11. Noise and vibration

This section presents the results of the noise and vibration assessment for the Project undertaken by Heggies. This section includes the following:

- Results of ambient noise monitoring conducted at (or near) seven residential locations in the communities surrounding the Project
- Recommended noise and vibration limits and criteria
- Noise and vibration impact assessment
- Mitigation measures to be implemented during the construction and operational phases of the Project

11.1 Existing noise environment

11.1.1 Background noise monitoring locations

In order to determine the existing noise environment in the vicinity of the Project, long-term unattended noise monitoring was undertaken at seven locations in the surrounding communities between Wednesday 20 February and Thursday 6 March 2008. Noise monitoring was repeated at Location 1 between Thursday 6 March and Wednesday 19 March 2008 due to a logger failure during the initial measurements.

The noise monitoring locations are illustrated in Figure 11.1, while Table 11.1 summarises the noise monitoring locations.

Table 11.1 Noise monitoring locations

Location	Sensitive Receptor Number	GPS Coordinates	Comments	Photo
1	23	-24.001600° 151.059967°	Logger located near boulders in front of yard	
2	14	-23.963033° 151.064433°	Logger located along fence adjacent to river	

Location	Sensitive Receptor Number	GPS Coordinates	Comments	Photo
3	15	-23.980433° 151.017726°	Logger located within back corner of tennis court	
4	30	-23.879444° 151.013910°	Logger located in garden in front of yard	
5	42	-23.810083° 151.001500°	Logger located along driveway fence line adjacent to house (approximately 4-5 m away)	
6	4	-23.839668° 151.100402°	Logger located near driveway adjacent to house (approximately 6-8 m away)	

Location	Sensitive Receptor Number	GPS Coordinates	Comments	Photo
7	13	-23.843883° 151.126917°	Logger located 1m from facade of shed (shed approximately 240 m from existing rail line)	

The noise monitoring locations were chosen to provide spatial coverage of the communities surrounding the Project. Each location is considered to be representative of the residential area in which it is located in terms of the existing noise environment and any potential noise impacts associated with the Project.

Attended noise measurements were also conducted at each site to confirm background noise levels and to observe typical noise sources associated with the ambient noise environment during the daytime, evening and night-time periods. The attended noise measurements were conducted for one 15 minute period during each of the day (7.00 am to 6.00 pm), evening (6.00 pm to 10.00 pm) and night (10.00 pm to 7.00 am) time periods at each location (ie three 15 minute attended measurements were undertaken at each location). These measurements occurred between 5 and 6 March 2008.

Weather data (15 minute) over the noise monitoring period was sourced from the Bureau of Meteorology (Gladstone Airport). The weather conditions during the monitoring period were generally fine, with temperatures ranging from 22°C to 29°C, with slight breezes (below 5 m/s) blowing generally from the south and east. Some rainfall was recorded during the monitoring period (these periods have been excluded from the measurement results). The weather conditions during the remainder of the monitoring period are considered to be suitable for background noise measurements. All these weather conditions described as occurring during the monitoring are within the acceptable tolerances nominated in AS 1055 Acoustics - Description and Measurement of Environmental Noise.

11.1.2 Instrumentation

The monitoring was undertaken using Acoustic Research Laboratories Type EL-215 and EL-316 Environmental Noise Loggers programmed to record various statistical noise levels over consecutive 15 minute intervals. Each logger was checked for calibration before and after the survey with a Rion NC-73 Sound Level Calibrator and no significant drift (greater than 1 dBA) in calibration was detected.

ARL EL-215 Noise Loggers are National Association of Testing Authorities (NATA) certified Type 2 Meters. ARL EL 316 Noise Loggers are NATA certified Type 1 meters. It is common practice to use Type 1 or 2 noise loggers for measuring background noise levels in accordance with the *Queensland Environmental Protection (Noise) Policy 1997* (EPP(Noise)). The noise floor of EL 215 loggers is around 26 dBA and the noise floor of EL 316 loggers is around 22 dBA.

Attended measurements were undertaken using a Rion NA-27 Precision Sound Level Meter and a SVAN 948 Sound Level Meter. Both units are a NATA certified Type 1 Sound Level Meter. Both units were checked for calibration before and after each set of noise measurements using a Rion NC-73 Sound Level Calibrator and no significant drift (greater than 1 dBA) in calibration signal level was observed.

All items of acoustic instrumentation employed during the noise monitoring were set to 'Fast' response in accordance with the relevant Australian Standards and the Queensland EPA's *Noise Measurement Manual*. All items of acoustic instrumentation employed during the noise measurement surveys were designed to comply with AS 1259.2 *Sound Level Meters* and carry current calibration certificates.

11.1.3 Noise monitoring results

Unattended logging

The unattended ambient noise measurements were used to determine the "Rating Background Level" (RBL) for the daytime (7.00 am to 6.00 pm), evening (6.00 pm to 10.00 pm) and night-time (10.00 pm to 7.00 am) periods at each location. The RBL is the median of the 90th percentile of the background (L_{A90}) noise levels in each assessment period (day, evening and night) over the duration of the monitoring. Table 11.2 contains the determined RBL for each measurement location.

Table 11.2 Rating background levels

Monitoring location	Rating background level (dBA)		
	Day	Evening	Night
Location 1	33	36	32
Location 2	31	34	36
Location 3	30	36	32
Location 4	33	32	29
Location 5	37	38	36
Location 6	39	39	37
Location 7	37	40	42

The maximum $L_{Aeq(1hour)}$ noise level representative of the ambient noise environment was noted for the daytime, evening and night-time periods. The representative maximum $L_{Aeq(1hour)}$ noise levels at each location are shown in Table 11.3.

Table 11.3 Maximum $L_{Aeq(1hour)}$ noise levels

Monitoring location	Maximum LAeq(1hour) (dBA)		
	Day	Evening	Night
Location 1	54	52	51
Location 2	49	49	46
Location 3	54	47	46
Location 4	48	46	47
Location 5	52	53	51
Location 6	55	53	54
Location 7	56	55	54

It is noted that several locations have higher evening and/or night-time RBLs than measured during day-time periods. During attended measurements, it was noted that the ambient noise environment was frequently dominated by insect noise at the majority of sites during these evening and night-time measurements. This is discussed further in the attended noise measurements section below.

Graphs showing the statistical noise levels measured at the monitoring locations over the whole monitoring period are presented in Appendix I1 for each 24-hour period. The graphs show various statistical noise levels, including the background (L_{A90}) noise level at each site.

Attended noise measurements

Attended measurements were undertaken at each monitoring location in order to confirm background noise levels and to observe typical noise sources associated with the ambient noise environment. The results of these measurements are summarised in Table 11.4.

Table 11.4 Attended measurements results – day, evening and night time periods

Monitoring location	Date	Time (end of 15 min Period	Measured noise level (dBA)			Comments
			L_{A90}	L_{Aeq}	L_{A10}	
Location 1	06/03/08	3:00 pm	37	41	43	Insect and bird noise; tree movement; occasional traffic noise from Dawson Highway
	06/03/08	8:15 pm	49	55	58	Insect noise dominant (~57 dBA), occasional traffic noise from Dawson Highway; train pass-by ~60-63 dBA (45-60 sec)
	06/03/08	11:30 pm	44	48	50	Insect noise dominant; light tree movement; occasional traffic on Dawson Highway (~45-48 dBA).
Location 2	06/03/08	4:00 pm	39	45	49	Insect and bird noise, tree movement; background levels with minimal tree movement around 38-39 dBA.
	06/03/08	8:00 pm	43	46	48	Insect noise dominant at 4 kHz, intermittent electric motor faintly audible; distant industry noise just audible (around 100 Hz) from Gladstone.
	06/03/08	2:30 am	41	42	43	Insect noise; occasional animals audible (horses moving/grazing within 20 m); distant industrial noise just audible (around 100 Hz)
Location 3	06/03/08	5:30 pm	43	48	50	Insect and birds noise dominant; tree movement; distant train just audible though did not raise above background noise levels; distant occasional cow audible.
	06/03/08	6:15 pm	41	47	49	Insect and birds noise dominant; tree movement; distant occasional cow audible.
	06/03/08	2:00 am	40	42	45	Measurement not taken near logger due to night time site access restriction (at owner's request), measurement taken at letterbox of property. Insect noise dominant; occasional frog noise; very distant industrial noise at 125 Hz.

Monitoring location	Date	Time (end of 15 min Period	Measured noise level (dBA)			Comments
			L_{A90}	L_{Aeq}	L_{A10}	
Location 4	06/03/08	4:30 pm	43	49	53	Tree movement; insect and birds; road traffic from Bruce Highway at 48-51 dBA, trucks up to 56 dBA; some domestic noise
	06/03/08	6:45 pm	36	47	51	Insect and birds; road traffic from Bruce Highway at 48-50 dBA, trucks up to 55 dBA; some domestic noise; occasional tree movement
	06/03/08	1:15 am	32	46	51	Insect noise dominant; frogs and occasional bird audible; intermittent road traffic noise with trucks up to 54 dBA.
Location 5	06/03/08	6:00 pm	42	48	49	Insect and bird noise; tree movement; distant industrial and road traffic noise.
	05/03/08	9:45 pm	37	42	42	Insect noise dominant (4 kHz); distant road traffic audible and dominant at times; occasional frogs audible.
	06/03/08	12:45 am	34	41	46	Insect noise dominant (4 kHz); distant road traffic audible and dominant at times; audible cow near-by; distant train audible up to 45 dBA.
Location 6	06/03/08	5:15 pm	41	52	58	Passing train dominant noise for ~3 min at ~50-55 dBA; insect and bird noise; tree movement; industry noise audible; occasional road traffic audible, occasional barking dog.
	05/03/08	9:00 pm	40	45	44	Insect and frogs dominant (4 kHz); tree movement; distant road traffic audible; industry audible (125 Hz); train passed in last 15s at ~60dBA.
	06/03/08	12:15 am	40	43	46	Insect and frog noise dominant (4 kHz); industry audible (125 Hz); occasional road traffic noise audible
Location 7	06/03/08	4:15 pm	43	49	52	Tree movement; insect and birds noise; industry audible (100 Hz), occasional dog barking
	05/03/08	8:00 pm	40	44	46	Insect noise (4 kHz), occasional road traffic noise audible: industry audible (125 Hz); train pass-by for ~30s at around 45 dBA (1 loco only).
	05/03/08	11:15 pm	38	51	56	Train pass-by at start of period, dominant at ~55-60 dBA (2 mins); insect noise dominant (4 kHz), industry audible (125 Hz); occasional road traffic noise audible; occasional barking dog.

Table notes:

1 The L_{A90} is the noise level exceeded for 90% of the sample period. This noise level is described as the background level.

2 The L_{Aeq} is the A-weighted equivalent noise level. It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

3 The L_{A10} is the noise level exceed for 10% of the sample period. This is commonly referred to as the average maximum noise level.

4 Daytime (7.00 am to 6.00 pm), evening (6.00 pm to 10.00 pm) and night-time (10.00 pm to 7.00 am).

The attended measurements and observations summarised in Table 11.4 show that insect noise frequently dominates the ambient noise environment at the majority of monitoring locations and time periods; particularly at Locations 2, 7 and to a lesser extent Location 3. Industrial noise was observed at Locations 6 and 7. Rail noise was observed (and dominant at times) at Locations 1, 6 and 7. Similarly, road traffic noise was observed at Locations 1, 4, 6 and 7 (dominant at times at Location 4). Distant industrial, road and rail noise were all observed at Location 5. Birds, frogs and other fauna noise were frequently observed at all locations.

The results obtained during the attended noise monitoring period were compared to those obtained from unattended noise logging and the difference between the measurements was shown to be negligible (±2dBA) for each relevant time period.

11.1.4 Background noise level summary

The results indicate that background noise levels at these residential locations are relatively quiet, with measured RBLs between 30 dBA and 40 dBA. Background levels of between 30 dBA and 40 dBA are typical of rural residential areas.

11.2 Recommended limits and criteria

11.2.1 Construction noise

Construction noise criteria

The EPP (Noise) does not include construction noise limits other than those which apply to blasting.

It should be noted that the QR Code of Practice for Railway Noise Management states that:

> *"Given the nature of railway operations however, particularly construction works within existing corridors, the only available time for some construction work may be outside the standard working hours including Sundays and public holidays. Work during these times will be minimised where practicable, however, the timing of work will be governed by railway operational requirements as well as safety constraints."*

This provision of the Code will be implemented as part of construction rail works.

Environmental Protection Act – Environmentally Relevant Activities

This section presents the likely conditions that would be imposed on a QR Environmentally Relevant Activity as defined by the EP Act. These conditions have been provided as a guideline for compliance with the typical conditions under the EP Act.

"(1) In the event of a complaint, and when requested by the administering authority, the holder will:
- *in the first instance alter procedures with to reduce the noise nuisance; and*
- *Liaise with the administering authority and/or complainant over remedial action*

Where the above actions do not resolve the nuisance noise issue and where appropriate, noise monitoring will be undertaken to investigate any complaint of environmental nuisance noise. When requested by the administering authority, noise monitoring must be undertaken to investigate any complaint of noise nuisance, and the results, once received by the holder, notified within 7 days to the administering authority. Monitoring must include:
(a) $L_{Amax, adj\ T}$;
(b) $L_{AN,\ T}$ (where N equals statistical levels of 1, 10, and 90);
(c) the level and frequency of occurrence of impulsive or tonal noise;

(d) atmospheric conditions including temperature, relative humidity and wind speed and direction; and
(e) effects due to extraneous factors such as traffic noise;

(2) The method of measurement and reporting of noise levels must comply with the latest edition of the Environmental Protection Agency's Noise Measurement Manual."

11.2.2 Operational noise

Rail noise criteria

The noise impacts associated with the proposed rail infrastructure will result from the proposed Aldoga Rail Yard (shunting) and the additional rail traffic that will be travelling on the proposed rail infrastructure.

The applicable criteria for rail noise (including noise from the rail yard) are:

- 87dBA Single event maximum level[1]
- 65dBA $L_{Aeq\ (24hours)}$

These are in accordance with the noise planning levels stipulated in both the EPP (Noise) and the QR's Code of Practice for Railway Noise Management ("the Code"). The Code was first endorsed for use by the Minister for the Environment in 1999. This was in accordance with Section 219 of the *Environmental Protection Act 1994* (EP Act). Following the required review, the Minister for Sustainability, Climate Change and Innovation re-endorsed the use of Version 2 of the Code in December 2007.

In recognising the different types of activities at the railway yards, the Code states noise characteristics (eg tonality and impulsiveness) shall not be considered during any assessment of their noise levels.

11.2.3 Vibration limits

The EPP (Noise), the EP Act and the *Environmental Protection Regulations 1998* (EP Regulations) do not include vibration limits other than those which apply to blasting.

Human comfort

Humans are far more sensitive to vibration than is commonly realised. They can detect and possibly even be annoyed by vibration at levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not, in itself, be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2 1975. On this basis, the resulting degrees of perception for humans are suggested by the continuous vibration level categories given in Table 11.5.

[1] In the absence of any statutory or Australian Standard definition of "single event maximum level", a reasonable and practical interpretation has been collaboratively defined with the administering authority (EPA). This interpretation being the arithmetic average of the highest 15 maximum levels over a 24 hour period.

Table 11.5 Vibration levels and human perception of motion

Approximate vibration level	Degree of perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Table note:
These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hz to 80 Hz.

The information above suggests that people will just be able to feel continuous floor vibration at levels of about 0.15 mm/s and that the motion becomes "noticeable" at a level of approximately 1 mm/s.

Guidance in relation to assessing the potential human disturbance from ground-borne vibration inside buildings and structures is contained in British Standard 6472-1992 "Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)" (BS 6472).

Satisfactory magnitudes of peak vertical vibration velocity (ie below which the probability of "adverse comment" is low) are shown in Table 11.6 for generally sinusoidal vibration.

Table 11.6 Satisfactory levels of peak vertical vibration velocity (1 Hz to 80 Hz)

Type of space occupancy	Time of Day	Satisfactory peak vibration levels in mm/s over the frequency range 1 Hz to 80 Hz			
		Continuous vibration		Impulsive vibration with up to three occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Critical working areas (eg hospital operating theatres, precision laboratories, etc)	Day Night	0.14 0.14	0.4 0.4	0.14 0.14	0.4 0.4
Residential	Day Night	0.3 to 0.6 0.2	0.8 to 1.6 0.6	8.4 to 12.6 2.8	24 to 36 8
Offices	Day Night	0.6 0.6	1.6 1.6	18 18	51 51
Workshops	Day Night	1.2 1.2	3.2 3.2	18 18	51 51

Source: After BS 6472-1992

The information above indicates that continuous floor vibration levels above which "adverse comment" in residences and offices may arise during daytime hours ranges from approximately 0.3 mm/s to 0.6 mm/s.

Construction vibration

Based on the structural damage, building contents and common services Standards, safe working distances from buildings are presented in Table 11.7 for typical construction equipment.

Table 11.7 Safe working distances for vibration intensive plant items

Item	"Safe" working distance	
	Cosmetic Damage (BS7385)	Human Comfort (BS6472)
Impact pile driver	20 m to 40 m	80 m to 120 m
Vibratory pile driver	5 m to 15 m	20 m to 50 m
Pile boring (<800 mm)	2 m (nominal)	n/a

11.2.4 Blasting criteria

Vibration – structural damage

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 11.8.

Table 11.8 Transient vibration guide values – minimal risk of cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	4 Hz to 15 Hz
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz

Vibration – human comfort

In accordance with the EP Regulation the following criteria are nominated with respect to the protection of human comfort from vibration:

> *"Noise from blasting is not unlawful environmental nuisance for an affected building if -"*
>
> *"(b) the ground vibration is –*
>
> *(i) for vibrations of more than 35Hz - no more than 25 mm a second ground vibration, peak particle velocity; or*
>
> *(ii) for vibrations of no more than 35Hz - no more than 10 mm a second ground vibration, peak particle velocity."*

The EP Regulation does not nominate times of blasting. However, the Queensland EPA's Ecoaccess Guideline document entitled *"Noise and vibration from blasting" (2006)* contains both blast emissions criteria and times of blasting.

The relevant sections are as follows:

> *"Vibration Criteria:*
>
> *Blasting operations must be carried out in such a manner that if ground vibration should propagate to a noise-sensitive place:*
>
> *(a) the ground-borne vibration must not exceed a peak particle velocity of 5mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and*
> *(b) the ground-borne vibration must not exceed a peak particle velocity of 10mm per second for any blast."*
>
> *"Blasting should generally only be permitted during the hours of 9am to 3pm, Monday to Friday, and from 9am to 1.00 pm on Saturdays. Blasting should not generally take place on Sundays or public holidays.*
>
> *Blasting outside these recommended times should be approved only where:*
>
> *(a) blasting during the preferred times is clearly impracticable (in such situations blasts should be limited in number and stricter airblast overpressure and ground vibration limits should apply); or*
> *(b) there is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site."*

Airblast criteria

Human comfort

In accordance with the EP Regulation, the following criteria are nominated with respect to the protection of human comfort from airblast:

> "Noise from blasting is not unlawful environment nuisance for an affected building if –"
> *"(a) the airblast overpressure is no more than 115 dB(Lin) Peak for 4 out of any 5 consecutive blasts;…"*

The EP Regulation does not nominate times of blasting. However, the Queensland EPA's Guideline document entitled *"Noise and Vibration from Blasting*", contains both blast emissions criteria and times of blasting.

The relevant section is as follows:

> *"Blasting operations must be carried out in such a manner that if noise should propagate to a noise-sensitive place, then:*
> *(a) the airblast overpressure must not be more than 115 dB(linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and*
> *(b) the airblast overpressure must not exceed 120 dB(linear) peak for any blast."*

The Guideline further states (under the heading of "Weather Effects") that:

> *"When a temperature inversion or a heavy low cloud cover is present, values of airblast overpressure will be higher than normal in surrounding areas. Accordingly, blasting should be avoided if predicted values of airblast overpressure in noise-sensitive places exceed acceptable levels. If this is not practicable, blasting should be scheduled to minimise noise annoyance. An appropriate period is generally between 11 am and 1 pm. Similarly, blasting should be avoided at times when strong winds are blowing from the blasting site towards noise sensitive places."*

Structural damage

Based largely on work carried out by the US Bureau of Mines, the US Office of Surface Mining has presented the following regulatory limits for airblast (depending on the low frequency limit of the measuring system) in Table 11.9.

Table 11.9 Peak airblast limits

Low frequency limit	Peak airblast limit
2 Hz or lower	132 dB(Lin)
6 Hz or lower	130 dB(Lin)

These levels are generally consistent with the level of 133 dB(Lin) nominated in AS 2187.2-2006.

11.3 Noise and vibration impact assessment approach

11.3.1 SoundPLAN modelling

A SoundPLAN (Version 6.4) computer noise model has been used for the prediction of future project noise levels at sensitive receivers. The noise model comprises a digitised ground map containing topography, buildings, all significant plant and relevant noise sources, including emission characteristics, and the location of noise sensitive receivers. The computer model calculates the received noise levels, taking into account:

- All noise source sound power levels and frequency spectra
- Noise propagation variables such as distance attenuation, ground absorption, air absorption and shielding attenuation
- Meteorological conditions, including wind effects

The model was based on the Project concept design (refer Section 2) and likely equipment to be used onsite.

The information in this section is relevant to the prediction of noise emission from all noise sources associated with the construction and operational phases of the Project. The distinction between whether the prediction of noise impacts relate to the construction and/or operational phases of the Project are summarised below.

- CONCAWE Standard – Construction and operational (shunting)
- Nordic Rail Traffic Prediction Method – Operational (rail)
- CoRTN Road Traffic Noise Prediction Method – Construction and operational (road)

Various computation algorithms were utilised within the SoundPLAN model. These are outlined below.

The CONCAWE Standard for construction scenarios and operational shunting predictions

CONCAWE is commonly implemented for environmental noise prediction of noise emissions from point sources such as rail yard shunting and construction activities. It allows for investigation of effects of wind and atmospheric stability on noise propagation. The CONCAWE standard is based on a research paper published in 1981 under the title "*The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*".

The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 - 1982), with the conclusion that CONCAWE was accurate to ±2 dBA in any one octave band between 63 Hz and 4 kHz and ± 1 dBA overall.

Nordic Rail Traffic Noise Prediction Method

The Nordic Rail Traffic Noise Prediction Method (Kilde 130) dates from 1984. Due to its ability to reliably deliver accurate predictions (within 2 dB(A) of measured), it has been commonly utilised in rail noise assessments across Queensland for over a decade. It calculates emission noise level based on the number of trains, speed, and length and predicts $L_{Aeq(24hours)}$ and pass-by maximum levels as required by the EPP (Noise).

CoRTN Road Traffic Noise Prediction Method

Calculation of Road Traffic Noise (CoRTN) was developed by the UK Department of Transport in 1984. It allows calculation of the statistical descriptors $L_{A10(1hour)}$ and an average $L_{A10(18hour)}$. CoRTN was used to compare the effect of a road traffic increase due to construction works and operation for the Project.

11.3.2 General SoundPLAN modelling parameters

Assessment receiver locations

Project assessment noise levels have been evaluated at 29 representative receivers throughout the residential areas of Yarwun, Mount Larcom and surrounding residential areas. The background noise monitoring sites for this EIS have been included in the assessment.

The assessment receivers have been selected on the basis of providing good spatial coverage of the surrounding areas, including those receivers closest to and potentially impacted by the proposed Project.

All receivers have been positioned 1.5 m above ground. In accordance with the EPP(Noise) planning levels, operational rail noise was assessed at a distance of 1 m from the most affected façade. Construction scenarios have been assessed at a minimum distance of 4 m from the nearest building (ie free field).

The receivers are grouped by proximity to the nearest representative noise monitoring location and numbered accordingly (refer Table 11.10).

Table 11.10 Residential receivers

Receiver	Address/Lot Number	Town	Sensitive Receiver Number
Location 1	3887 Dawson Highway	Wooderson (4680)	23
1-a	3887 Dawson Highway	Wooderson (4680)	22
1-b	3887 Dawson Highway	Wooderson (4680)	24
1-c	3887 Dawson Highway	Wooderson (4680)	24
1-d	69 Daetz Road	Wooderson (4680)	20
1-e	4131 Dawson Highway	Wooderson (4680)	-
Location 2	52333 Bruce Highway	East End (4695)	14
Location 3	889 Mt Alma Road	Bracewell (4695)	15
Location 4	56000 Bruce Highway	East End (4695)	30
4-a	Bruce Highway (~5.5 km South of NM-04)	East End (4695)	-
Location 5	The Narrows Road	Mount Larcom (4695)	42
5-a	265 The Narrows Road	Mount Larcom (4695)	44
5-b	327 The Narrows Road	Mount Larcom (4695)	43
Location 6	78 Flynn Road	Yarwun (4694)	4
6-a	94 Flynn Road	Yarwun (4694)	10

Receiver	Address/Lot Number	Town	Sensitive Receiver Number
6-b	93 Flynn Road	Yarwun (4694)	7
6-c	70 Flynn Road	Yarwun (4694)	1
6-d	77 Flynn Road	Yarwun (4694)	6
6-e	63 Flynn Road	Yarwun (4694)	5
6-f	9 Flynn Road	Yarwun (4694)	2
6-g	540 Gladstone-Mount Larcom Road	Yarwun (4694)	8
6-h	530 Gladstone-Mount Larcom Road	Yarwun (4694)	9
6-i	684 Gladstone-Mount Larcom Road	Yarwun (4694)	3
6-j	1261 Gladstone-Mount Larcom Road	Aldoga (4694)	-
6-k	24 The Narrows Road	Mount Larcom (4695)	-
6-l	11 Raglan Street	Mount Larcom (4695)	45
Location 7	21 Lindherr Road	Yarwun (4694)	13
7-a	1396 Calliope River Road	Yarwun (4694)	-
7-b	1417 Calliope River Road	Yarwun (4694)	-

CONCAWE setup

CONCAWE has been implemented for modelling of the construction activities for the rail infrastructure and operation of the Aldoga Rail Yard (ie shunting).

The operational noise assessment of rail yard impacts (ie shunting) has been carried out for both neutral and "worst case" meteorological enhancement conditions. For construction only the neutral case is considered.

Neutral weather conditions are modelled as:

- 10°C
- 70% humidity
- Pasquil Stability Category D
- 0 m/s wind speed

The worst case weather conditions used to assess the effect of adverse meteorological conditions on noise propagation from the operation of the rail yard facility are:

- 10°C
- 90% humidity
- Pasquil Stability Category F
- 2 m/s wind speed

Nordic rail prediction setup

Noise emission levels were corrected to reflect the local coal rail fleet, based on in-house measurement results provided by QR.

Wheel and rail noise have been modelled for all trains at 0.5 m above rail level. Diesel electric locomotive engine and exhaust noise were modelled separately at an elevation of 3.5 m above rail level.

Rail operations were modelled for the Project running at ultimate capacity (90 Mtpa).

11.4 Potential impacts

11.4.1 Construction scenarios

Construction noise sources typically include blasting, pile driving and mobile equipment (eg earthmoving equipment, cranes and trucks).

Full details of the exact equipment to be used for the construction activities are yet to be finalised, however a list of the currently proposed construction equipment with their associated maximum sound power levels is presented in Appendix I2 (Table 1).

Construction noise levels will generally depend upon the number of plant items and equipment operating at any one time and on their precise location relative to the receiver(s). A receiver will therefore experience a range of values representing "minimum" and "maximum" construction noise emissions depending upon:

- The location of the particular construction activity (ie if the plant of interest were as close as possible or further away from the receiver of interest).
- The likelihood of the various items of equipment of interest operating simultaneously.

While noise from diesel-powered mobile plant will generally form the major part of noise emissions over the construction phase, the highest noise levels are expected to occur where construction requires the use of pile driving and blasting.

Five representative construction scenarios have been generated that depict five "snapshots" of the proposed construction activities. Appendix I2 (Tables 2 to 6) illustrates the construction scenarios that generally reflect the proposed methodologies for construction of the Project.

Each scenario has been modelled to represent likely maximum construction noise levels within the communities surrounding the Project. Each noise source will act within a defined area. For the purposes of noise modelling, noise sources have been located within these areas as close as possible to the nearest residential receivers.

11.4.2 Construction noise assessment

Noise levels for Construction Scenarios 1 to 5 have been predicted at 29 representative receivers (refer Table 11.11). The predicted noise levels assume that no mitigation measures have been employed to limit noise emissions.

Table 11.11 Predicted construction noise levels (single event maximum level)

Receiver	Scenario 1 (dBA)	Scenario 2 (dBA)	Scenario 3 (dBA)	Scenario 4 (dBA)	Scenario 5 Site and emergency roads (dBA))	Scenario 5 Access roads only (dBA)
Location 1	59	62	63	<10	53	<10
1-a	59	64	62	<10	51	<10
1-b	67	59	76	<10	67	<10
1-c	64	57	73	<10	65	<10
1-d	42	61	49	<10	26	<10
1-e	63	66	72	<10	63	<10
Location 2	41	51	49	<10	36	<10
Location 3	38	51	42	<10	36	<10

Receiver	Scenario 1 (dBA)	Scenario 2 (dBA)	Scenario 3 (dBA)	Scenario 4 (dBA)	Scenario 5 Site and emergency roads (dBA))	Scenario 5 Access roads only (dBA)
Location 4	45	53	52	<10	40	<10
4-a	64	48	74	<10	64	<10
Location 5	42	48	50	<10	37	53
5-a	39	45	48	<10	33	43
5-b	17	21	25	<10	10	18
Location 6	56	52	64	19	53	64
6-a	57	56	67	22	57	73
6-b	58	55	67	14	58	77
6-c	53	55	60	25	51	62
6-d	59	59	63	13	58	62
6-e	55	63	59	13	53	66
6-f	46	67	53	11	44	71
6-g	36	44	45	<10	32	28
6-h	36	44	45	<10	32	23
6-i	50	56	36	35	43	42
6-l	67	43	78	<10	35	27
6-k	73	39	83	<10	30	28
6-j	60	69	57	62	55	50
Location 7	59	60	58	<10	32	<10
7-a	62	65	64	<10	36	<10
7-b	67	86	81	<10	47	<10

Noise levels from construction activities are dependant on the number of plant items and equipment operating at any one time as well as their precise location relative to the receiver(s). Therefore noise levels are likely to be lower than those contained in Table 11.11 if construction plant and equipment was located further away from the receiver(s).

11.4.3 Construction vibration assessment

Safe working distances for typical items of vibration intensive plant are listed in Table 11.7. Safe working distances are quoted for both “cosmetic” damage and human comfort. The human comfort safe working distances correspond to a “Low Probability of Adverse Comment” response.

The safe working distances given are indicative. They will vary depending upon the particular item of plant and local geotechnical conditions and presence of elevated water table. Furthermore, the safe working distances for “cosmetic” damage apply to damage of the most sensitive land use buildings and do not apply to industrial buildings.

The following information in relation to potential sources of ground vibration has been used as the basis for the vibration assessment.

Pile driving

Based on current proposed construction methodology, it is anticipated that the primary source of potential ground vibration is likely to be pile driving.

The typical levels of ground vibration from pile driving range from 1 mm/s to 3 mm/s at distances of 25 m to 50 m, depending on the ground conditions and the energy of the driving hammer. Recent measured vibration levels (September 2006) from pile driving at the RG Tanna Coal Terminal Berth 4 expansion for a 14 t hammer driving a 1200 mm pile of 600 mm wall thickness showed that vibration levels at a distance of 380 m from the piling site were not measurable; only ambient vibration levels were measured, at less than 0.1 mm/s Peak Particle Velocity (PPV).

The majority of sensitive receivers are located at distances of greater than 250 m from any pile driving site, vibration from pile driving is expected to be imperceptible at these receivers.

There are two sensitive receivers located within 250 m of a proposed pile driving site, receiver 7-b (70 m) which is located near the Calliope River Road overpass and receiver 6-j (175 m) which is located south of the EEMBL connection with the rail yard. Based on the separation distances between the sensitive receivers and the pile driving site it is expected that vibration levels could be noticeable. Pile driving activities should be carried out where practical during the daytime in these locations. Advance notification will be carried out with affected residents regarding proposed construction activities in order to minimise adverse comment.

The nearest residence is located approximately 70 m from the proposed piling works, therefore likely vibration levels from piling are expected to be below 1 mm/s. Vibration levels of less than 1 mm/s are significantly below the structural damage vibration criteria shown in Appendix I3. Therefore structural damage to buildings due to piling activities is not expected to occur.

Truck traffic

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 this data, vibration levels from truck traffic utilising the roads onsite will be well below both “cosmetic damage” and “human comfort” criteria. In fact, as most homes are greater than 25 m away from the roads, it is expected that any vibration from truck movements would be imperceptible (ie less than 0.15 mm/s).

11.4.4 Blast emissions impact assessment

In some areas of cut it may be necessary to excavate sections of rock via blast techniques. The precise locations of blasting activities has not yet been determined, therefore noise and vibration from blasting has been assessed at a number of set-back distances from blast sites.

Should blasting be necessary, the blasthole depths would likely be shallow and a possible blast design could be similar to that given in Table 11.12.

Table 11.12 Indicative blast design details

Blast design parameter	Typical dimension
Hole depth	4.2 m
Hole diameter	102 mm
Burden	3 m
Spacing	3 m
Charge length	1.5 m
Stemming depth	2.7 m (20 mm aggregate)
Delay timing	None

Blast design parameter	Typical dimension
Column explosive	Ammonium Nitrate – Fuel Oil
Powder factor	1.4 kg/m^3
Charge weight per blasthole	11 kg

The indicative blast design, consisting of 102 mm diameter blastholes on a 3 m x 3 m pattern with say three blastholes per delay, produces a maximum instantaneous charge (MIC) of 33 kg.

By adopting the indicative blast design, the level of blast emissions can be predicted using equation J7.3(i) of AS 2187 2006, applicable to free face blasting in “average field conditions”. A similar approach is advocated by ICI Australia (now Orica) in regard to prediction of airblast emissions. The relevant formulae used are as follows, with the airblast prediction formula adjusted to predict a 20% likelihood of exceedance:

PVS (average conditions) = $1140 (R/Q^{0.5})^{\wedge -1.6}$
dB (20% exceedance) = 168.9 - 24(log10 R - 0.33 log10 Q)

Where,

PVS = Peak Vector Sum ground vibration level (mm/s)
dB = Peak airblast level (dB Linear)
R = Distance between charge and receiver (m)
Q = Charge mass per delay (kg)

Based on the nominated ground vibration and airblast prediction formulae, the predicted blast emission levels at representative nearby receivers have been determined. These are presented in Table 11.13.

Table 11.13 Predicted levels of blast emission

Distance from blasting (approximately)	PVS ground vibration (mm/s)	Peak airblast
100 m	11.8	133
250 m	2.7	123
500 m	0.9	116
1,000 m	0.3	109
2,500 m	0.1	99

The following information is derived from the predicted levels of blast emissions given in Table 11.13:

- The predicted levels of ground vibration at all nearby receivers comply with the human comfort criterion of 10 mm/s at distances of greater than 115 m. Consequently, they also comply with the less stringent building structural damage criteria of 15 mm/s (at 4 Hz) given in BS 7385 at this distance.
- The predicted levels of peak airblast is expected to comply with the recommended human comfort criterion of 115 dB (Lin) at distances of greater than 550 m from the blast site.
- The predicted levels of peak airblast are well below the US Bureau of Mines building structural damage limit of 132 dB (Lin) (2 Hz cut off) at set-back distances of greater than 110 m.

11.4.5 Construction transport

Modelling results

All major roads that will carry traffic associated with site construction are shown in Table 11.14, with Annual Average Daily Traffic (AADT) numbers and predicted increases. The traffic data for Dawson Highway, Bruce Highway and Gladstone-Mount Larcom Road has been supplied by Main Roads (Rockhampton).

Table 11.14 Construction traffic

	Year	AADT	% Heavy vehicle traffic	% Increase in AADT	CoRTN predicted noise level ($L_{A10(18hr)}$)	Difference in noise level
Dawson Highway						
Predicted without MLARP	2010	1372	19.6%	-	66.0 dBA	-
Predicted with MLARP (Section 1: MSL to Calliope River)	2010	1392	19.8%	1.0%	66.1 dBA	0.1 dBA
Bruce Highway						
Predicted without MLARP	2010	5,008	31.9%	-	72.8 dBA	-
Predicted with MLARP (Section 2: Calliope to Bruce Highway Crossing)		5,032	31.9%	0.5%	72.8 dBA	0 dBA
Predicted with MLARP (Section 3: Bruce Highway Crossing to East End Crossing)		5,028	31.9%	0.4%	72.8 dBA	0 dBA
Predicted with MLARP (Section 4: East End Crossing to NCL)		5,028	31.9%	0.4%	72.8 dBA	0 dBA
Aldoga Rail Yard – Gladstone-Mount Larcom Road						
Predicted	2010	3,575	20.1%	-	70.2 dBA	-
Increase due to MLARP		3,841	19.1%	7%	70.4 dBA	0.2 dBA

Potential impacts

The increase in traffic volumes as a result of construction activities has been shown to have a negligible impact on traffic noise levels on all major affected roads.

11.4.6 Operation noise assessment – rail operations

Noise modelling results – rail traffic

The predicted $L_{Aeq(24hour)}$ and single event maximum level noise modelling results from rail traffic travelling on the proposed MLARP rail lines are shown in Table 11.15.

Table 11.15 Receiver noise levels – rail operations

Receiver	Moura Link Eastern Option		Moura Link Western Option	
	L_{Aeq} (dBA)	Single event maximum level (dBA)	L_{Aeq} (dBA)	Single event maximum level (dBA)
Location 1	45	56	33	40
1-a	46	58	33	40
1-b	48	63	29	38
1-c	47	62	27	37
1-d	41	52	35	42
1-e	24	37	46	54
Location 2	45	53	40	45
Location 3	34	45	45	54
Location 4	47	58	49	58
4-a	53	71	56	70
Location 5	48	56	48	56
5-a	46	53	46	53
5-b	41	51	41	51
Location 6	56	64	56	64
6-a	57	67	57	67
6-b	57	68	57	68
6-c	56	64	56	64
6-d	58	68	58	68
6-e	57	65	57	65
6-f	57	65	57	65
6-g	53	60	53	60
6-h	51	57	51	57
6-i	54	63	54	63
6-l	57	68	57	68
6-k	61	81	61	81
6-j	58	74	58	74
Location 7	57	68	57	68
7-a	58	70	58	70
7-b	61	76	61	76

Noise contour plots for $L_{Aeq(24hour)}$ and single event maximum level rail operations are shown in Figures 11.2 to 11.5

Noise modelling results – rail yard (shunting)

Potential noise sources associated with the rail yard activities typically include idling locomotives and wagon shunting/coupling.

The major noise sources (idling locomotives and wagon shunting/coupling) associated with rail yard activities are presented in Table 11.16.

Table 11.16 Summary of typical maximum sound power levels for rail yard activities

Equipment	Typical maximum sound power level (dB (Lin))
Locomotive idling	119
Wagon shunting/coupling	121

For the purposes of noise modelling, noise sources have been located within the rail yard as close as possible to the nearest residential receivers (representative of worst case noise levels).

Rail yard activities have been predicted at all noise sensitive receivers for neutral and 'worst case' weather conditions. The predicted noise levels are summarised in Table 11.17.

Table 11.17 Predicted noise levels – rail yard activities (shunting)

Receiver	Single event maximum level (dBA)	
	Neutral weather conditions	'Worst case' weather conditions
Location 1	<10	<10
1-a	<10	<10
1-b	<10	<10
1-c	<10	<10
1-d	<10	<10
1-e	<10	<10
Location 2	<10	<10
Location 3	<10	<10
Location 4	<10	<10
4-a	<10	<10
Location 5	26	31
5-a	24	30
5-b	23	28
Location 6	20	25
6-a	<10	<10
6-b	<10	<10
6-c	<10	<10
6-d	<10	<10
6-e	<10	<10
6-f	<10	<10
6-g	<10	<10
6-h	<10	<10
6-i	22	28
6-l	13	19
6-k	<10	12
6-j	58	61
Location 7	<10	<10
7-a	<10	<10
7-b	<10	<10

Noise contour plots for the rail yard operations for single event maximum level are shown in Figures 11.6 and 11.7.

The modelling results indicate that the compliance with the nominated operational noise criteria contained in Section 11.2.2.

Assessment against criteria

No exceedances of the $L_{Aeq(24hour)}$ or single event maximum level noise criteria for rail operations were predicted. Noise levels were higher for receivers in the Yarwun area and closest to the existing NCL operations.

11.4.7 Operational road transport servicing the Aldoga Rail Yard

Modelling results

All major roads that will carry traffic associated with operational phase of the Project (servicing the Aldoga Rail Yard) are shown in Table 11.18, with AADT numbers and predicted increases.

Table 11.18 Operational road traffic – Aldoga Rail Yard

	Year	AADT	% Heavy vehicle traffic	% Increase in AADT	CoRTN predicted noise level ($L_{A10(18hr)}$)	Difference in noise level
Gladstone-Mount Larcom Road						
Predicted	2020	6,909	20.1%	-	73.0 dBA	-
Increase due to the Project		7,782	18.5%	13%	73.4 dBA	0.4 dBA

Potential impacts

The increase in traffic volumes as a result of operational activities has been shown to have a negligible impact on traffic noise levels on all major affected roads.

11.5 Mitigation measures

The measures proposed to mitigate potential noise and vibration impacts of the Project are discussed in Section 20.

11.6 Conclusions

11.6.1 Construction works

Construction noise

Construction noise was assessed for five representative construction scenarios. The predicted results for early phase construction indicate that the construction noise has the potential to impact on nearby noise sensitive receivers.

Noise mitigation strategies will be implemented during any evening and night-time work periods to mitigate potential construction noise impacts.

AS2436-1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites*" sets out numerous practical recommendations to assist in mitigating construction noise emissions. In general, the quietest suitable plant and equipment will be utilised in combination with mitigation measures contained in Section 20 in order to minimise the potential noise impacts on the local community.

Construction vibration

The majority of sensitive receivers are located at distances of greater than 250 m from any pile driving site, therefore vibration from pile driving is expected to be imperceptible at these receivers (ie less than 0.1 mm/s PPV).

There are two sensitive receivers located within 250 m of a pile driving site (7-b and 6-j) located at approximately 70 m and 175 m from pile driving sites, respectively. Based on the separation distances between these sensitive receivers and the pile driving site it is expected that vibration levels would be barely noticeable. Pile driving activities should be carried out where practical during the daytime in these locations. Advance notification will be carried out with affected residents regarding proposed construction activities in order to minimise adverse comment.

The nearest residence is located approximately 70 m from the proposed piling works, therefore likely vibration levels from piling are expected to be below 1 mm/s. Vibration levels of less than 1 mm/s are significantly below the structural damage vibration criteria shown in Appendix I3. Therefore structural damage to buildings due to piling activities is not expected to occur.

Vibration levels from truck traffic utilising the roads on site will be well below both “cosmetic damage” and “human comfort” criteria. In fact, as most homes are greater than 25 m away from the roads, it is expected that any vibration from truck movements would be imperceptible (less than 0.15 mm/s PPV).

Based on predicted vibration levels and safe working distances, no mitigation measures are required to reduce vibration levels from pile driving or road traffic at residences in the communities surrounding the Project.

11.6.2 Rail operational noise

All receiver locations are predicted to comply with EPP (Noise) and the Code’s operational criteria applicable for noise from rail traffic and rail yard activity (including shunting).

11.7 Commitments

The noise and vibration commitments relevant to the Project include:

- Develop and implement noise and vibration mitigation measures (as part of the Construction EMP) during the construction phase of the Project.
- In advance notification with affected/adjoining property owners about timing and details of proposed construction works.