Central Eyre Iron Project
Environmental Impact Statement

CHAPTER 12

NOISE AND VIBRATION

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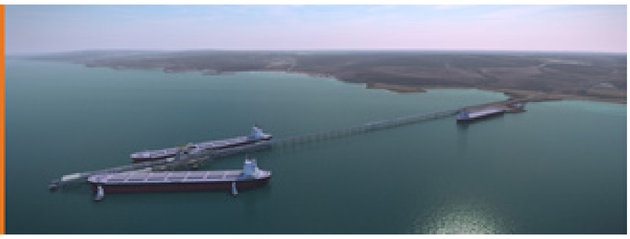

12 Noise and Vibration

The project area has a quiet rural character dominated by natural noise sources such as wind, insects and birds, and wave noise on the coast, with intermittent human-induced noise from road traffic, existing rail operations and agricultural machinery. The proposed CEIP Infrastructure will introduce new noise and vibration sources to the project area, including train movements along the proposed infrastructure corridor and materials handling and ship-loading activities at the proposed port site.

This chapter describes how the introduction of these new noise and vibration sources during construction and operation of the CEIP Infrastructure is expected to affect existing noise levels at sensitive receiver locations. It provides a comparison of the predicted levels against regulatory limits at these sensitive receiver locations. The design measures and management strategies that have been incorporated into the project to minimise noise and vibration are described. Risks associated with project-related noise and vibration sources that could reasonably occur during construction and operation of the CEIP Infrastructure are also considered.

The Environmental Noise and Vibration Assessment reports are provided in Appendix L and M.

The potential effects of noise and vibration from the project on terrestrial and marine fauna are addressed in Chapters 13 and 14 respectively. Chapter 14 is supported by the Marine Environmental Noise Assessment report provided in Appendix S.

12.1 Applicable Legislation and Standards

Noise criteria exist for a range of noise sources to provide guidance on acceptable noise levels for different activities. The applicable criteria and corresponding legislation are presented below for each major source relevant to the project. These include:

- Construction noise and blasting
- Rail noise
- Borefield noise
- Port noise
- Ground vibration

12.1.1 Explanation of Noise Terms and Units

As explained in the *Guidelines for the Use of the Environment Protection (Noise) Policy 2007* (EPA 2009), noise is commonly defined as unwanted sound. Sound is produced by small fluctuations in air pressure. The loudness of a sound is predominantly related to the size of the fluctuations, but is also related to their frequency, or the rate at which they are produced.

The loudness of sounds can range from those which the human ear can just detect (the threshold of hearing) to those that exceed a threshold of pain. Given that sound is produced by changes in air pressure, the international standard unit of sound pressure is a pressure measurement, the micropascal (μPa).

The range between the faintest audible sound and the loudest sound the human ear can stand is so large (20 μPa to 63 million μPa) that it would be cumbersome to express sound pressure fluctuations in these units. Instead, this range is compressed by expressing the sound pressure on a logarithmic scale, the unit of which is the more commonly known decibel (dB).

The logarithmic scale is different to a linear scale. A doubling of the sound pressure, say from 20 µPa to 40 µPa, produces an increase of 6 dB. In subjective terms, a 3 dB increase is often described as a just noticeable difference.

The frequency of a sound is the rate at which the fluctuations are produced per second. Practically all sounds contain a mixture of frequencies and the mix of frequencies affects the perceived loudness. A high-frequency sound (e.g. screeching or whistling) at the same acoustic pressure as a low-frequency sound (e.g. thunder) will be perceived to be louder. This is because the human ear is most sensitive to mid-range and high frequencies and is less sensitive to the lower frequencies.

To ensure measured levels approximate the human response, a weighting scale is used. It is known as the 'A' scale and the units are referred to as 'A' weighted decibels and written as dB(A). The dB(A) scale discriminates between sounds in much the same way as people do.

Some examples of typical sound levels in dB(A) are shown in Figure 12-1.

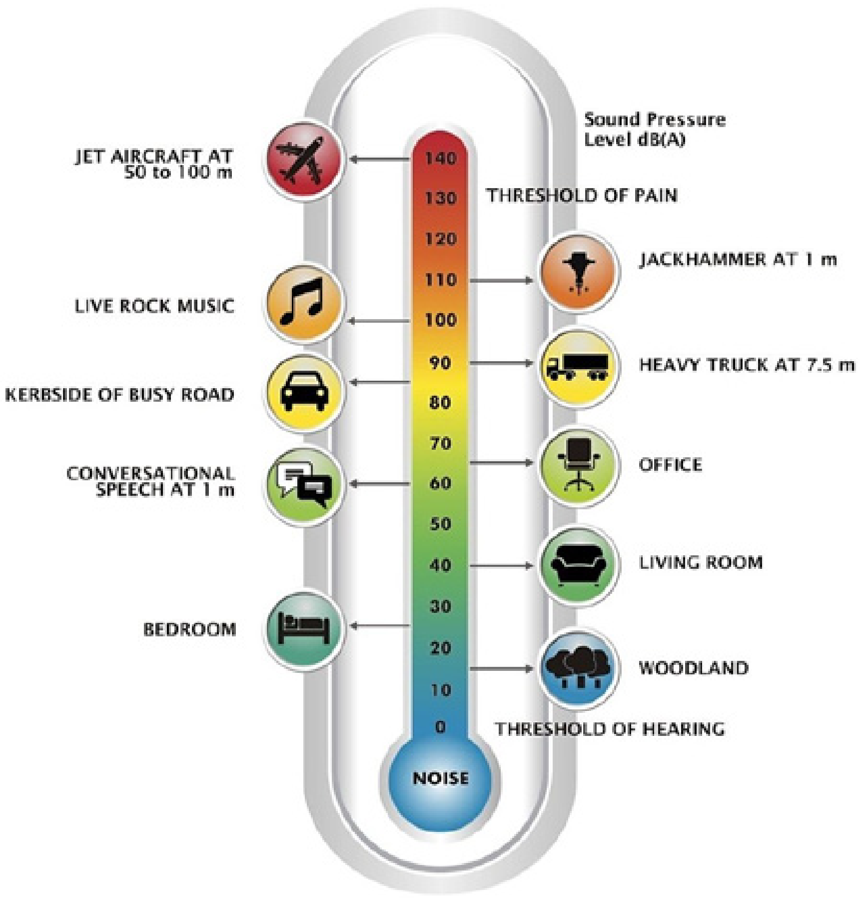

Figure 12-1 Some Examples of Typical Sound Levels in dB(A)

12.1.2 Construction Noise Criteria

For construction of CEIP Infrastructure, other than the proposed railway line, Clause 23 of the *Environment Protection (Noise) Policy 2007* (Noise Policy) is applicable. Clause 23 requires that all reasonable and practicable measures must be taken to minimise noise resulting from construction activity (which causes an adverse impact on amenity of sensitive receivers) at all times. It also requires that construction activity resulting in noise potentially having an adverse impact on amenity must not occur on a Sunday or Public Holiday or outside of the hours of 7am and 7pm (night-time works) unless the activity is scheduled to avoid unreasonable traffic interruption or the Environment Protection Authority (EPA) (or another administering agency) determines other sufficient grounds exist. If night-time, Sunday or Public Holiday noise from the construction activity exceeds a continuous level of 45 dB(A) or a maximum level of 60 dB(A) at a sensitive receiver, it is considered to be causing an adverse impact.

The guidelines presented in the Department of Planning, Transport and Infrastructure (DPTI) *Management of Noise and Vibration: Construction and Maintenance activities, Operational Instruction 21.7* (DPTI 2014) are relevant to road and railway construction as a means of demonstrating compliance with the general environmental duty established by the *Environment Protection Act 1993*. These guidelines include noise criteria for varying construction timeframes and periods of the day. Based on DPTI 2014, the adopted rail construction noise criteria is the long-term work criteria (exceeding 14 days) for night time (7 pm to 7 am), Sunday and public holidays of $L_{eq,15min}$ 45 dB(A) and L_{max} 75 dB(A).

The construction noise criteria are listed in Table 12-1.

Table 12-1 Construction Noise Criteria

Project Component	Continuous Noise Level Criteria	Maximum Noise Level Criteria
Proposed borefield, power transmission line, long-term employee village and port development	Day time – No criteria*	Day time – No criteria*
	Night time, Sundays and public holidays – L_{Aeq} 45 dB(A)	Night time, Sundays and public holidays – L_{Amax} 60 dB(A)
Proposed railway line	Day time – No criteria*	Day time – No criteria*
	Night time Sundays and public holidays – L_{Aeq} 45 dB(A)	Night time Sundays and public holidays – L_{max} 75 dB(A)

* However all reasonable and practicable measures must be taken to minimise noise resulting from construction activity (which causes an adverse impact on amenity of sensitive receivers) at all times.

12.1.3 Construction Blasting Criteria

Ground vibration and airblast are potential effects of blasting. Ground vibration from blasting is due to the movement of mechanical energy within the rock mass or soil. Airblast is the pressure wave produced by the blast and transmitted through the air. Studies and experience show that well-designed and controlled blasts are unlikely to create ground vibrations of a magnitude that causes damage to buildings or structures. Airblast is generally the cause of more complaints than ground vibration.

Australian Standard AS 2187.2 - 2006 titled *Explosives – Storage and use Part 2: Use of explosives* (AS 2187.2 – 2006) specifies requirements for the safe use of explosives including the mixing, testing, initiation and firing of charges. It provides background information, guidelines for measurement and criteria for peak levels of ground vibration and airblast.

For the purposes of construction blasting works, the relevant ground vibration and airblast criterion from AS 2187.2 – 2006 are the human comfort criterion for sensitive sites (e.g. houses), for operations lasting less than 12 months or less than 20 blasts, as is specified in Table 12-2. These criteria are more stringent than the criteria aimed at preventing damage to buildings, meaning that if these criteria are met, no damage to existing buildings or infrastructure would be expected.

Table 12-2 Ground Vibration and Airblast Criterion for Construction Blasting

Category	Criteria
Ground vibration	Peak component particle velocity of 10 mm/s at sensitive receiver locations unless agreement is reached with the occupier that a higher limit may apply.
Airblast	Peak sound pressure level of 120 dBL* for 95% blasts per year at sensitive receiver locations. 125 dBL maximum unless agreement is reached with the occupier that a higher limit may apply.

* dBL is a measurement of loudness of all frequencies with the same sensitivity.

12.1.4 Rail Noise Criteria

Rail noise was assessed in accordance with the *Guidelines for the assessment of noise from rail infrastructure* (EPA 2013) (the Rail Noise Guidelines). The Rail Noise Guidelines provide the following criteria for air-borne noise associated with railway operation:

- L_{Amax} – The maximum noise levels at a sensitive receiver due to individual train pass-by events
- $L_{Aeq,1h}$ – Equivalent noise level addressing the average noise exposure of a non-residential sensitive receiver measured over a 1 hour time period
- $L_{Aeq,9h}$ – Equivalent noise level addressing the average noise exposure of a residential sensitive receiver for the night-time period (from 10 pm to 7 am)
- $L_{Aeq,15h}$ – Equivalent noise levels addressing the average noise exposure of a residential sensitive receiver for the day-time period (from 7 am to 10 pm)

Figure 12-2 Visualisation of Proposed Railway and Adjacent Power Transmission Line

Table 12-3 below identifies the noise criteria relevant to sensitive receivers along the proposed railway line.

Table 12-3 Rail Noise Criteria

Sensitive Receiver	Period	Noise Criteria for New Railway Lines, dB(A)
Residential	Day time, 7 am to 10 pm	60 $L_{Aeq,15h}$ 80 L_{Amax}
Residential	Night time, 10 pm to 7 am	55 $L_{Aeq,9h}$ 80 L_{Amax}
Places of Worship	All times	60 $L_{Aeq,1h}$

12.1.5 Borefield Noise Criteria

The Noise Policy dictates the relevant indicative noise levels (noise criteria) for industrial noise sources, such as water pumps associated with a borefield, based on Development Plan zones in which the noise source and sensitive receivers are located. The proposed borefield and the nearest defined sensitive receivers are located in an area zoned Primary Production in the District Council of Cleve Development Plan (DPTI 2013). A Primary Production Zone is considered a rural industry land use in the Noise Policy. For development authorisation applications, the Noise Policy requires a noise criteria 5 dB(A) below the indicative noise level be applied. The rural industry noise criteria applicable to sensitive receivers near the proposed borefield are presented in Table 12-4.

Table 12-4 Noise Criteria Applicable to Sensitive Receivers near the Proposed Borefield

Period	Noise Criteria, dB(A)
Day time, 7am to 10 pm	52 $L_{Aeq,15\ mins}$
Night time, 10 pm to 7 am	45 $L_{Aeq,15\ mins}$

In addition, Clause 14(3) of the Noise Policy requires a penalty be applied to the predicted noise level to account for specific acoustic characteristics (impulsive, low frequency, modulating, tonal). Due to the likely tonal noise character of the electric motor of the borefield pump station, a noise character correction of 5 dB(A) is considered warranted.

12.1.6 Port Noise Criteria

The Noise Policy dictates the relevant indicative noise levels (noise criteria) for industrial noise sources, such as noise that would be expected from a port development, based on Development Plan zones in which the noise source and sensitive receivers are located. In accordance with the Noise Policy the variety of land uses 'principally promoted' within the relevant zones must be identified and taken into account when determining the indicative noise levels. The detailed explanation of how the port noise criteria were determined is provided in the *Environmental Noise and Vibration Assessment – Cape Hardy Port Facility* report in Appendix L. As mentioned above, for development authorisation applications, the Noise Policy requires a noise criteria 5 dB(A) below the indicative noise level be applied. In accordance with the Noise Policy, the noise criteria relevant to sensitive receiver locations near the proposed port development are identified in Table 12-5.

Table 12-5 Noise Criteria Applicable to Sensitive Receivers near the Proposed Port Development

Sensitive Receiver Locations	Period	Noise Criteria, dB(A)
Tumby Bay Coastal zone	Day time, 7am to 10 pm	53 $L_{Aeq,15mins}$
	Night time, 10 pm to 7 am	44 $L_{Aeq,15mins}$
Tumby Bay General Farming zone	Day time, 7am to 10 pm	53 $L_{Aeq,15mins}$
	Night time, 10 pm to 7 am	45 $L_{Aeq,15mins}$

In addition, Clause 14(3) of the Noise Policy requires a penalty be applied to the predicted noise level to account for specific acoustic characteristics (impulsive, low frequency, modulating, tonal). Due to the likely low frequency noise (locomotive engine noise) associated the operation of the proposed port development, a noise character correction of 5 dB(A) is considered warranted.

12.1.7 Ground Vibration Criteria – Construction and Operation

The effects of ground vibration are separated into two categories:

- Human response – Vibration that inconveniences or possibly disturbs the occupants or users of a building.
- Structural damage – Vibration that impacts the structural integrity of a building causing cracks in plaster walls and cracks in masonry.

The vibration criteria for human response are more stringent than the vibration criteria for structural damage for buildings. Cosmetic or structural damage to buildings would only occur due to extreme vibration levels relative to what humans would find tolerable.

The SA EPA does not have a policy or guideline for human response or structural damage effects due to vibration. A number of SA Government guidance documents refer to the A*ustralian Standard AS2670.2- 1990: Evaluation of human exposure to whole-body vibration*, however this standard was withdrawn in April 2014. For human response criteria, the NSW Department of Environment and Conservation (DEC) guideline titled *Assessing Vibration: a technical guideline* (DEC 2006) presents preferred and maximum vibration values for use in assessing human responses to vibration, derived from a *British Standard, BS 6472-1992, Evaluation of human exposure to vibration in buildings (1–80 Hz)*. DEC 2006 advises that there is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values, as listed in Table 12-6.

Table 12-6 Preferred and Maximum Vibration Values for Use in Assessing Human Responses to Vibration

Location	Assessment Period Day time (7:00 am – 10:00 pm) Night time (10:00 pm – 7:00 am)	Preferred and Maximum Weighted RMS Vibration Values (mm/s)	
		Preferred Value	Maximum Value
Continuous Vibration			
Critical Areas	Day time or Night time	0.10	0.20
Residences	Day time Night time	0.20 0.14	0.40 0.28
Office, schools, educational institutions and places of worship	Day time or Night time	0.40	0.80
Workshops	Day time or Night time	0.80	1.6
Impulsive Vibration			
Critical Areas	Day time or Night time	0.10	0.20
Residences	Day time Night time	6.0 2.0	12.0 4.0
Office, schools, educational institutions and places of worship	Day time or Night time	13.0	26.0
Workshop	Day time or Night time	13.0	26.0

There is no Australian Standard that provides recommended vibration levels to prevent building structural damage. The German Deutsches Institut für Normung (DIN) Standard DIN 4150-3 (1999-02), *Structural vibration Part 3 – Effects of vibration on structures* (DIN 1999), is a commonly used reference (including in the DPTI guideline, *Management of Noise and Vibration: Construction and Maintenance activities, Operational Instruction 21.7*). DIN 4150-3 (1999-02) presents recommended vibration limits for a range of building configurations as listed in Table 12-7.

Table 12-7 Recommended Maximum Ground Vibration Levels for a Range of Building Configurations

Type of Structure	Vibration Peak Particle Velocity (mm/s)			
	Foundation Frequency (Hz)			Plane of Floor of Uppermost Storey
	Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz or greater	Frequency Mixture
Buildings used for commercial purpose, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of design and/or use	5	20 to 40	40 to 50	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed above and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

12.2 Assessment Method

Noise and vibration assessments were undertaken for the project which included:

- Noise modelling of construction scenarios at a number of locations along the proposed infrastructure corridor, including construction of the borefield wells, power transmission line pylons, rail cuttings and bridges.
- Noise modelling of a construction scenario at the proposed port site.
- Prediction calculations for ground vibration and airblast due to blasting during construction at the proposed port site and at the proposed railway line/Lincoln Highway intersection.
- Noise modelling of the operation of the proposed railway line.
- Noise modelling of the operation of the proposed borefield.
- Noise modelling of the operation of the proposed port development.

The noise and vibration assessments were completed in accordance with methodology in the Noise Policy, Rail Noise Guidelines, AS 2187.2 – 2006 and the *Imperial Chemical Industries (ICI) Explosives Blasting Guide* (ICI Technical Services 1995). For a more detailed description of the impact assessment methodology refer to the Environmental Noise and Vibration Assessment reports provided in Appendix L and M.

The assessments incorporated the following tasks:

- Identification of potential noise and vibration sources from the proposed CEIP Infrastructure construction and operation.
- Determination of relevant noise standards and criteria including review of national and state legislative requirements.
- Identification of sensitive receivers that may be affected by construction and operation of the CEIP Infrastructure.
- Review of metrological conditions in the project area.
- Establishment of existing noise and vibration conditions in the project area, including measurement of background noise at the proposed port site.
- Literature review and collation of inputs required for the prediction modelling.
- Prediction of noise levels at sensitive receiver locations due to construction and operation of the CEIP Infrastructure using SoundPLAN noise modelling software.
- Prediction of ground vibration and airblast due to construction blasting.

- Comparison of the predicted noise levels with the relevant noise and construction blasting criteria.
- Modification of design or development of management measures to reduce predicted noise levels, if required.

12.3 Existing Environment

This section discusses the existing noise and vibration conditions and the location of sensitive receivers with the project area.

12.3.1 Existing Noise Environment

The proposed infrastructure corridor is used for agriculture, predominately cereal cropping, and has largely been cleared of native vegetation. The existing noise environment is expected to be dominated by natural noise sources such as wind, insects and birds. Local road traffic, existing train pass-bys and agricultural activity would have an influence on background noise in some locations.

Background noise-level measurements were performed on the south-west boundary of port land owned by Iron Road (refer to Plate 12-1). The background noise varied significantly at the proposed port site from levels as low as 25 dB(A) during the night time period up to approximately 50 dB(A) during the day time period. The main contributors to the overall noise level were insect noise, wind noise and wave noise.

Due to the agricultural use of the proposed infrastructure corridor and port site, sensitive receivers are sparse. Isolated sensitive receivers near the proposed CEIP Infrastructure enjoy a high level of amenity due to minimal human-induced noise sources.

The proposed long-term employee village is located adjacent to Wudinna where the existing noise conditions would be generated by residential, small businesses and services, including local traffic, delivery trucks, air conditioners and people.

Plate 12-1 Noise Logger Installed at Proposed Port Site

12.3.2 Existing Vibration Sources

No substantial sources of vibration were identified. Heavy vehicles on the surrounding highways and local roads and existing train pass-bys were the only potential vibration sources identified.

12.3.3 Sensitive Receivers

Sensitive receivers include locations where people live or work that may be affected by noise due to the proposed development of the CEIP Infrastructure. This includes dwellings, schools, hospitals, business premises or public recreational areas. Sensitive receivers may include derelict or uninhabitable dwellings or buildings as the site may have existing user rights which would allow re-development.

The locations of sensitive receivers have been primarily determined by desktop assessment of aerial imagery and are subject to field and community verification. As the sensitive receivers have been identified at different stages of the project development and assessment they are not sequential, however the same sensitive receiver numbers are used for the same sites throughout the EIS.

The sensitive receivers closest to the proposed development are individual dwellings on agricultural properties located intermittently around the proposed port development, along the infrastructure corridor and at Wudinna (near the proposed long-term employee village) as well as a number of small towns including Port Neill, Rudall and Verran. There are also two grain storage and handling facilities in the vicinity of the proposed infrastructure corridor – one near Port Neill and one at Taragoro (half way between Verran and Rudall). Refer to Figure 12-3 and Figure 12-4.

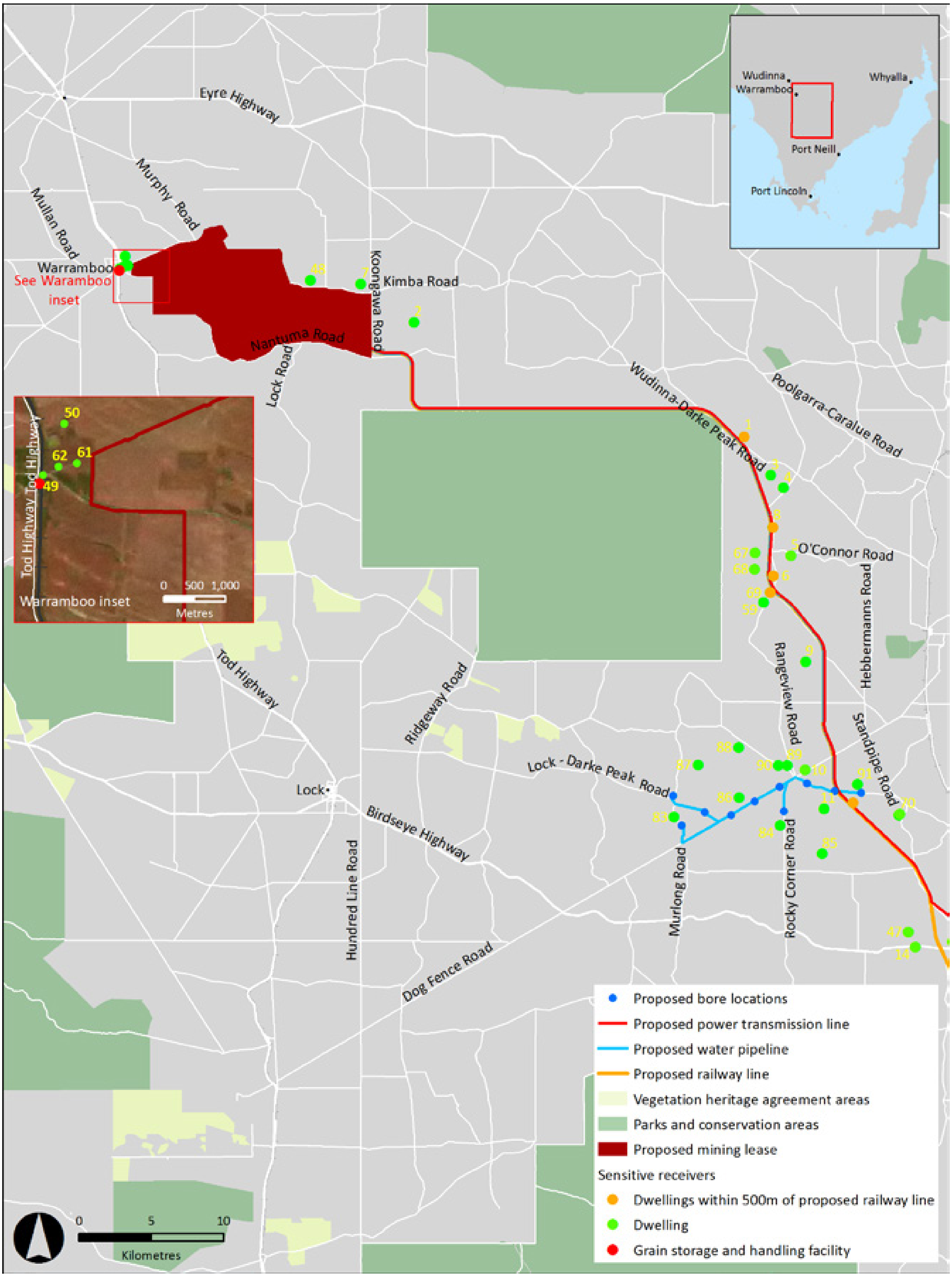

Figure 12-3 Noise and Vibration Sensitive Receivers – Northern Section of Proposed Infrastructure Corridor

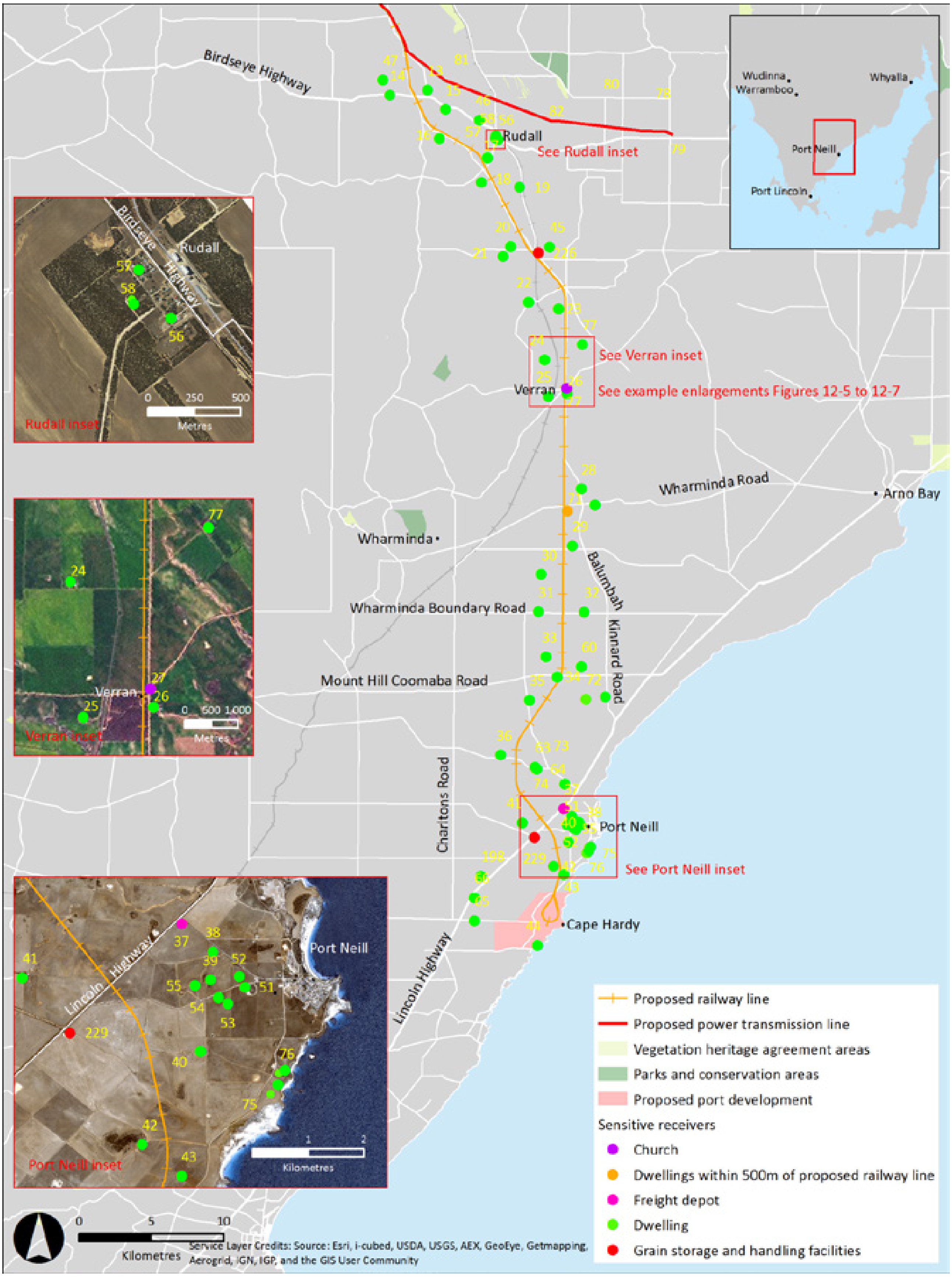

Figure 12-4 Noise and Vibration Sensitive Receivers – Southern Section of Proposed Infrastructure Corridor and Port

The focus of the noise and vibration assessments was on the closest sensitive receivers because the further away a receiver is located from the noise and vibration source, the lower the noise and vibration level. Note that the sensitive receivers surrounding the proposed mining lease which are not illustrated on Figure 12-3 have been considered in the noise assessment for the proposed mine.

The closest identified sensitive receiver to the port site is a dwelling located on land owned by the District Council of Tumby Bay, approximately 70 m from the boundary of port land owned by Iron Road, on the south-east side (sensitive receiver 44 on Figure 12-4). The other closest sensitive receivers to the proposed port development are residential dwellings located more than 1200 m from the boundary of port land owned by Iron Road.

The closest sensitive receiver to the proposed railway line has been identified as the Driver River Uniting Church at Verran (sensitive receiver 27 on Figure 12-4) which is located approximately 140 m from the proposed railway line. Along the infrastructure corridor, identified sensitive receivers are dwellings located at least 170 m away and the Taragoro grain storage and handling facility located approximately 310 m from the proposed railway line. There are 15 identified sensitive receivers located within 500 m of the proposed railway line (sensitive receivers 1, 6, 8, 12, 16, 17, 23, 26, 27, 34, 42, 43, 69, 71 and 226 on Figure 12-3 and Figure 12-4).

The sensitive receivers nearest to the proposed borefield are residential dwellings and the closest is located approximately 580 m from the proposed borefield infrastructure (sensitive receiver 91 on Figure 12-3).

The two closest sensitive receivers to the proposed power transmission line have been observed as potential uninhabitable dwellings located approximately 100 m and 170 m from the proposed transmission line route (sensitive receivers 8 and 12 on Figure 12-3). Sensitive receiver 8 is also the closest sensitive receiver to the proposed water pipeline at approximately 140 m. All other sensitive receivers near the proposed transmission line and water pipeline are located more than 290 m away.

12.3.4 Summary of Key Environmental Values

The proposed CEIP Infrastructure is located in an area where sensitive receivers enjoy a high level of amenity due to minimal human-induced noise sources. Road traffic, existing train pass-bys and agricultural machinery is expected to be the main sources of human-induced noise. The background noise levels vary and are dominated by natural noise sources such as wind, insects, birds and waves. No significant sources of vibration were identified.

The quiet rural environment enjoyed by sensitive receivers and the integrity of buildings and structures are key environmental values.

12.4 Design Measures to Protect Environmental Values

The design of the various CEIP Infrastructure components has incorporated several measures to minimise potential noise and vibration impacts. These are summarised below.

12.4.1 Proposed Infrastructure Corridor

The design of the proposed infrastructure includes the following measures to minimise potential noise and vibration impacts:

Proposed Railway Line

- The rail alignment has been located as far as feasible away from houses and townships.
- The railway line will be a continuously welded rail which avoids the noise of the wheels impacting on the rail joints which occurs for existing jointed railway lines.
- The gradient of the railway line has been minimised to maximise fuel efficiency. Additional outcomes are reduced engine strain, braking and brake noise.

- The railway line has been designed with wide bends and loops to minimise wheel squeal.
- Passing sidings have been located away from sensitive receivers to avoid the impact of idling noise.
- New locomotives will be used which will meet the Australian Standards for railway rolling stock and emit less noise than older locomotives.

Proposed Borefield

- Submersible pumps will be used for the 10 bores to minimise the noise of pumping.
- Only one pump station is needed to transport the groundwater along the water pipeline. The design incorporates a break tank to which groundwater will be pumped and then gravity fed along the remaining length of pipeline.

12.4.2 Proposed Port Development

The design of the proposed port development includes the following measures to minimise potential noise and vibration impacts:

- The rail unloading facility will be enclosed to protect equipment, control dust and to minimise noise from the unloading operation.
- Unloading of iron concentrate from the bottom of the train wagons allows continuous very slow movement of the train which will eliminate engine braking noise and the shunting noise of wagons which occurs in rotary car dumping systems.
- The two transfer stations and conveyor systems will be fully covered to minimise dust and noise.

12.5 Impact Assessment

This section assesses noise and vibration impacts on surrounding sensitive receivers that are expected to result from the construction and operation of the proposed CEIP Infrastructure.

Impacts have been assessed in accordance with the impact assessment methodology outlined in Chapter 9 and Section 12.2. A summary table of these impacts is provided in Section 12.5.4.

12.5.1 Noise and Vibration Sources

Noise and vibration associated with the proposed CEIP Infrastructure may result from construction activities including blasting of rock, rail transport of iron concentrate, borefield operation and port operations. The noise and vibration sources related to each of these project components are summarised below.

Examples of types of vibration

Continuous vibration – Machinery, steady road traffic, continuous construction activity.

Impulsive vibration – Infrequent activities, e.g. occasional dropping of heavy equipment, occasional loading and unloading.

Intermittent vibration – Blasting, trains, nearby intermittent construction activity, passing heavy vehicles, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Source: DEC 2006 (modified for relevance)

Construction Equipment

A range of equipment will be used during construction of the CEIP Infrastructure which will generate noise and vibration to some extent.

Typical equipment used for construction of a railway line, borefield, power transmission line pylon and port are listed in Table 12-8. These configurations of construction equipment were used for modelling of construction noise scenarios. As sound power levels for track-laying equipment were not available, the sound power levels generated by earth moving equipment were used for the purpose of the noise level prediction modelling; it has been assumed that the track-laying equipment will have a similar noise level and character.

The vibration produced by construction works will be highly dependent on the particular construction process and equipment that is employed and also on the local geotechnical conditions encountered once construction commences. Of the construction equipment proposed, vibratory roller/compactor operations have the most potential to cause vibration impacts from construction as demonstrated by the list of typical vibration levels due to construction equipment in Table 12-9.

It should be noted that night-time construction works would only be undertaken in exceptional circumstances and would be uncommon. Day-time construction, seven days a week (including on Sundays and public holidays) is planned. As night-time construction works would only be undertaken in exceptional circumstances and would be uncommon, modelling of day-time noise levels have been completed.

Table 12-8 Typical Construction Equipment and Sound Power Levels

Construction Activity	Equipment	Number of Units	Overall Sound Power Level, dB(A)
Railway Cutting	Tracked excavator	2	104
	Front end loader	2	108
	Vibratory compactor	1	110
	Trucks	6	108
	Grader	1	112
	Water truck	1	108
	Bulldozer	1	116
	Generator	1	102
Bridge Construction	Cranes	2	104
	Concrete Trucks	1	110
	Articulated Truck	1	111
	Tracked excavator	1	104
	Front end loader	1	108
	Generator	1	102
Level Ground and Embankment Preparation	Tracked excavator	1	104
	Front end loader	1	108
	Vibratory compactor	3	110
	Trucks	6	108
	Grader	2	112
	Water truck	2	108
	Bulldozer	1	116
	Generator	1	102

Construction Activity	Equipment	Number of Units	Overall Sound Power Level, dB(A)
Borefield Well	Drill Rig	1	86
	Front end loader	1	108
	Vibratory compactor	1	110
	Trucks	2	108
	Grader	1	112
	Generator	1	102
Transmission Line	Crane	1	104
	Front end loader	1	108
	Vibratory compactor	1	110
	Trucks	2	108
	Grader	1	112
	Generator	1	102
Port Development	Tracked excavator	3	104
	Front end loader	2	108
	Vibratory compactor	1	110
	Trucks	4	108
	Grader	2	112
	Bulldozer	2	116
	Pile driver	1	116
	Crane	2	104
	Concrete truck	2	110
	Articulated truck	2	111
	Generators	4	102
	Drill rig	2	86

Table 12-9 Typical Vibration Levels and Safe Working Distances for Construction Equipment (DPTI 2014)

Activity	Typical Levels of Ground Vibration
Vibratory Rollers	1.5 mm/s at 25 m Higher levels could occur at closer distances depending on local conditions and the roller operation. For a heavy roller, it is expected that damage will not occur with a minimum 12 m buffer to the foundations of a standard residential building.
Hydraulic Rock Breakers (levels typical of a large rock breaker in hard sandstone)	4.5 mm/s at 5 m 1.3 mm/s at 10 m 0.4 mm/s at 20 m 0.1 mm/s at 50 m
Compactor	20 mm/s at 5 m 2 mm/s at 15 m 0.3 mm/s at 30 m
Excavators	0.2 mm/s at 40 m

Activity	Typical Levels of Ground Vibration
Ballast Tamping	6 mm/s at 3 m 2 mm/s at 10 m
Truck Traffic (over maintained road surfaces)	0.2 mm/s at 10 m
Truck Traffic (over irregular surfaces)	2 mm/s at 10 m
Impact Pile Driving/Removal	≤ 15 mm/s at distances of 15 m ≤ 9 mm/s at distances greater than 25 m Typically below 3 mm/s at 50 m Significant changes to the vibration levels can occur based on the soil conditions and the driving energy of the hammer
Continuous Flight Auger (CFA) Piling	Negligible vibration at distances greater than 20 m from the piling
Bored Piling	Negligible vibration at distances greater than 20 m from the piling
Bulldozers	2 mm/s at 5 m 0.2 mm/s at 20 m
Air Track Drill	5 mm/s at 5 m 1.5 mm/s at 10 m 0.6 mm/s at 25 m 0.1 mm/s at 50 m
Jackhammer	1 mm/s at 10 m

Construction Blasting

Blasting will be used during construction of the CEIP Infrastructure for:

- Excavation works at a number of railway line crossings along the first 7.5 km of the proposed railway line from the proposed port development.
- Excavation for the railway unloading facility at the proposed port site and construction of the module off-loading facility.

Construction of the proposed port development may extend to 18 months, however blasting works are expected to be completed within 5-6 months. Although blasting requirements along the infrastructure corridor are not fully defined, it is most likely to be completed within 12 months. Blasting will be completed at regular times during the day.

Railway Operation

The proposed railway operation comprises three trains, each consisting of two locomotives and 138 wagons, running two return trips each per day. This amounts to 12 train pass-bys per day for sensitive receivers along the proposed railway line. The planned cycle time for each train is 8.5 hours including travel to the proposed mine, loading, return to port and unloading.

The train pass-bys would generate very short periods of noise (when compared to the background noise levels), intermittently during the day and night, separated by long periods of quiet.

Actual noise level measurements of heavy haul coal trains and locomotive noise levels of iron ore train pass-bys in the Pilbara were sourced from literature and used to determine a representative noise level for the proposed CEIP railway operation for input to the noise modelling. The noise level data used in the noise modelling of the CEIP railway operation is provided in Table 12-10 and Table 12-11. To replicate the CEIP iron concentrate train configuration, the noise data for the coal wagons was extrapolated to 138 wagons and the highest recorded noise level for the locomotives pulling iron ore wagons was applied.

Table 12-10 Benchmarking Noise Levels of Pass-Bys of Locomotives Pulling Iron Ore Wagons

Train Configuration	Distance from Train (m)	Measured Maximum Noise Level dB(A) L_{Amax}
Five Diesel Locomotives pulling iron ore wagons	15	93

Table 12-11 Noise Levels of Pass-Bys of Coal Wagons

Train Configuration	Pass-By Duration (seconds)	Distance from Train (m)	Measured Noise Level dB(A) L_{Aeq}
50 loaded coal wagons – travelling at 53.5 km/h	53	30	65
42 empty coal wagons – travelling at 77.5 km/h	31	23	78

Borefield Operation

The proposed borefield will consist of 10 bores, nominally each with 150 – 200 kW electric submersible pumps, to deliver the groundwater through above ground water pipelines to the pump station. The electrical power supply to each bore pump will be via pole-mounted transformers.

The pump station will comprise two 900 kW pumps which will transfer the groundwater along a water pipeline to a header tank where it will gravity feed along the infrastructure corridor to the proposed mining lease. The electrical power supply to the pump station will be from a prefabricated (enclosed) transformer.

Due to the noise associated with the pumps and transformers, the operation of the borefield has potential to impact on sensitive receivers in close proximity.

Port Operations

The materials handling operation at the proposed port site will generate noise. The material handling system comprises:

- The rail unloading facility (as illustrated in Figure 12-5): Iron concentrate will be unloaded from the bottom of the train wagons to receiving chutes below the railway level. Belt feeders located underneath the chutes will collect the iron concentrate and transfer it to a conveyor system.
- Two conveyor systems: The stockpile conveyor system will connect the rail unloading facility to the concentrate stockpile. The ship loader conveyor system will connect the concentrate stockpile to the ship loader.
- Two enclosed transfer stations: Included in the conveyor system design to enclose the transfer points where iron concentrate is transferred from one conveyor to the next.
- A concentrate stockpile: On which the iron concentrate will be deposited by a boom stacker.
- A low height bucket-wheel reclaimer: Used to move the concentrate from the stockpile to the conveyor system feeding the ship loader.
- A ship loader: Located at the end of the jetty with a boom and flared telescopic chute that will extend into the ship loading hatch.

Each of these components, as well as the train movements and locomotive engine noise associated with the unloading operation, were incorporated as noise sources in the port noise modelling.

Ship and tug noise were not included as noise sources as noise level is low (approximately 60 dB overall on the adjacent jetty as measured at Dampier) compared with the ship loader (approximately 129 dB overall – refer to Appendix L), therefore noise will be masked by general background noise, e.g. wave noise etc., and other operational noise.

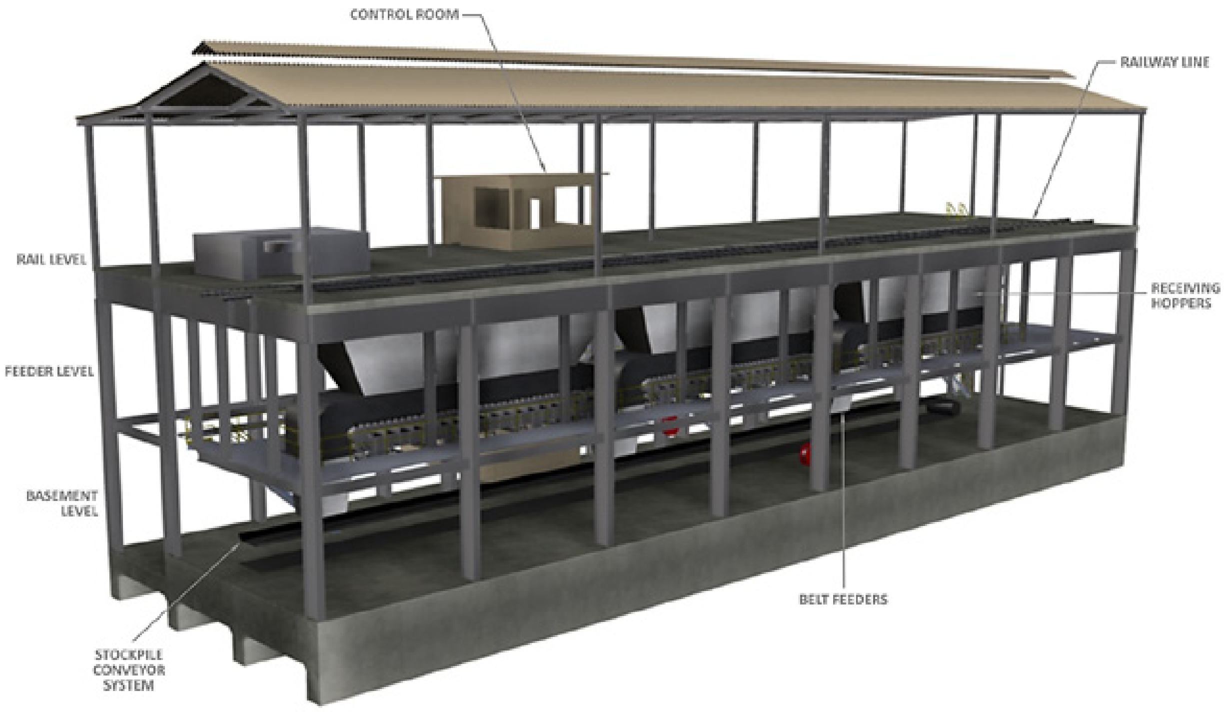

Figure 12-5 Rail Unloading Facility

12.5.2 Predicted Noise Levels

Predicted noise levels at sensitive receivers are described below. Additional detail is provided in Appendix L and M.

Predicted Construction Noise

The noise levels that may be generated during construction of the proposed railway line, borefield, power transmission line pylons and port development, were modelled using noise levels for a range of typical construction equipment configurations (refer to Table 12-8).

Construction noise modelling was not completed for construction of the long-term employee village as the final location of the village on the north eastern edge of Wudinna is to be determined and there are effective standard noise controls which are commonly applied for residential construction.

It should be noted that night-time construction works would only be undertaken in exceptional circumstances and would be uncommon. Day-time construction, seven days a week (including on Sundays and public holidays) is planned.

Infrastructure Corridor Construction Noise

The construction noise prediction modelling for the railway line, borefield and power transmission line pylons indicates that day-time noise levels would be sufficiently attenuated to meet noise criteria of L_{Aeq} 45 dB(A) for construction works on Sundays and public holidays, if the separation distance between the construction activity and sensitive receiver is in excess of approximately 1 to 1.5 km (refer to Appendix M for additional detail).

Impacts of construction noise for the infrastructure corridor are expected to be **low**, due to the following:

- As listed in Chapter 10, Air Quality, there are approximately 30 dwellings, the Driver River Uniting Church (Verran) and the Taragoro grain storage and handling facility within 1 km of the proposed infrastructure components along the approximate 130 km infrastructure corridor (including the borefield wells, water pipeline, railway line and power transmission line). Considering the sparseness of sensitive receivers, it is envisaged the management and staging of construction works will either maintain a separation distance of 1 to 1.5 km between the construction works and sensitive receivers or specific environmental management controls as detailed in the Construction Environmental Management Plan (CEMP) will be implemented to ensure the noise emissions meet the noise criteria when performed on Sundays or public holidays, and at night time if required.
- Construction works will be performed in sections along the proposed infrastructure corridor so noise levels generated at individual sensitive receiver locations will be for a relatively short duration as the construction operations move along the infrastructure corridor.
- The prediction noise modelling for construction was performed assuming that all of the construction equipment is operating at full load, therefore presenting the worst-case scenario. In practice this is generally not the case as some equipment will be idling or switched off when not in use while others will be working at full load.
- As the modelling was based on a worst-case scenario there is considerable scope for managing the actual noise levels within the relevant noise criteria.

Port Development Construction Noise

Two port construction scenarios were modelled in which equipment was “placed” in two different locations:

1. All of the construction plant and equipment working near the materials handling infrastructure landside of the proposed jetty.
2. All of the construction plant and equipment working near the rail unloading facility and associated infrastructure.

Table 12-12 lists the predicted noise levels at the nearest sensitive receivers to the proposed port development during the construction phase with all equipment operating for the day-time period.

Table 12-12 Predicted Noise Levels from Port Construction at the Nearest Sensitive Receivers

Sensitive Receiver IDs	Predicted $L_{Aeq,15mins}$ (Day) Sound Pressure Level, dB(A)*	
	Construction Scenario 1	Construction Scenario 2
Sensitive receiver 43	33	40
Sensitive receiver 42	31	37
Sensitive receiver 198	25	21
Sensitive receiver 66	27	21
Sensitive receiver 65	28	21

Sensitive Receiver IDs	Predicted $L_{Aeq,15mins}$ (Day) Sound Pressure Level, dB(A)*	
	Construction Scenario 1	Construction Scenario 2
Sensitive receiver 44	51	34
Noise criteria – Sundays and public holidays only	45	45

*Note:

- Predicted sound pressure levels are rounded to nearest whole number

Port development construction noise impacts are expected to be **low**, due to the following:

- As listed in Table 12-12, the predicted construction noise level for scenario one exceeds 45 dB(A) (which is the day-time noise criteria for Sundays and public holidays) at the closest sensitive receiver (number 44), however the construction noise criteria is not exceeded at any of the sensitive receiver locations for construction scenario two. The modelling demonstrates that construction can be managed to avoid adverse impact on amenity of all sensitive receivers by managing the location, timing and type of construction activities as required in accordance with the Noise Policy.
- The prediction noise modelling for construction was performed assuming that all of the construction equipment is operating simultaneously at full load for each scenario with worst-case weather conditions applied, therefore presenting the worst-case scenario. In practice this is generally not the case as some equipment will be idling or switched off when not in use while others will be working at full load.
- As the modelling was based on a worst-case scenario there is considerable scope for managing the actual noise levels within the relevant noise criteria.

Predicted Railway Operational Noise

The noise of train pass-bys will occur for 12 short periods (approximately 60 to 90 seconds when passing a fixed point) intermittently during the day and night, separated by long periods of quiet. Train noise will build slowly to a peak as the train approaches and then gradually decrease as the train travels along the track.

The predicted noise levels at sensitive receivers along the proposed infrastructure corridor due to the rail movements are presented in Table 12-13 and Table 12-14 (also refer to Figure 12-3 and Figure 12-4 for locations of sensitive receivers). Examples of modelled railway noise level contours for night time are shown in Figure 12-6, Figure 12-7 and Figure 12-8. The modelled noise contours for sections of the proposed railway line where the closest sensitive receivers are located are provided in Appendix N.

From the noise level prediction modelling, it can be determined that the noise levels due to the railway line operation would be below the noise criteria presented in the Rail Noise Guidelines for both the day-time and night-time periods:

- The predicted L_{Amax} noise levels at identified dwellings were at least 8 dB(A) less than the 80 dB L_{Amax} criterion.
- The predicted $L_{Aeq,15\,hr\,(Day)}$ and $L_{Aeq,9\,hr\,(Night)}$ noise levels at the identified dwellings were at least 9 dB(A) less than respective criteria and the majority of predicted noise levels were significantly lower.
- The predicted $L_{Aeq,1\,hr}$ noise levels at the closest sensitive receiver, the Driver River Uniting Church at Verran (sensitive receiver 27), were 8 dB(A) below the day-time and night-time noise criteria.

The impact of the railway operational noise is assessed as **low**, because:

- The rail noise modelling predicts a detectable negative change that complies with the relevant rail noise criteria.
- Rail noise will be for short periods of time each day
- Noise will be minimised as much as possible in accordance with the Operational Environmental Management Plan (OEMP) including training of train drivers to lightly tap horns at crossings to minimise nuisance noise at nearby dwellings while maintaining safety requirements.

Despite the predicted rail noise levels meeting the Rail Noise Guideline criteria and being assessed as low impact, it is acknowledged that the rail noise will be audible and initially intrusive for some sensitive receivers used to a relatively quiet rural environment and that the train horns may be a nuisance for dwellings nearby crossings. For further discussion in relation to the impact of CEIP Infrastructure on rural amenity refer to Chapter 22 Social Environment.

Table 12-13 Predicted Noise Levels from Rail Operations at Identified Dwellings

Sensitive Receiver ID	Predicted 'A' Weighted Sound Pressure Level (dBA)*			
	$L_{eq15\ hr}$ (Day) (Criteria of 60 $L_{Aeq,\ 15h}$)	$L_{eq9\ hr}$ (Night) (Criteria of 55 $L_{Aeq,\ 9h}$)	L_{max} (Day) (Criteria of 80 L_{Amax})	L_{max} (Night) (Criteria of 80 L_{Amax})
1	38	38	62	61
2	25	25	43	43
3	33	33	53	53
4	27	27	45	45
5	30	30	49	49
6	35	35	55	55
7	24	24	38	38
8	44	44	69	69
9	31	31	51	51
10	28	28	45	45
11	27	27	44	44
12	43	43	67	67
13	35	35	55	55
14	30	30	49	49
15	31	31	49	49
16	40	40	63	63
17	39	39	65	64
18	37	37	59	59
19	32	31	50	50
20	31	31	52	51
21	27	26	44	44
22	28	28	43	43
23	39	39	64	64
24	32	32	51	51
25	34	34	54	54
26	46	46	72	72

Sensitive Receiver ID	Predicted 'A' Weighted Sound Pressure Level (dBA)*			
	$L_{eq15\ hr}$ (Day) (Criteria of 60 $L_{Aeq,\ 15h}$)	$L_{eq9\ hr}$ (Night) (Criteria of 55 $L_{Aeq,\ 9h}$)	L_{max} (Day) (Criteria of 80 L_{Amax})	L_{max} (Night) (Criteria of 80 L_{Amax})
28	32	32	52	52
29	36	35	57	57
30	30	30	49	49
31	31	31	48	48
32	31	30	49	49
33	34	34	53	53
34	45	44	70	69
35	32	32	55	55
36	33	33	54	54
37	25	25	41	41
38	26	26	42	42
39	27	27	46	46
40	35	35	56	56
41	28	28	51	51
42	41	41	64	64
43	30	30	55	55
44	25	25	46	46
45	33	33	52	52
46	26	26	43	43
47	28	28	45	45
48	34	34	54	54
49	6	6	11	11
50	6	6	9	10
51	24	24	44	44
52	24	24	43	43
53	27	27	47	47
54	27	27	47	47
55	29	29	51	51
56	27	27	47	47
57	26	26	46	46
58	27	27	47	46
59	32	32	54	53
60	27	27	48	48
61	7	7	13	13
62	6	6	12	12
63	28	28	45	45
64	28	28	46	46
65	15	15	27	27

Sensitive Receiver ID	Predicted ‘A’ Weighted Sound Pressure Level (dBA)*			
	$L_{eq15\ hr}$ (Day) (Criteria of 60 $L_{Aeq,\ 15h}$)	$L_{eq9\ hr}$ (Night) (Criteria of 55 $L_{Aeq,\ 9h}$)	L_{max} (Day) (Criteria of 80 L_{Amax})	L_{max} (Night) (Criteria of 80 L_{Amax})
66	16	16	26	26
67	35	35	56	56
68	35	35	58	57
69	43	42	68	68
70	26	26	44	43
71	43	42	68	68
72	24	24	46	46
73	23	23	38	38
74	23	23	41	41
75	27	27	45	45
76	25	25	42	42
77	33	33	52	52

*Note: Predicted sound pressure levels are rounded to nearest whole number

Table 12-14 Predicted Noise Levels from Rail Operations at Driver River Uniting Church, Verran

Sensitive Receiver ID	Predicted ‘A’ Weighted Sound Pressure Level (dBA)*	
	$L_{eq1\ hr}$ (Day) (Criteria of 60 $L_{Aeq,\ 1h}$)	$L_{eq1\ hr}$ (Night) (Criteria of 60 $L_{Aeq,\ 1h}$)
27 - Church	52	52

*Note: Predicted sound pressure levels are rounded to nearest whole number

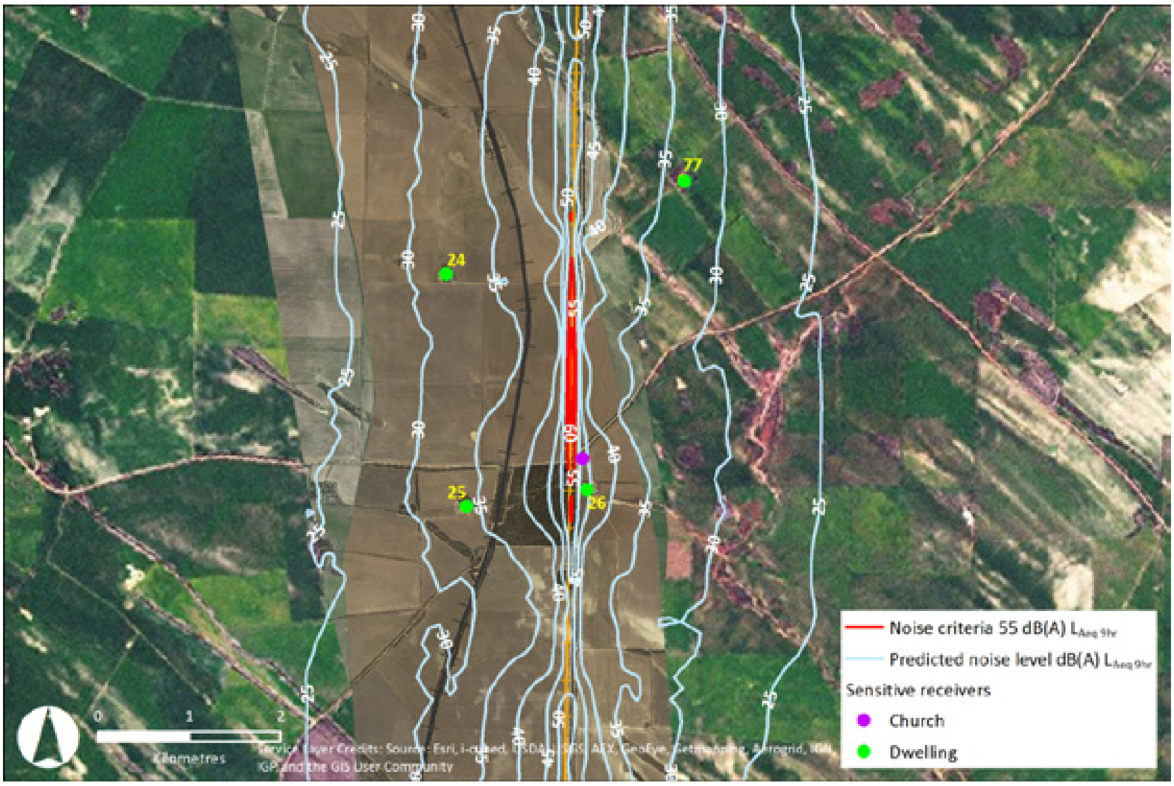

Figure 12-6 Example Enlargement of the Predicted Noise Contours, Night $L_{Aeq\ 9hr}$ for the Operation of the Railway

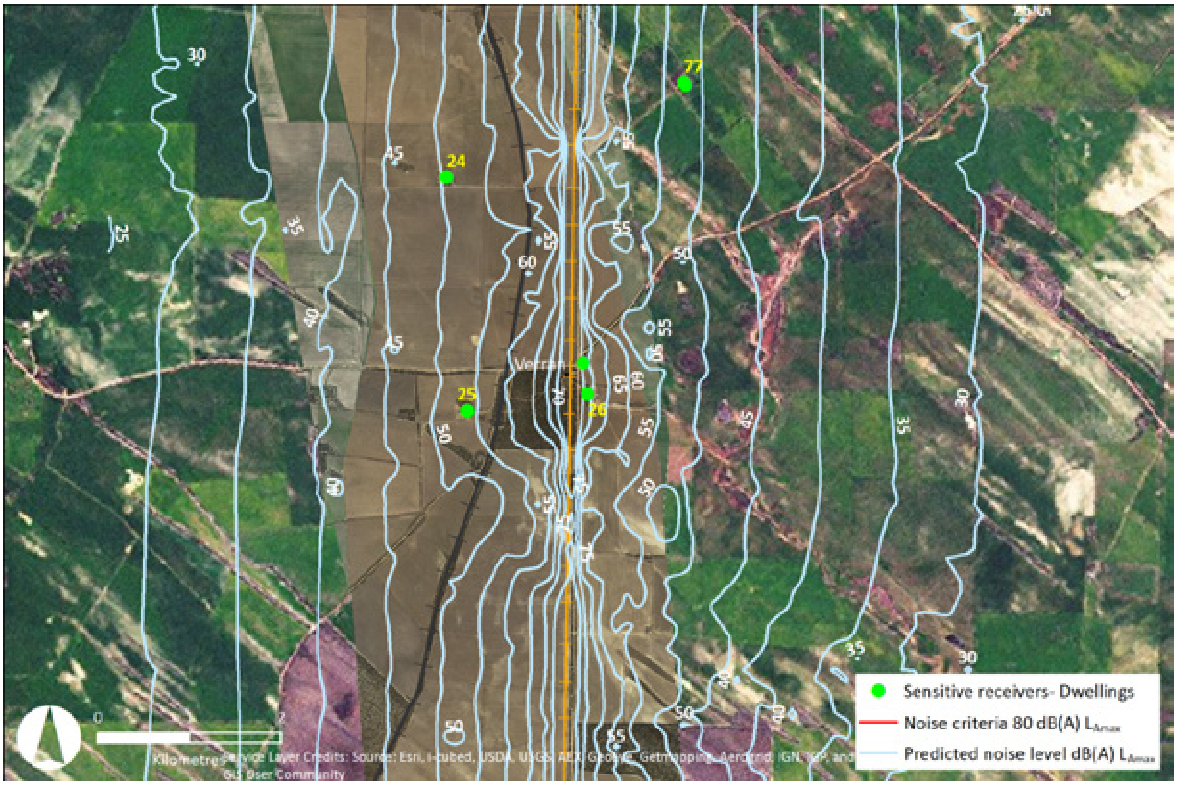

Figure 12-7 Example Enlargement of the Predicted Noise Contours, Night L_{Amax} for the Operation of the Railway

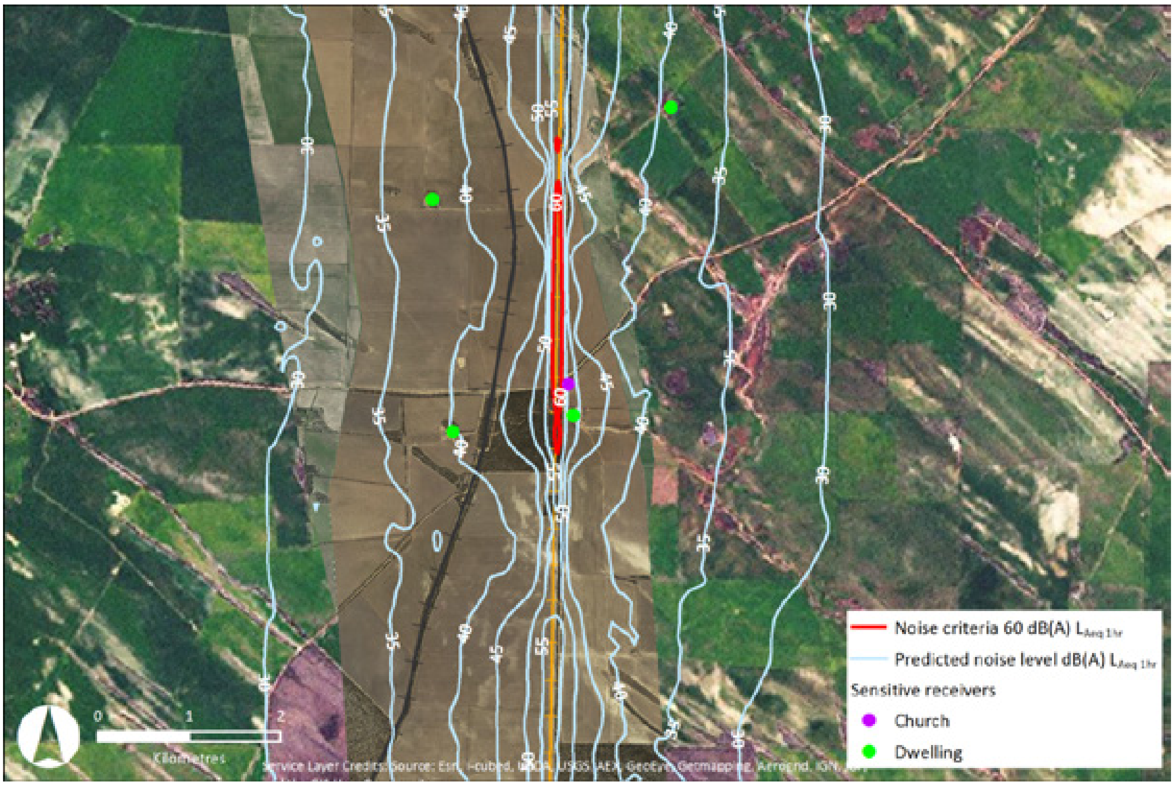

Figure 12-8 Example Enlargement of Predicted Noise Contours, Night $L_{Aeq\ 1hr}$ for the Operation of the Railway

Predicted Borefield Operational Noise

During operation of the proposed borefield, noise will be generated by the transformers and pumps.

Clause 14(3) of the Noise Policy requires a penalty be applied to the predicted noise level to account for specific acoustic characteristics (impulsive, low frequency, modulating, tonal). Due to the likely tonal noise character of the electric motor of the borefield pump station, a noise character correction of 5 dB(A) is considered warranted and has been applied in accordance with the Noise Policy.

Based on modelling of the borefield noise sources, and due to the use of submersible pumps, the noise generated at the individual bore sites will be minor and considerably lower than the relevant noise criteria. The noise generated by the pump station is the most significant noise source at the borefield.

The predicted noise levels, including the 5 dB(A) noise character penalty, for the four closest sensitive receivers to the pump station are presented in Table 12-15.

Table 12-15 Predicted Noise Levels from the Operation of the Proposed Borefield Pump Station

Sensitive Receiver ID	Predicted $L_{Aeq\ 15\ mins}$ Noise Levels including a 5 dB(A) Noise Character Penalty*	
	Day time (Criteria of 52 $L_{Aeq,15mins}$)	Night time (Criteria of 45 $L_{Aeq,15mins}$)
Sensitive receiver 10	17	19
Sensitive receiver 11	30	27
Sensitive receiver 12	30	27
Sensitive receiver 91	29	26

*Note:

- Due to the likely tonal noise character of the electric motor of the borefield pump station, a noise character correction of 5 dB(A) is considered warranted and has been applied in accordance with the Noise Policy.
- Predicted sound pressure levels are rounded to nearest whole number.

The predicted noise levels due to the operation of equipment at the borefield are considerably below the noise criteria and therefore the impact of borefield noise is considered to be **negligible**.

Predicted Port Development Operational Noise

The operational noise level for the proposed port development was predicted for a worst-case scenario where all plant and equipment was running simultaneously, including conveyors operating and unloading of trains. The conservative scenario included:

- Train unloading operation including wheel squeal and wagon indexing
- Locomotive engine noise
- Stacker operating
- Reclaimer operating
- Ship loader operating
- Conveyors and conveyor drives operational

The construction camp will be removed after construction is complete and therefore it was not considered as part of the noise modelling for operation of the proposed port development.

Based on historical wind data it was determined that the prevailing wind direction was dependent on the season. Therefore the worst-case wind direction with the wind from the proposed port development directed towards the nearest sensitive receiver (between north and north-east) was used in the model.

Analysis of the TAPM model for meteorological data generated specifically for the port site, for the year 2009 (the same case study year used for the air quality impact assessment) was undertaken to determine the likely frequency of worst-case weather conditions, including a wind direction between north and north-east. It was found that:

- The number of nights (10 pm to 7 am) per year, approximately, that wind direction would be between north and northeast, on at least one hour during a night, is approximately 50 nights (approximately 14% of nights per year).
- The number of night hours in which wind direction would be between north and northeast was approximately 226 hours (6.9% of total night time hours per year).

In addition to wind direction, the existence of temperature inversions provide worst-case conditions for noise and in general occur at night, late morning, and early evening. Temperature inversions can be directly related to 'F class' atmospheric stability, which were extracted from the TAPM model. It was found that:

- The number of nights with wind direction between north and northeast and 'F class' atmospheric stability for at least one hour was 20 nights (5.5% of nights per year).
- The number of night hours in which wind direction is between north and northeast and with 'F class' atmospheric stability was approximately 71 hours (2.2% of total night time hours per year).

Clause 14(3) of the Noise Policy requires a penalty be applied to the predicted noise level to account for specific acoustic characteristics (impulsive, low frequency, modulating, tonal). Due to the likely low frequency noise (locomotive engine noise) associated the operation of the proposed port development, a noise character correction of 5 dB(A) is considered warranted and has been applied in accordance with the Noise Policy.

The predicted noise levels, including the 5 dB(A) noise character penalty, at the closest sensitive receivers are presented in Table 12-16.

The modelled noise contours for the operation of the proposed port development are shown in Figure 12-9 and Figure 12-10.

Table 12-16 Predicted Noise Levels from Port Operations at Sensitive Receivers

Sensitive Receiver ID	Predicted $L_{Aeq\ 15\ mins}$ Noise Levels including 5 dB(A) Penalty*	
	Day time (Criteria of 53 $L_{Aeq,15mins}$)	Night time (Criteria of 44 $L_{Aeq,15mins}$)
43	28	28
42	26	26
198	21	21
66	22	22
65	23	23
44	42	42

*Note:

- Due to the likely low frequency noise (locomotive engine noise) associated the operation of the proposed port development, a noise character correction of 5 dB(A) is considered warranted and has been applied in accordance with the Noise Policy.
- Predicted sound pressure levels are rounded to nearest whole number.

All predicted noise levels at the closest sensitive receivers are below the relevant noise criteria and worst-case weather conditions are likely to occur for only 2.2% of total night time hours per year, therefore it is expected the impact of noise from the operation of the proposed port development will be **low**.

Power Transmission Line Operational Noise

Noise modelling was not performed for the operation of the proposed power transmission line as the only noise generated by the transmission line would be due to the ‘corona’ effect. This phenomenon generally occurs only during fog or rain conditions and generates noise levels of the order of 40 to 50 dB(A) at a distance of 3 m (Egger et al. 2009 and Wszolek 2008). During dry conditions this noise source rarely occurs.

Based on the measured overall noise levels presented for the corona effect (45 to 50 dB(A) at a distance of 3 m) it is predicted the noise levels would be significantly attenuated by a distance of 100 m from the transmission line to approximately 25 to 35 dB(A), well within the noise criteria of 45 dB(A) for the night time.

As the level of noise from the transmission line is not expected to be distinguishable from the existing ambient noise level at sensitive receiver locations, the impact is expected to be **negligible**.

Long-Term Employee Village Operation Noise

Noise from the long-term employee village will comprise standard domestic noises such as air conditioners and vehicles entering and leaving the premises.

As the level of noise from the long-term employee village will be similar to existing adjacent residential noise, it is considered the impact will be **low**.

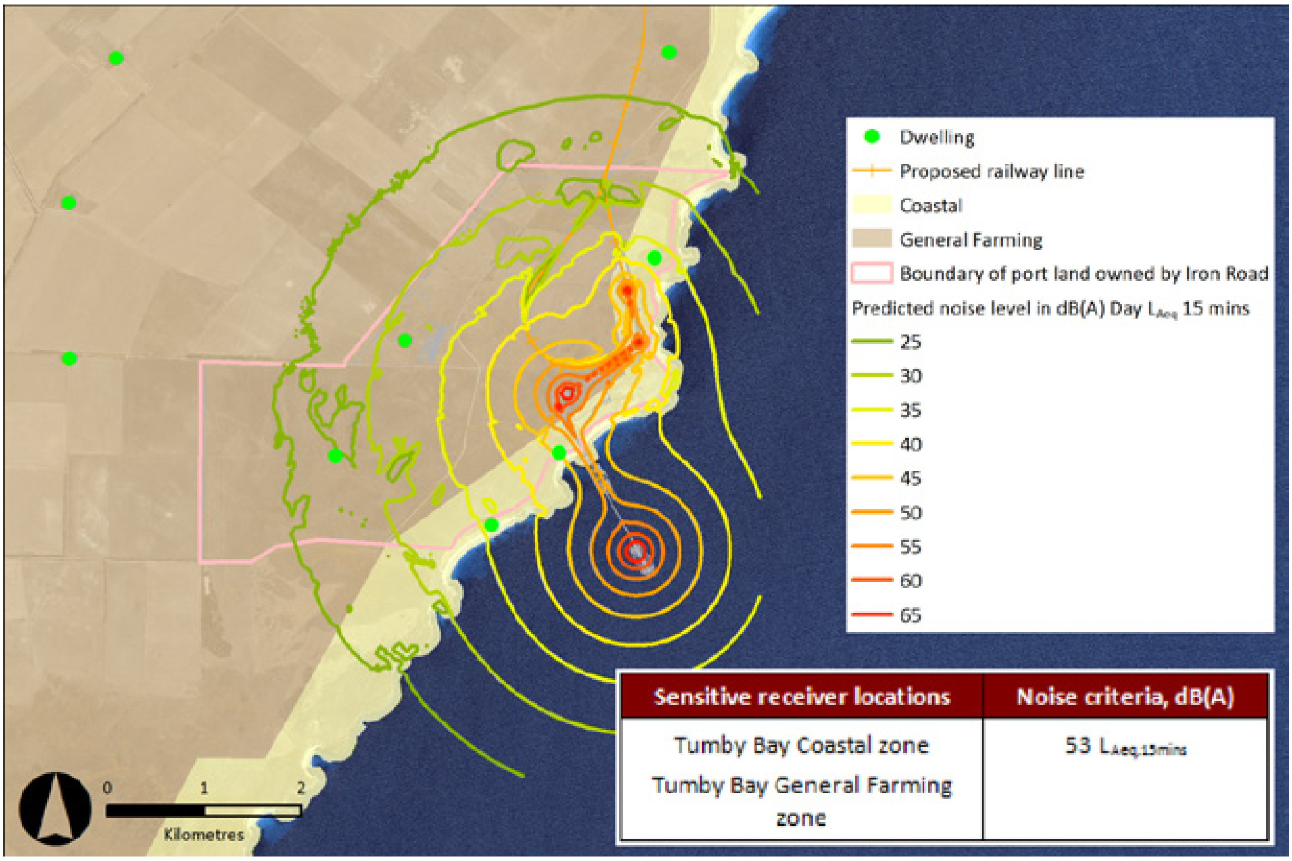

Figure 12-9 Predicted Operational Noise Contours for Proposed Port Development, Day $L_{Aeq,15mins}$

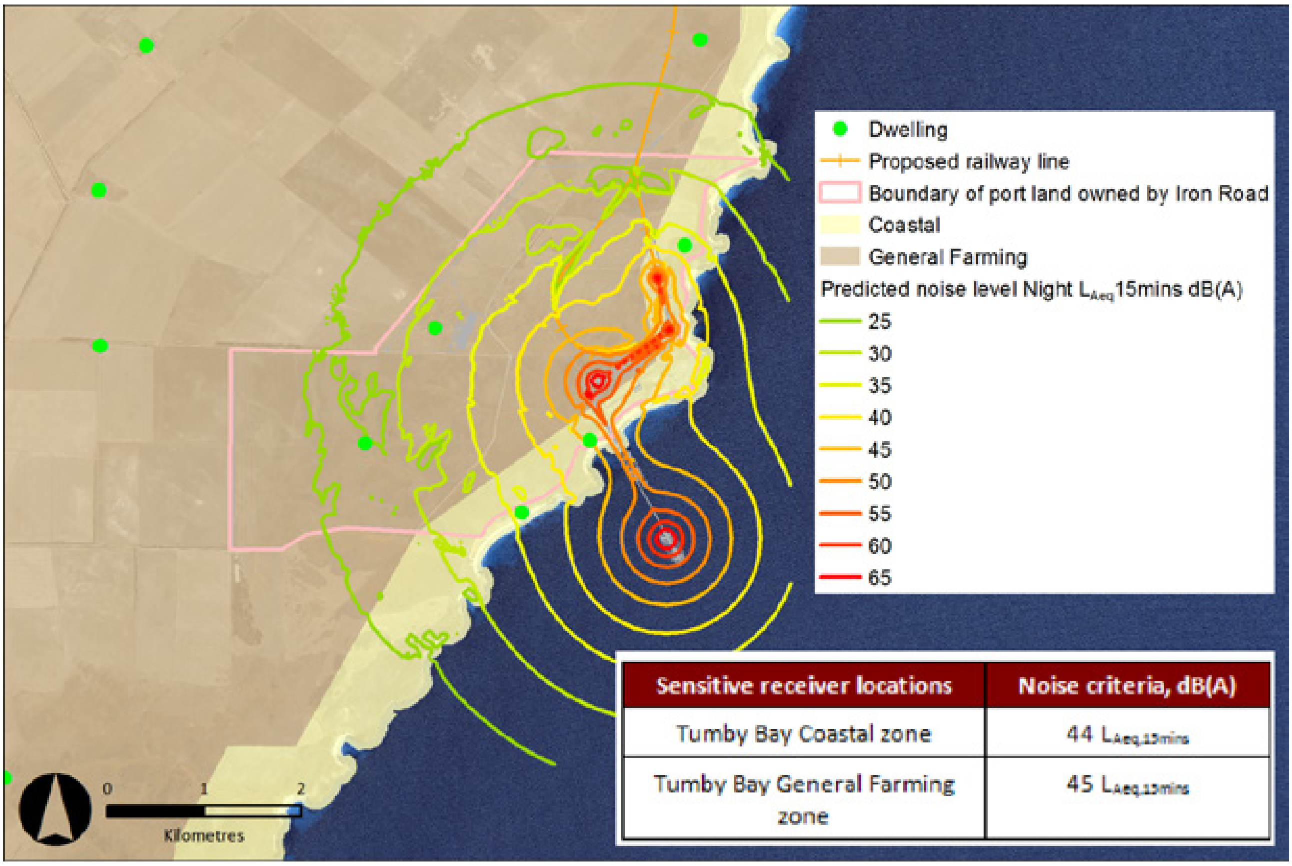

Figure 12-10 Predicted Operational Noise Contours for Proposed Port Development, Night $L_{Aeq,15mins}$

12.5.3 Predicted Vibration Levels

Predicted Vibration During Construction – Blasting

Ground vibration and airblast generated by blasting was predicted using the formula in *ICI Explosives Blasting Guide* (ICI Technical Services 1995). Although the locations of blasting and the blasting procedures have not been fully defined, predictions presented in Table 12-17 provide guidance on the minimum distances allowable from the blast site to sensitive receivers for different charge masses.

Table 12-17 Minimum Distances for Blasting Based on Various Blast Charges

Charge Mass (Kg)	Indicative Minimum Distances to Sensitive Receivers	Predicted Ground Vibration Level (mm/s) (Criteria is 10 mm/s)	Predicted Airblast Over Pressure (dBL) (Criteria is 120 dBL)
2	100	1.2	120
20	200	2.6	120
60	300	3.3	120
160	400	4.5	120
275	500	5	120
400	600	5	120
550	700	5	119

Blasting procedures will be developed and implemented in accordance with AS 2187.2 – 2006, therefore it is considered that the impact of ground vibration and airblast due to blasting will be **low**.

Predicted Vibration During Construction – Construction Equipment

The vibration produced by the construction works will be highly dependent on the particular construction processes and equipment that is employed and also on the local geotechnical conditions encountered once construction commences. However it is known that vibration from construction equipment has a limited distance before being imperceptible.

Typical ground vibration levels for various pieces of construction equipment are well known (refer to Table 12-9), including for the likely equipment to be used during construction of the proposed railway line, borefield, power transmission line and port including compactors and vibratory rollers.

As the separation distance between construction works and sensitive receivers is over 100 m and it is known that attenuation of vibration from construction equipment occurs over short distances, it is deemed that construction vibration levels will be below the preferred day-time human response levels in Section 12.1.7, and hence well below the structural damage criteria.

As vibration from construction equipment is expected to meet the applicable criteria and be of a short-term nature, the impacts from construction equipment vibration are considered to be **low**.

Predicted Vibration from Operation of CEIP Infrastructure

Ground vibration predictions were not completed for the operational phase of the port development. Potential vibration sources during operation of the proposed port facility will include train movements, unloading of iron concentrate at the rail unloading facility, stacking and reclaiming iron concentrate from the concentrate stockpile and the conveyor system. However as much of the equipment is relatively slow and constant speed (e.g. train speed of approximately 0.8 km/h during unloading and conveyor speed of approximately 3 m/s), the vibration levels due to the operation of the equipment will be very low.

Vibration levels from laden and unladen coal trains have been widely studied in the Hunter Valley. For example it was found that most train pass-by vibration measurements at a distance of 20 m did not 'trigger' the data logger to start monitoring when it was set to a 0.5 mm/s trigger point (Spectrum Acoustics 2008). The calculated maximum vibration level due to a train pass-by (using the vibration level of 0.5 mm/s at 20 m) at a distance of 140 m (the distance from the proposed railway line to the closest sensitive receiver) is in the order of 0.07 mm/s. The calculated ground vibration level is below the recommended vibration criteria presented in Table 12-6 which presents the human response preferred values for vibration, the most stringent criteria being 0.1 mm/s (for continuous vibration in critical areas e.g. operating theatres).

There are no sources of vibration during operation of the proposed borefield, transmission line or long-term employee village.

It is expected that vibration levels generated during operation of CEIP Infrastructure will be considerably lower in magnitude than the vibration levels generated during the construction phase.

Based on the relatively slow and constant speed of port operational equipment and limited distance required to mitigate train pass-by vibration, the impact of vibration due to the operation of the CEIP Infrastructure is expected to be **negligible**.

12.5.4 Summary of Impacts

The residual impacts due to noise from the construction and operation of the proposed CEIP Infrastructure are summarised in Table 12-18.

Through the adoption of design measures (refer to Section 12.4) and management strategies (refer to Section 12.6), all identified impacts were categorised as low or negligible and were considered to be as low as reasonably practicable and therefore acceptable.

Table 12-18 Summary of Impacts: Noise and Vibration Impacts

Impact	Comment	Level of Impact
Construction		
Impacts to sensitive receivers from noise generated during construction of the CEIP Infrastructure.	Construction noise impacts are expected to be low as the modelling demonstrates that construction can be managed to meet the applicable noise criteria at all sensitive receivers by managing the location, timing and type of construction activities in accordance with a CEMP. In addition, the prediction noise modelling for construction was based on the worst-case scenario of all of the construction equipment operating at full load, simultaneously. As the modelling was based on a worst-case scenario there is considerable scope for managing the actual noise levels within the relevant noise criteria.	Low
Impacts to sensitive receivers from vibration caused by equipment used during construction of CEIP Infrastructure.	Vibration generated due to construction works will be highly dependent on the construction process and equipment that is employed and also on the local geotechnical conditions. However it is known that vibration from construction equipment has a limited distance before being imperceptible. As the separation distance between construction works and sensitive receivers is over 100 m and it is known that attenuation of vibration from construction equipment occurs over short distances, it is deemed that construction vibration levels will be below the applicable vibration criteria. It is therefore anticipated that vibration impacts due to construction will be low.	Low
Impacts to sensitive receivers from ground vibration and airblast generated by blasting during construction of CEIP Infrastructure.	Although the locations of blasting and the blasting procedures have not been fully defined, predictions provide an indication of the minimum distances allowable for different charge masses to meet blasting criteria. Blasting procedures will be developed and implemented in accordance with *AS 2187.2 – 2006*, therefore it is considered that the impact of ground vibration and airblast due to blasting will be low.	Low
Operation		
Impacts to sensitive receivers from noise associated with the operation of the proposed railway line.	The noise prediction modelling demonstrates that the noise levels due to the proposed railway line operation will comply with the Rail Noise Guidelines for both the day-time and night-time periods. The train pass-bys will generate relatively short periods of noise (when compared to the background noise levels), intermittently during the day and night, separated by longer periods of quiet. Noise management strategies will be implemented in accordance with the OEMP to minimise noise impacts as much as possible. Therefore, the impact of rail noise is expected to be low.	Low

Impact	Comment	Level of Impact
Impacts to sensitive receivers from noise generated by the operation of the proposed borefield.	Due to the use of submersible pumps, the noise generated at the individual bore sites will be minimal. The noise generated by the pump station will be the most significant noise source at the proposed borefield. The predicted noise levels due to the operation of equipment at the borefield are considerably below the noise criteria and therefore the impact of the proposed borefield noise is considered to be low.	Negligible
Impacts to sensitive receivers from noise generated by the operation of the proposed port development.	The train movements, locomotive engines and material handling system at the proposed port development will generate noise during operation. All predicted noise levels at the closest sensitive receivers are below the relevant noise criteria and worst-case weather conditions are likely to occur for only 2.2% of total night time hours per year, therefore it is expected the impact of noise from the operation of the proposed port development will be low.	Low
Impacts to sensitive receivers from noise generated by the operation of the transmission line.	The 'corona' effect is expected to be the only noise generated by the proposed transmission line during operation. This phenomenon generally occurs only during fog or rain conditions and generates noise levels of the order of 40 to 50 dB(A) at a distance of 3 m (Egger *et al* 2009 and Wszolek 2008). During dry conditions this noise source rarely occurs. The potential noise level will be significantly attenuated by distance and it is expected the noise will be inaudible from the existing ambient noise level at all sensitive receivers.	Negligible
Impacts to sensitive receivers from noise generated by the operation of the long-term employee village.	As the level of noise from the long-term employee village will be similar to existing adjacent residential noise, it is considered the impact will be low.	Low
Impacts to sensitive receivers due to vibration from operation of CEIP Infrastructure.	It is expected that vibration levels generated during operation of CEIP Infrastructure will be considerably lower in magnitude than the vibration levels generated during the construction phase. Based on the relatively slow and constant speed of port operational equipment and limited distance required to mitigate train pass-by vibration, the impact of vibration due to the operation of the CEIP Infrastructure is expected to be negligible.	Negligible

12.6 Control and Management Strategies

In order to minimise the impact on, and potential risks to, the noise and vibration amenity of sensitive receivers during construction and operation, a series of control and management strategies will be incorporated into the CEMP and OEMP and implemented for each project component. Key control and management strategies are summarised in Table 12-19. Chapter 24 provides a framework for implementation of these strategies and environmental controls for the whole of the CEIP Infrastructure. A draft CEMP is contained in Appendix AA and a draft OEMP is contained in Appendix BB.

Table 12-19 Control and Management Strategies: Noise and Vibration

Control and Management Strategies	EM ID
Construction	
All reasonable and practicable measures will be taken to minimise noise resulting from construction activity having an adverse impact on amenity of sensitive receivers at all times.	NV_C1

Control and Management Strategies	EM ID
Construction activity resulting in noise potentially having an adverse impact on amenity (e.g. above a continuous noise level of 45 dB(A) or maximum noise level of 60 dB(A)) will not occur on a Sunday or Public Holiday or at night time without approval.	
Noisy equipment or processes are to be located in strategic locations so that their impact on nearby sensitive receivers will be minimised (e.g. work or processes will be performed at locations further away from residential buildings or behind barriers such as buildings etc.).	NV_C2
Equipment will be shut off or throttled down whenever it is not in actual use.	NV_C3
Noise reduction devices such as mufflers will be fitted and will operate effectively.	NV_C4
Equipment will be serviced regularly and equipment in need of repair will not be used.	NV_C5
Equipment will be operated and materials handled in a way as to minimise the impact of noise and vibration.	NV_C6
Operation	
Train operation safety measures will require sounding of the train horn on the approach to crossings. The noise level due to the horns is highly dependent on driver operation (the noise generated can be up to 14 dB higher if the driver presses heavily on the horn) so train drivers will be trained to operate horns by 'tapping' lightly and work procedures put in place to minimise nuisance noise at nearby dwellings.	NV_01
Train schedules and potential noise impacts will be communicated widely to the local and regional community.	NV_02
Vehicles, locomotives and rail wagons will be regularly maintained. Maintenance requirements for rail wagons will be determined and addressed to minimise rail noise through such procedures as regular inspections which may include wheel roughness, brake system set-up and bogie suspension-tracking operation, or installation of noise cameras to identify noisy rail wagons.	NV_03
Monitoring programme will be developed in accordance with statutory requirements.	NV_04

12.7 Residual Risk Assessment

This section identifies and assesses noise and vibration risks to surrounding sensitive receivers that would not be expected as part of the normal operation of the CEIP Infrastructure, but could occur as a result of faults, failures and unplanned events. Although the risks may or may not eventuate, the purpose of the risk assessment process was to identify management and mitigation measures required to reduce the identified risks to a level that is acceptable. The noise and vibration control and management strategies identified are presented in Section 12.6 and form the basis of the Environmental Management Framework presented in Chapter 24.

The key environmental risks associated with the project related to noise emissions and vibration are presented in Table 12-20.

12.7.1 Construction Noise and Vibration Risks

During construction, the residual noise and vibration risks to sensitive receivers surrounding the CEIP Infrastructure include:

- *Failure by construction crews to implement the controls, or inadequate control measures specified, in the CEMP which cause a failure to effectively manage construction related noise and vibration.*

  Construction-generated noise and vibration due to failure or inadequacy of controls would be localised and may cause a short-term exceedance of noise or vibration criteria, therefore the consequence is categorised as minor. It is considered possible that noise and vibration controls would fail or be inadequate at some stage during the construction period. As the consequence is considered minor and likelihood as possible, the risk is considered to be **low**.

- *Construction work in locations or at times not anticipated in the noise and vibration assessment, for example night-time construction works are required.*

  Construction work undertaken in locations where there is a reduced separation distance between the construction site and sensitive receiver/s (compared with what has been assessed) or at night time could cause noise and vibration that impacts on the amenity of sensitive receivers, however the impact would be minimised with the implementation of control measures and it would be localised and short term, therefore the consequence is categorised as minor. It is considered possible that construction work would be undertaken in locations or at times not anticipated in the noise and vibration assessment at some stage during the construction period. With a consequence categorised as minor and likelihood categorised as possible, the risk is considered to be **low**.

12.7.2 Operational Noise and Vibration Risks

During operation, the residual noise and vibration risks to sensitive receivers surrounding the CEIP Infrastructure include:

- *More noise than predicted is generated by the railway operation along the proposed infrastructure corridor.*

  Based on the noise modelling results for the proposed railway operation, which predicts noise levels will be 8 to 9 dB(A) below the noise criteria, it is considered that even if greater noise is generated by the railway operation than predicted, it would not exceed the noise criteria at any sensitive receiver. Therefore the consequence is categorised as minor. As the noise modelling represents a conservative scenario (due to the worst-case locomotive noise levels used in the modelling) it is considered unlikely that railway operational noise will be higher than predicted. Due to the consequence being considered minor and likelihood being unlikely, the risk is considered to be **low**.

- *More noise than predicted is generated by the operation of the proposed port development.*

  Based on the noise modelling results for the port operation, which predicts the noise level for all but the closest sensitive receiver (sensitive receiver 44) will be considerably below the noise criteria, it is considered that if the port operation generates more noise than predicted, the noise level may exceed the noise criteria at sensitive receiver 44. As one sensitive receiver would be impacted it is considered a localised and minor long-term exceedance of the noise criteria for which the consequence is categorised as moderate. As the noise modelling represents a conservative scenario (as the modelling included all plant and conveyors operating with simultaneous train unloading and ship loading underway) it is considered unlikely that port operational noise will be higher than predicted. Due to the consequence being considered moderate and likelihood being unlikely, the risk is considered to be **medium**.

- *Lack of regular maintenance of the rail wagon fleet causing more noise than predicted along the proposed infrastructure corridor.*

  Based on the noise modelling results for the proposed railway operation, which predicts noise levels will be 8 to 9 dB(A) below the noise criteria, it is considered that even if greater noise is generated by the railway operation than predicted, it would not exceed the noise criteria at any sensitive receiver. Therefore the consequence is categorised as minor. As the noise modelling represents a conservative scenario (due to the worst-case locomotive noise levels used in the modelling) it is considered unlikely that railway operational noise will be higher than predicted. Due to the consequence being considered minor and likelihood being unlikely, the risk is considered to be **low**.

- *Excessive noise due to port operational equipment or controls failure.*

  Based on the noise modelling results for the port operation, which predicts the noise level for all but the closest sensitive receiver (sensitive receiver 44) will be considerably below the noise criteria, it is considered that if the port operation generates more noise than predicted, the noise level may exceed the noise criteria at sensitive receiver 44. As one sensitive receiver would be impacted it is considered a localised and minor long-term exceedance of the noise criteria for which the consequence is categorised as moderate. As the noise modelling represents a conservative scenario (as the modelling included all plant and conveyors operating with simultaneous train unloading and ship loading underway) it is considered unlikely that port operational noise will be higher than predicted. Due to the consequence being considered moderate and likelihood being unlikely, the risk is considered to be **medium**.

12.7.3 Summary of Risks

The residual risks associated with noise and vibration are presented in Table 12-20.

Through the adoption of design measures or management measures, all identified risks were reduced to levels of low or medium and were considered to be as low as reasonably practicable and therefore acceptable. Risks would be monitored through the CEIP Environmental Management Framework presented in Chapter 24.

Table 12-20 Residual Risk Assessment Outcomes: Noise and Vibration

Risk Event	Pathway	Receptor	Consequence	Likelihood	Residual Risk
Construction noise exceeds expected levels	Failure to implement the controls, or inadequacy of controls, specified in the CEMP	Sensitive receivers	Minor	Possible	Low
Construction noise exceeds expected levels	Construction work in locations or at times not anticipated in the noise and vibration assessment	Sensitive receivers	Minor	Possible	Low
Railway operational noise exceeds expected levels	More noise than predicted is generated by the proposed railway operation	Sensitive receivers	Minor	Unlikely	Low
Port operational noise exceeds expected levels	More noise than predicted is generated by the operation of the proposed port development	Sensitive receivers	Moderate	Unlikely	Medium
Railway operational noise exceeds expected levels	Lack of regular maintenance of the rail wagon fleet	Sensitive receivers	Minor	Unlikely	Low
Port operational noise exceeds expected levels	Failure of port operational equipment or noise controls	Sensitive receivers	Moderate	Unlikely	Medium

12.8 Findings and Conclusion

The assessment of noise and vibration impacts due to the proposed CEIP Infrastructure has identified sensitive receivers potentially affected by noise and vibration sources associated with the project, then determined predicted noise and vibration levels at the sensitive receiver locations and compared them with regulatory criteria.

The assessment of construction noise and vibration impacts has shown that:

- Construction noise impacts are expected to be low as the modelling demonstrates that construction can be managed to meet the applicable noise criteria at all sensitive receivers by managing the location, timing and type of construction activities in accordance with a CEMP. In addition, the prediction noise modelling for construction was based on the worst-case scenario of all of the construction equipment operating at full load, simultaneously. As the modelling was based on a worst-case scenario there is considerable scope for managing the actual noise levels within the relevant noise criteria.

- Vibration generated due to construction works will be highly dependent on the construction process and equipment that is employed and also on the local geotechnical conditions. However it is known that vibration from construction equipment has a limited distance before being imperceptible. As the separation distance between construction works and sensitive receivers is over 100 m and it is known that attenuation of vibration from construction equipment occurs over short distances, it is deemed that construction vibration levels will be below the applicable vibration criteria. It is therefore anticipated that vibration impacts due to construction will be low.
- Although the locations of blasting and the blasting procedures have not been fully defined, predictions provide an indication of the minimum distances allowable for different charge masses to meet blasting criteria. Blasting procedures will be developed and implemented in accordance with AS 2187.2 – 2006, therefore it is considered that the impact of ground vibration and airblast due to blasting will be low.

The assessment of operation noise and vibration impacts has shown that:

- The noise prediction modelling demonstrates that the noise levels due to the proposed railway line operation will comply with the Rail Noise Guidelines for both the day-time and night-time periods. The noise of train pass-bys will occur for 12 short periods (approximately 60 to 90 seconds when passing a fixed point) intermittently during the day and night, separated by long periods of quiet. Train noise will build slowly to a peak as the train approaches and then gradually decrease as the train travels along the track. Noise management strategies will be implemented in accordance with the OEMP to minimise noise impacts as much as possible. Therefore, the impact of rail noise has been assessed as low. However, despite the predicted rail noise levels meeting the Rail Noise Guideline criteria and being assessed as low impact, it is acknowledged that the rail noise will be audible and initially intrusive for some sensitive receivers used to a relatively quiet rural environment and that the train horns may be a nuisance for dwellings nearby crossings. For further discussion in relation to the impact of CEIP Infrastructure on rural amenity refer to Chapter 22 Social Environment.
- Due to the use of submersible pumps, the noise generated at the individual bore sites will be minimal. The noise generated by the pump station will be the most significant noise source at the proposed borefield. The predicted noise levels due to the operation of equipment at the borefield are considerably below the noise criteria and therefore the impact of the proposed borefield noise is considered to be negligible.
- All predicted noise levels at the closest sensitive receivers to the proposed port development were below the relevant noise criteria and worst-case weather conditions are likely to occur for only 2.2% of total night time hours per year, therefore it is expected the impact of noise from the operation of the proposed port development will be low.
- The potential noise generated by the ‘corona’ effect associated with transmission lines will be significantly attenuated by distance and it is expected the noise will be inaudible from the existing ambient noise level at all sensitive receivers, resulting in a negligible impact.
- As the level of noise from the long-term employee village will be similar to existing adjacent residential noise, it is considered the impact will be low.
- The impact of vibration due to the operation of the CEIP Infrastructure is expected to be negligible.

In summary, noise control and management strategies during the construction of the CEIP Infrastructure will be required to managing impacts to within acceptable levels. Once the infrastructure is operational the predicted noise impacts are expected to be well within relevant noise criteria. An effective EMP which includes noise monitoring will enable detection of any exceedance of noise criteria, and therefore allow development of adaptive management strategies to manage noise levels.

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