Central Eyre Iron Project
Mining Lease Proposal

# APPENDIX L
## NOISE AND VIBRATION ASSESSMENT

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# Central Eyre Iron Project

IRON ROAD LIMITED

## Mine Environmental Noise and Vibration Assessment

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# Central Eyre Iron Project

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# Executive Summary

This environmental noise and vibration assessment report considers noise and vibration levels expected to be generated due to the construction and operation of the proposed Central Eyre Iron Project (CEIP) mine.

Separate assessment reports address predicted noise and vibration levels due to the infrastructure corridor and the proposed port facility as part of the CEIP.

It is proposed that iron concentrate will be transported by rail to the port facility from the proposed mine located approximately 130 kilometres (km)[1] north - west of Cape Hardy. Iron Road plans to export 21.5 million tonnes per annum (Mtpa) of iron concentrate for at least 25 years from the mine.

This assessment includes:

- Identification of relevant noise and vibration criteria and standards.
- A review of the proposed mine layout and identification of noise sources and processes and determination of their corresponding Sound Power Levels.
- A review of the proposed mine layout and identification of ground vibration sources and processes.
- Acoustic modelling using the SoundPlan computer model using the CONCAWE algorithm to predict noise levels due to construction works and the operation of the mine site. Noise contours have been presented in steps of 5 dBA from a lower limit of 30 dBA.
- Comparison of the predicted noise levels at the closest noise sensitive receivers due to the proposed mine construction and operation with the noise criteria derived in accordance with the *Environment Protection (Noise) Policy 2007* (Noise Policy).
- Consideration of typical vibration levels from construction and operation of the proposed mine and comparison with the applicable vibration criteria.
- Calculation of potential airblast and ground vibration due to blasting during operation of the mine using the methodology presented in the *Imperial Chemical Industries (ICI) Blasting Guide* (ICI 1995).

The predicted noise levels for each of the scenarios has been compared to the noise level criteria of 57 dB(A) (day) and 50 dBA (night) in accordance with the Noise Policy and advice from DSD and EPA.

Noise prediction modelling was performed for four operating scenarios over the expected operational life of the mine. The initial scenario, Scenario 1 represents the mine construction phase while scenarios 2, 3 and 4 represent operational phases of the proposed mine.

In comparing the results of the noise prediction modelling, including addition of a 5 dB(A) noise character penalty, against the noise criteria it is evident that the noise criteria determined in accordance with the Noise Policy will be met at all of the nearest sensitive receivers for the construction and operational phases of the proposed mine site.

Based on the typical ground vibration levels generated by mobile equipment that may be generated by the proposed mining equipment, it can be noted that the ground vibration levels would be unperceivable at distances greater than 100 m.

As the nearest sensitive receiver to the proposed mining lease boundary is located approximately 250 m from the boundary and the nearest sensitive receiver to the proposed mine pit is located approximately 1,950 m from the edge of the pit, it is considered that there is low probability of adverse comment or disturbance to sensitive receivers due to ground vibration generated by mine construction and operational plant and equipment.

[1] Measured from the proposed mining lease boundary to the boundary of the port site

Ground vibration and airblast levels have been predicted using the methodology outlined in the *ICI Blasting Guide* (ICI 1995) to predict the potential of impacts from blasting. Generic calculations have been performed to predict the typical airblast over pressure and ground vibration for a maximum instantaneous explosive charge of 900 kg.

From the prediction results it has been determined  that a maximum explosive charge mass of 900 kg will meet the airblast and ground vibration human comfort criteria presented in the AS 2187.2-2006 at a distance of 1,950 m which is the distance to the nearest sensitive receiver from the blast site in the mine pit.

# Glossary

| Term | Description |
|---|---|
| Acoustic spectrum | The sound pressure level (or sound power level) as a function of frequency (eg octave band, 1/3 octave or narrow band). Generally used to identify noise sources contributing to an overall noise level. |
| Ambient noise level | The prevailing noise level at a location due to all noise sources but excluding the noise from the specific noise source under consideration. Generally measured as a dB(A) noise level. |
| Background noise level | The lower ambient noise level, usually defined as the value of the time varying ambient noise level exceeded for 90% of the measurement time. Usually defined in the dB(A) scale - $L_{A90}$. |
| Central Eyre Iron Project (CEIP) | Refers to the entire CEIP project (proposed mine, long term employee village, infrastructure corridor including railway line, transmission line, water pipeline and borefield, and port). |
| CEIP Infrastructure | Refers to the proposed port development, railway line, water pipeline, power transmission line, borefield and the long term employee village. |
| dB | Sound pressure levels are expressed in decibels as a ratio between the measured sound pressure level and the reference pressure. The reference pressure is $2x10^{-6}$ Pascal (Newtons per square meter). |
| dBA | The A-weighted sound pressure level in decibels, denoted dB(A) is the unit generally used for the measurement of environmental, transportation or industrial noise. The A-weighting scale approximates the sensitivity of the human ear when it is exposed to normal levels and correlates well with subjective perception over a number of different types of sounds. |
| dBZ / dBL | It is accepted dBZ is equal to dBL.<br>It is an unweighted or linear sound pressure level that has not been filtered.<br>Z weighting is a flat frequency response between 10Hz and 20kHz ±1.5dB excluding microphone response. |
| Frequency | The rate of repetition of a sound wave. The unit of frequency is the Hertz (Hz), defined as one cycle per second.<br>Human hearing ranges generally from 20 Hz to 20,000 Hz for normally occurring sounds. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. The most commonly used frequency bands are octave bands. For more detailed analysis each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands. |
| Imperceptible | So slight, gradual, or subtle as not to be perceived. |
| Indicative noise level | Noise level limit for a noise source (ie port facility) at nearby sensitive receivers determined in accordance with Clauses 4, 5 and 20 of the Noise Policy. |
| Infrastructure corridor | Corridor incorporating the railway line, railway access road, road crossings and realignments, water pipeline and transmission line between the proposed mine and the port site |
| $L_{A90}$ | The 'A' weighted Sound Pressure Level that is exceeded for 90% of the measurement period. Usually used to represent the background noise level. |
| $L_{Amax}$ | The maximum noise levels at a sensitive land use due to individual events |
| $L_{Aeq}$ | The 'A' weighted equivalent continuous sound level is denoted $L_{Aeq}$. |
| $L_{eq}$ | The equivalent continuous sound level. The steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level. |
| MIC | Mass instantaneous charge |
| Mtpa | Million tonnes per annum |
| Noise Policy | The *Environment Protection (Noise) Policy 2007* (Noise Policy) provides a legal framework for the assessment of a wide range of often complex noise issues. |

| Term | Description |
|---|---|
| PPV | Ground vibration peak particle velocity |
| RMS | Root Mean Square |
| Sensitive receivers | As defined in the Noise Policy “noise-affected premises” or sensitive receivers are defined as premises that:<br>(a) are in separate occupation from the noise source and used for residential or business purposes; or<br>(b) constitute a quiet ambient environment set aside as a park or reserve or for public recreation or enjoyment. |
| Sound level meter | An instrument consisting of a microphone, amplifier and data analysis package for measuring and quantifying noise. |
| Sound Power Level (PWL) | The sound power level of a source is a measure of the total acoustic power radiated by a source. It is a characteristic of the sound source which is not affected by the environment within which the source is located. |
| Sound Pressure Level (SPL) | Sound pressure or acoustic pressure is the local pressure deviation from the ambient (average, or equilibrium) atmospheric pressure, caused by a sound wave. In air, sound pressure can be measured using a microphone. |

# 1. Introduction

Iron Road has engaged Jacobs to conduct an assessment of the predicted environmental noise and vibration levels that are likely to be generated due the construction and operation of the Central Eyre Iron Project (CEIP).

Iron Road's CEIP incorporates development of an iron ore mining and processing operation at Warramboo, approximately 25 km south east of Wudinna on the Eyre Peninsula of South Australia and associated ancillary infrastructure.

Iron Road is seeking approval for the infrastructure to export 21.5 Mtpa of iron concentrate from the proposed mine site. The iron concentrate is to be transported by rail from the mine site to a port facility located at Cape Hardy.

This assessment report considers noise and vibration levels expected to be generated due to the construction and operation of the proposed mining operation only.

This assessment includes:

- Identification of relevant noise and vibration criteria and standards.
- A review of the proposed mine layout and identification of noise sources and processes and determination of their corresponding Sound Power Levels.
- A review of the proposed mine layout and identification of ground vibration sources and processes.
- Acoustic modelling using the SoundPlan computer model using the CONCAWE algorithm to predict noise levels due to construction works and the operation of the mine site. Noise contours have been presented in steps of 5 dBA from a lower limit of 30 dBA.
- Comparison of the predicted noise levels at the closest noise sensitive receivers due to the proposed mine operation with the noise criteria derived in accordance with the Noise Policy.
- Consideration of typical vibration levels from construction and operation of the proposed mine and comparison with the applicable vibration criteria.
- Calculation of potential airblast and ground vibration due to blasting during operation of the mine using the methodology presented in the *ICI Blasting Guide* (ICI 1995).

# 2. Project Description

## 2.1 Existing site description

The proposed mine will be located approximately 25 km south east of the township of Wudinna[2] near Warramboo, South Australia. The edge of the proposed mine pit will be approximately 5 km west of the centre of the Warramboo township.

Figure 2-1 illustrates the location of the proposed mine in relation to the associated infrastructure corridor and port site.

Figure 2-1: Relative location of the proposed mine, infrastructure corridor and port site

Land within the proposed mining lease is gently undulating with remnant sparse Mallee trees. The existing land use is dryland agriculture with a mix of cropping and grazing.

Figure 2-2 below presents a view of the landscape where the proposed mine is located.

[2] Distance measured from the proposed mining lease boundary to the centre of Wudinna in a straight line

Figure 2-2: View of proposed mining lease from Schultze Road on the north west boundary, looking to the south east

Figure 2-3 below presents a general overview of the topography of the area around the proposed mining lease.

Figure 2-3: Topography surrounding the proposed mining lease

## 2.2 Proposed mining operation

The proposed mining operation will use open pit mining with the ore processed at the mine site to produce 21.5 Mtpa of iron concentrate for the operational mine life of at least 25 years.

As illustrated in Figure 2-4 two open pits will be developed - Murphy South pit will be developed first and will be operational while the Boo Loo pit is being developed. Murphy South pit will reach a depth of approximately 600 (metres) m and Boo Loo pit approximately 325 m after 25 years of mining.

The first three years will be a pre-strip to expose the ore body starting in the Murphy South pit area and construction of the surface infrastructure (pre-production phase). Production will commence in the Murphy South pit and remain exclusively in Murphy South until year 11 of operation, when pre-stripping of Boo Loo pit commences. Production will commence in the Boo Loo pit from year 14 with both pits in operation up to year 25.

An in-pit crushing and conveying (IPCC) mining operation is proposed and comprises traditional open pit operation consisting of drilling and blasting followed by direct feed of six mobile primary crushers by large diesel powered excavators. Each crusher pair will feed one of the three conveyors exiting the mine pit where the material will be batch handled for delivery by conveyor either to the course ore stockpiles or the integrated waste landform.

Blasting will break the iron ore into loose material that allows the mining equipment to readily excavate the iron ore prior to the primary crushing operation within the pit and then transfer of the iron ore to the processing plant by conveyor. The iron ore body is drilled and blasted in benches. The blast holes will be drilled by a fleet of production drill rigs and drilled in a “pattern” in an area of the bench identified for blasting. The pattern comprises evenly-spaced rows of drill holes set out in a specific pattern and depth.

The blasting process requires a significant number of blast holes (approximately 335 blast holes per day) each being 310 mm in diameter, to a typical depth of 13.1 m and at 9 m spacing drilled into the iron ore body (bench). Approximately 900 kilograms of explosive will be put into each individual blast hole. Once all holes have been charged, they are tied in – connected together to explode in a certain sequence. Blasting is done on a hole-by-hole basis – no two holes are blasted at exactly the same time. This process not only presents optimum blasting performance but also helps reduce airblast noise and ground vibration.

All conveyors on the mine site will be covered to contain the material and avoid dust escape and limit noise emission. Transfer stations are included in the conveyor system design to enclose the transfer points where the conveyor changes direction and will be fitted with dust extraction units to capture dust and also reduce noise emission.

Ore treatment by conventional crushing, milling and magnetic/gravity separation is planned to deliver low impurity iron concentrate. The ore processing facility will treat up to 150 Mtpa of feed material at a head grade of 15.5% Fe. It has been designed to produce up to 21.5 Mtpa iron concentrate at approximately 67% Fe with a relatively coarse size distribution of greater than -130 µm (80% passing; P80).

The modularised ore processing facility will be constructed on the south east edge of the pit. The facility has three discrete crushing, grinding and recovery trains to provide a high level of plant availability and to minimise operational downtime. Each processing train will incorporate:

- Semi-Autogenous Grinding (SAG) Mill
- Rougher Magnetic Separator (RMS)
- Gravity Beneficiation Circuit
- Ball Mills
- Cleaner Magnetic Separator (CMS)

Tailings from each processing train will pass through the tailings thickener and filter building to reduce moisture to approximately 10%. The tailings are then transferred to the integrated waste landform via the waste rock conveyor from the mine.

Iron concentrate from the ore processing facility will be transferred onto a conveyor that delivers the concentrate for stacking on the mine site concentrate stockpile. Once reclaimed from the concentrate stockpile the concentrate will be loaded into rail wagons at the train out-load facility for transporting to the proposed port at Cape Hardy.

Figure 2-4: Proposed mine layout illustrating two mine pits, plant and loading facilities

## 2.3 Nearest sensitive receiver locations

The land around the proposed mine is used for dryland farming and the nearest noise and vibration sensitive receivers are farm houses located at distances ranging from approximately 1.2 to 2.4 km from the proposed mine infrastructure as illustrated in Figure 2-5.[3] The township of Warramboo has a small population and is approximately 2.7 km west of the closest edge of the proposed mine pit. Any residential buildings within the mine lease have not been taken into account within this assessment as Iron Road will own the land.

The sensitive receivers have been identified at different stages of the project development and assessment process so are not sequential, however the same sensitive receiver numbers are used for the same sites in each CEIP environmental impact assessment report to allow cross-referencing, e.g. noise and air quality.

[3] The locations of sensitive receivers have been primarily determined by desktop assessment and are subject to field and community verification.

Figure 2-5: Location of the nearest sensitive receivers in relation to the mine pit and mine site boundary.

# 3. Noise and Vibration Criteria

Noise criteria which dictate the indicative noise levels that must be achieved at surrounding sensitive receivers have been determined in accordance with the Noise Policy.

Vibration criteria which dictate vibration levels acceptable at sensitive receiver locations have been determined from international and Australian standards.

## 3.1 Construction noise and vibration criteria

### 3.1.1 Construction noise

Construction noise limits detailed in Clause 23 of the Noise Policy do not apply to activities if development authorization under the *Development Act 1993* is not required. As the proposed mine is to be assessed in accordance with the *Mining Act 1971* (Mining Act) and does not require development authorization, Clause 23 of the Noise Policy does not apply.

As confirmed by representatives of the Department of State Development (DSD) and Environment Protection Authority (EPA) the noise limits for construction activities approved under the Mining Act will have the same noise limits as for the mining operation as determined in accordance with the Noise Policy.[4]

The relevant noise criteria for construction and operation of the proposed mine is detailed in Section 3.2.1.

### 3.1.2 Construction vibration

Vibration from construction works has the potential to impact on sensitive receivers located near the proposed mining lease.

#### 3.1.2.1 Human response vibration levels

The human response criteria for the vibration generated during the construction phase of work is the same as the criteria presented for the operational phase. Refer to Section 3.2.2.1 of this report.

#### 3.1.2.2 Structural vibration levels

The risk of cosmetic or structural damage to buildings is only found to be due to extreme vibration levels, relative to what humans would find tolerable. The German Deutsches Institut für Normung (DIN) standard DIN 4150-3 1999 (DIN 1999) presents the maximum recommended vibration limits for a range of various building configurations for short and long term evaluation. As the construction and operational phases of the proposed mine site are closely aligned the long term vibration criteria presented in Section 3.2.2.2 will be applied to both construction and operation phases.

## 3.2 Operational noise and vibration criteria

### 3.2.1 Operational noise

The Noise Policy dictates the relevant indicative noise levels be (noise criteria) based on Development Plan zoning in which the noise source and noise sensitive receivers are located. The proposed mining lease and the nearest sensitive receivers are located in an area zoned primary production in the *Wudinna District Council Development Plan* (DPTI 2013).

[4] Andrew Querzoli (DSD) and Max Browne (EPA) *pers comm* 25/11/14. Confirmed by email A Querzoli 29/12/14

The indicative noise limits are determined for day time and night time periods as defined below:

- Day time – 7:00 am – 10:00 pm
- Night time - 10:00 pm – 7:00 am

As the primary production zone is considered a rural industry land use in the Noise Policy and both the noise sources and sensitive receivers are located in this zone, the rural industry indicative noise factor is considered the noise limit, as shown in Table 3-1.

Table 3-1: Indicative noise levels for the proposed mine

| Land use | Indicative noise levels, $L_{Aeq,15mins}$ dB(A) | |
|---|---|---|
| | Day (7 am - 10 pm) | Night (10 pm - 7 am) |
| Rural industry land use / proposed mining lease | 57 | 50 |

#### 3.2.1.1 Noise character penalty

The prediction modelling does not take into account noise character such as tonality, impulsive, modulating and low frequency noise components. If a noise character is present a penalty is applied under Clause 14 (3) of the Noise Policy. Clause 14 (3) states:

> "If the noise from the noise source contains characteristics, the noise source level (continuous) must be further adjusted in the following way:
>
> a) If the noise from the noise source contains 1 characteristic, 5 dB(A) must be added to the source noise level (continuously);
>
> b) If the noise from the noise source contains 2 characteristics, 8 dB(A) must be added to the source noise level (continuously);
>
> c) If the noise from the noise source contains 3 or 4 characteristics, 10 dB(A) must be added to the source noise level (continuously)"

It has been assumed that tonal audible reversing alarms will not be used at the mine site and that a 'broadband' reversing alarm system will be installed on all of the mobile mining equipment.

Following discussions with the DSD and EPA[5], it was confirmed a 5 dB(A) penalty should be applied to take into account one noise characteristic due to noise modulation of the mine equipment. Modelling results incorporating a noise character penalty of 5 dB(A) applied to the predicted sound pressure levels and the overall predicted noise levels have been presented in Section 6.1.

### 3.2.2 Operational vibration

Vibration from operation of the proposed mine has the potential to impact on sensitive receivers located near the proposed mining lease.

#### 3.2.2.1 Human response vibration levels

The human response to vibration is significantly more sensitive than the vibration levels for structures.

[5] Andrew Querzoli (DSD) and Max Browne (EPA) *pers comm* 25/11/14. Confirmed by email A Querzoli 29/12/14

The EPA does not have a vibration policy or guideline and the *Australian Standard AS 2670.2-1990: Evaluation of human exposure to whole-body vibration* was withdrawn in April 2014. In Appendix C of the guideline titled *Assessing Vibration: a technical guideline* (DEC 2006), acceptable root mean square (RMS) vibration values for continuous and impulsive vibration are provided and are considered applicable for the purpose of this assessment. These vibration levels in the guideline have been derived from *British Standard, BS 6472-1992, Evaluation of human exposure to vibration in buildings (1–80 Hz)*.The guideline presents the vibration criteria levels as preferred and maximum values as presented in Table 3-2 below.

Table 3-2: Preferred and maximum vibration levels at the nearest vibration sensitive receivers (mm/s)

| Location | Assessment Period<br>Day time<br>(7:00 am – 10:00 pm)<br>Night Time<br>(10:00 pm – 7:00 am) | Preferred and Maximum Weighted RMS Vibration Values *(mm/s)* | |
|---|---|---|---|
| | | Preferred value | Maximum value |
| **CONTINUOUS VIBRATION** | | | |
| Critical Areas | Day or Night | 0.10 | 0.20 |
| Residences | Daytime<br>Night time | 0.20<br>0.14 | 0.40<br>0.28 |
| Office, schools, educational institutions and places of worship | Day or night time | 0.40 | 0.80 |
| Workshops | Day or night time | 0.80 | 1.6 |
| **IMPULSIVE VIBRATION** | | | |
| Critical Areas | Day or Night | 0.10 | 0.20 |
| Residences | Daytime<br>Night time | 6.0<br>2.0 | 12.0<br>4.0 |
| Office, schools, educational institutions and places of worship | Day or night time | 13.0 | 26.0 |
| Workshop | Day or night time | 13.0 | 26.0 |

There is a low probability of adverse comment or disturbance to building occupants at vibration levels below the preferred values. Adverse comment or complaints may be expected if vibration approaches the maximum values (DEC 2006).

For the purposes of this assessment, the preferred values in Table 3-2 have been adopted as the vibration criteria for construction and operation.

#### 3.2.2.2 Structural vibration levels

Vibration from construction and operational works may have the potential to impact on sensitive receivers located near the proposed mining lease. Since human response to vibration is much more sensitive than the structural sensitivity of buildings, construction vibration impacts are usually limited to some subjective discomfort for occupants in nearby buildings.

The risk of cosmetic or structural damage to buildings is only found to be due to extreme vibration levels, relative to what humans would find tolerable. As noted in Section 3.1.2.2 the German DIN standard DIN 4150-3 1999 (DIN 1999) presents the maximum recommended vibration limits for a range of various building configurations for short and long term evaluation. As the construction and operational phases of the proposed mine site are closely aligned the long term vibration criteria presented in Table 3-3.

Table 3-3: Recommended maximum vibration levels presented by DIN 4150-3 1999.

| Type of Structure | Vibration Peak Particle Velocity (PPV) (mm/s) |
|---|---|
| Buildings used for commercial purpose, industrial buildings and buildings of similar design | 10 |
| Dwellings and buildings of design and/or use | 5 |
| Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (eg buildings that are under a preservation order) | 2.5 |

Where the sensitive receiver type does not fall into a category in Table 3-2, the values shown in Table 3-3 will be used as the vibration criteria.

## 3.3 Blasting Criteria

The blasting process requires a significant number of blast holes. Once all holes have been charged (approximately 335 holes per day), they are tied in – connected together to explode in a certain sequence. Blasting is done on a hole-by-hole basis – no two holes are blasted at exactly the same time. The prediction methodology of the airblast and ground vibration levels takes into account the mass instantaneous charge (MIC) mass (that is the explosive charge mass of one blast hole only, in the this case the expected MIC is 900 kg).

Australian Standard *AS 2187.2-2006: Explosives – Storage and use Part 2: Use of explosives* (AS 2187.2-2006) addresses two potential environmental effects of blasting:

- Airblast (sound pressure levels (dBL))
- Ground vibration (peak particle velocity (PPV))

AS 2187.2-2006 provides background information, guidelines for measurement and criteria for peak levels of ground vibration and airblast.

It is recognised that ground vibration and airblast produced by blasting falls into two categories:-

- those causing human discomfort; and
- those with the potential for causing damage to structures, architectural elements and services.

Human discomfort levels set by authorities are less than the levels that are likely to cause damage to structures, architectural elements and services. Ground vibration and airblast levels are influenced by a number of factors some of which are not under the control of the shotfirer.

### 3.3.1 Airblast

Airblast is the pressure wave produced by the blast and transmitted through the air. Unlike ground vibration there is only one airblast phase but it is a complex wave train consisting of various peaks and with a range of frequencies.

The sources of the airblast include:-

- Air pressure pulse generated by ground vibration
- Direct air pressure pulse generated by rock movement during the blast

- An air pressure pulse caused by direct venting of gases from the region of the blast

It must be also noted that airblast may be reflected by layers within the atmosphere and that the airblast may be refocused at distances remote from the blast.

Airblast may be audible by people if it contains energy in the audible frequency range, typically 20 Hz – 20 kHz. However, some of the energy is sub audible and lies in the frequency range between 2 Hz and 20 Hz. Such low frequency airblast is often experienced indoors as secondary audible effects, such as rattling of windows and of sliding doors. A blast perceived as loud indoors may be barely audible outdoors.

Airblast are generally the cause of more complaints than ground vibration.

Table 3-4 below presents the recommended airblast limits presented in AS 2187.2-2006 for damage control.

Table 3-4: Recommended airblast limits presented in AS 2187.2-2006 for damage control

| Category | Type of Blasting Operation | Peak Sound Pressure Levels (dBL) |
|---|---|---|
| Structures that include masonry, plaster and plasterboard in their construction and may also unoccupied structures of reinforced concrete or steel construction | All blasting | 133 dBL maximum unless agreement is reached with the owner that a higher limit may apply |
| Service structures, such as pipe lines, power lines and cables located above the ground. | All blasting | Limit to be determined by structural design methodology |

Table 3-5 below presents the recommended airblast limits for human comfort.

Table 3-5: Airblast limits presented in AS 2187.2-2006 for human comfort.

| Category | Type of Blasting Operations | Peak Sound Pressure Levels (dBL) |
|---|---|---|
| Sensitive site (includes houses) | Operations lasting longer than 12 months or more than 20 blasts | 115 dBL for 95% blasts per year. 120 dBL maximum unless agreement is reached with the occupier that a higher limit may apply |
| Sensitive site (includes houses) | Operations lasting less than 12 months or less than 20 blasts | 120 dBL for 95% blasts per year. 125 dBL maximum unless agreement is reached with the occupier that a higher limit may apply |
| Occupied non – sensitive site, such as factories and commercial premises | All blasting | 125 dBL maximum unless agreement is reached with occupier that a limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation. |

The human comfort criterion is the most stringent criteria and has been used as the criterion that must be achieved.

### 3.3.2 Ground vibration

Ground vibration from blasting is the radiation of mechanical energy within a rock mass or soil. It comprises of various vibration phases travelling at different velocities. These phases are reflected, refracted, attenuated and scattered within the rock mass or soil, so that the resulting ground vibration at any particular location will have a complex character with various peaks and frequency content. Typically, higher frequencies are attenuated rapidly so that at close distances to the source such frequencies will be present in greater proportion than at far distances from the source.

Significant factors influencing the ground vibration levels during the blasting operation are the:

- Amount of explosive detonated per delay
- The distance from the blast to the sensitive receiver
- Geological factors

Therefore, as blasting activities approach the neighbouring residences, a reduction in effective charge weights may be required.

Studies and experience show that well designed and controlled blasts are unlikely to create ground vibrations of a magnitude that cause damage to buildings or structures.

Table 3-6 below presents the ground vibration levels specified in AS 2187.2-2006 for human comfort.

Table 3-6: Ground vibration limits presented in AS 2187.2 -2006 for human comfort

| Category | Type of Blasting Operations | Peak component particle velocity (mm/s) |
|---|---|---|
| Sensitive site (includes houses) | Operations lasting longer than 12 months or more than 20 blasts | 5 mm/s for 95% blasts per year. 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply |
| Sensitive site (includes houses) | Operations lasting less than 12 months or less than 20 blasts | 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply |
| Occupied non – sensitive site, such as factories and commercial premises | All blasting | 25 mm/s maximum unless agreement is reached with occupier that a limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation. |

The recommended vibration criteria minimising human discomfort at a sensitive receiver site for the blasting operations lasting more than 12 months and more than 20 blasts has been used to form the compliance limit criterion.

### 3.3.3 Ground vibration and airblast criteria

As the blasting operations are expected to be of a duration that is more than 12 months and be more than 20 blasts the following blast criteria limit is proposed based on the human comfort criteria.

Table 3-7 presents the ground vibration and airblast criteria limits.

Table 3-7: Ground vibration and airblast criteria limits as presented in AS 2187.2 - 2006.

| Category | Type of Blasting Operations | Peak Level (mm/s – dBL) |
|---|---|---|
| Airblast<br>Sensitive site (includes houses) | Operations lasting more than 12 months or more than 20 blasts | 115 dBL for 95% blasts per year. 120 dBL maximum unless agreement is reached with the occupier that a higher limit may apply |
| Ground Vibration<br>Sensitive site (includes houses) | Operations lasting more than 12 months or more than 20 blasts | 5 mm/s for 95% blasts per year. 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply |

# 4. Prediction Modelling Methodology and Input Data

## 4.1 Mine Layout

The mine layout and equipment configurations assessed for this noise and vibration assessment were provided by Iron Road and were current at November 2014. Since November 2014 the only change to the mine layout has been the removal of a low grade ore stockpile site on the south east edge of the mine pit. The removal of this stockpile site from the mine layout does not have effect the validity of the assessment.

## 4.2 Noise modelling summary

In order to estimate the likely noise levels at sensitive receivers resulting from the construction and operational works performed at the proposed mining lease, noise models were developed using SoundPlan V7.25, a modelling package that is accepted and endorsed by numerous agencies nationally and internationally including the South Australian EPA.

Four scenarios were modelled as detailed in Section 4.3. A full list of equipment noise sources included in the modelling is shown in Section 4.4.

The SoundPlan computer prediction modelling used the CONCAWE algorithm to predict the noise levels at noise sensitive receiver locations as well as noise level contours for both day and night time periods.

The CONCAWE prediction algorithm takes into account attenuation due to distance, atmospheric absorption, structural and topographical barriers, directivity of the noise sources and the effect of intervening ground types. The CONCAWE prediction algorithm divides the various meteorological weather conditions into six individual weather categories. Each weather category considers wind speed, direction, time of day, and level of cloud cover. The following meteorological categories options are available:

- Category 1 presents the 'best case weather' conditions, i.e. weather conditions conducive for the lowest propagation levels
- Category 4 presents 'neutral weather' conditions
- Category 5 presents 'worst case weather' conditions, i.e. weather conditions conducive for the highest propagation levels (used for day time conditions)
- Category 6 presents the 'worst case weather' conditions, i.e. weather conditions conducive for the highest propagation levels (used for night time conditions).

The CONCAWE methodology is referenced in the Noise Policy and the guidelines titled *Guidelines for the Use of the Environmental Protection (Noise) Policy 2007*, page 46, which state :-

> *"*Predictions of the sources noise levels for distances over 100 metres should be made using default weather conditions that are equivalent to the CONCAWE meteorological category 6 at night and CONCAWE meteorological category 5 for the day period. A different category to the default values can be used for comparison against the Noise policy where it can be shown that the associated weather conditions occur for less than 10% of the year and 30% of any one season during the day or night period as relevant*".*

From the wind rose data obtained from the Bureau of Meteorology (BoM) Wudinna site for the year 2009 (presented in Appendix E) it was determined that the associated weather conditions would be exceeded for more than 10% of the year and 30% of any one season during the day and night period and therefore the default criterion was used.

Appendix E presents the wind roses for the seasons as well as for the total year.

The prediction model also performs noise level prediction taking into account the topography of the proposed mine site, the sensitive receiver locations and the terrain between the sensitive receivers and noise emitting equipment.

Table 4-1 below presents the meteorological parameters that were used in the prediction modelling.

Table 4-1: Meteorological parameters

| Parameter | Meteorological conditions – 'default' weather conditions | |
|---|---|---|
| | Day (category 5) | Night (category 6) |
| Temperature ($^{o}$C) | 20$^{o}$C | 15$^{o}$C |
| Humidity (%) | 70% | 70% |
| Wind Speed (m/sec) | 4 m/s (in direction of noise source to the noise sensitive receiver) | 3 m/s (in direction of noise source to the noise sensitive receiver) |
| Pasquil Stability Index | E | F |

The uncertainty of the noise level prediction is +/- 3 dBA within a 90 percent confidence limit.

## 4.3 Noise modelling scenarios

To obtain an indication of the acoustic impact due to the various stages of the mining operation four scenarios were modelled including a construction scenario and three different operational scenarios. The scenarios are described below:

- **Scenario 1 - Construction**
  - Period of approximately 3 years prior to mine production commencing
  - Pre-stripping across surface of Murphy South pit area
  - Construction of surface infrastructure
- **Scenario 2 - Year 2-3 of mining operation**
  - Murphy South Pit operational only
  - Pit depth of 60 m
- **Scenario 3 - Year 15-18 of mining operation**
  - Both Murphy South and Boo Loo mine pits operational
  - Depth of Murphy South pit of 460 m
  - Depth of Boo Loo pit of 60 m
- **Scenario 4 - Year 21 - 22 of mining operation**
  - Both Murphy South and Boo Loo mine pits operational
  - Depth of Murphy South pit of 600 m
  - Depth of Boo Loo pit of 300 m

## 4.4 Equipment for the construction and operational phases

Iron Road provided advice on the construction and operational equipment that is expected to be utilised during the four scenarios modelled as part of this assessment.

### 4.4.1 Scenario 1 - Construction equipment

To predict the noise levels that may be generated during the construction phase, typical sound power levels for a range of equipment that may be utilised during the mine site construction and pre-stripping were used in the prediction modelling.

The construction phase is defined as:

- Preparation of infrastructure sites including processing plant, transformer sites etc
- Construction of plant e.g. processing plant, concentrate handling and train out-load facility, electrical power and water utilities
- Removal of over burden (pre-stripping)

As a worst case scenario, noise levels for construction activities have been modelled with the equipment all running simultaneously at normal operating condition. Using this scenario will present a conservative estimation of the noise and vibration levels at the nearest noise sensitive receiver locations.

Noise source heights have been taken to be 2 m above the existing ground level for plant (representing exhaust noise and casing radiation), with the exception of mobile cranes which have been modelled at a height of 3 m.

Table 4-2 below presents a list of the typical heavy equipment that may be employed during the construction phase of the project.

Table 4-2: Major items of plant associated with the mine site construction

| Construction Equipment Configuration | Number of Equipment |
|---|---|
| ***Mobile Equipment*** | |
| Concrete Batch Plant | 1 |
| Tracked excavator - Liebherr 9800 | 7 |
| Haul Trucks – 360T Ultra Class | 12 |
| Haul Trucks – 240T Class | 2 |
| Caterpillar - CAT 944H Loader | 1 |
| Bulldozer - CAT D11 | 6 |
| Bulldozer – CAT D10 | 4 |
| Dozer - Wheel | 3 |
| Grader – 24M | 6 |
| Grader – 16M | 1 |
| Water Truck – 135KI | 5 |
| Water Truck – 85KI | 2 |
| Diesel Generators | 3 |
| Pipe layers | 4 |
| Cranes | 3 |
| ***Materials handling (pre-stripping)*** | |
| Primary Crushers - 8.5 t/hr | 1 |
| Primary Crushers - 7.5 t/hr | 1 |
| Enclosed conveyors | Yes – total length modelled 6,500 m |
| Transfer stations | 4 |
| Integrated waste landform stackers (waste rock / tailings) | 1 |

### 4.4.2 Scenario 2, 3 & 4 - Operational equipment

To predict the noise levels that may be generated during the operational phase, typical sound power levels for a range of equipment that may be utilised at the mine site during the operational phase were used.

As a worst case scenario, noise levels for operational activities have been modelled with the equipment all running simultaneously at normal operating condition. Using this operational scenario will present a conservative estimation of the noise levels at the nearest noise sensitive receiver locations.

Noise source heights have been taken to be 2 m above working level for plant (representing exhaust noise and casing radiation).Table 4-3 below presents the type and number of mine equipment that are expected to be operational for the three operation scenarios of the mine.

Table 4-3: Major items of plant associated with operational phase of the mine site

| Operational Equipment Configuration | Operational Scenarios | | |
|---|---|---|---|
| | No. of Pieces of Equipment | | |
| | Scenario 2 Operation | Scenario 3 Operation | Scenario 4 Operation |
| ***Mobile Equipment*** | | | |
| Tracked excavator - Liebherr 9800 | 7 | 7 | 7 |
| Pipe Layer | 4 | 4 | 4 |
| Haul Trucks – Liebherr 240T Class | 2 | 2 | 2 |
| Caterpillar - CAT 944H Loader | 1 | 1 | 1 |
| Bulldozer - CAT D11 | 6 | 6 | 6 |
| Bulldozer – CAT D10 | 4 | 4 | 4 |
| Dozer –Wheel - CAT | 3 | 3 | 3 |
| Grader – CAT 24M | 6 | 6 | 6 |
| Grader – CAT 16M | 1 | 1 | 1 |
| Water Truck – 135KI | 5 | 5 | 5 |
| Water Truck – 85KI | 2 | 2 | 2 |
| Drill Rig- D90K | 20* | 20* | 20* |
| Drill Rig- Atlas Copco PV271 | 7* | 7* | 7* |
| Locomotives (*Train load-out facility*) | 2 | 2 | 2 |
| ***Processing Plant and Concentrate Handling*** | | | |
| Primary Crushers - 8.5 t/hr | 3 | 3 | 3 |
| Primary Crushers - 7.5 t/hr | 3 | 3 | 3 |
| Semi Auto-genous Grinder (SAG) (22MW) | 3 | 3 | 3 |
| Ball Mill (22 MW) | 3 | 3 | 3 |
| Enclosed conveyors | Yes – total length modelled 24,750 m | Yes – total length modelled 32,800 m | Yes – total length modelled 35,100 m |
| Transfer stations | 16 | 16 | 16 |
| Integrated waste landform stackers (waste rock / tailings) | 3 | 3 | 3 |
| Iron concentrate stacker | 1 | 1 | 1 |
| Iron concentrate reclaimer | 1 | 1 | 1 |
| Train load-out facility | 1 | 1 | 1 |
| Sub Station (transformers) | 10 | 10 | 10 |

| Operational Equipment Configuration | Operational Scenarios | | |
|---|---|---|---|
| | No. of Pieces of Equipment | | |
| | Scenario 2 Operation | Scenario 3 Operation | Scenario 4 Operation |
| Groundwater de-watering pumps | 11 | 11 | 11 |

**It is intended to operate 2 benches daily with a bench height of 15 meters, drilling 310 diameter holes, at 9 meters spacing resulting in 335 holes daily. 27 rigs working at 90% utilisation were modelled for this assessment, however to meet requirements in preliminary blasting plan only 10 drill rigs on each bench will be required meaning a total of 20 operating at an utilisation rate of 90%.*

### 4.4.3 Construction and operational equipment sound power levels used in noise prediction modelling

The sound power levels assigned to the various pieces of construction equipment have been obtained from manufacturers (Leibherr), Jacobs' noise level database and from information presented by the Department for Environment, Food and Rural Affairs, UK (DEFRA).

The sound power levels used in the prediction modelling for the construction works and the operational phases are shown in Table 4-4 below.

Table 4-4: Sound power levels for the proposed equipment to be used for the construction and operational phases

| Equipment Identification | Sound Power Levels (dB) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Octave Band Centre Frequency (Hz) | | | | | | | | | Overall SPL (dBZ) | Overall SPL (dBA) |
| | 31.5 | 63 | 125 | 250 | 500 | 1K | 2K | 4K | 8K | | |
| **Construction and Mine Pit Equipment** | | | | | | | | | | | |
| Concrete batching plant (100 $m^3$/h) | 103 | 103 | 100 | 108 | 108 | 104 | 103 | 95 | 95 | 114 | 111 |
| Cranes | 105 | 109 | 120 | 107 | 109 | 111 | 106 | 100 | 92 | 121 | 114 |
| Excavator - Liebherr 9800 [1] | 109 | 111 | 120 | 117 | 114 | 108 | 105 | 100 | 95 | 121 | 114 |
| Haul truck - 360T Ultra Class [1] | 104 | 106 | 114 | 117 | 114 | 108 | 105 | 100 | 95 | 121 | 109 |
| Haul Truck - 240T class [1] | 104 | 106 | 114 | 117 | 114 | 108 | 105 | 100 | 95 | 121 | 109 |
| Pipe Layers | 120 | 121 | 115 | 115 | 111 | 109 | 107 | 105 | 101 | 126 | 117 |
| Cat 944H Loader | 114 | 109 | 107 | 110 | 108 | 104 | 101 | 93 | 87 | 118 | 115 |
| Bulldozer - D11 | 120 | 121 | 115 | 115 | 111 | 109 | 107 | 105 | 101 | 126 | 117 |
| Bulldozer - D10 | 120 | 121 | 115 | 115 | 111 | 109 | 107 | 105 | 101 | 126 | 117 |
| Bulldozer - Wheel | 112 | 115 | 119 | 117 | 115 | 113 | 110 | 103 | 96 | 124 | 118 |
| Grader - 24M | 103 | 104 | 110 | 109 | 109 | 110 | 105 | 102 | 99 | 117 | 113 |
| Grader 16M | 103 | 104 | 110 | 109 | 109 | 110 | 105 | 102 | 99 | 117 | 113 |
| Water Truck - 135Kl | 110 | 112 | 121 | 118 | 115 | 109 | 106 | 101 | 96 | 122 | 115 |
| Water Truck - 85Kl | 110 | 112 | 121 | 118 | 115 | 109 | 106 | 101 | 96 | 122 | 115 |

| Equipment Identification | Sound Power Levels (dB) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Octave Band Centre Frequency (Hz) | | | | | | | | | Overall SPL (dBZ) | Overall SPL (dBA) |
| | 31.5 | 63 | 125 | 250 | 500 | 1K | 2K | 4K | 8K | | |
| Generators | 60 | 77 | 84 | 95 | 95 | 97 | 94 | 85 | 74 | 101.5 | 102 |
| Drill- Sandvik D90K [2] (Atlas Copco PV 311) | 112 | 113 | 121 | 112 | 114 | 114 | 110 | 110 | 110 | 126 | 118.5 |
| Drill – Atlas Copco PV271 [3] | 112 | 113 | 121 | 112 | 114 | 114 | 110 | 110 | 110 | 126 | 118.5 |
| Locomotive – load out facility | 128 | 117 | 114 | 110 | 108 | 107 | 107 | 107 | 105 | 129 | 114 |
| **Processing Equipment & Operations Equipment** | | | | | | | | | | | |
| Crushers – 7,500 tph | 117 | 117 | 114 | 122 | 122 | 118 | 116 | 109 | 109 | 127 | 124 |
| Crushers – 8,500 tph | 118 | 118 | 115 | 123 | 123 | 119 | 117 | 110 | 110 | 128 | 125 |
| Conveyors | 104 | 101 | 97 | 84 | 75 | 64 | 58 | 60 | 52 | 105 | 83 |
| Stockpile stacker | 89 | 93 | 94 | 92 | 93 | 93 | 89 | 81 | 76 | 100 | 97 |
| Tailings Stacker | 89 | 93 | 94 | 92 | 93 | 93 | 89 | 81 | 76 | 100 | 97 |
| Iron Concentrate Reclaimer | 137 | 123 | 113 | 105 | 101 | 101 | 99 | 99 | 80 | 137 | 108 |
| SAG mills – 22 MW | 118 | 118 | 117 | 118 | 114 | 111 | 108 | 110 | 95 | 125 | 117 |
| Ball mill – 22 MW | 113 | 113 | 113 | 115 | 119 | 111 | 106 | 98 | 93 | 123 | 118 |
| Transformers (Sub Station) | 95 | 88 | 90 | 85 | 85 | 79 | 76 | 71 | 60 | 99 | 85.5 |
| Dewatering Pumps (125 kW) | 82 | 82 | 91 | 89 | 87 | 83 | 60 | 56 | 43 | 121 | 95 |
| Groundwater pump (125 kW) | 82 | 82 | 91 | 89 | 87 | 83 | 60 | 56 | 43 | 121 | 95 |
| Freshwater pump (100 kW) | 82 | 82 | 91 | 89 | 87 | 83 | 60 | 56 | 43 | 121 | 95 |
| Transfer stations | 101 | 100 | 103 | 101 | 103 | 99 | 101 | 94 | 92 | 110 | 101 |

*Notes:*

1. *The noise data used in the noise prediction modelling for the Leibherr 9800 excavators and haul trucks incorporate 'factory' fitted noise mitigation treatments – data supplied by manufacturer*
2. *The noise data used in the noise prediction modelling to represent a Sandvik D90K drill was for an Atlas Copco PV 311 drill, with a noise mitigation package incorporated to achieve a 3 dB noise reduction on 'standard rig', which is considered representative and was supplied by Atlas Copco*
3. *The noise data used in the noise prediction modelling for Atlas Copco PV271 drill was supplied by Atlas Copco – noise levels generated by a 'standard rig' without noise mitigation packages.*

## 4.5 Typical vibration levels of construction and operational equipment

The vibration produced by mine construction and operation will be highly dependent on the particular processes and equipment that will be employed.

The EPA does not have any guidelines pertaining to ground vibration, however the Department of Planning, Transport and Infrastructure (DPTI) has issued a document titled *Management of Noise & Vibration Construction and Maintenance Activities 21.7* (DPTI 2014) which presents typical vibration levels generated by construction equipment which are listed in Table 4-5. Vibration levels are influenced by the actual operating condition of the plant and equipment being considered and the local site and geographical conditions therefore, this table should be used for indicative purposes only.

Table 4-5: Typical vibration levels for various configurations of construction equipment.

| Activity | Typical levels of ground vibration |
|---|---|
| Vibratory Rollers | 1.5 mm/s at 25m<br>*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 12m 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 5m<br>1.3 mm/s at 10m<br>0.4 mm/s at 20m<br>0.1 mm/s at 50m |
| Compactor | 20 mm/s at 5m<br>2 mm/s at 15m<br>0.3 mm/s at 30m |
| Excavators | 0.2 mm/s at 40m |
| Ballast Tamping | 6 mm/s at 3m<br>2 mm/s at 10m |
| Truck traffic (over maintained road surfaces) | 0.2 mm/s at 10m |
| Truck traffic (over irregular surfaces) | 2 mm/s at 10m |
| Impact pile driving / removal | ≤ 15 mm/s at distances of 15 m<br>≤ 9 mm/s at distances greater than 25 m<br>Typically below 3 mm/s at 50m<br>*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 5m<br>0.2 mm/s at 20m |
| Air track drill | 5 mm/s at 5m<br>1.5 mm/s at 10m<br>0.6 mm/s at 25m<br>0.1 mm/s at 50m |
| Jackhammer | 1 mm/s at 10m |

Vibration impacts from construction works will have a limited distance before being imperceptible. Typical ground vibration levels generated by various pieces of equipment have been presented in 4-5 and it can be seen at distance greater than 200 m the ground vibration levels will become imperceptible.

## 4.6 Blasting impact prediction method

Ground vibration and airblast levels have been predicted using the methodology outlined in the *ICI Blasting Guide* (ICI 1995) to provide an understanding of the potential of impacts from blasting at the nearest sensitive receiver. The airblast and blasting vibration prediction formulae, based on this guideline, are detailed in the following sections.

### 4.6.1 Airblast prediction

The 95$^{th}$ percentile airblast site formula, which may be exceeded up to 5% of the total annual blasts is defined by the peak airblast level (SPL) measured in dB (Z) and is defined as:

- Airblast OP (95%) = 165.3– 24 $\log_{10}$ (SD)

  -where scaled distance (SD) is calculated as :-

  SD= d /(MIC$^{-0.333}$)

  - MIC is the maximum instantaneous explosive charge mass (kilograms) detonated per delay at any 8 millisecond interval.
  - d is the distance between the charge (blast location) and sensitive receptor (metres)

### 4.6.2 Ground vibration prediction

The Peak Vector Sum (PVS) ground vibration site law is defined as:

- PVS (mm/s) = 1140 (SD) $^{-1.6}$

  -where scaled distance (SD) is calculated as:

  SD= d /√MIC

  - MIC is the maximum instantaneous explosive charge mass (kilograms) detonated per delay at a 1 - 5 millisecond interval;
  - d is the distance between charge and receptor (metres)

# 5. Noise and Vibration Prediction Modelling Results

## 5.1 Noise modelling results

As detailed in Section 4.1, the CONCAWE prediction method algorithm was used for the noise level prediction modelling assuming 'default' meteorological conditions to predict airborne noise levels at the nearest identified sensitive receiver locations.

The CONCAWE prediction method provides the $L_{Aeq}$ (time average) sound pressure levels at the sensitive receiver locations.

The noise prediction modelling was performed for four scenarios summarised in Section 4.3 representing different phases of the mining operation. The results are summarised below in Sections 5.1.1 to 5.1.4.

The prediction modelling does not take into account noise character such as tonality, impulsive, modulating and low frequency noise components.

Modelling results incorporating the noise character penalty of 5 dB(A) have been presented in Section 6.1.

### 5.1.1 Prediction modelling - Construction works – Scenario 1

The prediction modelling has been performed for the surface work only for pre-stripping the Murphy South pit and construction of surface infrastructure to the south east of the mine pit. It is assumed that this scenario will be representative of the construction works generally as it will mainly consist of removal of overburden, construction of the processing plant, construction rail loading facility and general infrastructure works.

During the construction works most equipment will be at the existing ground level for a significant amount of time.

The predicted sound pressure levels have been 'rounded' to the nearest integer number in accordance with Clause 16 of the Noise Policy.

Table 5-1 below presents the predicted noise levels at the nearest identified noise sensitive receivers. The predicted noise levels do not include the 5 dB(A) noise characteristic penalty. Refer to Figure 2-5 to determine the location of sensitive receivers referred to in the table.

Table 5-1: Predicted sound pressure levels due to the operation of construction equipment and works – Scenario 1 (no noise character penalty)

| Identified sensitive receiver locations | Predicted 'A' weighted sound pressure level (dBA) (Leq) | | Indication noise level (dBA) (noise limit) | |
|---|---|---|---|---|
| | Day | Night | Day | Night |
| Sensitive receiver 48 | 41 | 41 | **57** | **50** |
| Sensitive receiver 50 | 31 | 31 | **57** | **50** |
| Sensitive receiver 61 | 32 | 33 | **57** | **50** |
| Sensitive receiver 62 | 31 | 32 | **57** | **50** |
| Sensitive receiver 92 | 34 | 34 | **57** | **50** |
| Sensitive receiver 93 | 44 | 45 | **57** | **50** |
| Sensitive receiver 96 | 31 | 31 | **57** | **50** |
| Sensitive receiver 97 | 36 | 37 | **57** | **50** |
| Sensitive receiver 98 | 32 | 33 | **57** | **50** |

| Identified sensitive receiver locations | Predicted 'A' weighted sound pressure level (dBA) (Leq) | | Indication noise level (dBA) (noise limit) | |
|---|---|---|---|---|
| | Day | Night | Day | Night |
| Sensitive receiver 99 | 33 | 34 | **57** | **50** |
| Sensitive receiver 101 | 35 | 36 | **57** | **50** |
| Sensitive receiver 147 | 31 | 31 | **57** | **50** |
| Sensitive receiver 148 | 26 | 27 | **57** | **50** |

Appendix A1 and A2 presents the predicted noise level contours due to the construction works for the day and night time periods.

Appendix A3 presents the positions of the various pieces of operational equipment and plant used in the noise prediction model.

### 5.1.2 Prediction modelling – Year 2-3 of mine operation - Scenario 2

Table 5-2 below presents the predicted $L_{Aeq}$ sound pressure at the nearest identified sensitive receivers during year 2-3 of mining operations. The predicted noise levels do not include the 5 dB(A) noise characteristic penalty. Refer to Figure 2-5 to determine the location of sensitive receivers referred to in the table.

The depth of the pit will be approximately 60 m for this operational scenario, therefore the equipment in the mine pit has been modelled at this depth.

Table 5-2: Predicted sound pressure levels due to the mine operation – Scenario 2 (no noise character penalty)

| Identified sensitive receiver locations | Predicted 'A' weighted sound pressure level (dBA) (Leq) | | Indication noise level (dBA) (noise limit) | |
|---|---|---|---|---|
| | Day | Night | Day | Night |
| Sensitive receiver 48 | 42 | 43 | **57** | **50** |
| Sensitive receiver 50 | 32 | 33 | **57** | **50** |
| Sensitive receiver 61 | 33 | 34 | **57** | **50** |
| Sensitive receiver 62 | 32 | 33 | **57** | **50** |
| Sensitive receiver 92 | 35 | 35 | **57** | **50** |
| Sensitive receiver 93 | 42 | 43 | **57** | **50** |
| Sensitive receiver 96 | 30 | 30 | **57** | **50** |
| Sensitive receiver 97 | 35 | 36 | **57** | **50** |
| Sensitive receiver 98 | 31 | 32 | **57** | **50** |
| Sensitive receiver 99 | 35 | 35 | **57** | **50** |
| Sensitive receiver 101 | 35 | 36 | **57** | **50** |
| Sensitive receiver 147 | 33 | 34 | **57** | **50** |
| Sensitive receiver 148 | 27 | 28 | **57** | **50** |

Appendices B1 and B2 present the predicted noise level contours due to the mine operation for the day and night time periods.

Appendix B3 presents the positions of the various pieces of operational equipment and plant used in the noise prediction model.

### 5.1.3 Prediction modelling – Year 15-18 of mine operation – Scenario 3

Table 5-3 below presents the predicted noise levels at the nearest identified noise sensitive receivers at years 15 – 18 of operation. The predicted noise levels do not include the 5 dB(A) noise characteristic penalty. Refer to Figure 2-5 to determine the location of sensitive receivers referred to in the table.

The depth of the mine pits will be approximately 460 m for the Murphy South pit and 60 m for the Boo Loo pit for this scenario. The mine equipment in the mine pits has been modelled at these depths.

Table 5-3: Predicted sound pressure levels due to the mine operation – Scenario 3 (no noise character penalty)

| Identified sensitive receiver locations | Predicted 'A' weighted sound pressure level (dBA) (Leq) | | Indication noise level (dBA) (noise limit) | |
|---|---|---|---|---|
| | Day | Night | Day | Night |
| Sensitive receiver 48 | 40 | 40 | **57** | **50** |
| Sensitive receiver 50 | 33 | 34 | **57** | **50** |
| Sensitive receiver 61 | 38 | 38 | **57** | **50** |
| Sensitive receiver 62 | 37 | 37 | **57** | **50** |
| Sensitive receiver 92 | 36 | 37 | **57** | **50** |
| Sensitive receiver 93 | 41 | 42 | **57** | **50** |
| Sensitive receiver 96 | 28 | 29 | **57** | **50** |
| Sensitive receiver 97 | 34 | 35 | **57** | **50** |
| Sensitive receiver 98 | 30 | 31 | **57** | **50** |
| Sensitive receiver 99 | 31 | 32 | **57** | **50** |
| Sensitive receiver 101 | 40 | 40 | **57** | **50** |
| Sensitive receiver 147 | 29 | 30 | **57** | **50** |
| Sensitive receiver 148 | 27 | 28 | **57** | **50** |

Appendices C1 and C2 presents the predicted noise level contours due to the mine operation for the day and night time periods.

Appendix C3 presents the positions of the various pieces of operational equipment and plant used in the noise prediction model.

### 5.1.4 Prediction modelling – Year 21- 22 of mine operation – Scenario 4

Table 5-4 below presents the predicted noise levels at the nearest identified noise sensitive receivers after year 21 – 22 of mining operations. The predicted noise levels do not include the 5 dB(A) noise characteristic penalty. Refer to Figure 2-5 to determine the location of sensitive receivers referred to in the table.

The depth of the mine pits will be approximately 600 m for the Murphy South pit and 300 m for the Boo Loo pit for this scenario. The mine equipment in the mine pits has been modelled at these depths.

Table 5-4: Predicted sound pressure levels due to the mine operation – Scenario 4 (no noise character penalty)

| Identified sensitive receiver locations | Predicted 'A' weighted sound pressure level (dBA) (Leq) | | Indication Noise level (dBA) (noise Limit) | |
|---|---|---|---|---|
| | Day | Night | Day | Night |
| Sensitive receiver 48 | 40 | 40 | **57** | **50** |
| Sensitive receiver 50 | 30 | 30 | **57** | **50** |
| Sensitive receiver 61 | 27 | 28 | **57** | **50** |
| Sensitive receiver 62 | 26 | 27 | **57** | **50** |
| Sensitive receiver 92 | 35 | 35 | **57** | **50** |
| Sensitive receiver 93 | 39 | 40 | **57** | **50** |
| Sensitive receiver 96 | 29 | 29 | **57** | **50** |
| Sensitive receiver 97 | 35 | 36 | **57** | **50** |
| Sensitive receiver 98 | 32 | 32 | **57** | **50** |
| Sensitive receiver 99 | 31 | 32 | **57** | **50** |
| Sensitive receiver 101 | 32 | 33 | **57** | **50** |
| Sensitive receiver 147 | 29 | 30 | **57** | **50** |
| Sensitive receiver 148 | 25 | 26 | **57** | **50** |

Appendices D1 and D2 presents the predicted noise level contours due to the mine operation for the day and night time periods.

Appendix D3 presents the positions of the various pieces of operational equipment and plant used in the noise prediction model.

## 5.2 Ground vibration due to construction and operational plant and equipment

### 5.2.1 Mine construction

Pre-stripping works will be performed using various pieces of equipment including excavators, haul trucks bulldozers and graders (refer to Table 4-2). The overburden would be transported from the proposed mine pit to a staging area initially by trucks and later by conveyors. Similar equipment will also be utilised during construction of surface infrastructure including earthworks.

From the typical ground vibration levels presented Table 4-5 it can be noted that the ground vibration levels generated by proposed construction equipment would be unperceivable at distances greater than 100 m. Even allowing for the use of 'heavy' mining equipment it is predicted that the ground vibration levels at a distance of 200 m would be below the preferred human response vibration levels listed in Section 3.2.2.1, and hence well below the structural damage criteria presented in Section 3.2.2.2. The nearest vibration sensitive receiver is located approximately 250 m from the mine lease boundary.

### 5.2.2 Mining operation

The mobile equipment used in the mine pit such as primary crushers and the excavators are slow moving and therefore would generate low ground vibration levels. The nearest sensitive receiver to the proposed mine pit is located approximately 1,950 m from the edge of the pit.

Other mobile equipment will be utilised on the surface in the vicinity of the mine infrastructure, buildings and integrated waste landform and may be operated near the edge of the proposed mining lease boundary, particularly in the late stages of mining. The nearest vibration sensitive receiver is located approximately 250 m from the mine lease boundary.

Again it can be noted that the ground vibration levels generated by various pieces of equipment as presented in Table 4-5 are unperceivable at distances greater than 100 m (and are considered comparable to the levels generated by proposed mining equipment) and at a distance of 200 m would be below the preferred human response vibration levels listed in Section 3.2.2.1, and hence well below the structural damage criteria presented in Section 3.2.2.2.

Ground vibration predictions have not been completed for the stockpiling operation and train loading. Potential vibratory sources will include train movements, loading of the wagons with iron concentrate, stacking and reclaiming iron concentrate from the concentrate stockpile and the conveyor system. However, the equipment will operate at relatively slow speeds (e.g. train speed during the loading operation is approximately 0.8 km/h, conveyor speeds 3 m/s, the reclaimer travels at relatively slow speeds on tracks) therefore generating low ground vibration levels.

The proposed wagon loading operation is a continuous process with the iron concentrate being relatively 'fine' (coarse gravel consistency) therefore generating low impact vibration levels when the concentrate is loaded. The iron concentrate would be stockpiled using a stacker and again the concentrate is relatively fine therefore minimal ground vibration as the concentrate is stockpiled. The ground vibration levels generated during these processes would be unperceivable at the nearest sensitive receivers.

It is considered that there is low probability of adverse comment or disturbance to sensitive receivers due to ground vibration generated by mine operation plant and equipment. This is because attenuation of vibration occurs over short distances and the separation distance between the proposed mining lease boundary and sensitive receivers is over 250 m.

## 5.3 Blasting predictions

Ground vibration and airblast levels have been predicted using the methodology outlined in the *ICI Blasting Guide* (ICI 1995) to provide an understanding of the potential of impacts from blasting operations.

Initial calculations based on the proposed iron concentrate export tonnage (21.5 Mtpa) has estimated a maximum instantaneous charge (MIC) of 900 kg per blast hole and a total number of 335 blast holes per detonation. It is proposed one blasting operation will be performed per day.

The distance from the edge of the mine pit, within which blasting will occur, to the nearest identified sensitive receivers is approximately 1,950 m. The nearest sensitive receiver site has been used to predict the ground vibration and airblast overpressure levels and to ensure compliance with recommended human comfort the criteria presented in AS 2187-2006.

### 5.3.1 Ground vibration

Significant factors influencing the impact of ground vibration during the blasting operation are the:

- Amount of explosive detonated per delay
- The distance from the blast to the sensitive receiver
- Geological factors

The ground vibration prediction levels are based on a generic formula to determine the typical vibration levels that may be experienced by the vibration sensitive receiver.

Table 5-5 below presents the calculated MIC to generate a ground vibration level PPV of 5 mm/sec (AS 2187 – 2006 human comfort criterion for blasting operations lasting greater than 12 months).

Table 5-5: Predicted ground vibration levels with varying maximum instantaneous explosive charge masses at the nearest noise sensitive receiver from blasting site

| Maximum Instantaneous Explosive Charge Mass (MIC) (Kg) | Distance from blast site to the nearest sensitive receiver (m) | Predicted PPV (mm/sec) | AS 2187 – 2006 Human Comfort Criterion (mm/sec) |
|---|---|---|---|
| **900** | **1,950** | **1.6 mm/sec** | **5 mm/sec** |
| 1,000 | 1,950 | 1.8 mm/sec | 5 mm/sec |
| 2,000 | 1,950 | 3.4 mm/sec | 5 mm/sec |
| 2,500 | 1,950 | 3.6 mm/sec | 5 mm/sec |
| 3,000 | 1,950 | 4.2 mm/sec | 5 mm/sec |

### 5.3.2 Airblast overpressure

The airblast over pressure has been calculated in accordance the formula presented in the Ground vibration and airblast levels have been predicted using the methodology outlined in the ICI Blasting Guide (ICI 1995) to provide an understanding of the potential of impacts from the blasting operation.

Table 5-6 below presents the calculated charge mass to generate a ground airblast over pressure of 115 dBL (AS 2187 – 2006 human comfort criterion).

Table 5-6: Predicted air blast over pressure levels with varying charge masses

| Maximum Instantaneous Charge Mass (Kg) | Distance from blast site to the nearest sensitive receiver (m) | Predicted Airblast OP level (dBL) | AS 2187 – 2006 Human Comfort Criterion (115 dBL) |
|---|---|---|---|
| **900** | **1,950** | **110** | **115 dBL** |
| 1,000 | 1,950 | 110 | 115 dBL |
| 2,000 | 1,950 | 113 | 115 dBL |
| 2,500 | 1,950 | 114 | 115 dBL |
| 3,000 | 1,950 | 115 | 115 dBL |

# 6. Discussion and Conclusions

## 6.1 Construction and operational noise

Noise prediction modelling was performed for four operating scenarios over the expected operational life of the mine. The initial scenario, Scenario 1 represents the mine construction phase while scenarios 2, 3 and 4 represent operational phases of the proposed mine.

The predicted noise levels for each of the scenarios has been compared to the noise level criteria of 57 dB(A) (day) and 50 dBA (night) in accordance with the Noise Policy and advice from DSD and EPA.

Table 6-1 presents the predicted sound pressure levels at each of the sensitive receivers for the four mine site operating scenarios including the 5 dB(A) noise character penalty under worst case weather conditions.

Table 6-1: Predicted sound pressure levels at the identified sensitive receivers including 5 dB noise character penalty

| Identified sensitive receiver locations | Predicted 'A' weighted sound pressure level (dBA) (Leq) plus 5 dB(A) noise character penalty | | | | | | | | Indicative noise levels (dBA) (noise limit) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario 1 | | Scenario 2 | | Scenario 3 | | Scenario 4 | | | |
| | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| Sensitive receiver 48 | 46 | 46 | 47 | 48 | 45 | 45 | 45 | 45 | **57** | **50** |
| Sensitive receiver 50 | 36 | 36 | 37 | 38 | 38 | 39 | 35 | 35 | **57** | **50** |
| Sensitive receiver 61 | 37 | 38 | 38 | 39 | 43 | 43 | 32 | 33 | **57** | **50** |
| Sensitive receiver 62 | 36 | 37 | 37 | 38 | 42 | 42 | 31 | 32 | **57** | **50** |
| Sensitive receiver 92 | 39 | 39 | 40 | 40 | 41 | 42 | 40 | 40 | **57** | **50** |
| Sensitive receiver 93 | 49 | 50 | 47 | 48 | 46 | 47 | 44 | 45 | **57** | **50** |
| Sensitive receiver 96 | 36 | 36 | 35 | 35 | 33 | 34 | 34 | 34 | **57** | **50** |
| Sensitive receiver 97 | 41 | 42 | 40 | 41 | 39 | 40 | 40 | 41 | **57** | **50** |
| Sensitive receiver 98 | 37 | 38 | 36 | 47 | 35 | 36 | 37 | 37 | **57** | **50** |
| Sensitive receiver 99 | 38 | 39 | 40 | 40 | 36 | 37 | 36 | 37 | **57** | **50** |
| Sensitive receiver 101 | 40 | 41 | 40 | 41 | 45 | 45 | 37 | 38 | **57** | **50** |
| Sensitive receiver 147 | 36 | 36 | 38 | 39 | 34 | 35 | 34 | 35 | **57** | **50** |
| Sensitive receiver 148 | 31 | 32 | 32 | 33 | 32 | 33 | 30 | 32 | **57** | **50** |

In comparing the results of the noise prediction modelling and application of the 5 dB(A) noise character penalty in Table 6-1 it is evident that the noise criteria determined in accordance with the Noise Policy will be met at all of the nearest sensitive receivers for the construction and operational phases of the proposed mine.

The prediction modelling has been based on the 'worst case' weather conditions and assumes simultaneous operation at full operating speed of all of the mobile fleet, pit mining equipment, transfer equipment, processing plant, integrated waste landform, mine infrastructure (electrical transformers, water treatment plant) and the train loading process.

To monitor and to help ensure the noise limits are not exceeded a continuous monitoring station will be located at a strategic location to immediately identify a noise exceedance and allow noise management procedures to be implemented to ensure compliance.

## 6.2 Ground vibration

Based on the typical ground vibration levels generated by mobile equipment as presented in Table 4-5, that are considered comparable to the levels that may be generated by the proposed mining equipment, it can be noted that the ground vibration levels would be unperceivable at distances greater than 100 m. In addition all processing and materials handling equipment will operate at relatively slow constant speeds (e.g. train speed during the loading operation is approximately 0.8 km/h, conveyor speeds 3 m/s, the reclaimer travels at relatively slow speeds on tracks) therefore generating low ground vibration levels. Even allowing for the use of 'heavy' mining equipment it is predicted that the ground vibration levels generated during construction and operation of the proposed mine, due to mining plant and equipment, would be below the preferred human response vibration levels listed in Section 3.2.2.1 at a distance of 200 m, and hence well below the structural damage criteria presented in Section 3.2.2.2.

As the nearest sensitive receiver to the proposed mining lease boundary is located approximately 250 m from the boundary and the nearest sensitive receiver to the proposed mine pit is located approximately 1,950 m from the edge of the pit, it is considered that there is low probability of adverse comment or disturbance to sensitive receivers due to ground vibration generated by mine construction and operational plant and equipment.

## 6.3 Blasting

Ground vibration and airblast levels have been predicted using the methodology outlined in the *ICI Blasting Guide* (ICI 1995) to predict the potential of impacts from blasting. Generic calculations have been performed to predict the typical airblast over pressure and ground vibration for a maximum instantaneous explosive charge of 900 kg.

From the prediction results presented in Section 5.3 of this report, it can be seen that a maximum explosive charge mass of 900 kg will meet the airblast and ground vibration human comfort criteria presented in AS 2187.2-2006 at a distance of 1,950 m which is the distance to the nearest sensitive receiver from the blast site in the mine pit.

## 6.4 Noise and vibration management measures

Prediction noise modelling for the four scenarios show that the noise criteria will not be exceeded during the day and night time periods including a 5 dB(A) noise characteristic penalty and it has been predicted that ground vibration and airblast will meet the applicable criteria. However noise and vibration management measures will be implemented for the construction and operational phases of the proposed mine to manage compliance to the noise and vibration criteria.

The management measures to be performed are:

- Installation of a permanent continuous noise monitoring station to be located at a strategic site to allow continuous review of the noise emissions from the proposed mine into the local environment. The noise levels at the noise measurement location can be regularly monitored to determine if there are exceedances and also allow for the archiving the noise level history over the life time of the mine.

  The mine management team will set up operating operational procedures to be implemented if the noise levels at the nearest noise sensitive receiver exceed the noise limit criteria.

  The procedures will include directives such as all equipment not being used to be turned off and not left idling for long periods, noisier operations or processes to be performed the during day time period if feasible, etc.
- If required, feasible noise mitigation will be applied to significant noise sources or processes to reduce the overall noise level emission. These noise mitigation treatments may include the fitting of high acoustic mufflers to diesel engine equipment and plant, acoustics enclosures to high noise sources etc.
- If required, manufacturer noise mitigation packages will be fitted to noisy machinery such as excavators, haul trucks and drill rigs to reduce the overall noise level emission.

- For the initial blasting operation, noise and ground vibration monitoring will be performed to confirm compliance with the airblast and ground vibration criteria.

# 7. References

Department of Environment and Conservation 2006, *Assessing Vibration: a technical guideline*, Department of Environment and Conservation, NSW.

Department of Planning, Transport and Infrastructure 2012, *Wudinna District Council Development Plan, Consolidated – 25 October 2012*, Government of South Australia.

Department of Planning, Transport and Infrastructure 2014, *Management of Noise and Vibration: Construction and Maintenance activities, Operational Instruction 21.7*, Department of Planning, Transport and Infrastructure, Government of South Australia (First published 2007, updated 2014).

Deutsches Institut für Normung 1999, *Structural vibration – Effects of vibration on structures*, DIN 4150-3 (1999-02), Deutsches Institut für Normung, Berlin.

Environment Protection Authority 2009, *Guidelines for the Use of the Environment Protection (Noise) Policy 2007*, Environment Protection Authority.

*Environment Protection (Noise) Policy 2007* (SA).

Imperial Chemical Industries (ICI) Technical Services 1995, ICI Explosives Blasting Guide, ICI Australia Operations.

Standards Australia 2006, *Explosives – Storage and use, Part 2: Use of explosives*, AS 2187.2-2006, Standards Australia, Sydney.

# Appendix A. Predicted Noise Level Contours – Scenario 1 - Construction works

Appendix A1 – Predicted noise level contours for construction works for the Day time period - worst case weather conditions

Appendix A2 – Predicted noise level contours for construction works for the Night time period- worst case weather conditions

Appendix A3 – Equipment locations used for the prediction modelling

**Appendix A1 – Predicted noise level contours for construction works for the Day time period**

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

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30/01/2015

## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

**Appendix A2 – Predicted noise level contours for construction works for the Night time period**

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

GraphicMineSc1Night

30/01/2015

## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

## Appendix A3 – Equipment locations used for the prediction modelling

Client: Iron Road

Supplier: Jacobs

## Signs and symbols

- Proposed Mine Layout
- Resident receiver
- Noise Source
- Conveyor
- Conveyor Transfer

Levels: $dBL_{Aeq}$

| Item | ID Number |
|---|---|
| Cat 944 Loader | 2 |
| Concrete Batching Plant | 4 |
| Crane | 6 |
| Diesel Generator | 9 |
| Dozer D10 | 10 |
| Dozer D11 | 11 |
| Dozer Wheel | 12 |
| Excavator Liebherr 9800 | 15 |
| Grader 16M | 17 |
| Grader 24M | 18 |
| Haul Truck | 20 |
| Water Truck 85Kl | 29 |

EquipLocSc1

17/04/2015

0 250 500 1000 m

N

# Appendix B. Predicted Noise level Contours – Scenario 2

Appendix B1 – Predicted noise level for Scenario 2 for the Day time period – worst case weather conditions

Appendix B2 – Predicted noise level for Scenario 2 for the Night time period – worst case weather conditions

Appendix B3 – Equipment locations used for the prediction modelling

**Appendix B1 – Predicted noise level for Scenario 2 for the Day time period**

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

GraphicMineSc2Day

30/01/2015

## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

## Appendix B2 – Predicted noise level for Scenario 2 for the Night time period

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

GraphicMineSc2Night

30/01/2015

## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

## Appendix B3 – Equipment locations used for the prediction modelling

Client: Iron Road

Supplier: Jacobs

## Signs and symbols

- Proposed Mine Layout
- Resident receiver
- Noise Source
- Conveyor
- Conveyor Transfer

Levels: $dBL_{Aeq}$

| Item | ID Number |
|---|---|
| Ball Mill | 1 |
| Cat 944 Loader | 2 |
| Concentrate Reclaimer | 3 |
| Crusher 7.5kT/hr | 7 |
| Crusher 8.5kT/hr | 8 |
| Dozer D10 | 10 |
| Dozer D11 | 11 |
| Dozer Wheel | 12 |
| Drill D90K | 13 |
| Drill PV271 | 14 |
| Excavator Liebherr 9800 | 15 |
| Freshwater Pump | 16 |
| Grader 16M | 17 |
| Grader 24M | 18 |
| Groundwater Pump | 19 |
| Haul Truck 240T | 20 |
| Idle Loco x 2 | 21 |
| Pipe Layer | 22 |
| SAG Mill | 23 |
| Stockpile Stacker | 24 |
| Tails Stacker | 25 |
| Train Loadout Facility | 26 |
| Transfomer | 27 |
| Transformer | 28 |
| Water Truck 85Kl | 29 |
| Wheel Sqeal | 30 |

EquipLocSc2

17/04/2015

0 250 500 1000 m

N

# Appendix C. Predicted Noise level Contours – Scenario 3

Appendix C1 – Predicted noise level for Scenario 3 for the Day time period – worst case weather conditions

Appendix C2 – Predicted noise level for Scenario 3 for the Night time period– worst case weather conditions

Appendix C3 – Equipment locations used for the prediction modelling

**Appendix C1 – Predicted noise level for Scenario 3 for the Day time period**

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

GraphicMineSc3Day

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## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

**Appendix C2 – Predicted noise level for Scenario 3 for the Night time period**

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

GraphicMineSc3Night

30/01/2015

## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

**Appendix C3 – Equipment locations used for the prediction modelling**

Client: Iron Road

Supplier: Jacobs

## Signs and symbols

- Proposed Mine Layout
- Resident receiver
- Noise Source
- Conveyor
- Conveyor Transfer

Levels: $dBL_{Aeq}$

| Item | ID Number |
|---|---|
| Ball Mill | 1 |
| Concentrate Reclaimer | 3 |
| Crusher 7.5kT/hr | 7 |
| Crusher 8.5kT/hr | 8 |
| Dozer D10 | 10 |
| Dozer D11 | 11 |
| Dozer Wheel | 12 |
| Drill D90K | 13 |
| Drill PV271 | 14 |
| Excavator Liebherr 9800 | 15 |
| Freshwater Pump | 16 |
| Grader 16M | 17 |
| Grader 24M | 18 |
| Groundwater Pump | 19 |
| Haul Truck 240T | 20 |
| Idle Loco x 2 | 21 |
| Pipe Layer | 22 |
| SAG Mill | 23 |
| Stockpile Stacker | 24 |
| Tails Stacker | 25 |
| Train Loadout Facility | 26 |
| Transfomer | 27 |
| Transformer | 28 |
| Water Truck 85Kl | 29 |
| Wheel Sqeal | 30 |

EquipLocSc3

17/04/2015

0 250 500 1000 m

N

# Appendix D. Predicted Noise level Contours – Scenario 4

Appendix D1 – Predicted noise level for Scenario 4 for the Day time period - worst case weather conditions

Appendix D2 – Predicted noise level for Scenario 4 for the Night time period - worst case weather conditions

Appendix D3 – Equipment locations used for the prediction modelling

**Appendix D1 – Predicted noise level for Scenario 4 for the Day time period**

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

GraphicMineSc4Day

30/01/2015

## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

**Appendix D2 – Predicted noise level for Scenario 4 for the Night time period**

Client: Iron Road

Consultant: Jacobs

## Noise level
in dB(A)

| | |
|---|---|
| | < 10 |
| | 10 - 15 |
| | 15 - 20 |
| | 20 - 25 |
| | 25 - 30 |
| | 30 - 35 |
| | 35 - 40 |
| | 40 - 45 |
| | 45 - 50 |
| | 50 - 55 |
| | 55 - 60 |
| | >= 60 |

GraphicMineSc4Night

30/01/2015

## Signs and symbols

- Proposed Mine Layout
- Proposed Mining Lease
- Resident receiver
- Noise Source
- Contour Line
- 148 Sensitive Receiver No.

Levels: $dBL_{Aeq}$

N

0 400 800 1600 m

**Appendix D3 – Equipment locations used for the prediction modelling**

Client: Iron Road

Supplier: Jacobs

## Signs and symbols

- Proposed Mine Layout
- Resident receiver
- Noise Source
- Conveyor
- Conveyor Transfer

Levels: $dBL_{Aeq}$

| Item | ID Number |
|---|---|
| Ball Mill | 1 |
| Concentrate Reclaimer | 3 |
| Crusher 7.5kT/hr | 7 |
| Crusher 8.5kT/hr | 8 |
| Dozer D10 | 10 |
| Dozer D11 | 11 |
| Dozer Wheel | 12 |
| Drill D90K | 13 |
| Drill PV271 | 14 |
| Excavator Liebherr 9800 | 15 |
| Freshwater Pump | 16 |
| Grader 16M | 17 |
| Grader 24M | 18 |
| Groundwater Pump | 19 |
| Haul Truck 240T | 20 |
| Idle Loco x 2 | 21 |
| Pipe Layer | 22 |
| SAG Mill | 23 |
| Stockpile Stacker | 24 |
| Tails Stacker | 25 |
| Train Loadout Facility | 26 |
| Transfomer | 27 |
| Transformer | 28 |
| Water Truck 85Kl | 29 |
| Wheel Sqeal E | 30 |

EquipLocSc4

17/04/2015

0 250 500 1000 m

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# Appendix E. Wind Roses for the Year 2009

Appendix E1 – Wind rose – all hours - 2009

Appendix E2 – Wind rose – Autumn - 2009

Appendix E3 – Wind rose – Spring - 2009

Appendix E4 – Wind rose – Summer - 2009

Appendix E5 – Wind rose – Winter - 2009

## Appendix E1 – Wind rose – all hours - 2009

WIND ROSE PLOT:

**Wudinna Aero BoM 2009**
**2009, all hours**

DISPLAY:

**Wind Speed**
**Direction (blowing from)**

| COMMENTS: | DATA PERIOD: | COMPANY NAME: | |
|---|---|---|---|
| | **Start Date: 1/01/2009 - 00:00**<br>**End Date: 31/12/2009 - 23:00** | **Jacobs** | |
| | | MODELER: | |
| | CALM WINDS: | TOTAL COUNT: | |
| | **4.78%** | **8705 hrs.** | |
| | AVG. WIND SPEED: | DATE: | PROJECT NO.: |
| | **4.62 m/s** | **30/09/2014** | **VE23730** |

WRPLOT View - Lakes Environmental Software

## Appendix E2 – Wind rose – Autumn - 2009

WIND ROSE PLOT:

**Wudinna Aero BoM 2009**
**2009, Autumn**

DISPLAY:

**Wind Speed**
**Direction (blowing from)**

| COMMENTS: | DATA PERIOD: | COMPANY NAME: | |
|---|---|---|---|
| | **Start Date: 1/03/2009 - 00:00**<br>**End Date: 31/05/2009 - 23:00** | **Jacobs** | |
| | | MODELER: | |
| | CALM WINDS: | TOTAL COUNT: | |
| | **10.53%** | **2187 hrs.** | |
| | AVG. WIND SPEED: | DATE: | PROJECT NO.: |
| | **3.67 m/s** | **30/09/2014** | **VE23730** |

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## AppendixF3 – Wind rose – Spring – 2009

WIND ROSE PLOT:

**Wudinna Aero BoM 2009**
**2009, Spring**

DISPLAY:

**Wind Speed**
**Direction (blowing from)**

| COMMENTS: | DATA PERIOD: | COMPANY NAME: | |
|---|---|---|---|
| | **Start Date: 1/09/2009 - 00:00**<br>**End Date: 30/11/2009 - 23:00** | **Jacobs** | |
| | | MODELER: | |
| | CALM WINDS: | TOTAL COUNT: | |
| | **2.72%** | **2184 hrs.** | |
| | AVG. WIND SPEED: | DATE: | PROJECT NO.: |
| | **4.93 m/s** | **30/09/2014** | **VE23730** |

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## AppendixE4 – Wind rose – Summer - 2009

WIND ROSE PLOT:

**Wudinna Aero BoM 2009**
**2009, Summer**

DISPLAY:

**Wind Speed**
**Direction (blowing from)**

| COMMENTS: | DATA PERIOD: | COMPANY NAME: | |
|---|---|---|---|
| | **Start Date: 1/01/2009 - 00:00**<br>**End Date: 31/12/2009 - 23:00** | **Jacobs** | |
| | | MODELER: | |
| | CALM WINDS: | TOTAL COUNT: | |
| | **2.28%** | **2138 hrs.** | |
| | AVG. WIND SPEED: | DATE: | PROJECT NO.: |
| | **4.86 m/s** | **30/09/2014** | **VE23730** |

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## Appendix E5 – Wind rose – Winter – 2009

WIND ROSE PLOT:

**Wudinna Aero BoM 2009**
**2009, Winter**

DISPLAY:

**Wind Speed**
**Direction (blowing from)**

| COMMENTS: | DATA PERIOD: | COMPANY NAME: | |
|---|---|---|---|
| | **Start Date: 1/06/2009 - 00:00**<br>**End Date: 31/08/2009 - 23:00** | **Jacobs** | |
| | | MODELER: | |
| | CALM WINDS:<br>**3.20%** | TOTAL COUNT:<br>**2196 hrs.** | |
| | AVG. WIND SPEED:<br>**5.04 m/s** | DATE:<br>**30/09/2014** | PROJECT NO.:<br>**VE23730** |

WRPLOT View - Lakes Environmental Software

## Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is an environmental noise and vibration assessment in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

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