# Noise and vibration 17

Enter ▶ Go back to contents ▶

# Contents

## Tables



## Figures

# 17 Noise and vibration

## 17.1 Introduction

This section describes the noise and vibration aspects of the GFD Project area and surrounds.

The ambient acoustic environment of the region is characteristic of a rural environment with low background noise levels that follow a typical diurnal pattern, reducing during the evening and night time when bird, insect and road traffic activity is negligible. Existing ambient ground vibrations from industry, construction and heavy transport corridors are generally not perceptible at the majority of sensitive receptors, except at locations near where third party mines and quarries conduct blasting.

The potential impacts arising from the GFD Project activities on noise and vibration are described, mitigation measures identified. Full details of the noise and vibration assessment are provided in Appendix Q: Noise and vibration.

This section has been prepared in response to the requirements of section 4.9 of the *Terms of reference for an environmental impact statement* issued March 2013. The index to locate where each ToR requirement is addressed is included in Appendix B: Terms of reference cross-reference.

## 17.2 Regulatory context

This EIS has been prepared in accordance with the State and Commonwealth regulatory requirements described within Appendix C: Regulatory framework. Relevant legislation, policies, standards and guidelines that apply to noise and vibration values and impacts are outlined in Table 17-1.

**Table 17-1 Regulatory context – noise and vibration**

| Legislation, policy or guideline | Relevance to the GFD Project |
|---|---|
| *Environmental Protection (Noise) Policy 2008* (EPP Noise)<br>EPP Noise achieves the objectives of the Environment Protection Act 1994 (Qld) in relation to the acoustic environment by stating objectives for enhancing or protecting the environmental values and providing a framework for making consistent, equitable and informed decisions about the acoustic environment. | The EPP Noise:<br>• Identifies environmental values that are to be enhanced or protected<br>• States acoustic quality objectives for enhancing or protecting environmental values<br>• Provides a framework for making consistent, equitable and informed decisions about the acoustic environment.<br>Noise assessment criteria used in this assessment aim to protect the acoustic values of a sensitive receptor in rural or isolated areas to achieve the acoustic quality objectives set out in the EPP Noise. |
| *Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities* (Petroleum and Gas Noise Assessment guideline) (EHP, 2012)<br>The guideline enables the application of EPP Noise for petroleum and gas activities by providing best practice noise limits. | This EIS has adopted the best practice noise limits as prescribed in the guideline in assessing the potential noise impacts of the GFD Project. |
| *Planning for Noise Control* (EPA, 2004). | Prescribes applicable assessment methodology for background noise monitoring and meteorological parameters for modelling purposes, which have been applied for background noise monitoring and modelling for the GFD Project. |
| *Assessment of Low Frequency Noise* (EHP, Draft, 2013). | Outlines applicable low frequency noise criteria and assessment methodology, which have been applied for the GFD Project. |

| Legislation, policy or guideline | Relevance to the GFD Project |
|---|---|
| *Health Effects of Environmental Noise – Other Than Hearing Loss* (enHealth Council, 2004)<br>The document reviews the health effects (other than hearing loss) of environmental noises and recommends appropriate measures for managing these. | The best practice noise limits from Petroleum and Gas Noise Assessment guideline (EHP, 2012) considered in this assessment are below the most stringent of the World Health Organisation noise levels referenced by enHealth. |
| *Road Traffic Noise Management: Code of Practice* (TMR Code of Practice) (TMR, 2008)<br>The Code sets the policy and framework for the assessment, design and management of the impact of road traffic noise, including construction noise and vibration, on the built environment beside State-controlled roads in Queensland. | Outlines road traffic noise criteria for State-controlled roads applied to this assessment of the GFD Project. |
| *British Standard BS 6472:1992 Evaluation of Human Exposure to Vibration in Buildings*<br>This standard provides general guidance on human exposure to building vibration in the frequency range 1 hertz to 80 hertz. | Outlines vibration criteria for assessment of annoyance/human comfort applied to this assessment of the GFD Project. |
| *German Standard DIN 4150-3 1999 Structural Vibration – Part 3: Effects of Vibration on Structures*<br>This standard specifies methods for measuring and evaluating the effects of vibration on structures; it provides guideline values that will prevent damage to structures from vibration. | Outlines vibration criteria for assessment and protection against building damage applied to this assessment of the GFD Project. |
| *Noise Measurement Manual* (EHP, 2013)<br>This manual prescribes the process required to measure noise in accordance with the *Environmental Protection Regulation 2008.* | Outlines measurement procedures applied for background noise monitoring carried out for the GFD Project. |
| *Guideline: Noise and Vibration from Blasting* (Environmental Protection Agency, 2006)<br>This guideline sets out criteria to assist in minimising annoyance and discomfort that may be caused by blasting activities such as mining, quarrying, construction and other operations. | Blasting is not anticipated for the GFD Project; therefore, this guideline was not required for assessing the GFD Project. |
| Australian Standard AS 2187.2-2006 *Explosives – Storage and Use, Part 2 Use of Explosives* (Standards Australia, 2006).<br>This standard guides the use and management of explosives, including their destruction, in a manner where risks are acceptably minimised. | Blasting is not anticipated for the GFD Project; therefore, this guideline was not required for assessing the GFD Project. |

This EIS seeks to obtain primary approvals for the project including the Queensland Government Coordinator-Generals Report and Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Cth) approval.

Application for or amendments to existing environmental authorities will occur subsequent to this EIS process. Other subsequent approvals required after the EIS process has been completed, corresponding triggers and legislative frameworks applicable to the GFD Project are identified in Section 2: Project approvals.

Approval of this EIS will trigger a number of subsequent approvals required for the GFD Project to proceed. Approvals will be required on tenure and off-tenure. Section 2: Project approvals summarises the key approvals necessary for the planning, construction, operations and decommissioning of the GFD Project. The triggers for each approval, the relevant administering authority and application details are provided. Consultation on the subsequent approvals will be ongoing with the administering authorities.

## 17.3 Assessment methodology

This assessment describes the noise and vibration values within the GFD Project area and assesses the GFD Project's potential impacts on these values. Impacts were assessed using the compliance assessment methodology, which determined the degree to which the GFD Project complies with quantifiable guidelines set out in the Petroleum and Gas Noise Assessment guideline (EHP, 2012) to achieve the acoustic quality objectives set out in the EPP Noise. The full description of the compliance assessment methodology is described in section 5.6.3 of Section 5: Assessment framework and in Appendix Q: Noise and vibration.

Environmental values were established from baseline surveys of the ambient noise environment within the rural regions of the Surat and Bowen basins. Modelling was used to estimate the distances at which noise from typical GFD Project noise sources during assessed construction, operation and decommissioning scenarios would comply with the selected criteria at sensitive receptors. Should sensitive receptors be located closer to the noise sources, noise management and mitigation measures would be required.

Once the field planning has been completed and the location of major facilities (such as gas compression facilities) and final specifications on the size and number of equipment is known, more detailed modelling will be performed to include location-specific factors such as the surrounding topography and land use.

### 17.3.1 Assessment criteria

Noise assessment criteria were used to protect the acoustic values of a sensitive receptor in rural or isolated areas and to achieve the acoustic quality objectives set out in the EPP Noise, while considering cumulative impacts and background creep. Noise criteria were defined for assessing:

- Noise from GFD Project activities
- Low frequency noise
- Road traffic
- Vibration.

#### *Noise from GFD Project activities*

Best practice noise emission limits sourced from the *Prescribing noise conditions for petroleum activities guideline* (EHP, 2013) were used to assess GFD Project noise sources are shown in Table 17-2.

**Table 17-2 Summary of construction/decommissioning and operation noise limits**

| Time period | Parameter | Noise limit (dBA) | | |
|---|---|---|---|---|
| | | Short-term[1] | Medium-term[2] | Long-term[3] |
| 7:00 am – 6:00 pm | LAeq, adj, 15mins | 45 | 43 | 40 |
| 6:00 pm – 10:00 pm | LAeq, adj, 15mins | 40 | 38 | 35 |
| 10:00 pm – 6:00 am | LAeq, adj, 15mins | 28 | 28 | 28 |
| 6:00 am – 7:00 am | LAeq, adj, 15mins | 40 | 38 | 35 |

[1] Noise exposure lasting for no more than eight hours and does not reoccur for at least seven days.
[2] Noise exposure lasting for no more than five days and does not reoccur for at least four weeks.
[3] Noise exposure lasting for more than five days, even when there are respite periods when noise is inaudible within those five days. Most construction and operational scenarios will fall within this long term noise event specification.

It is considered that fauna (including domesticated mammals) exposed to less than 65 dBA $L_{Aeq}$ are unlikely to experience adverse impacts.

### *Low frequency noise*

Low frequency noise ranges from approximately 20 hertz (Hz) to 200 Hz. EHP's draft guideline, *Assessment of Low Frequency Noise* (2013), indicates that the overall sound pressure level inside residences should not exceed 55 Z-weighted decibels (dBZ, i.e. linear unweighted noise levels). The 2013 issue is the latest publically available version of the EHP's draft low frequency noise guideline and as such has been used for this assessment. To establish the potential for low frequency noise impacts from the GFD Project, an initial screening test has been conducted using an outdoor screening level of an equivalent continuous (or 'average') noise level 60 dBZ $L_{eq}$ (assuming 5 dB facade reduction inside dwellings).

### *Road traffic noise*

The noise criteria contained in the *Transport Noise Management Code of Practice* (TMR, 2013) has been used in this assessment for GFD Project-related traffic, as shown in Table 17-3.

**Table 17-3 Summary of road traffic noise criteria**

| Road control | Road type | Criteria |
|---|---|---|
| State-controlled road | Existing road | 68 dB $L_{A10(18hour)}$ and ≤ 2 dBA change in existing $L_{A10\ (18hour)}$ |
| | New road | 63 dB $L_{A10(18hour)}$ |
| Council-controlled road | Existing road | 63 dB $L_{A10(18hour)}$ and ≤ 2 dBA change in existing $L_{A10\ (18hour)}$ |
| | New road | 63 dB $L_{A10(18hour)}$ |

### *Vibration*

A summary of applicable vibration criteria in peak particle velocity (PPV) is shown in Table 17-4**.**

**Table 17-4 Summary of vibration criteria**

| Receiver type | Residential | Commercial |
|---|---|---|
| Property damage (cosmetic) (mm/s PPV) | 7.5 | 7.5 |
| Human comfort (mm/s PPV) | According to AS 2670 refer to Table D1 | |
| Sensitive building contents (mm/s PPV) | - | 0.5[1] |

[1] Equipment specific vibration criteria may be required for highly sensitive equipment (i.e. electron microscopes, MRI systems or similar) as part of future location-specific detailed investigations.

## 17.3.2 Modelling

Noise modelling has been undertaken to predict the distances from typical GFD Project noise sources at which the various assessment criteria discussed above would be achieved and to provide information on mitigation strategies that may be required.

The SoundPLAN (Version 7.2) environmental computer model was used to calculate noise emission levels at various distances from sources. The model considers factors such as the source sound power levels and locations, distance attenuation, ground absorption, air absorption and shielding attenuation, as well as meteorological conditions such as wind effects.

The CONCAWE prediction methodology within SoundPLAN has been used for noise predictions, with the exception of road traffic noise predictions. The CONCAWE prediction method is designed for large facilities and incorporates the influence of wind effects and the stability of the atmosphere. Noise levels have been calculated for both neutral and adverse weather conditions where appropriate.

Road traffic noise was assessed using the CoRTN prediction technique recommended in TMR's Code of Practice. These calculations account for traffic volumes, composition, vehicle speed, and road surface. Weather parameter and meteorological conditions for the GFD Project area are provided in Section 7: Climate and Section 15: Air quality.

### 17.3.3 Assumptions

The noise assessment methodology has been based on predicting noise levels at various distances, assuming propagation over flat, soft ground (i.e. open grassland) to a typical sensitive receptor. However, it is well known that topographic and vegetation features can potentially influence predicted noise levels. As discussed in section 0, these location-specific factors will be considered by remodelling once preferred locations for individual major facilities (such as gas compression facilities) are confirmed during the ongoing field development process.

## 17.4 Environmental values

The environmental values defined in the EPP Noise aim to preserve or enhance qualities of the acoustic environment that protect human health and wellbeing (i.e. by ensuring suitable environments to sleep, study, learn, be involved in recreation, relaxation and conversation, and protect the amenity of the community), as well as the health and biodiversity of ecosystems.

### 17.4.1 Existing ambient background noise levels

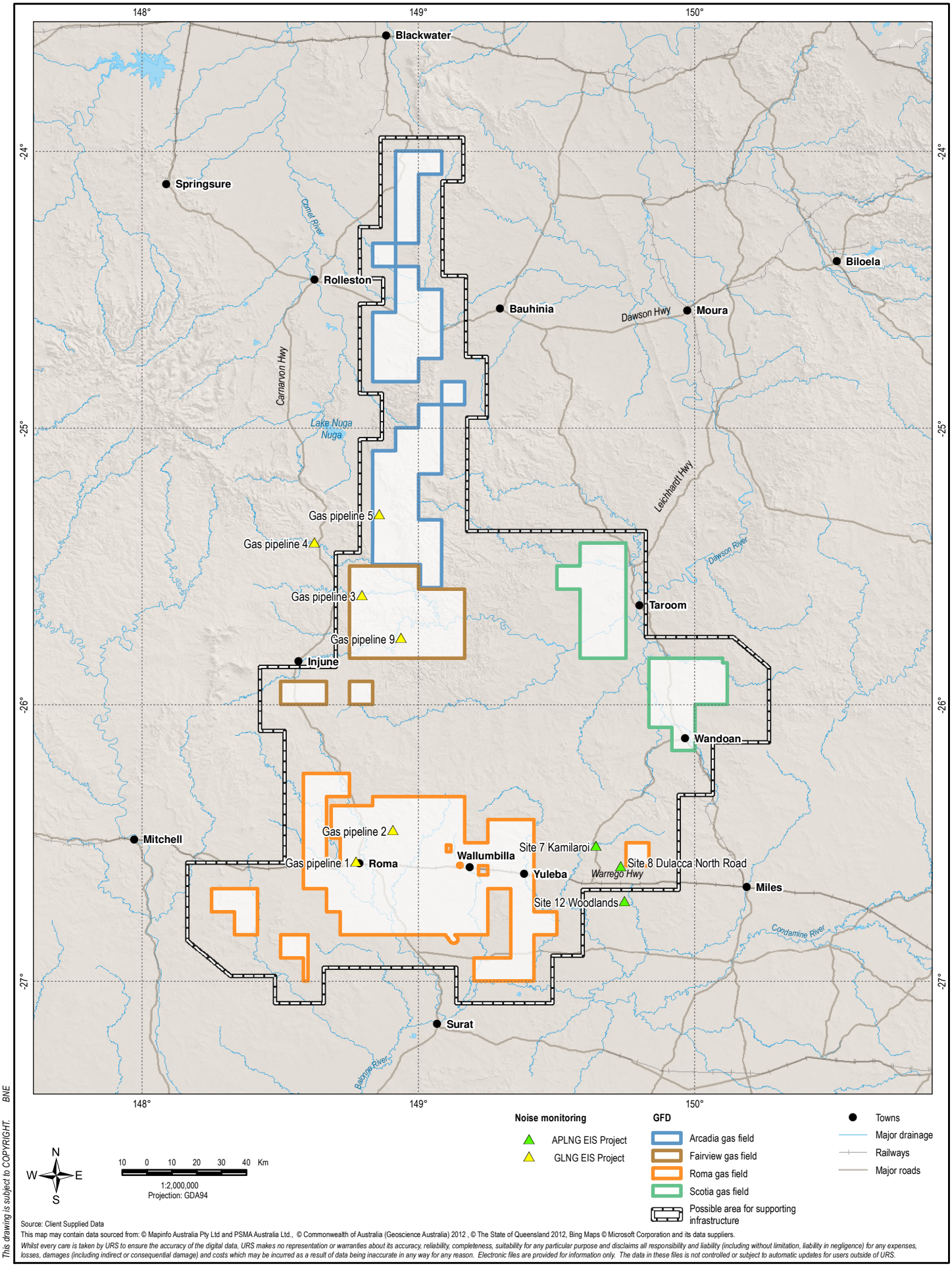
Environmental values were established from baseline surveys of the ambient noise environment within the rural regions of the Surat and Bowen basins conducted in 2008 as part of the EIS for the GLNG Project (2009 EIS) and in 2009 as part of the EIS for the Australia Pacific LNG Project EIS (Savery and Associates, 2009).

The noise monitoring locations used are shown on Figure 17-1. While there has been no specific baseline noise monitoring conducted within the Scotia gas field, the noise monitoring undertaken is representative of the typical rural environment throughout the GFD Project area, including the Scotia gas field.

The existing background noise levels at the monitoring locations were primarily influenced by local birds and insect activity consistent with the rural environment in the GFD Project area.

At some of the monitoring locations, intermittent road traffic noise from Currey Street (Roma), Warrego Highway and the Carnarvon Highway was audible during the daytime and evening periods. It was assumed that no significant road traffic noise is audible during night-time.

The noise measurements collected for the baseline survey/assessment were taken during the cooler winter months to represent worst case conditions in terms of noise propagation; in contrast, in the warmer months of the year, the ambient acoustic environment is likely to contain additional insect noise.




BNE



Source: Client Supplied Data



Santos GLNG Project

GFD PROJECT EIS

# BASELINE NOISE MONITORING LOCATIONS

URS

NOISE AND VIBRATION

Figure: 17-1

File No: 42627064-g-1059.mxd Drawn: XL Approved: RS Date: 21-08-2014 Rev. B A4

Long term noise measurements in Table 17-5 provide an indication of ambient background noise levels, including adjusted rating background levels (RBL). The RBL is the median of the 90th percentile background ($L_{A90}$) noise levels for each period over the duration of the monitoring period. The maximum hourly ($L_{Aeq}$) noise level is more sensitive than the $L_{A90}$ to short-term and peak noise generating events and is applied as a measurement of the steady noise level over the monitoring period.

**Table 17-5 Ambient background noise levels**

| Location[1] | Adjusted rating background level ($L_{A90}$ dBA) | | | Maximum hourly noise levels ($L_{Aeq(1hour)}$ dBA) | | |
|---|---|---|---|---|---|---|
| | Day | Evening | Night | Day | Evening | Night |
| Deemed background noise level[2] | 35 | 30 | 25 | - | - | - |
| **2009 EIS[3]** | | | | | | |
| Gas pipeline 1 | 37 | 34 | 28 | 58 | 53 | 55 |
| Gas pipeline 2 | 23 | 18[4] | 17[4] | 55 | 45 | 45 |
| Gas pipeline 3 | 24 | 18[4] | 18[4] | 54 | 37 | 41 |
| Gas pipeline 4 | 27 | 19[4] | 18[4] | 52 | 38 | 43 |
| Gas pipeline 5 | 21[4] | 18[4] | 17[4] | 46 | 29 | 40 |
| Gas pipeline 9 | 30 | 29 | 29 | 49 | 40 | 47 |
| **APLNG EIS[4]** | | | | | | |
| Site 7 Kamilaroi | 20 | <15[5] | <15[5] | 37 | 27 | <15[3] |
| Site 8 Dulacca North Road | 19 | <15[5] | <15[5] | 33 | 20 | 18 |
| Site 12 Woodlands | 25 | <15[5] | <15[5] | 42 | 27 | 21 |

[1] Monitoring locations were away from existing facilities and representative of typical background noise levels in the area without contribution from existing GLNG Project or APLNG Project-related facilities.
[2] Petroleum and Gas Noise Assessment guideline (EHP, 2012)
[3] 2009 EIS Noise and Vibration (Terrestrial) 20-2014-R1 (SLR, 2009)
[4] Australia Pacific LNG Project, vol 5: Attachment 32: Noise and Vibration Impact Study (Savery and Associates, 2009)
[5] Measured RBL adjusted for the measurement threshold of the noise logger.

The long-term measured noise levels follow a typical diurnal pattern with noise levels reduced during the evening and night-time periods when bird, insect and road traffic activity is negligible. Measured noise levels of below 30 dBA ($L_{A90}$) during the daytime and below 20 dBA ($L_{A90}$) during the evening and night-time are low and characteristic of rural environments with minimal noise influences. The exception was the Gas pipeline 1 location in the township of Roma, where noise levels are influenced by traffic noise from the Warrego Highway.

The deemed background noise levels according to the Petroleum and Gas Noise Assessment guideline (EHP, 2012) are the lower limit of applicable background noise levels for assessment purposes. By comparing the deemed background noise levels with the measured background noise levels presented in Table 17-5, it can be seen that the measured background levels are lower than the deemed background levels for each monitoring location except for Gas pipeline 1. Nevertheless, in accordance with the Petroleum and Gas Noise Assessment guideline (EHP, 2012), the deemed background noise levels have been adopted for noise sensitive receptors associated with the GFD Project.

### 17.4.2 Existing ground vibration levels

Existing ambient ground vibrations are not expected to be perceptible at the majority of sensitive receptors in the GFD Project area. The exceptions to this would be sensitive receptors located near third party mines and quarries that conduct blasting. Existing and future planned mining projects in the GFD Project area that may include blasting are included in appendix B of Appendix Q: Noise and vibration. Other existing sources of ground vibration would be industry, construction and heavy transport corridors. These activities generally result in perceptible vibrations within 70 m of the vibration source. It is unlikely that many receptors within the GFD Project are currently exposed to ground vibrations from these sources.

## 17.5 Potential impacts

Potential noise impacts could occur when the assessment criteria discussed in section 17.3.1 are exceeded. This can be expected when the noise sensitive receptor is located closer to the noise source than the impact distance (distance at which a specified noise criteria is met without noise management or mitigation measures). Should this occur, noise management and mitigation measures will be required to enable the criteria to be met.

The potential noise impacts on environmental values that may occur as a result of the GFD Project are outlined in Table 17-6.

**Table 17-6 Potential impacts**

| Environmental value | Potential impact |
|---|---|
| Health and wellbeing | Noise and vibration emissions from the GFD Project could contribute to an exceedance of the criteria outlined within section 17.3.1, which may result in annoyance, stress, sleep disturbance and reduced wellbeing. |
| Fauna health and wellbeing | Noise emissions from the GFD Project could contribute to an exceedance of noise emissions greater than 65 dBA $L_{Aeq}$ potentially disturbing native fauna. |
| Property | Vibration emissions from the GFD Project could contribute to an exceedance of the criteria outlined within section 17.3.1, which may result in cosmetic damage. |

GFD Project infrastructure and corresponding construction, operation and decommissioning activities, including timing and duration, are described in Section 4: Project description. A number of scenarios representative of GFD Project construction, operation and decommissioning, and transportation activities were used to predict potential noise impacts on sensitive receptors.

Noise level predictions for activities likely to occur during the day-time period were assessed under neutral meteorological conditions. Activities that are likely to occur 24 hours a day (i.e. drilling) were assessed for adverse meteorological conditions (where temperature inversions are considered applicable).

Predicted construction noise levels will inevitably depend upon the number of plant items and equipment operating at one time and on their precise location relative to the sensitive receptor(s). Therefore a sensitive receptor will experience a range of values representing “minimum” and “maximum” construction noise emissions depending upon:

- The location of the particular construction activity (i.e. if the plant item of interest were as close as practical to or further away from the sensitive receptor of interest)
- The likelihood of the various items of equipment operating simultaneously.

### 17.5.1 Construction

The assessed construction scenarios are shown in Table 17-7. Drilling and completion activities will occur 24 hours a day, with the remaining major noise-generating construction activities likely to occur in daytime. The drilling and completion scenario has been modelled both with and without the blooie line operating. The blooie line is a surface pipe that discharges air, water and well cuttings during drilling operations. The higher noise emission from the blooie line is mostly during the primary jet discharge, which lasts for a few minutes when connecting a new drill pipe to the drill string.

Table 17-7 Modelled construction scenarios

| Scenario | Activity specification |
|---|---|
| Drilling and completion | Well lease construction |
| | Drilling rig |
| | Hydraulic fracturing and commissioning |
| | Completions rig |
| Facilities such as hub and nodal gas compression facilities | Clear and grade |
| | Concrete pad and foundations |
| | Set up facilities |
| | Construct compressors and coolers |
| Gathering lines and infield transmission pipelines | Clear and grade |
| | Stringing, welding and joint coating |
| | Pressure testing |
| | Trenching |
| | Lowering of pipe |
| | Padding and backfilling |
| | Tie-ins, push sections and road crossings |
| | Restoration and rehabilitation |
| Borrow pits | Excavating material |
| Laydown areas | Clear and grade |
| | Laydown yard operations |
| Communication infrastructure | Clear and grade |
| | Civil works |
| Roads/access tracks (similar to power lines) | Clear and grade |
| | Civil works |

#### *Noise*

Predicted noise levels at various impact distances for the construction scenarios are presented in Table 17-8, while Table 17-9 shows the distances at which various noise levels are experienced. The data presented in these tables show that the highest noise levels are associated with drilling activities.

Table 17-9 shows that for night-time drilling activities (typically only occurring for a period of two weeks), the noise criterion of 28 dBA (Table 17-2) will be achieved at sensitive receptors which are at distances greater than 2,800 m from the drilling. Should a blooie line (a flow line from the wellhead to a flare pit) be operating, the distance is 4,400 m. For sensitive receptors closer to the source, noise management and mitigation measures may be required.

For other construction activities, Table 17-2 shows that the noise criterion is 35 dBA (assuming construction activities are limited to 6 am to 10 pm). Table 17-9 shows that for the other construction activities the distances at which the criterion will be achieved vary from 850 m to 1,700 m depending on the activity. For sensitive receptors closer to the source, noise management and mitigation measures may be required.

**Table 17-8 Predicted construction noise levels at various distances**

| Construction scenario | Weather conditions | Predicted noise level at distance (dBA $L_{Aeq}$)[1] | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 50 m | 100 m | 250 m | 500 m | 1,000 m | 2,000 m | 5,000 m |
| Drilling and completion[2] | Adverse | 79 (86) | 73 (80) | 64 (72) | 55 (63) | 44 (53) | 33 (42) | 16 (25) |
| Facilities | Neutral | 75 | 68 | 57 | 48 | 40 | 31 | 15 |
| Gathering lines | Neutral | 72 | 65 | 54 | 45 | 37 | 28 | < 15 |
| Borrow pits | Neutral | 76 | 70 | 58 | 50 | 42 | 32 | 17 |
| Laydown areas | Neutral | 70 | 64 | 52 | 43 | 35 | 26 | < 15 |
| Power lines and communications | Neutral | 70 | 64 | 52 | 43 | 35 | 26 | < 15 |
| Access tracks | Neutral | 67 | 60 | 49 | 41 | 33 | 24 | < 15 |

[1] Predictions are based on the expected summation of noise sources at the receiver for the noisiest construction stage.
[2] Values in brackets include operation of blooie line.

**Table 17-9 Distances for various predicted construction noise levels**

| Construction scenario | Weather conditions | Distance to predicted noise level (m) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 65dBA | 55dBA | 50dBA | 45dBA | 40dBA | 35dBA | 30dBA | 28dBA | 25dBA |
| Drilling and completion[1] | Adverse | 250 (450) | 500 (900) | 700 (1,200) | 950 (1,700) | 1,300 (2,300) | 1,800 (3,100) | 2,500 (4,000) | 2,800 (4,400) | 3,300 (5,100) |
| Facilities | Neutral | 150 | 300 | 450 | 650 | 1,000 | 1,500 | 2,100 | 2,400 | 2,900 |
| Gathering lines | Neutral | 150 | 250 | 350 | 550 | 800 | 1,200 | 1,800 | 2,000 | 2,500 |
| Borrow pits | Neutral | 150 | 350 | 500 | 800 | 1,200 | 1,700 | 2,400 | 2,700 | 3,200 |
| Laydown areas | Neutral | 100 | 200 | 300 | 450 | 650 | 1,000 | 1,500 | 1,700 | 2,100 |
| Power lines and communications | Neutral | 100 | 200 | 300 | 450 | 650 | 1,000 | 1,500 | 1,700 | 2,100 |
| Access tracks | Neutral | 100 | 150 | 250 | 350 | 550 | 850 | 1,300 | 1,500 | 1,900 |

Grey cells indicate noise management and mitigation measures required to achieve noise limits.
[1] Values in brackets include operation of blooie line.

The distances where the noise criterion is predicted to be achieved for fauna during construction activities are detailed in Table 17-10. For construction of facilities and infrastructure, noise predictions show that distances of greater than approximately 100 m to 150 m will achieve the noise criterion of 65 dBA $L_{Aeq}$ to mitigate impacts on fauna. For drilling under adverse weather conditions, the noise criterion is predicted to be achieved for distances greater than 250 m, and for distances greater than 450 m with blooie line operation.

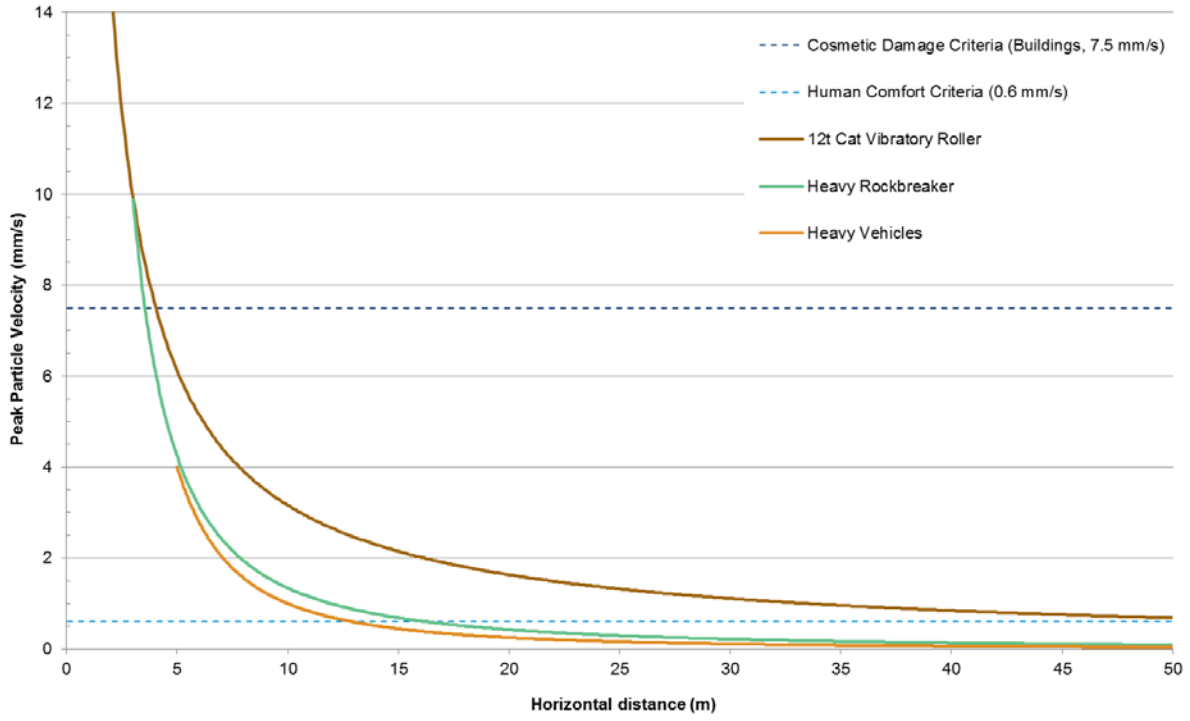
Table 17-10 Distances for construction noise impacts on fauna

| Phase | Noise criterion | Activity / conditions | Maximum impact distance (m) |
|---|---|---|---|
| Construction | 65 dBA $L_{Aeq}$ | Construction of facilities and infrastructure | 100-150 |
| | | Drilling (adverse weather) | 250 |
| | | Blooie line operation (adverse weather) | 450 |

### *Vibration*

The typical maximum levels of ground vibration from rock breaking, vibratory rollers and heavy vehicle movements sourced from the SLR Vibration Measurement Database are shown in Figure 17-2. Heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels, typically ranging from 0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m to 20 m from a roadway. Very large surface irregularities can cause levels up to 5 to 10 times higher. Based on a rough gravel access road, vibration levels of up to 1 mm/s at 10 m from the access road have been assumed.

Figure 17-2 Maximum ground vibration from rock breaking, vibratory rollers and heavy vehicles




The distances required to achieve the building damage criterion for the GFD Project is approximately five metres from construction work (excluding blasting). The distance required to achieve the human comfort criterion for sensitive receptors is approximately 20 m for rockbreaking and heavy vehicle movements rough gravel access roads and approximately 50 m for a heavy vibratory roller. Piling associated with facilities construction has been assumed to be undertaken by bored piling, which generates less vibration than the rockbreaker.

### 17.5.2 Operations

The operations scenarios involved an assessment of typical facilities under a range of operating scenarios. Consistent with the current design and operations of these facilities, both non-electrified (facilities with their own electricity generation facilities) and electrified (facilities connected to the electricity grid) were assessed. The operations scenarios in Table 17-11 are assumed to operate 24 hours a day.

**Table 17-11 Modelled operations scenarios**

| Scenario | Activity specification |
|---|---|
| Hub gas compression facility | Non-electrified |
| | Electrified |
| | Flaring |
| Nodal gas compression facility | Non-electrified |
| Water management facility | - |
| Production well | Non-electrified |
| | Electrified or free flowing |
| Accommodation camp (400 man) | - |

The predicted noise levels during operations (which can occur 24 hours a day) at various distances from a number of operation scenarios (under adverse weather conditions) are presented in Table 17-12. The potential impact distances to various noise levels have been presented in Table 17-13. The data presented in these tables show that the highest noise levels are associated with the operation of a hub gas compression facility. Table 17-13 shows that for a hub gas compression facility under normal operating conditions, the night-time noise criteria of 28 dBA will be achieved where sensitive receptors are at distance greater than 5,500 m (non-electrified) and 4,100 m (electrified). For other facilities, Table 17-13 shows that the distances at which the criterion will be achieved vary from 950 m to 3,500 m. For well operation, Table 17-13 shows that the distances at which the criterion will be achieved is 550 m (non-electrified) and 110 m (electrified/free-flowing).

For sensitive receptors closer to the source than the above identified impact distances, the implementation of noise management and mitigation measures may be required.

**Table 17-12 Predicted operations noise levels at various distances (adverse conditions)**

| Operation scenario | Predicted noise level at distance (dBA $L_{Aeq}$) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 50 m | 100 m | 250 m | 500 m | 1,000 m | 2,000 m | 5,000 m |
| Hub gas compression facility (non-electrified) | 84 | 78 | 69 | 62 | 53 | 44 | 30 |
| Hub gas compression facility (electrified) | 78 | 72 | 62 | 55 | 47 | 39 | 24 |
| Nodal gas compression facility | 78 | 72 | 63 | 55 | 46 | 37 | 21 |
| Water management (desalination) facility | 58 | 52 | 44 | 36 | 27 | 17 | <15 |
| Well (non-electrified) | 51 | 45 | 36 | 28 | 20 | <15 | <15 |
| Well (electrified/free-flowing) | 37 | 28 | 20 | 15 | <15 | <15 | <15 |
| Gas compression facility - flaring | 81 | 75 | 67 | 59 | 51 | 41 | 25 |
| Accommodation camp | 64 | 59 | 50 | 42 | 34 | 25 | <15 |

Table 17-13 Distances for various predicted operations noise levels (adverse conditions)

| Operation scenario | Distance to predicted noise level (m) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 65dBA | 55dBA | 50dBA | 45dBA | 40dBA | 35dBA | 30dBA | 28dBA | 25dBA |
| Hub gas compression facility (non-electrified) | 400 | 900 | 1,300 | 1,900 | 2,700 | 3,700 | 4,900 | 5,500 | 6,500 |
| Hub gas compression facility (electrified) | 200 | 500 | 800 | 1,200 | 1,800 | 2,600 | 3,600 | 4,100 | 4,800 |
| Nodal gas compression facility | 250 | 500 | 750 | 1,200 | 1,700 | 2,300 | 3,200 | 3,500 | 4,200 |
| Water management (desalination) facility | <50 | 80 | 130 | 250 | 350 | 550 | 800 | 950 | 1,200 |
| Well (non-electrified) | <50 | 50 | 60 | 110 | 180 | 300 | 450 | 550 | 700 |
| Well (electrified/free-flowing) | <50 | <50 | <50 | <50 | <50 | 60 | 80 | 110 | 150 |
| Flaring at gas compression facility | 300 | 700 | 1,100 | 1,600 | 2,200 | 3,000 | 3,900 | 4,400 | 5,100 |
| Accommodation camp | <50 | 160 | 250 | 400 | 600 | 900 | 1,400 | 1,600 | 2,000 |

Grey cells indicate where noise management and mitigation measures may be required to achieve noise limits.

The distances where the noise criterion is predicted to be achieved for fauna during operations are detailed in Table 17-14. For facility operations, the worst case is for the hub gas compression facility for which the noise criterion is achieved at distances greater than 400 m under adverse weather conditions. For well operation the distance to achieve the noise criterion is 12.5 m (non-electrified) and 4 m (electrified or free flowing) from the well head under adverse weather conditions.

Table 17-14 Distances for operations noise impacts on fauna

| Phase | Noise criterion | Activity / conditions | Maximum impact distance (m) |
|---|---|---|---|
| Operation | 65 dBA $L_{Aeq}$ | Hub gas compression facility (adverse weather) | 400 |
| | | Well (non-electrified) (adverse weather) | 12.5 |
| | | Well (electrified or free flowing) (adverse weather) | 4 |

### 17.5.3 Decommissioning and rehabilitation

Generally, decommissioning will consist of disconnection of services and disassembly. The wells and surface infrastructure are decommissioned and the surrounding area rehabilitated. This is similar to the construction of these facilities, but in reverse and with slightly lower noise emissions. The construction modelling scenarios detailed above will therefore be representative of a maximised assessment for the decommissioning and rehabilitation phase.

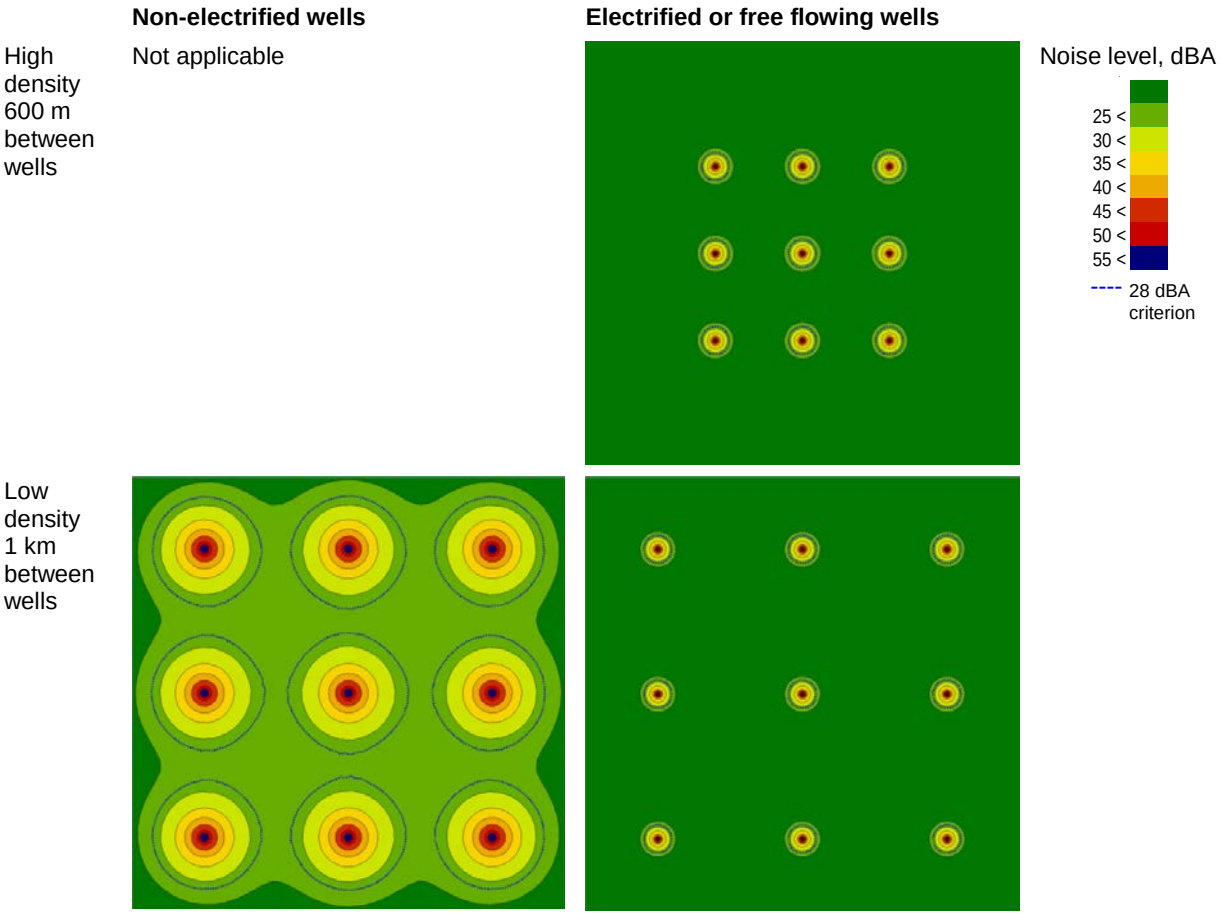
### 17.5.4 Cumulative impacts

Where GFD Project infrastructure is co-located, the cumulative noise levels predicted to be generated have been assessed, and where practicable, impact distances generated as discussed below.

#### *Multiple well leases*

The predicted noise contours for multiple well leases at high density (600 m spacing) and low density (1 km spacing) is illustrated in Figure 17-3.

Figure 17-3 Cumulative noise levels from high and low density production well configurations




Generally, development scenarios involving higher well densities will result in electrification of wells via either centralised power generation facilities (at the hub gas compression facilities) or connection to the electricity grid. As can be seen from Figure 17-3, the potential development scenarios will not result in overlap or cumulative noise impacts from adjacent wells.

### *Well leases adjacent to gas compression facilities*

There is potential for cumulative noise impacts from well leases located adjacent to gas compression facilities. Modelling has shown that the potential impact distances beyond which cumulative impacts will be avoided are 130 m (electrified or free flowing well) to 450 m (non-electrified well), for a well lease located between 4,000 m and 5,000 m from a non-electrified hub gas compression facility or between 2,500 m and 3,000 m from a nodal or electrified hub gas compression facility.

### *Co-location of water management facility and gas compression facility*

There will be a negligible increase to noise emissions in instances where water management (desalination) facilities are co-located with gas compression facilities. This is because the noise emissions from water management (desalination) facilities are predicted to be at least 10 dBa lower than that of the gas compression facilities; as a result, the total facilities' emissions will be dominated by that of the gas compression facility.

### 17.5.5 Low frequency noise

Similar to the noise predictions for the A-weighted (dBA) noise levels discussed above, the linear unweighted noise levels (dBZ) have been predicted to assess potential low frequency impacts. The predicted distance to achieve the internal low frequency criterion of 55 dBZ was shorter compared to the corresponding impact distance to achieve the overall A-weighted criteria. This means that if the night-time noise criterion of 28 dBA $L_{Aeq}$ is achieved, the low frequency criterion will also be achieved.

### 17.5.6 Vibration

There is no significant vibration-generating plant or equipment associated with the operation of the GFD Project that has the potential to cause vibration levels perceivable outside the construction or development area. No significant vibration impacts are anticipated from the operation of the GFD Project.

### 17.5.7 Transportation

For State-controlled roads, where traffic volume predictions are available, road traffic noise levels at different impact distances from the roads have been predicted.

For Council-controlled roads and access roads, where no traffic volume predictions are available:

- Overall traffic noise levels are assessed based on assumed GFD Project-related traffic numbers and speeds
- Incremental changes in traffic noise levels are assessed based on assumed GFD Project-related traffic and existing traffic volumes.

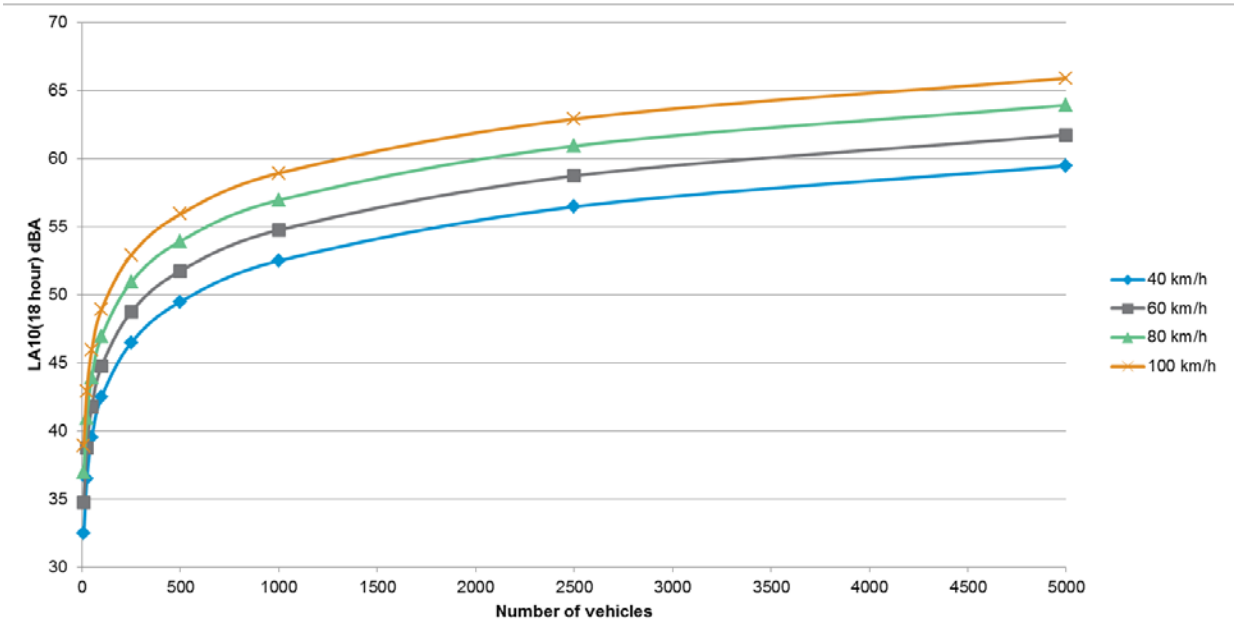
#### *State-controlled roads*

The relationship between road traffic noise at a distance of 25 m from the road edge for a range of traffic volumes and speeds is shown in Figure 17-4. The noise levels are for a dense graded asphalt road surface which is typical for a State-controlled highway. This shows that the road traffic noise criterion of 68 dBA $L_{A10(18hour)}$ described in Table 17-3 is achieved for traffic volumes less than 5,000 vehicles per day.

The predicted traffic volumes for existing plus maximum GFD Project traffic (Appendix M: Traffic and transport) are less than 5,000 vehicles per day for relevant State-controlled roads except for the Carnarvon Highway and the Warrego Highway. Hence, apart from these exceptions, the noise criterion will be met on State-controlled roads.

For the Carnarvon Highway, the peak existing plus GFD-Project traffic volume is predicted to be 5,368 vehicles per day and by extrapolating Figure 17-4 it can be seen that the criterion of 68 dBA $L_{A10(18hour)}$ would be met. For the Warrego Highway, the maximum existing plus GFD-Project traffic volume is predicted to be 17,107 vehicles per day. While this would exceed 68 dBA $L_{A10(18hour)}$, noise modelling has shown that the incremental change in road traffic noise levels due to the contribution of the GFD-Project traffic for this road is less than 2 dBA and hence the road traffic noise criterion in Table 17-3 is achieved.

**Figure 17-4** Relationship between road traffic noise level, traffic volume and vehicle speed



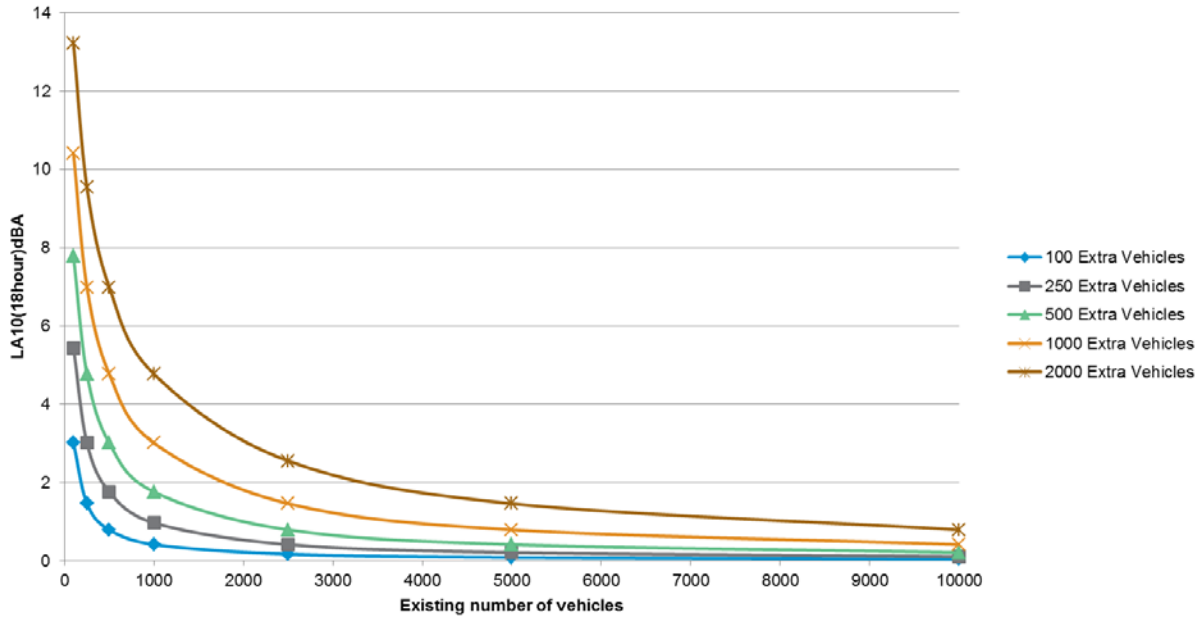

Note: Road traffic noise levels are predicted at an off-set distance from the road pavement edge of 25 m.

### *Council-controlled roads and access roads*

Data relating to existing and GFD-Project traffic volumes on council-controlled roads and access roads within the GFD Project area are currently not available. Therefore potential impacts have been assessed on the basis of the change in $L_{A10(18hour)}$ road traffic noise levels as a result of the increase in traffic volumes generated by the GFD Project on the these roads.

Figure 17-5 shows the predicted change in road noise for additional traffic volumes for a range of existing traffic flows assuming that the proportion of heavy vehicles, traffic speed and road surface remain constant.

**Figure 17-5 Change in road traffic noise levels with additional traffic**



The relationship between additional traffic and road traffic noise shown in Figure 17-5 has been summarised in Table 17-15.

**Table 17-15 Relationship between traffic volume changes and $L_{A10(18hour)}$ noise levels**

| Increase/decrease in traffic volumes (%) | Change in $L_{A10(18hour)}$ noise level (dBA) |
|---|---|
| 10 | 0.4 |
| 25 | 1.0 |
| 50 | 1.8 |
| 75 | 2.4 |
| 100 | 3.0 |

Table 17-15 shows that an increase in traffic volumes of approximately 50% would result in less than 2 dBA change in noise level and achieve the incremental change noise criterion of less than 2 dBA for existing council-controlled roads (Table 17-3). This equates to approximately 1,000 GFD-Project related traffic movements on a council-controlled road with background traffic of 2,000 vehicle movements as illustrated in Figure 17-5.

The above relationship between additional traffic and road traffic noise assumes a constant percentage of heavy vehicles. Should the ratio of heavy vehicles to light vehicles change as a result of the GFD Project, the potential impacts are shown in Table 17-16.

**Table 17-16 Relationship between percentage heavy vehicle movements and $L_{A10(18hour)}$ noise levels**

| Existing %HV | Change to noise levels (dBA) vs future %HV | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% |
| 5% | - | 0.9 | 2.3 | 3.4 | 4.3 | 5.0 | 5.6 | 6.1 | 6.6 |
| 10% | -0.9 | - | 1.4 | 2.5 | 3.3 | 4.0 | 4.7 | 5.2 | 5.7 |
| 20% | -2.3 | -1.4 | - | 1.1 | 1.9 | 2.6 | 3.2 | 3.8 | 4.3 |
| 30% | -3.4 | -2.5 | -1.1 | - | 0.9 | 1.6 | 2.2 | 2.7 | 3.2 |
| 40% | -4.3 | -3.3 | -1.9 | -0.9 | - | 0.7 | 1.3 | 1.9 | 2.3 |
| 50% | -5.0 | -4.0 | -2.6 | -1.6 | -0.7 | - | 0.6 | 1.1 | 1.6 |

## 17.6 Mitigation measures

Santos GLNG's management framework, described in Section 6: Management framework, includes the Environment Hazard Standard EHS12 Noise emissions, which defines requirements for managing noise from operations that may impact on the surrounding environment.

The Noise management plan (NMP) (Appendix Y-K) outlines the strategy and procedures developed by Santos GLNG to manage noise emissions of the GLNG Project, and will apply to the GFD Project. The objectives of the NMP are to:

- Facilitate compliance with relevant State legislation, regulations and approvals
- Facilitate compliance with EHS12 Noise emissions
- Provide a framework for Santos GLNG to:
  - Minimise noise emissions from Santos GLNG assets and activities
  - Engage stakeholders including landholders and local communities in assisting Santos GLNG in the identification and management of noise emissions
  - Identify, monitor and prioritise the management of noise emissions present on Santos GLNG assets and activities
  - Minimise nuisance noise emissions to sensitive receptors.

Based on the noise management principles and hierarchy of the EPP Noise, the NMP outlines the following noise management strategy:

- Avoid — plan the activity and engage with potentially affected stakeholders
- Minimise — implement noise mitigation measures to minimise noise impacts
- Manage — conduct monitoring, review mitigation methods and ensure compliance with Santos GLNG procedures.

Santos GLNG is committed to implementing the mitigation measures in Table 17-17 to manage potential noise impacts as outlined in the NMP. The measures discussed in this section will be considered during the planning and scheduling of GFD Project activities to minimise noise impacts at nearby sensitive receptors.

Community consultation prior to noisy work proceeding (especially night-time works) is an important step in forging mutually beneficial relationships between involved parties.

Due to safety and construction issues, drilling activities are conducted 24 hours a day, with the drilling works at an individual location typically complete within two to three weeks. Potentially affected residencies would be contacted and consulted with regards to scheduled works prior to commencing the work. If night-time construction activities are undertaken at major facility locations then specific planning, mitigation and consultation with potentially affected parties may be required.

Table 17-17 Mitigation measures

| Management plan | Mitigation measures |
|---|---|
| GFD Project environmental protocol for constraints planning and field development (the Constraints protocol) | The Constraints protocol applies to all gas field related activities. The scope of the Constraints protocol is to:<br>• Enable Santos GLNG to comply with all relevant State and Federal statutory approvals and legislation<br>• Support Santos GLNG's environmental policies and the General Environmental Duty (GED) as outlined in the EP Act<br>• Promote the avoidance, minimisation, mitigation and management of direct and indirect adverse environmental impacts associated with land disturbances<br>• Minimise cumulative impacts on environmental values.<br>The Constraints protocol provides a framework to guide placement of infrastructure and adopts the following management principles:<br>• Avoidance — avoiding direct and indirect impacts<br>• Minimisation — minimise potential impacts<br>• Mitigation — implement mitigation and management measures<br>• Remediation and rehabilitation — actively remediate and rehabilitate impacted areas<br>• Offset — offset residual adverse impacts in accordance with regulatory requirements.<br>The Constraints protocol enables the systematic identification and assessment of environmental values and the application of development constraints to effectively avoid and/or manage environmental impacts.<br>Noise is identified as a planning constraint within the Constraints protocol. Noise constraints will be identified and managed in accordance with the Noise Management Plan. |
| Blast management plan, if required | Blasting is not anticipated for the GFD Project. However should it be necessary, a blast management plan will be developed prior to blasting activity occurring in accordance with Australian Standard 2187 *Explosives - Storage, Transport and Use*. |
| Draft environmental management plan<br>(Draft EM plan) | The Draft EM plan provides the environmental monitoring and assessment approach Santos GLNG implements across its development activities.<br>Monitoring and reporting requirements are outlined within the Noise management plan and Draft EM plan, which include objectives to be achieved to protect the noise environment.<br>Noise monitoring and compliance testing will be conducted by a suitably qualified person in accordance with the prescribed standards in the Noise Measurement Manual (EHP, 2013) and the *AS1055.1-1997 Acoustics - Description and Measurement of environmental noise - Part 1: General Procedures*. |

| Management plan | Mitigation measures |
|---|---|
| Noise management plan (NMP) | The NMP identifies potential noise impacts from Santos GLNG activities and provides a strategy, methods and controls to:<br>• Avoid — plan the activity and engage with potentially affected stakeholders<br>• Minimise — implement noise mitigation measures to minimise noise impacts<br>• Manage — conduct monitoring, review mitigation methods and ensure compliance with Santos GLNG procedures.<br>Noise will be managed in accordance with the NMP, which details:<br>• Risk / constraint analysis methods to be undertaken prior to new operation or installation of new equipment that has the potential to create noise nuisance<br>• Procedures and methods to undertake noise assessments to assess compliance with the stipulated noise limits<br>• Procedures for handling noise complaints, and procedures for community liaison and consultation<br>• Details of petroleum activities and measured and / or predicted noise levels of noise sources associated with those activities<br>• Reasonable and practicable control or abatement measures to ensure compliance with the established noise limits<br>• Mediation processes to be used in the event that noise complaints are not able to be resolved.<br>The NMP provides the following:<br>• Overview of noise management strategies<br>• Description of relevant roles and responsibilities<br>• Noise monitoring procedures including a noise measurement form specifying relevant noise parameter and information that as a minimum should be documented when undertaking compliance noise monitoring<br>• Summary of the noise-related environmental authority conditions<br>• Overview of potential non-compliance issues and methods for re-establishing compliance, as practicable<br>• Community liaison and consultation procedures<br>• Complaint management procedures.<br>The NMP also outlines a process for assessing and managing noise issues in the following manner:<br>• Identifying noise producing activity<br>• Identifying the duration of the activity from short-term to long-term<br>• Identifying the time periods that the activity will be carried out and defining background noise levels<br>• Predicting the noise levels resulting from the activity at sensitive receptor(s)<br>• Assessing the risk for the activity and following relevant noise protocols accordingly.<br>The NMP also sets out the noise control hierarchy adopted by Santos GLNG:<br>• Elimination of the noise source (i.e. facilities to be located outside estimated impact distances in Table 17-9 and Table 17-13, where practical).<br>• Substitution with quieter equipment/process (at the planning stage investigate alternative quieter equipment)<br>• Engineering noise controls at the source (e.g. upgraded exhaust silencers, enclosures). The noise emissions from the treated plant could typically be reduced by 10 dBA to 20 dBA<br>• Treatment of the noise propagation path (e.g. noise barriers, orientation and location of plant items). The noise emission at sensitive receptor could typically be reduced by 5 dBA to 15 dBA<br>• Noise mitigation measures at the sensitive receptor. Appropriate measures to be negotiated through community liaison controls. |

### *Monitoring and review*

Noise monitoring, recording and corrective action will be undertaken to assess compliance with the applicable environmental authority noise limits when triggered by a noise complaint. Noise monitoring will be conducted by a suitably qualified person in accordance with the NMP. Should the administering authority advise Santos GLNG of a complaint alleging noise nuisance, the complaint will be investigated as soon as practicable. Investigations in accordance with the environmental authority conditions will usually involve monitoring and actions proposed to resolve the complaint.

## 17.7 Conclusion

This noise and vibration assessment has established the potential for noise impacts at various propagation distances associated with the major project activities and noise generating infrastructure. It is based on an assessment against regulatory criteria and published guidelines, in order to protect the health and wellbeing of people and fauna. This information will be incorporated into the planning process for construction, operation and decommissioning of the GFD Project.

If during project planning a risk of noise impact above these criteria is identified, mitigation activities such as detailed modelling and/or physical, engineering or other mitigation controls will be implemented in consultation with the landholder.