site 13b – 'The Pines'	43	22	19
Site 13c –Middle Creek Rd	38	27	18
Site 14 – '4 Mile Homestead'	38	35	27
Site 16 – 'Stoorallyn'	41	37	30
Site 19 – 'Drildool'	35	28	21
Site 20 – 'Haywen'	33	28	24
Site 21 – 1389 Tara-Chinchilla Rd	50	43	25
Site 22 – 'Gavindale'	37	21	17

[5] Corrected for instrumentation noise floor

[6] Day, evening and night levels were dominated by noise from a nearby water feature

Measurement Location	Minimum equivalent noise level (minLAeq,1hour – dB(A))		
	Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Site 23 – Tara-Kogan Road	43	30	23
Site 24 – 'The Meadows'	38	25	17
Site 27 – 92 Bark Road	30	27	25
Site 28 – 'Western Creek'	42	28	22

15.3.3 Background vibration levels

Whilst the Walloons gas fields cover a large area of approximately 570,000 hectares, it is not expected that there are any current activities close to proposed project infrastructure that may cause a significant background level of ground vibration. Existing coal mining and quarrying activities might cause periodic localised ground vibrations associated with their activities.

15.3.4 Summary

In general, the baseline noise levels show the acoustic environment in the gas fields during winter months is relatively quiet at all times of the day or night, except for bird calls at dawn and dusk, rustling vegetation in response to winds, and the intermittent sound of passing vehicles at locations within 'earshot' of major roadways.

Night-time background noise levels were consistently below the 15dB(A) detection threshold of the monitoring instrumentation; with the exception of monitoring sites relatively close (less than approximately 1km) to major roadways.

The ambient acoustic environment often contains significant additional sustained insect noise from cicadas and crickets during warmer months and following rainfall, which generally causes increased background noise levels. However, it is the noise levels in the 'quieter' months of the year that represent the worst case and which are relevant for setting of noise limits.

15.4 Potential impacts

15.4.1 Construction

Gas wells

A significant source of noise emissions during the construction of the gas fields will be associated with the drilling and completion of gas wells. Australia Pacific LNG proposes to develop approximately 10,000 wells over the planned 30-year life of the Project. It is expected that up to 600 wells per annum will be constructed during the first five years of the Project to produce sufficient CSG to meet the LNG facility requirements.

Gas well construction involves the drilling and completion of production wells, typically on a continuous 24-hour basis. It is common for gas well construction noise generating activities to occur at any time of the day or night. The night period is the most critical for noise to nearby sensitive receptors. Drilling activities are a significant noise source in quiet rural environments but the noise duration is limited for individual dwellings.

The time required for drilling and furnishing a single production well is approximately 5 to 12 days and varies with the geological characteristics of the overlying strata and the depth and characteristics of the coal seam(s). The following activities are typically associated with the construction cycle of a gas well.

- Rig setup and pull-down operations are characterised by the movement of approximately 10 to 20 semi-trailer loads of mechanical plant and site buildings in day time hours
- Drilling operations result in steady noise emissions consisting of diesel and hydraulic drives and air-compressors
- Air-drilling is a noisy activity with drilling cycles interspersed with well-unloading which uses a high pressure air venturi at the end of the flare-line to induce gas flow up the well
- Mud-drilling operations result in steady noise emissions consisting of diesel and hydraulic drives. Mud drilling is quieter than air drilling because it does not include well-unloading
- Cementing noise occurs when diesel powered pumps are used to inject cement slurry into the cavity surrounding the well casing at high pressure. The process occurs for about 30 minutes per well
- Fraccing noise is comparable to cementing noise. It occurs when diesel powered high-pressure compressors inject fraccing fluid into the coal seam to open up the structure in order to release gas.

Cavitation is an alternative technology for well completion that may be utilised for some wells in the study area when other well completion methodologies are not suitable. Cavitation noise is comparable to the sound of a jet engine, and occurs with the sudden release of compressed air from the coal seam via the well and flare line.

A turbulent horizontally-directed rush of air generates intense broad-band noise for a period of approximately 30 seconds. Two to three hours of pumping compressed air into the well precedes the cavitation release. The cycle may be repeated several times over a nominal 24-hour period, with increased duration of compressed air pumping between successive releases (up to six hours). The process is repeated until the expelled gas composition indicates that the well is ready for production. Details of the noise logging from the various well construction activities are presented in Volume 5 Attachment 32, Appendix D.

Other plant and infrastructure

Construction of the pipeline gathering system involves vegetation clearing, trenching, welding together of pipeline sections in the field, lowering piping into the trench, backfilling and vegetation restoration. At any given noise sensitive location near the pipeline route, the construction activities are typically completed within a week using the standard 6.30am to 6.30pm construction hours (refer to Section 15.1.3).

The noise level, character and duration of pipeline trenching (with a trencher or excavator) and other pipeline operations is comparable to the noise of standard road-paving operations and is not expected to result in an adverse impact upon any nearby noise sensitive location.

Construction of GPFs, WTFs and other infrastructure involves conventional industrial building techniques for site preparation, foundation pouring and erection of metal framed buildings. No adverse impact from construction is expected due to the relatively large separation distances between GPFs and noise sensitive locations.

Significant road traffic and heavy vehicle transportation will occur during the construction phases of the Project. The noise impact will be greatest on roads that normally have very low daily traffic volumes. Sleep disturbance or unwanted noise intrusion is possible for some people, depending upon individual circumstances and sensitivities. The greatest potential for adverse noise impacts will be during the night or early morning.

Construction and operational accommodation facilities are proposed to be located at least 1km from the nearest noise sensitive dwellings. Typical accommodation facility noise sources include domestic reverse-cycle split-type air conditioning units, kitchen exhaust fans and power generation plant. No adverse noise impact is expected from such facilities. The only noticeable noise associated with accommodation facilities may be vehicular traffic in the morning and evening, but noise levels will generally be no greater than the noise levels normally experienced from traffic on local roads.

Potential impacts of ground vibration and blast overpressure are cosmetic or minor structural damage to property (such as dwellings and swimming pools) and heritage listed structures, disturbance of work or relaxation, or temporary disturbance of livestock. Buildings and other structures of heritage significance in the gas fields are discussed in Volume 2 Chapter 19.

The majority of the gas fields' infrastructure will be constructed using conventional earthmoving methods and are unlikely to generate significant ground vibration at any receiver location. However, during construction of some sections of pipelines, particularly the larger diameter high pressure gas and water pipelines, it may be necessary to use a rock-breaker and rock-saw or even blasting to trench continuous sections of hard rock.

Levels of ground vibration associated with a range of mechanical construction vibration sources decrease with distance, and after 100m become insignificant for all trenching activities likely to occur, except for blasting. If blasting is required, the blast will be designed to address the statutory criteria set down in Section 15.1.3 and with regard to any particular vibration or overpressure requirements or sensitivities of the nearby receptor locations. Blast vibration or overpressure may be perceived at levels much lower than levels that cause cosmetic or minor damage to property. Subjective perception of vibration or overpressure (evidenced by rattling of windows or contents) may lead to heightened awareness of construction activities.

Terrestrial fauna and avifauna

Noise emissions associated with most construction activities are unlikely to cause any harm to terrestrial animals or birds. The only potential for significant disturbance to terrestrial animals or birds would be associated with specific well completion activities, in particular using the cavitation well stimulation methodology. Cavitation can produce very loud noises, comparable to a jet engine (125-130dB(A)), at 25m from the flare line for 20 to 30 seconds as compressed air is released from the well. This activity could be repeated every three to six hours over a one to two day period.

The likely response of terrestrial animals and birds to such noise would be flight from the area or to remain in shelter such as tree hollows or burrows, both of which would significantly reduce the likelihood of harm to the individual's hearing. Potential effects could be disruption of feeding patterns and avoidance of nesting sites. However, given the transient nature and relatively short duration of such activities, this is considered to be a very low risk. Further, Australia Pacific LNG will only use the cavitation well stimulation methodology if other methods are unsuitable.

15.4.2 Operations

Gas wells

Well pumps are driven by a CSG powered reciprocating engine in a noise enclosure that hydraulically drives the well pump which is located at the bottom of the gas well.

The minimum spacing between gas wells is typically 750m. Towards the end of the production life of a gas field, it is likely that most or all well pumps within a gas field will be running simultaneously.

All reciprocating engine well pump drives produce a low-frequency exhaust hum that has sometimes caused noise complaints for close noise sensitive receptors.

The noise levels from the newer drives (Kudu, new oil-lift and twin micro-turbine) proposed for the Project are much quieter than the older style drives previously used in the gas fields.

Gas processing facilities

GPFs are the largest long-term noise source associated with CSG production. GPF capacities in the range of 75 terajoules per day (TJ/d) to 225TJ/d will be utilised to match the gas production potential of the various gas fields in the study area.

A range of technologies can be utilised within the GPF to provide the power (reciprocating gas engines or electric drives), gas compression (reciprocating or screw compressors) and cooling (mechanical or electric driven fans). The optimal selection of technologies will depend on the availability of electrical power, the gas field productivity characteristics and site-specific noise constraints.

Up to 23 GPFs will be constructed and will consist of a combination of two types, namely a CSG powered reciprocating gas engine connected to a reciprocating compressor, or a CSG powered reciprocating gas engine connected to a screw compressor.

Each gas compressor requires cooling. Compressors driven by reciprocating gas engines are generally cooled by a series of mechanical fans on a horizontal shaft driven by the gas engine. The cool air is drawn in through the sides and end of the unit and expelled upwards.

When gas production temporarily exceeds the capacity of the GPF, the excess gas is burnt in a flare. Flaring typically occurs if a gas compression unit shuts down due to a process fault and may continue until the fault is rectified, or until gas well flows are re-balanced to the available GPF capacity.

Flare noise is a minor source of noise relative to the total noise of the GPF and is only discernible in the context of other GPF noise at relatively short distances from the flare.

Water treatment facilities

WTFs are proposed to be powered by electricity generated from CSG reciprocating gas engines in fully enclosed acoustic structures. The water transfer pumps which transfer water from untreated storage ponds to the filtration and reverse-osmosis plant are relatively quiet compared to the noise emitted by a GPF. The water pumps are typically housed in a standard steel clad building. The electricity generator noise level may require adjustment as a result of a tonal hum from the exhaust.

15.4.3 Modelling results

Gas wells

Modelling of gas well development activities within 1.5km to 3.5km of a dwelling (depending on the process) has indicated that noise mitigation is likely to be needed to meet recommended limits for out-of-hours construction work between 6.30pm and 6.30am Monday to Saturday, Sundays and public holidays. If cavitation is used in well development then modelling indicates that a separation distance of approximately 10km or greater may be necessary to achieve the recommended sleep disturbance criterion at night unless barrier mitigation or restriction to operating times are employed

The noise modelling of 50kW hydraulic well-drives has indicated that the noise of multiple wellhead operations will meet a 28 dB(A) $L_{Aeq,adj}$ noise criterion using a nominal grid spacing of 750m and a minimum separation of 600m from a dwelling, if noise contributions from other plant items are negligible. The modelling assumes that other sources of noise, such as the GPF noise, are not significant.

Additional mitigation may be required where noise from wellhead operations interacts with noise from a GPF at a receiver location. The minimum separation distances may need to be increased to maintain a total noise contribution from mechanical sources not exceeding the criterion, or noise mitigation at the wellheads may be necessary. The new distances, or degree of noise mitigation necessary, would depend upon the relative predicted levels of GPF and well noise at the particular receiver location.

The modelling indicates that well spacing and minimum separation distances may be reduced if significant intervening bushland or forest, or topographic features that provide acoustic shielding, are located between the wellheads and receivers.

Gas processing facilities

The noise emissions of reciprocating engines and screw and reciprocating compressors were modelled with partial or full driver-compressor acoustic enclosures, attenuated engine exhausts and standard and low-noise air cooler fans. Adjustments for tonal character were applied, where applicable, according to the separation distance between the source and receiver.

Partial enclosure of the engine-compressor achieves a noise reduction in the direction acoustically shielded by the partial enclosure and may be applied where the nearest receivers are located in only one direction from the GPF.

The engine-compressor acoustic enclosure coupled with standard air cooler fans achieves a noise reduction at distant receivers of approximately 6dB. The noise of the standard fan is the limiting factor for further GPF noise reduction. However, evening and night noise levels could be reduced further by using variable speed electric motors to slow the speed of the standard air-cooler fans during these periods when less cooling is necessary.

Electric drives will need to be either connected to the electricity grid or supplied with electricity from a locally sited gas turbine generator. Gas turbine generators are also a significant noise source and their siting will have similar noise constraints as a GPF. The consideration of gas generator noise was beyond the scope of this study at the time of reporting.

The low frequency C-weighted outdoor noise level of the GPFs for all plant capacities considered complies with the low frequency criterion of 60dB(C) outdoors when the predicted noise level at the receiver is equal to, or less than, 28dB(A) $L_{Aeq,adj.}$

Water treatment facilities

Noise contour modelling has been conducted for a WTF constructed with noise controls to the same standard as existing WTFs. The WTF is predicted to meet a 28dB(A) $L_{Aeq,adj}$ limit at distances greater than 1,000m from the generation plant, including a tonal adjustment of 2-3dB(A) for power generation plant hum.

This noise limit may be achieved at a reduced separation distance of 500m if the WTF building is located between the generation plant and the receptor so that the building provides an acoustic shielding to the receptor.

15.4.4 Explanation of results

The noise modelling and analysis for the gas wells and GPFs has assumed a simplified worst-case flat-terrain scenario between the noise sources and the receivers. Where ridges or hills, or significant bushland or forest is located between and close to either the source or receiver locations, substantially improved noise attenuation may be achieved compared to the flat-terrain scenario. Under such favourable siting conditions, the minimum recommended separation distances to achieve the noise criteria at sensitive receptors may be reduced.

15.4.5 Summary of impacts

Background noise levels were very low throughout the project area with evening and night RBLs typically at or below 15dBA. Sites within 1km of major highways have higher night rating background levels of up to 18dBA.

Gas well development and plant construction will be planned to address the building work construction requirements of the EP Act and the sleep disturbance criteria of the 'Planning for noise control' guideline. Well development (drilling and completion) is considered similar to construction in that the noise is transient and the duration is temporary.

Gas wells on a 750m grid and 600m minimum separation distance to a sensitive receptor will meet a planning noise level of 28dBA at the nearest residence.

GPFs will be designed to address the 28dBA planning noise level using a combination of full acoustic enclosures for the driver-compressor and standard or low noise fans for air-cooling. Variable speed electric drives will enable slower fan speeds (and noise levels) to apply during the evening and night when less cooling is necessary.

Where GPFs and wellheads contribute to the noise levels at a receiver during operation, acoustic barriers near the closest wellhead(s) may also be required to address the planning noise level, or alternatively larger separation distances will be necessary.

The C-weighted outdoor noise level of the GPFs for all plant capacities considered complies with the low frequency criterion of 60dB(C) outdoors when the predicted noise level at the receiver is equal to, or less than, the 28dBA planning noise level.

Ground vibration impacts associated with the construction phase are expected to be minimal as proposed construction methods will not generate significant vibration beyond 100m from the source, unless blasting is required. Any rock breaking that requires blasting will be designed to meet the EP Act criteria and not cause any structural damage to buildings, buried infrastructure or other sensitive structures (e.g. heritage listed sites).

15.5 Mitigation and management

15.5.1 Construction

Gas wells

Reduced separation distances between gas well drilling sites and receptors may be possible based on site specific noise analyses that account for additional noise attenuation possibilities associated with:

- Favourable topography screening
- Use of temporary barriers
- Individual agreements or arrangements with potentially affected residents.

In addition, a flare pit barrier may provide attenuation of short duration well unloading and cavitation noise to receptors in the noise shielded zone relative to the barrier, where receivers are located on only one side of the well. A flare pit barrier may reduce the minimum night separation distance from 3.5km to only 2km.

During gas well development, cavitation will be conducted during regular construction hours, if used and where practicable.

The total duration of cumulative noise impacts from drilling, at a dwelling bordering or surrounded by a proposed field of gas wells, may range from two months to two years depending on the number of wells that are simultaneously constructed nearby (nominally within 2km of) a dwelling. For dwellings likely to be exposed to well development noise from numerous nearby wells, a suitable noise management strategy will be developed.

For residents likely to be affected by gas well development noise that have not previously experienced well-drilling noise, the well development process and indicative noise levels will be described and a field inspection will be arranged, where practicable.

The EM Plan, which will include noise management, will be completed following the submission of the EIS and completion of front-end engineering and design. The EM Plan will cover the proposed drilling program and noise management within each of the gas fields' development areas. The EM Plan will refer to community consultation to ensure consistent approaches to community and landholder engagement.

The following noise controls will be incorporated as required into the layout of drill-rig sites near dwellings and other sensitive receptors:

- Modular reflective screens to reflect noise away from dwellings.
- Flare-pit noise barriers, if used, will have a length of approximately 10m in length, located 5m upstream of the flare-line end
- The current practice of directing the flare-line away from the nearest dwelling will be maintained.

Other plant and infrastructure

Construction activities undertaken out-of-hours[7] for GPFs, WTFs, pipelines and other infrastructure within 2km of a residence will be conducted subject to noise management in the EM Plan addressing the recommended construction noise limits.

[7] Sundays, evenings and nights as per EP Act, section 440R.

A minimum separation distance of 100m between pipelines and sensitive dwellings will prevent adverse vibration impacts to buildings from possible mechanical excavation methods, including trenching, excavating, rock-sawing and directional drilling.

If blasting is required, it will be designed to meet the requirements of the EP Act.

Vibration monitoring will be considered if blasting and predicted blast vibration levels are more than 20% of the statutory vibration limit values. Lower vibration goals would be considered in the case of heritage-listed structures, or where there is elevated sensitivity of persons (e.g. infirmity) or building contents to vibration.

Any construction blasting will be conducted to maintain a minimum 100m buffer from all identified cultural heritage sites as specified in Volume 2 Chapter 19, in addition to site-specific adoption of appropriate vibration management goals.

15.5.2 Operations

No additional noise mitigation is necessary for gas well operations when developed on a 750m grid with a minimum separation distance of 600m from a dwelling as this will meet the 28dB(A) criterion. If there is a need to reduce the separation distance, and the noise from other sources such as a GPF is not significant at the receiver location, then noise mitigation in the form of an acoustic barrier near the wellhead may allow the separation distance to be reduced.

Noise mitigation measures for GPF and wellhead operations will be determined on a case-by-case basis taking into account the site location, the relative location of receivers, any intervening topographic features or vegetation and the proximity of the gas field wellheads to the nearest receivers.

Where required, the driver and compressor will be housed in an acoustic enclosure with lower noise cooling fans.

The combination of acoustic enclosures, variable speed fan drives and low noise fans is predicted to meet the 28dB(A) noise criterion for the minimum recommended separation distances.

For situations where cumulative noise from GPFs and the gas wells may impact upon particular receivers, wellhead acoustic barriers may also be necessary. In these cases, an acceptable solution with respect to the GPF noise (the larger noise source) will be determined. Additional noise control will then be applied, as required to meet the noise criteria, to well-drives nearest the dwelling. The most likely form of noise control at a wellhead is a portable free-standing noise screen/barrier.

Standard building enclosure treatments similar to existing practices will be adequate to mitigate noise from WTFs. No additional noise mitigation is necessary.

Noise associated with traffic during both the construction and operational phases of the Project will be managed as part of a traffic management plan, which is included in the gas fields' EM Plan (refer to Volume 2 Chapter 25).

15.6 Conclusion

15.6.1 Assessment outcomes

A summary of the environmental values, sustainability principles, potential impacts and mitigation measures in relation to noise and vibration associated with the gas fields is presented in Table 15.4.

This table also includes the residual risk levels for noise and vibration. A risk assessment has been undertaken to identify potential risks, causes and consequences from the noise and vibration. Mitigation measures to reduce the risk have been nominated and the residual risk has been calculated. Further details on the risk assessment methodology are provided in Volume 1 Chapter 4.

Implementation of the proposed mitigation and management measures will minimise the potential impacts of noise and vibration associated with the construction and operation of the gas fields infrastructure, such that there a very low risk of potential adverse health effects or impacts on terrestrial fauna. There is a residual risk of noise disturbance during both construction, (including drilling and well completion) and operations, given the number and widespread distribution of gas wells and associated infrastructure across the gas fields.

Australia Pacific LNG is able to undertake its activities in accord with its sustainability principles by:

- Locating the gas fields' infrastructure away from sensitive receptors where ever practicable
- Using lower noise design drilling rigs, CSG wells, GPFs, WTFs and other infrastructure
- Managing construction activities to minimise noise and vibration emissions
- Negotiating acceptable mitigation and management outcomes with potentially affected people.

Table 15.4 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
Qualities of the acoustic environment that are conducive to: • health and diversity of ecosystems • human health and wellbeing to enable people to sleep, study and learn, engage in recreation and relaxation • protect the amenity of the community	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	**Construction** Annoyance of persons within hearing of noise sources Sleep disturbance Disturbance of terrestrial fauna and avifauna	Noise from construction activities (for example, clearing, trenching, rock breaking, rock-sawing, drilling) Noise from gas well drilling and completion activities (for example, drilling, cementing, fraccing, cavitation) Traffic noise, especially heavy vehicle transport of construction materials and equipment. Noise from temporary accommodation facilities (for example, generators, air conditioners, loud music)	Restrict out-of-hours (6.30pm to 6.30am) construction activities within 2km of sensitive receptors, unless alternative arrangements have been agreed with the potentially affected residents. Consult residents within 2km of proposed well sites of planned drilling and well completion activities Implement noise attenuation measures at well sites, as required (e.g. using temporary sound barriers and flare-pit barriers, orientating flare line away from nearest dwellings) Notify residents or businesses within 200m of non-standard trenching operations, such as rock-sawing, rock-hammering, before any of these activities are scheduled during standard daytime (6.30am to 6.30pm) working hours. Undertake unavoidable out-of-hours activities (e.g. drilling) in accordance with the environmental management plan that includes noise mitigation measures. Identify suitable routes and times of travel prior to well development and plant construction to reduce disturbances to residents and traffic conditions Undertake truck deliveries to construction sites during normal operating hours, when ever possible. Locate temporary accommodation facilities at appropriate distances from sensitive receptors.	Medium (for well development) Low (for all other construction activities)

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
• health and diversity of ecosystems • human health and wellbeing to enable people to sleep, study and learn, engage in recreation and relaxation • protect the amenity of the community	As above	**Operations** Annoyance of persons within hearing of noise sources Sleep disturbance Disturbance of terrestrial fauna and avifauna	Noise from operation of plant and equipment (gas wells, GPFs, WTFs, electricity generation and other infrastructure) Noise from accommodation facilities	Locate major plant sites (e.g. GPFs and WTFs) as far as practicable from noise sensitive receptors and to maximise natural noise attenuation from terrain and vegetation. Incorporate lower noise technology into plant design (e.g. cooling fans, electric drive engines), where required. Install noise attenuation barriers (sound walls) and orientate GPFs to mitigate directional noise emissions at the nearest sensitive receptors, as required. Operate gas-fired power electricity facilities in acoustic enclosures, as required. Locate accommodation facilities at appropriate distances from sensitive receptors.	Low
Life, health and wellbeing of people.	Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	**Blasting** Concern about perceived harm to property or sensitive equipment Damage to structures (cosmetic cracking, structural damage)	Ground vibration from non-standard construction activities (e.g. rock breaking and blasting)	Locate plant construction sites or pipelines that require rock-breaking and blasting at least 100m from buildings and other sensitive structures. Where required, design blasting to meet with the relevant criteria. Conduct pre- and post-construction inspections of sensitive structures and monitor during construction if predicted levels of ground vibration exceed 20% of statutory limits.	Negligible

15.6.2 Commitments

In order to manage potential impacts of airborne noise and ground vibration during gas well-development and plant and other infrastructure construction, Australia Pacific LNG will:

- Identify noise management measures for out-of-hours (6.30pm to 6.30am) construction activities within 2km of dwellings, if required, in consultation with potentially affected residents
- Develop and implement construction noise and vibration management measures on a case by case basis for potentially affected residents, as appropriate
- Orient wellhead flare lines away from the nearest sensitive receptors, wherever possible
- Schedule and identify noise management measures for cavitation activities in consultation with potentially affected residents
- Locate gas and water pipelines at appropriate distances from sensitive dwellings, commercial premises or cultural heritage listed structures to minimise the risk of harm from ground vibration associated with construction activities
- Design blasting to meet with the relevant criteria
- Identify suitable routes and times of travel prior to well development and plant construction to reduce disturbances to residents and traffic conditions
- Encourage deliveries to construction sites during normal operating hours where practicable
- Locate accommodation facilities at appropriate distances from sensitive receptors.

Australia Pacific LNG will address the planning noise level for residences or otherwise reach agreements with affected landowners to manage potential impacts of airborne noise during normal operations by:

- Planning gas well and gas processing facility locations and designing noise mitigation treatments for all plant to address the planning noise level for all operating equipment at noise sensitive receptors
- Designing the orientation of gas processing facilities and constructing noise attenuation walls to minimise directional noise emissions to nearest sensitive receptors, as required
- Utilising lower noise cooling fans for compressor engines at gas processing facilities, as required
- Incorporating noise controls into water treatment facilities
- Investigating the alternative of electric drive motors instead of gas-fired engines for gas processing facilities, water treatment facilities, and wellheads.