Appendix C
Noise Review

Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

Cristal Mining Australia Limited
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Development Manager

7 July 2014

Re: Snapper Mine Production Increase Modification Noise Review

1 INTRODUCTION

Cristal Mining Australia Limited (Cristal Mining) operates the Snapper and Ginkgo Mines, which are located approximately 85 kilometres (km) north-east of Wentworth and approximately 170 km to the south-east of Broken Hill in western New South Wales (NSW) (**Figure 1.1**).

Cristal Mining is preparing an Environmental Assessment (EA) to support an application to modify the Snapper Mine Project Approval (06_0168) (the Snapper Mine Production Increase Modification [the Modification]). A review of the potential noise impacts associated with the Modification is required to inform the EA.

Cristal Mining lodged a separate application to modify the Ginkgo Mine Development Consent (DA 251-09-01) under section 75W of the EP&A Act in November 2012 (the November 2012 Modification). This separate application is relevant to the development of the satellite Crayfish Deposit and is unrelated to this Modification.

2 OVERVIEW OF THE MODIFICATION

The Modification would include the following key components:

- variations to the Snapper Mine mining sequence (Mining Options 1 to 3);
- increase in the Snapper Mine maximum annual ore extraction rate from 9.1 million tonnes per annum [Mtpa] to 14 Mtpa);
- an option to use an overburden slurry pipeline system to transport overburden at the Snapper Mine; and
- increase in the combined mineral concentrate/heavy mineral concentrate (HMC) haulage rate from 735,000 tonnes per annum (tpa) to 975,000 tpa.

The variations to the Snapper Mine mining sequence would include either of the following mining options (**Figure 2.1** to **Figure 2.3**):

- **Mining Option 1** – initial single-pass mining followed by double-pass mining (in an anti-clockwise direction) using conventional dredge mining methods supplemented with dry mining (i.e. as per the currently approved) at an increased ore production rate of up to approximately 14 Mtpa.
- **Mining Option 2** – initial single-pass mining followed by double-pass mining (in a clockwise direction) using conventional dredge mining methods supplemented with dry mining at an increased ore production rate of up to approximately 14 Mtpa.
- **Mining Option 3** – single-pass mining using conventional dredge mining methods supplemented with an additional small dredge and dry mining at an increased ore production rate of up to approximately 14 Mtpa.

Additional mobile fleet would be required at the Snapper Mine to allow for the proposed increase in ore production. A detailed description of the Modification is provided in Section 3 of the EA.

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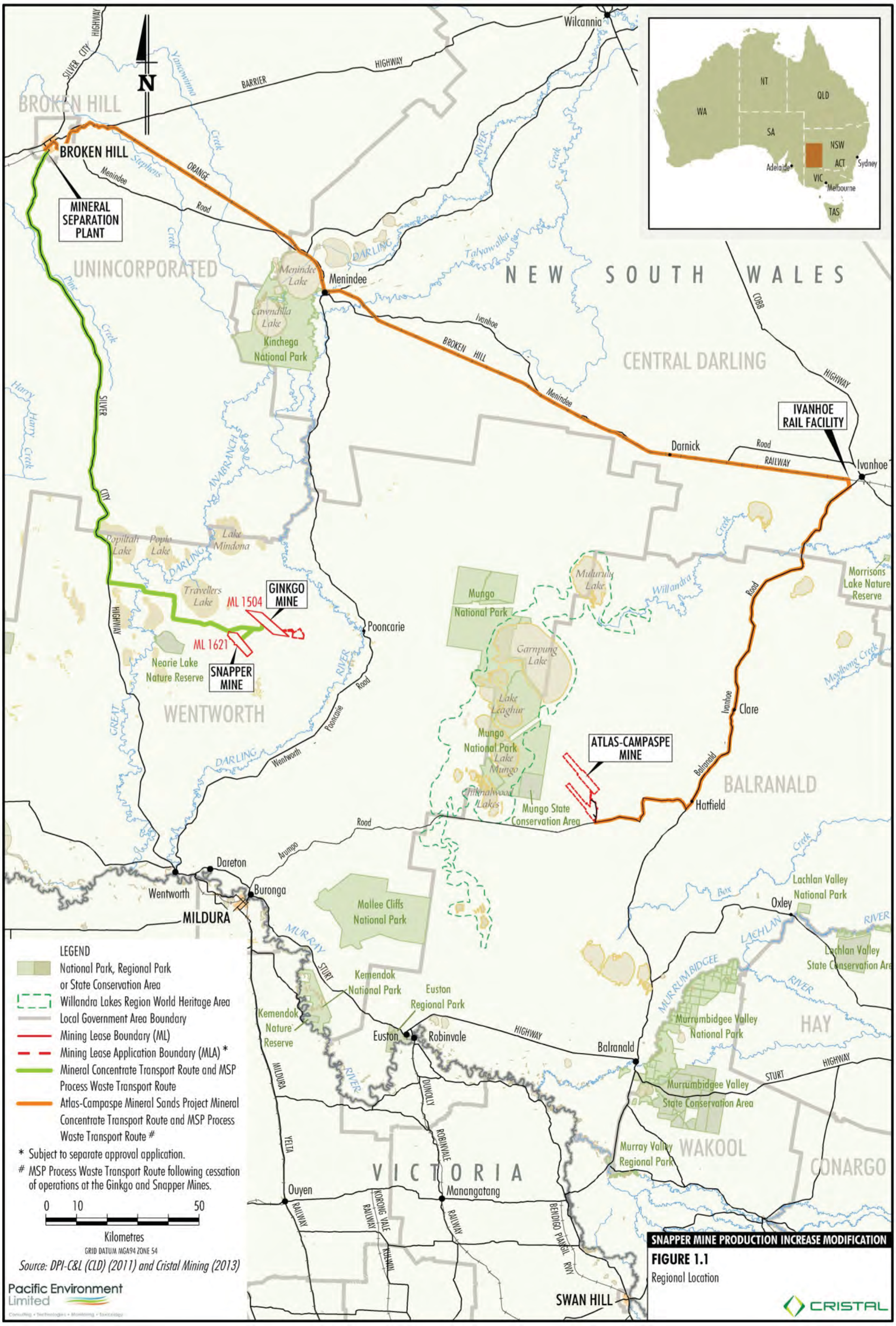
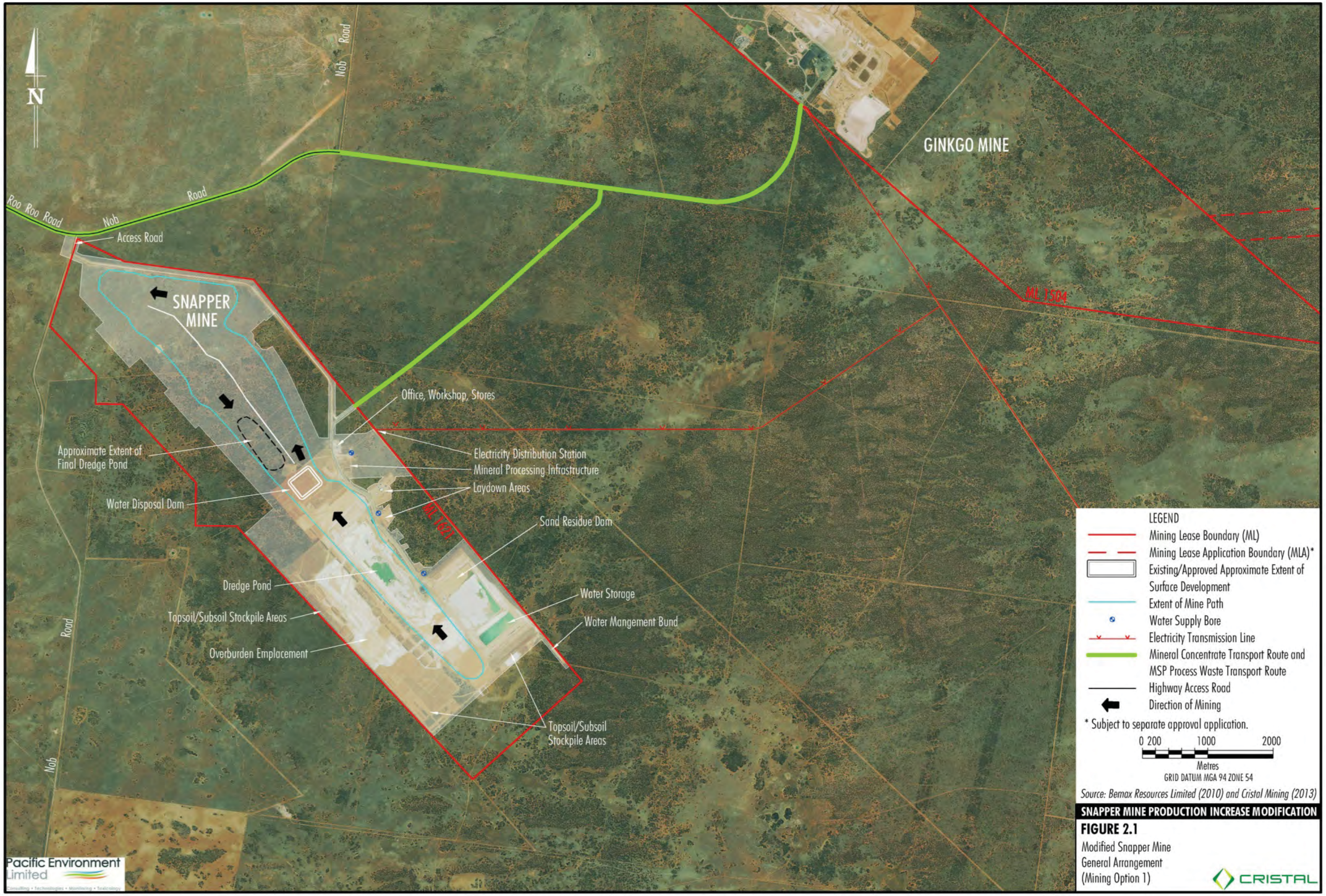

BROKEN HILL
MINERAL SEPARATION PLANT
UNINCORPORATED
Menindee
NEW SOUTH WALES
CENTRAL DARLING
IVANHOE RAIL FACILITY
Ivanhoe
Darnick
Wilcannia
Kinchega National Park
GINKGO MINE
ML 1504
ML 1621
SNAPPER MINE
Nearie Lake Nature Reserve
WENTWORTH
Pooncarie
Mungo National Park
ATLAS-CAMPASPE MINE
Mungo State Conservation Area
BALRANALD
Clare
Hatfield
Dareton
Wentworth
Buronga
MILDURA
Mallee Cliffs National Park
Euston
Robinvale
Balranald
HAY
WAKOOL
CONARGO
VICTORIA
Ouyen
Manangatang
SWAN HILL
WA
NT
QLD
SA
NSW
ACT
VIC
TAS
Adelaide
Sydney
Melbourne
LEGEND
National Park, Regional Park or State Conservation Area
Willandra Lakes Region World Heritage Area
Local Government Area Boundary
Mining Lease Boundary (ML)
Mining Lease Application Boundary (MLA) *
Mineral Concentrate Transport Route and MSP Process Waste Transport Route
Atlas-Campaspe Mineral Sands Project Mineral Concentrate Transport Route and MSP Process Waste Transport Route #
* Subject to separate approval application.
# MSP Process Waste Transport Route following cessation of operations at the Ginkgo and Snapper Mines.
0 10 50
Kilometres
GRID DATUM MGA94 ZONE 54
Source: DPI-C&L (CLD) (2011) and Cristal Mining (2013)
SNAPPER MINE PRODUCTION INCREASE MODIFICATION
FIGURE 1.1
Regional Location
CRISTAL


N
Roo Roo Road
Nob Road
Access Road
Nob Road
SNAPPER MINE
GINKGO MINE
ML 1504
ML 1421
Office, Workshop, Stores
Electricity Distribution Station
Mineral Processing Infrastructure
Laydown Areas
Approximate Extent of Final Dredge Pond
Water Disposal Dam
Sand Residue Dam
Dredge Pond
Topsoil/Subsoil Stockpile Areas
Overburden Emplacement
Water Storage
Water Mangement Bund
Topsoil/Subsoil Stockpile Areas
LEGEND
Mining Lease Boundary (ML)
Mining Lease Application Boundary (MLA)*
Existing/Approved Approximate Extent of Surface Development
Extent of Mine Path
Water Supply Bore
Electricity Transmission Line
Mineral Concentrate Transport Route and MSP Process Waste Transport Route
Highway Access Road
Direction of Mining
* Subject to separate approval application.
0 200 1000 2000
Metres
GRID DATUM MGA 94 ZONE 54
Source: Bemax Resources Limited (2010) and Cristal Mining (2013)
SNAPPER MINE PRODUCTION INCREASE MODIFICATION
FIGURE 2.1
Modified Snapper Mine General Arrangement (Mining Option 1)
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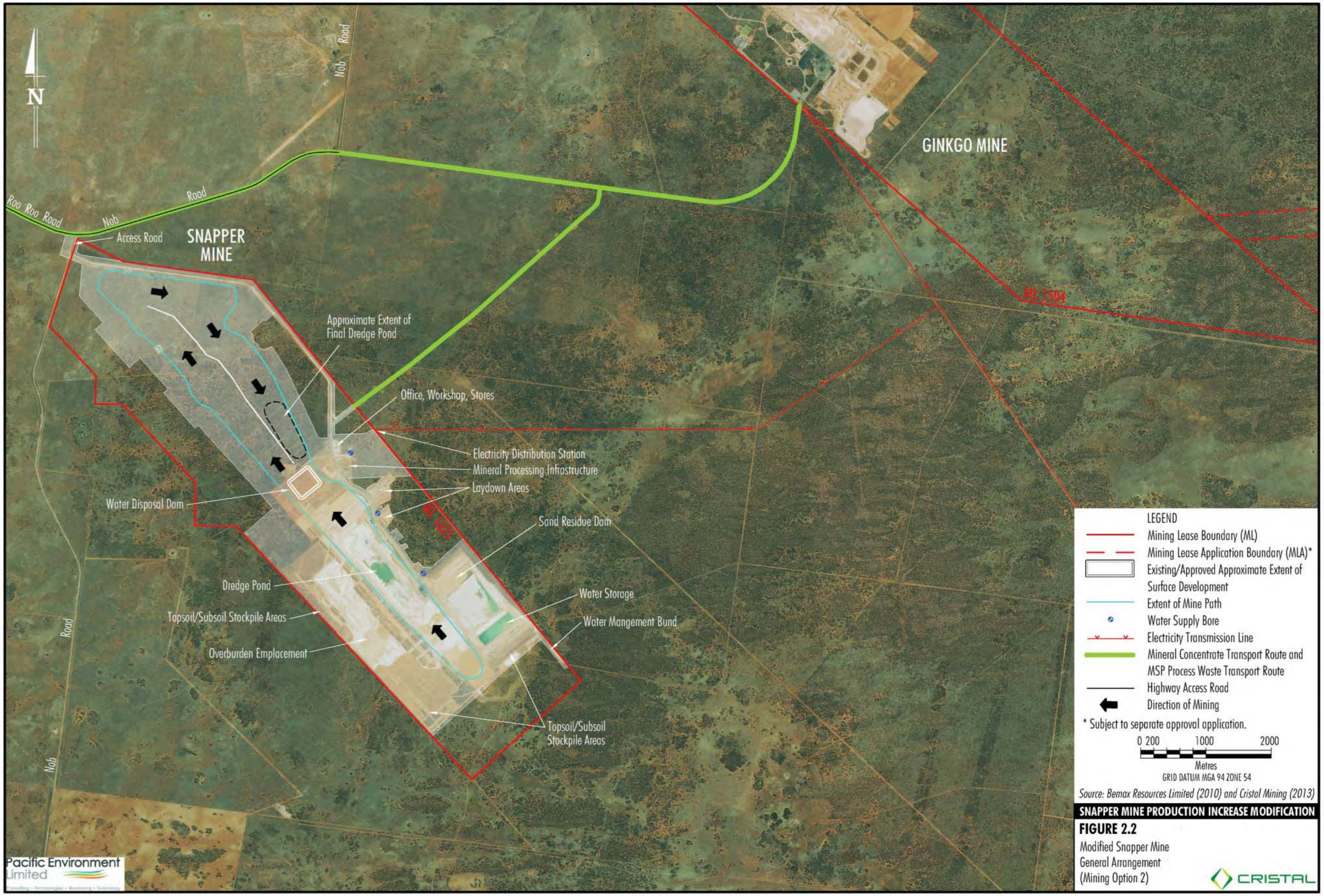
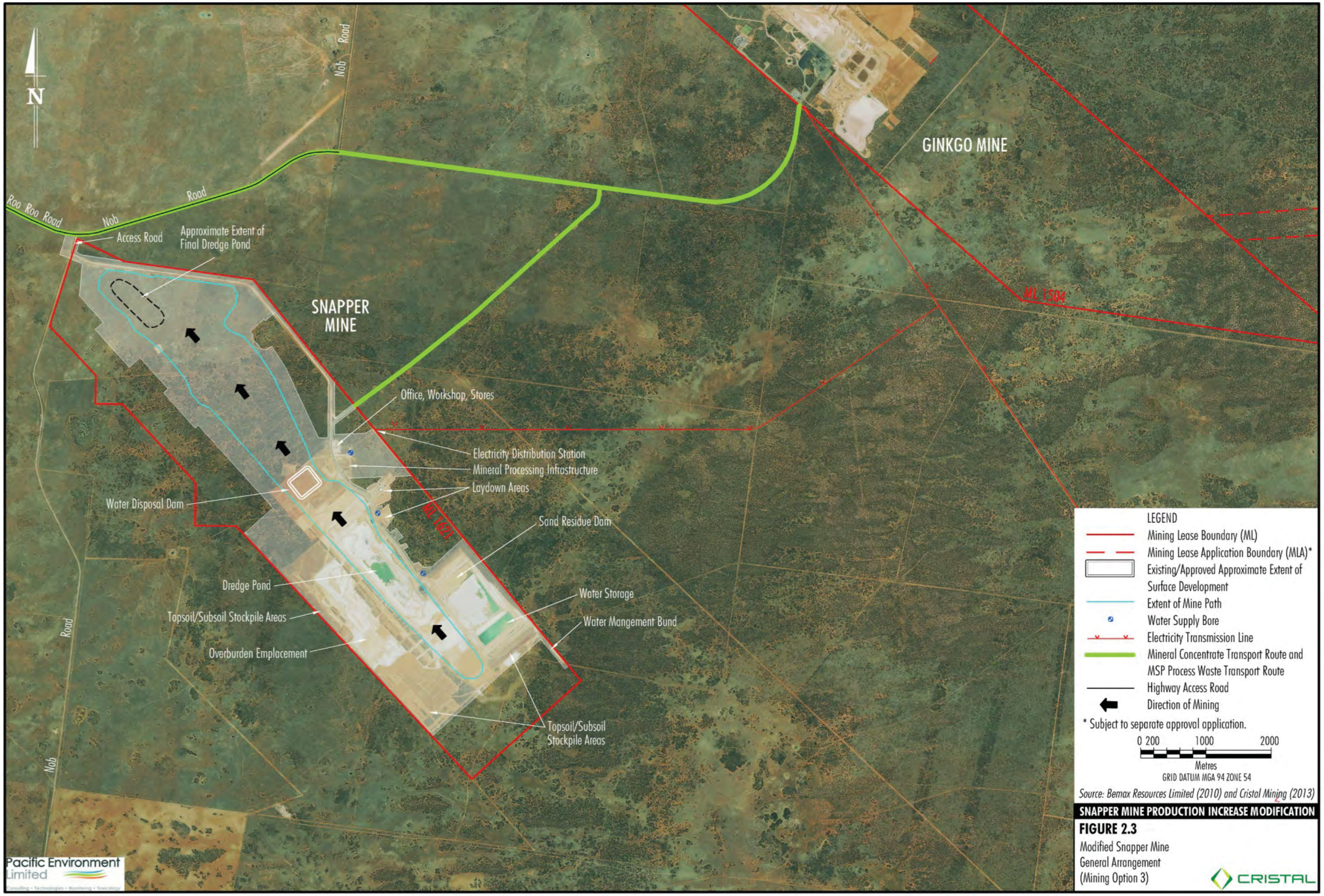

N
Roo Roo Road
Nob Road
Access Road
SNAPPER MINE
GINKGO MINE
Approximate Extent of Final Dredge Pond
Office, Workshop, Stores
Electricity Distribution Station
Mineral Processing Infrastructure
Laydown Areas
Water Disposal Dam
Sand Residue Dam
Dredge Pond
Topsoil/Subsoil Stockpile Areas
Overburden Emplacement
Water Storage
Water Mangement Bund
Topsoil/Subsoil Stockpile Areas
LEGEND
Mining Lease Boundary (ML)
Mining Lease Application Boundary (MLA)*
Existing/Approved Approximate Extent of Surface Development
Extent of Mine Path
Water Supply Bore
Electricity Transmission Line
Mineral Concentrate Transport Route and MSP Process Waste Transport Route
Highway Access Road
Direction of Mining
* Subject to separate approval application.
0 200 1000 2000
Metres
GRID DATUM MGA 94 ZONE 54
Source: Bemax Resources Limited (2010) and Cristal Mining (2013)
SNAPPER MINE PRODUCTION INCREASE MODIFICATION
FIGURE 2.2
Modified Snapper Mine General Arrangement (Mining Option 2)
CRISTAL


N
Roo Roo Road
Nob Road
Nob Road
Road
Nob
Access Road
Approximate Extent of Final Dredge Pond
SNAPPER MINE
GINKGO MINE
ML 1504
ML 1621
Office, Workshop, Stores
Electricity Distribution Station
Mineral Processing Infrastructure
Laydown Areas
Water Disposal Dam
Sand Residue Dam
Dredge Pond
Topsoil/Subsoil Stockpile Areas
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Water Storage
Water Mangement Bund
Topsoil/Subsoil Stockpile Areas
LEGEND
Mining Lease Boundary (ML)
Mining Lease Application Boundary (MLA)*
Existing/Approved Approximate Extent of Surface Development
Extent of Mine Path
Water Supply Bore
Electricity Transmission Line
Mineral Concentrate Transport Route and MSP Process Waste Transport Route
Highway Access Road
Direction of Mining
* Subject to separate approval application.
0 200 1000 2000
Metres
GRID DATUM MGA 94 ZONE 54
Source: Bemax Resources Limited (2010) and Cristal Mining (2013)
SNAPPER MINE PRODUCTION INCREASE MODIFICATION
FIGURE 2.3
Modified Snapper Mine General Arrangement (Mining Option 3)
CRISTAL
Pacific Environment Limited

3 NOISE CRITERIA

3.1 Operational Noise

The noise impact assessment criterion for operational noise is contained with the Snapper Mine Project Approval (06_0168). The criterion is $L_{eq,15min}$ 35 A-weighted decibels (dB[A]) at any residence on non-proponent held land, consistent with the NSW Industrial Noise Policy (INP) (**Environmental Protection Authority** [**EPA**], **2000**).

The criterion does not apply under the following meteorological conditions: (1) winds above 3 metres per second (m/s) at 10 metres (m) or temperature inversions greater than 3 degrees Celsius per 100 metres (°C/100 m); and (2) wind speeds greater than 2 m/s at 10 m.

The criterion also does not apply where the proponent has an agreement with the relevant owner(s) of the residences to generate higher noise levels and the proponent has advised the Department of Planning and Environment in writing of the terms of the agreements.

3.2 Road Traffic Noise

The Snapper Mine Project Approval (06_0168) also specifies traffic noise criteria, applicable to traffic noise generated by the Cristal Mining related vehicles on the Highway Access Road (HAR) component of the mineral concentrate transport route. Traffic noise criteria for the HAR are summarised in **Table 3.1.**

Table 3.1: Traffic Noise Criteria for HAR

Receiver	Traffic Noise Level $L_{eq,1hr}$ dB(A)	
	Day (7.00am to 10.00pm)	Night (10.00pm to 7.00am)
Residence on any non-proponent held land	50	45

Further to the criteria for Cristal Mining related vehicles on the HAR, the potential for impacts to arise as a result of the Modification on public roads is also assessed. The Road Noise Policy (RNP) (**EPA, 2011**) outlines noise assessment criteria for existing residences affected by additional traffic on existing freeways, arterial and sub-arterial roads generated by land use developments. The Silver City Highway is considered an arterial road. The noise assessment criteria apply to all road traffic noise (existing plus proposed project related movements) and are as follows:

- $L_{eq,15hr}$ 60 dB(A) during the day (7.00am to 10.00pm).
- $L_{eq,9hr}$ 55 dB(A) during the night (10.00pm to 7.00am).

In addition, the RNP states that where existing road traffic noise levels exceed or are within 2 dB of the criteria, any increase in traffic noise levels as a result of additional traffic from a development should be limited to 2 dB above the existing traffic noise levels.

3.3 Cumulative Noise Impacts

To limit continuing increases in noise levels, the ambient noise level within an area from industrial noise sources is limited by the INP amenity criteria. The amenity criteria determines the acceptable ambient noise level from all industrial noise sources within an area and is dependent on the land use in the vicinity of the receivers.

Therefore the cumulative impact from the multiple industrial projects in the vicinity of a receiver is assessed according to the amenity criteria. The closest receivers in the vicinity of the project are classed as “rural” according to the INP. The applicable amenity criteria are presented in **Table 3.2**.

Table 3.2: Amenity Noise Criteria

Receiver	Amenity Criteria $L_{eq,period}$ dB(A)[1]		
	Day	Evening	Night
Residential (rural)	50	45	40

Note: 1. Day is defined as 7.00am to 6.00pm, Evening 6.00pm to 10.00pm and Night 10.00pm to 7.00am

4 EXISTING ENVIRONMENT

4.1 Sensitive Receivers

There are a number of sensitive receivers located in the vicinity of the Snapper and Ginkgo Mines as per **Figure 4.1**. The Manila and Trelega homesteads are the closest private receivers to the Snapper Mine (located approximately 4 km to the northeast and 7 km south respectively).

4.2 Noise

4.2.1 Background Noise Monitoring

Background noise measurements were conducted in 2006 (**Holmes Air Sciences** [**HAS**], **2007**). The background noise measurements characterised and measured ambient and background noise levels at sensitive receivers in the vicinity of the Snapper Mine. The locations of the sensitive receivers where measurements occurred are shown in **Figure 4.1**. **Table 4.1** presents a summary of the background noise monitoring.

Table 4.1: Summary of Measured Rating Background Levels

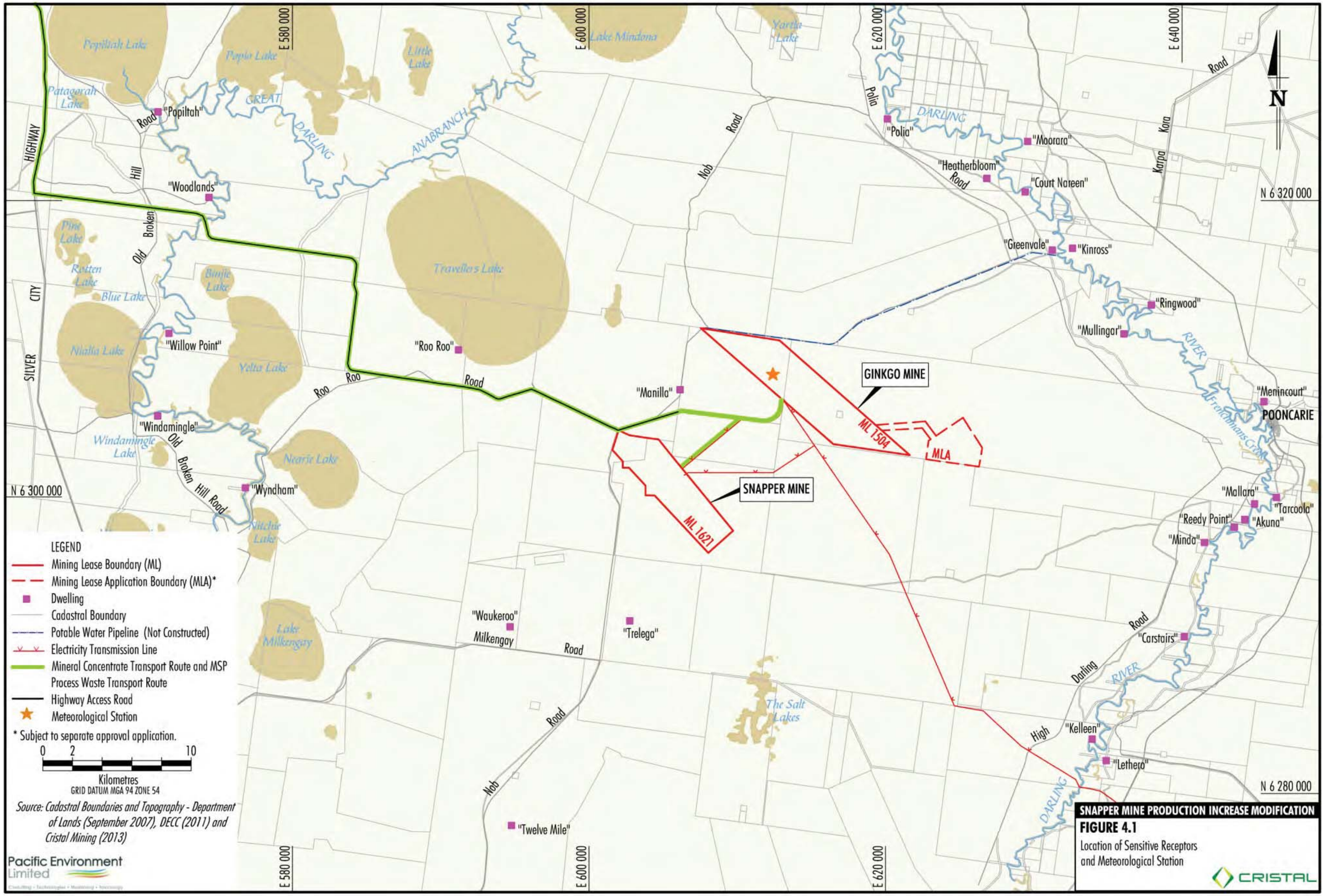
Receiver	Measured Rating Background Level, dB(A)[1,2]		
	Day	Evening	Night
Manilla	26	25	25
Trelega	26	25	26

Notes: 1. Day is defined as 7.00am to 6.00pm, Evening as 6.00pm to 10.00pm and Night 10.00pm to 7.00am
2. Rating Background Level as determined from procedures outlined in the INP.

4.2.2 Compliance Noise Monitoring

Compliance noise monitoring was undertaken for the Snapper Mine in 2011 and 2012 and was reported in the 2011 and 2012 Annual Environmental Management Reports (AEMR) (**Bemax Resources** [**2012**], **Bemax Resources** [**2013**]). The monitoring was compared with the Snapper Mine Project Approval (06_0168) criteria (**Section 3**) for compliance. The limits are $L_{eq,15mins}$ 35 dB(A) for operational noise at private sensitive receivers.

In 2011, unattended and attended compliance noise monitoring was conducted at Manilla. The unattended monitoring recorded noise levels in excess of the Snapper Mine Project Approval (06_0168) criteria, however the attended monitoring determined that mining noise was not likely to be the cause of the exceedance (**Bemax Resources, 2012**).



SNAPPER MINE PRODUCTION INCREASE MODIFICATION

FIGURE 4.1

Location of Sensitive Receptors and Meteorological Station

In 2012, unattended noise monitoring was carried out at Manilla and Woodlands (**Bemax Resources, 2013**). The noise monitoring determined that noise levels were below the Snapper Mine Project Approval (06_0168) criteria at Woodlands. At Manilla, measured noise levels were above the Snapper Mine Project Approval (06_0168) criteria. Using audio recordings from the noise logging, noise sources were identified as being sources not associated with Cristal Mining's mining or transportation operations at Manilla. The monitoring concluded that whilst on occasion, noise from mining operations was audible, it was found in all cases to be compliant with the Snapper Mine Project Approval (06_0168) criteria. It was also noted that transport noise from the mine on public roads was occasionally audible, which is distinguished from on-site operational noise.

The compliance monitoring confirms compliance with the Snapper Mine Project Approval (06_0168) criteria. This is consistent with the previous noise assessments for the Snapper Mine.

Summaries of the monitoring results for 2011 and 2012 are provided in **Table 4.2** and **Table 4.3**.

Table 4.2: 2011 Snapper Mine Compliance Noise Monitoring

Location	Date Start	Date End	Measured Noise Level, dB(A)						Notes
			Day (0700-2200)			Night (2200-0700)			
			L_{90}	L_{eq}	L_{10}	L_{90}	L_{eq}	L_{10}	
Unattended									
Manilla	14/12/2011	21/12/2011	31	39	37	29	35	37	Audible sources included insects, birds and wind in trees. Wind data not taken therefore monitoring results could be compromised by invalid data.
Attended									
Manilla	21/12/2011	22/12/2011	23	34	36	20	29	26	Audible sources included operations (mine) and vehicle passbys. Generally dominated by gusty wind and birds. During early morning some Ginkgo Mine noise was noted around background level with a max level of 29 dB(A) observed. The Snapper Mine was not observed to be audible during this monitoring.

Table 4.3: 2012 Snapper Mine Compliance Noise Monitoring

Location	Date Start	Date End	Measured Noise Level, dB(A)						Notes
			Day (0700-2200)			Night (2200-0700)			
			L_{90}	L_{eq}	L_{10}	L_{90}	L_{eq}	L_{10}	
Unattended									
Manilla	6/12/2012	13/12/2012	30	41	42	24	31	31	Audible sources included insects, birds and wind in trees. Examination of audio shows that Snapper and Ginkgo Mine related noise sources were not significant and noise was generated primarily by wind and galahs.
Woodlands	21/12/2012	28/12/2012	25	33	35	25	30	31	Audible sources included insects, birds and wind in trees.

4.3 Meteorology

4.3.1 Introduction

The effect on noise levels at relatively large distances from the source can be influenced by wind and temperature gradients. The INP contains guidance for the assessment of effects due to meteorological effects.

Wind in the direction of source to receiver has the potential to enhance noise levels at the receiver. The INP states that where winds less than 3 m/s at 10 m height are present for more than 30 percent (%) of the time in any assessment period (day, evening, night) during any season, they are to be considered as a feature and should be considered when predicting noise impacts. The INP considers 3 m/s as the upper limit of wind speed that can noticeably increase source noise levels without increasing ambient noise levels so that they mask noise from the source.

Temperature inversions, which are positive temperature gradients, can increase noise levels at surrounding receivers due to upper layers of warmer air causing sound waves to be refracted back towards the ground. Generally temperature inversions occur predominantly at night during cooler seasons. The INP states that where temperature inversions occur for more than 30% of the time during winter evening and nights (6.00pm to 7.00am) then they should be considered a feature and accounted for in an assessment.

4.3.2 Previously Assessed Meteorological Conditions

HAS (**2007**) analysed meteorological data collected from the Ginkgo Mine meteorological station (**Figure 4.1**). **HAS (2007)** concluded that annually, the most common winds are from the south or the north. In summer the winds are generally from the south while in winter the winds are typically from the north. Autumn and spring winds exhibit a mix of both summer and winter patterns. On an annual basis there are 8.9% calms and the annual average wind speed is 2.4 m/s.

HAS (**2007**) determined from analysis of the meteorological data that temperature inversions of Pasquill stability class F and G occurred for 80% of the time during winter nights. According to the INP, the default temperature inversion strength for arid and semi-arid areas is Pasquill stability class G, equivalent to a temperature gradient of 8 °C/100 m. The default temperature inversion strength was considered as part of the **HAS** (**2007**) assessment. The assessment took a conservative approach and considered a drainage flow wind of 1m/s (source to receiver) was applicable in conjunction with an 8 °C/100 m temperature inversion.

The most recent assessment in the vicinity of the Snapper Mine was the Ginkgo Mine Crayfish Modification conducted by Wilkinson Murray (WM) (**WM, 2012**). It presented an analysis of wind in the vicinity of the Ginkgo Mine using 2012 data. It showed that the dominant wind directions were from the south and south west. It should be noted that the assessment took a conservative approach and considered default worst-case source to receiver winds of 3 m/s.

5 OVERVIEW OF PREVIOUS ASSESSMENTS

Pacific Environment (formally PAEHolmes [PAEH] and HAS) had previously completed noise assessments for the Snapper and/or Ginkgo Mines in 2001, 2007 and 2010, as follows:

- Ginkgo Mineral Sands Mine Noise Assessment (the Ginkgo Mine Noise Assessment): for the construction and operation of the Ginkgo Mine (**HAS, 2001**).
- Snapper Mineral Sands Mine Noise Assessment (the Snapper Mine Noise Assessment): for the construction and operation of the Snapper Mine (**HAS, 2007**).
- 2010 Modification Noise Assessment (the 2010 Modification Noise Assessment): for a modification to both the Snapper and Ginkgo Mines, including changes to extraction rates and haulage of mineral concentrate/HMC (**PAEH, 2010**).

In addition to these noise assessments, WM prepared a noise assessment for an application to modify the Ginkgo Mine Development Consent in 2012 to allow for the development of the Crayfish deposit (the Ginkgo Mine Modification Noise Assessment) (**WM, 2012**).

A brief summary of these noise assessments is provided below.

The Ginkgo Mine Noise Assessment concluded that the greatest predicted $L_{eq,15min}$ noise level from mining operations would be 29 dB(A) at the nearest sensitive receiver (Manilla). The assessment used conservative assumptions and predicted that the greatest noise levels would occur in Years 5 to 7 of the Ginkgo Mine operation, with Year 1 designated as 2006 (**HAS, 2001**).

The Snapper Mine Noise Assessment considered scenarios for construction and operations. The operational scenario was selected to be when operations would be at their closest points to the nearest private sensitive receivers Manilla and Trelega. **Table 5.1** presents the predicted noise levels. The highest noise levels were predicted at Manilla (**HAS, 2007**).

Table 5.1: Snapper Mine Predicted Noise Levels (HAS, 2007)

Sensitive Receiver	Criteria $L_{eq,15min}$ dB(A)	Predicted Noise Level $L_{eq,15min}$ dB(A)			
		Neutral Meteorological Conditions		Adverse Meteorological Conditions[2]	
		Construction	Operations	Construction	Operations
Manilla	35	<10	21	19	28
Trelega	35	10	<10	22	14
Others[1]	35	<10	<10	<15	<15

Note: 1. Conservative estimate based on noise contours.
2. Adverse meteorological conditions determined to be Stability Class G Temperature Inversion (8 °C/100 m) with 1 m/s source to receiver wind.

The 2010 Modification Noise Assessment considered a number of minor changes to the equipment fleet and haulage arrangements. Using a comparison of existing and proposed equipment changes, the assessment determined that the potential changes in total fleet sound power levels would be an increase of less than 1 dB during the construction scenario and a decrease of less than 1 dB during the operational scenario (**PAEH, 2010**). The 2010 Modification Noise Assessment concluded that noise levels in excess of the criteria would be unlikely at the nearest private sensitive receivers under neutral or temperature inversion meteorological conditions (**PAEH, 2010**). A summary of the estimated noise levels is presented in **Table 5.2**.

Table 5.2: 2010 Snapper Mine Estimated Noise Levels (PAEH, 2010)

Sensitive Receiver	Criteria $L_{eq,15min}$ dB(A)	Estimated Noise Level $L_{eq,15min}$ dB(A)			
		Neutral Meteorological Conditions		Adverse Meteorological Conditions[2]	
		Construction	Operations	Construction	Operations
Manilla	35	<10	20	20	27
Trelega	35	11	<10	23	13
Others[1]	35	<10	<10	<15	<15

Note: 1. Conservative estimate based on noise contours.
2. Adverse meteorological conditions determined to be Stability Class G Temperature Inversion (8 °C/100 m) with 1 m/s source to receiver wind.

The Ginkgo Mine Modification Noise Assessment predicted noise levels under neutral and adverse (gradient winds and temperature inversions) meteorological conditions for two mining scenarios.

Table 5.3 presents a summary of the predicted noise levels for the private sensitive receptors closest to the Snapper and Ginkgo Mines. The assessment concluded that the development of the Crayfish deposit would not have an acoustically significant contribution to the noise emission of the Snapper and Ginkgo Mines at the surrounding private sensitive receivers.

Table 5.3: Ginkgo Mine Crayfish Modification Predicted Noise Levels (WM, 2012)

Sensitive Receiver	Criteria $L_{eq,15min}$ dB(A)	Predicted Noise Level $L_{eq,15min}$ dB(A)					
		Neutral Meteorological Conditions		Gradient Wind Conditions[2]		Temperature Inversion Conditions[3]	
		Year 1	Year 4	Year 1	Year 4	Year 1	Year 4
Manilla	35	<10	<10	<10	<10	<10	<10
Trelega	35	<10	<10	<10	<10	<10	<10
Others [1]	35	<10	<10	<15	<15	<15	<15

Notes: 1. Other receivers based on predicted noise levels presented in **WM** (**2012**).
2. Gradient Wind Conditions determined to be 3m/s source to receiver wind.
3. Temperature Inversion Conditions determined to be Stability Class G Temperature Inversion (8 °C/100 m) with 1 m/s source to receiver wind.

6 OPERATIONAL NOISE ASSESSMENT

6.1 Methodology

A screening assessment based on changes to the equipment fleet has been conducted. The total sound power levels from the previously assessed and proposed mining fleets are compared and the resultant change in fleet sound power levels determined. Based on the outcomes of the screening assessment, it is decided if further noise modelling is required for the Modification.

Generally, noise sources associated with mining operations are distributed over a working area and not all items of plant have the same distance or shielding relative to the receiver. Each source provides a noise contribution at the receiver. The sum of all the contributions make up the overall noise received from the operation at the receiver. The noise level of each contribution is determined by the characteristics of the source, receiver and the path from source to receiver. The path is subject to various attenuation mechanisms that affect the propagation of noise such as geometrical spreading, atmospheric absorption, shielding, and ground effect amongst others.

In order to estimate the change in noise level at the receiver as a result of the Modification, the distance from the receiver to each source has been determined from the previous assessment (**HAS, 2007**). Using these distances, the relative contribution of each source at the receiver is determined. The sources are then adjusted to account for changes in fleet quantities. The resultant change from the relative contributions is then applied to the predicted noise level at the receiver.

It is noted that this represents a conservative approach as the relative contribution is calculated based on distance only and does not take into account shielding which varies from source to source. The effect of shielding on a source's relative contribution would only lower its contribution. Other attenuation mechanisms including atmospheric absorption, ground effect and geometrical spreading are, amongst other things, functions of distance. Therefore the relative contributions would be similar to the contributions calculated using distance only. In this way it represents a conservative approach.

The previous noise assessments (**HAS** [**2007**] and **PAEH** [**2010**]) considered scenarios for construction and operations. The operational scenario was selected to be when operations would be at their closest points to the nearest private sensitive receivers Manilla and Trelega. The Snapper Mine is currently operational and therefore the construction scenario is no longer relevant. Therefore only the operations scenario has been assessed. The receiver Manilla is the closest sensitive receiver to the Snapper Mine and therefore, where compliance is predicted at this location, it is assumed that compliance would also be achieved at receivers further from the Snapper Mine.

The noise sources considered in this review are expected to be at the same location as previously assessed regardless of the mining options mentioned in **Section 2**.

6.2 Mining Fleet

Table 6.1 presents a summary of the previously assessed mining fleet (**PAEH, 2010**) and the proposed mining fleet (assuming the overburden slurry pipeline system is not adopted). Changes to the mining fleet are highlighted in bold.

If the overburden slurry pipeline system was adopted, the required mining fleet would be smaller than presented in **Table 6.1** as less haul trucks would be required to transport the overburden. Therefore the mining fleet presented in **Table 6.1** would represent the greatest noise impact scenario.

Table 6.1: Schedule of Previously Assessed and Proposed Mining Fleet

Equipment	Previously Assessed Mobile Fleet[1]	Proposed Mobile Fleet	Change
Backhoe	1	1	0
Bucket Scoop	3	**4**	**1**
Dozer	7	7	0
Excavator	4	**7**	**3**
Front End Loader	3	3	0
Grader	2	2	0
Lighting Tower	6	6	0
Scraper	1	1	0
Haul Truck	8	**24**	**16**
Water Truck	2	2	0
Service Truck	0	**1**	**1**
Articulated Dump Truck	0	**4**	**4**

Notes: 1. **PAEH (2010)**

6.3 Equipment Sound Power Levels

Equipment sound power levels have been sourced from the 2010 Modification Noise Assessment. **Table 6.2** presents a summary of the octave band sound power levels used in the 2010 Modification Noise Assessment.

Table 6.2: Equipment Sound Power Levels

Equipment	Octave Band Sound Power Level dB(A)[1] Frequency (Hz)								Overall dB(A)
	63	125	250	500	1,000	2,000	4,000	8,000	
Backhoe	92	96	100	112	111	110	101	94	116
Bucket Scoop	90	97	108	105	107	103	98	93	113
Dozer	88	93	106	101	103	99	94	89	109
Excavator	88	93	106	101	103	99	94	89	109
Front End Loader	88	93	106	101	103	99	94	89	109
Grader	92	96	100	112	111	110	101	94	116
Lighting Tower	68	88	88	96	94	97	92	82	102
Scraper	90	97	108	105	107	103	98	93	113
Dump Truck (Cat 740)	70	77	81	92	96	94	89	84	100
Water Truck	70	77	81	92	96	94	89	84	100
Service Truck	70	77	81	92	96	94	89	84	100
Articulated Dump Truck	70	77	81	92	96	94	89	84	100

Note: 1. Sound power levels sourced from **PAEH** (**2010**).

A review of the sound power levels used in the 2010 Modification Noise Assessment indicates differences in levels when compared to those used in the Ginkgo Modification Noise Assessment. In general, the Ginkgo Modification Noise Assessment used higher sound power levels than those used for the 2010 Modification Noise Assessment. Conservatively, the higher sound power levels used in the Ginkgo Modification Noise Assessment have been adopted for this assessment. **Table 6.3** compares the previous and revised sound power levels for the items of equipment.

Table 6.3: Comparison of Equipment Sound Power Levels

Equipment	Sound Power Level dB(A)	
	Previously Assessed[1]	Modification[2]
Backhoe	116	102
Bucket Scoop	113	115
Dozer	109	116
Excavator	109	114
Front End Loader	109	111
Grader	116	108
Lighting Tower	102	103
Scraper	113	115
Dump Truck (Cat 740)	100	115
Water Truck[3]	100	115
Service Truck[3]	100	109
Articulated Dump Truck	100	115

Notes: 1. Sound power levels sourced from **HAS** (**2007**) and **PAEH** (**2010**)
2. Sound power levels sourced from **WM** (**2012**)
3. Assumed based on similar equipment

Table 6.4 presents the total increase in sound power levels for the total Snapper Mine fleet. A review of **Table 6.4** shows that as a result of the Modification, the increase in total sound power level compared with the 2010 Modification Noise Assessment is 2 dB.

Table 6.4: Changes in Total Snapper Mine Fleet Sound Power Levels

Sound Power Level Source	Total Snapper Mine Fleet Sound Power Level, dB(A)	
	2010 Modification Fleet	Modification Fleet
Revised[1]	130	132

Notes: 1. Sound power levels sourced from **WM** (**2012**)

6.4 Assessment

Using the conservative approach described in **Section 6.1** , noise levels at the nearest sensitive receivers (i.e. Manilla and Trelega) using the revised sound power levels when operations are at their closest point to Manilla were estimated (**Section 6.1**). The estimated noise levels indicate that compliance would be achieved at the nearest sensitive receiver (Manilla) under neutral and temperature inversion conditions. It is therefore predicted that compliance would also be achieved at receivers located further from the Snapper Mine.

Table 6.5: Estimated Noise Levels for the Modification

Sensitive Receiver	Criteria $L_{eq,15min}$ dB(A)	Estimated Noise Level $L_{eq,15min}$ dB(A)[1]	
		Neutral Meteorological Conditions	Adverse Meteorological Conditions[2]
Manilla	35	27	34
Trelega	35	<10	20

Note: 1. Predicted noise levels are indicative only and are based on the proposed mining fleet for the Modification.
2. Adverse meteorological conditions determined to be Stability Class G Temperature Inversion (8 °C/100 m) with 1 m/s source to receiver wind.

The predicted noise levels in **Table 6.5** represent noise levels at receivers when operations are at their closest to Manilla. Manilla is the closest sensitive receiver to the Snapper Mine. It is assumed that the fleet configuration is similar when operations are in the southern end of the mining area and that there is no additional shielding by topography between Manilla and the Snapper Mine. Therefore it is expected that when operations are at their closest to Trelega, noise levels would be below the criteria.

6.5 Cumulative Assessment

The combined noise level of the Snapper and Ginkgo Mines (including the proposed Crayfish deposit) are considered to potentially have a cumulative impact at receivers. The receiver Manilla is the closest receiver located between the Snapper and Ginkgo Mines.

The cumulative assessment combined the greatest predicted noise level from the Snapper and Ginkgo Mines (including the proposed Crayfish deposit) at the receiver. This represents a conservative approach as the greatest predicted noise levels from each mine may not occur simultaneously. **Table 6.6** provides a summary of the indicative cumulative noise levels at Manilla. As this receiver is the closest receiver to the Snapper and Ginkgo Mines, it is assumed that where compliance is achieved at Manilla, it would also be achieved at other receivers.

Table 6.6: Indicative Cumulative Noise Levels at Manilla

Project	Predicted Noise Level at Receiver Manilla $L_{eq,15min}$ dB(A)
Snapper Mine[1]	34
Ginkgo Mine (worst-case)[2]	29
Crayfish Deposit (Year 4)[3]	<10
Total	**35**
INP Amenity Criteria (Night)	**40**

Notes: 1. Refer to **Table 6.5**
2. Predicted noise level from **HAS** (**2001**)
3. Predicted noise level from **WM** (**2012**)

A review of **Table 6.6** indicates that the predicted cumulative noise levels do not exceed 35 dB(A) and are below the INP amenity criteria for rural residences.

7 OFF-SITE TRANSPORT NOISE ASSESSMENT

7.1 Introduction

Off-site road haulage of mineral concentrate/HMC is generated by Cristal Mining. The haulage route follows the HAR (an approved haulage route) to the Silver City Highway where it travels north to the Mineral Separation Plant in Broken Hill (**Figure 1.1**).

Project generated road traffic noise is assessed against specific criteria when travelling on the HAR, as outlined in **Section 3.2**. Project related noise impacts on public roads, such as the Silver City Highway are assessed against the RNP criteria.

7.2 Highway Access Road

The Snapper Mine Noise Assessment assumed approximately 37 mineral concentrate/HMC loads per day (or approximately 74 movements per day). In addition 10 service trucks (or approximately 20 movements per day) were considered, giving a combined total of 95 truck movements per day (**HAS, 2007**).

The maximum mineral concentrate/HMC transport rate would increase from approximately 735,000 tpa to approximately 975,000 tpa for the Modification.

It is expected that there would be no increase in the approved mineral concentrate/HMC transport vehicle movements (i.e. 37 loads per day [or 74 movements per day]) despite the proposed increase in the mineral concentrate/HMC transport rate as larger AB-triple vehicles (capacity of 77 tonnes) are now predominately used rather than double road trains (capacity of 54 t).

In summary, due to an increase in truck capacity, haulage truck movements are expected to remain the same for the Modification compared with previous assessments.

As the number of truck movements is not expected to increase, the Modification is not expected to cause an increase in traffic noise levels on the HAR.

7.3 Silver City Highway

As described in **Section 7.2**, it is expected that there would be no increase in the approved mineral concentrate/HMC transport vehicle movements. Therefore, the Modification is not expected to cause an increase in traffic noise levels on the Silver City Highway.

8 CONCLUSIONS

This study has assessed the potential noise impacts associated with the Modification. A quantitative assessment was used to assess the potential for noise impacts at sensitive receptors with reference to previous detailed modelling studies.

The study found that the Modification is not expected to cause an increase in noise levels above the operational noise criteria at the nearest sensitive receivers.

In addition, the study found that the Modification would not result in a change in mineral concentrate/HMC transport movements and therefore the Modification is not expected to cause road traffic noise levels to be in excess of traffic noise criteria on the HAR or Silver City Highway.

9 REFERENCES

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