Appendix 6

Noise and Vibration Assessment

prepared by

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Noise and Vibration Impact Assessment

Strontian Quarry

Prepared for: RW Corkery & Co. Pty Limited
On Behalf of: Milbrae Quarries Pty Ltd
October 2020
MAC191007-02RP1

MAC
Muller Acoustic Consulting

Document Information

Noise and Vibration Impact Assessment

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by RW Corkery & Co. Pty Limited (RWC) on behalf of Milbrae Quarries Pty Ltd (the 'Applicant') to prepare a Noise and Vibration Impact Assessment (NVIA) to quantify potential noise emissions associated with the continued operation and extension of the Strontian Quarry (the 'Quarry').

The Quarry is located on Crown Land within Lots 133 and 134 of DP726537, approximately 11km southeast of Narrandera, NSW (see **Figure 1**). The Quarry Site covers a total area of 15.0ha of which approximately 7.6ha would be disturbed throughout the life of the Quarry. The Quarry Access Road provides access to the Quarry Site from Strontian Road and traverses Lot 105 of DP754552.

The NVIA is provided to accompany the Environmental Impact Statement (EIS) being prepared to assess the Proposal. The NVIA has been undertaken in accordance with the following policies and guidelines:

- NSW Environment Protection Authority's (EPA's), Noise Policy for Industry (NPI), 2017;
- NSW Department of Environment and Climate Change (DECC), Interim Construction Noise Guideline (ICNG), 2009;
- NSW Department of Environment, Climate Change and Water (DECCW), NSW Road Noise Policy (RNP), 2011;
- Australian Standard AS2187.2-2006 (AS2187.2) – Explosives-Storage and Use Part 2: Use of Explosives; and
- Australian and New Zealand Environment Conservation Council (ANZECC), 1990, Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A.**

Figure 1

Location Map

1.1 Project Background

MAC understands that the Quarry, which is currently operating under Development Consent DA27/2011/12 issued by Narrandera Shire Council on 27 March 2012, has approval to extract, process and transport up to 30,000 tonnes indurated sandstone per annum. Quarry material is extracted using conventional drilling and blasting methods and processed on site using mobile crushing and screening equipment within the existing extraction area. Quarry products are stockpiled within the extraction area prior to despatch to local and regional markets. The existing quarry layout is provided in Figure 2.

The Applicant has identified a further 2.97 million tonnes of indurated sandstone material adjacent to and beneath the approved extraction area. To efficiently access and extract the identified resource, it is proposed that a new development consent is sought that would supersede the existing development consent. As part of the development consent, the Applicant proposes to increase the approved maximum extraction rate from 30,000tpa to 125,000tpa to allow for existing and future market demands to be met. The proposed quarry layout is provided in Figure 3.

The activities for which the Applicant is seeking development consent would involve the following:

- Extraction of material from within the proposed extraction area to produce up to 125,000t of Quarry products per annum;
- Importation of up to 1,500t of concrete washout and other construction materials per annum for recycling and incorporation into Quarry products;
- Crushing and screening of fragmented rock and imported materials on site using a mobile processing plant;
- Ongoing transportation of up to 125,000tpa of Quarry products to end points of use within the Narrandera LGA and broader Riverina Region; and
- Progressive and final rehabilitation of the Quarry to develop a final landform suitable for passive nature conservation.

Extraction and processing operations would occur on a campaign basis with approximately four campaigns between 20 to 30 days in duration required per year. Product loading and transportation operations would occur year-round with peaks in activity driven by demand.

Transportation of Quarry products and importation of concrete washout and other construction materials would involve a maximum of 48 laden loads per day and a peak of 12 laden loads per hour. Three indicative travel routes have been identified and are described as follows:

- North to Narrandera via Strontian Road and Sturt Highway (60% of laden trucks);
- South to Wagga Wagga via Strontian Road and Sturt Highway (25% of laden trucks); and
- South to Boree Creek via Strontian Road (15% of laden trucks).

1.2 Hours of Operation

Table 1 presents the proposed operating hours for the Quarry. The proposed hours and combination of activities for the Quarry have formed the basis of the noise modelling scenarios for this assessment.

Table 1 Proposed Hours for Quarry Operation

Activity	Monday to Friday[1]	Saturday	Sunday
Site Establishment and Construction	6am-6pm	8am-5pm	N/A
Extraction Operations	6am-6pm	8am-5pm	N/A
Blasting Operations	10am-3pm	N/A	N/A
Processing Operations	6am-6pm	8am-5pm	N/A
Product Despatch	6am-6pm	8am-5pm	N/A
Maintenance	24 hrs/day	24 hrs/day	N/A

Note 1: Excludes public holidays which would operate as per the proposed hours of operation for Sunday.

1.3 Potentially Sensitive Receivers

From review of aerial imagery and associated project information, the following potentially sensitive receivers have been identified. Receivers in the locality are primarily rural / residential. **Table 2** presents a summary of receiver identification, address and MGA(55) coordinates. The location of the receivers are presented visually in **Figure 4**.

Table 2 Receiver Locations

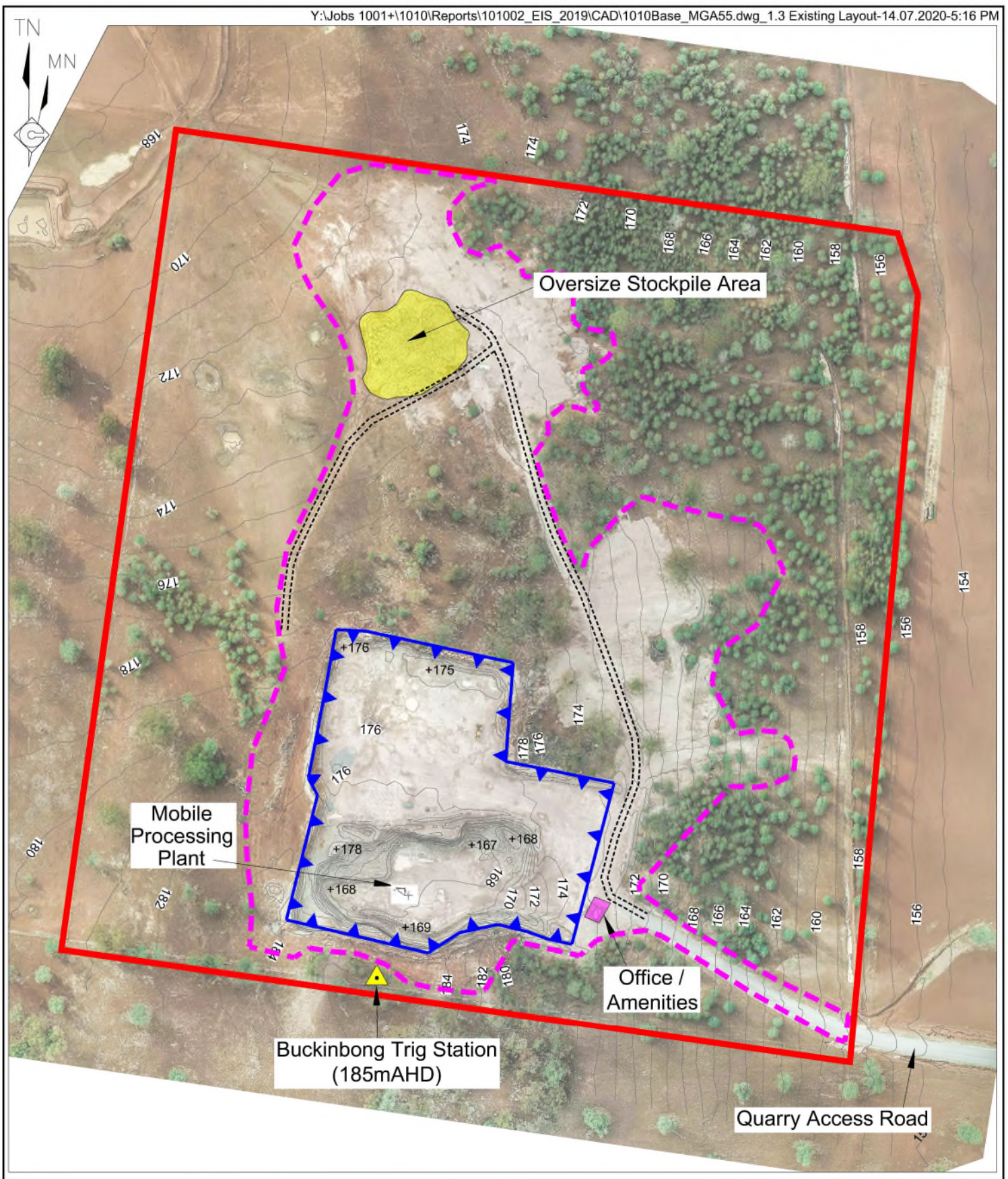
Receivers	Address	MGA55 Coordinates	
		Easting	Northing
R3	1083 Buckingbong Road	468269	6142601
R6A	456 Quilters Road	460863	6139293
R6B	204 Quilters Road	463399	6138773
R7	106 Rosedale Road	468093	6141392
R8	1002 The Gap Road	455925	6141949
R9	596 The Gap Road	457963	6145656
R10	484 The Gap Road	458129	6146701
R14	8946 Sturt Highway	462378	6149182
R15	9119 Sturt Highway	460359	6149747
R17	539 Buckingbong Road	464225	6149619

1.4 Coverage of Secretary's Environmental Assessment Requirements

The key issues to be addressed, as part of this NVIA are outlined in the Secretary's Environmental Assessment Requirements (SEARs) which are reproduced in Error! Reference source not found..

Table 3 Coverage of SEARs and Other Government Agency Requirements

Noise and Vibration Assessment Requirement	Reference
Coverage of Secretary's Environmental Assessment Requirements	
Include a quantitative assessment of potential:	
▪ Construction and operational noise and off-site transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and NSW Road Noise Policy respectively;	Section 5
▪ Reasonable and feasible mitigation measures to minimise noise emissions; and	Section 6
▪ Monitoring and management measures.	Section 6
Blasting and Vibration – including:	
▪ A description of the proposed blasting hours, frequency and methods; and	Section 1.2 / 5.4
▪ An assessment of the likely blasting and vibration impacts of the development having regard to the relevant ANZEC guidelines and paying particular attention to impacts on people, buildings, livestock, infrastructure and significant natural features.	Section 5.4
Coverage of Issues Identified by Other Government Agencies	
EPA (12 June 2019):	
▪ The goals of the project should include design, construction, operation and maintenance of the facility in accordance with relevant EPA policy, guidelines and criteria, and in order to minimise potential impacts from noise.	Section 1 / 4
▪ The EPA expects that potential noise sources are assessed in accordance with the Noise Policy for Industry (EPA 2017), and where required mitigation measures are proposed (e.g. appropriate equipment chosen to minimise noise levels).	Section 5
▪ All residential or noise sensitive premises likely to be impacted by the development must be identified and included in the assessment.	Section 1.3
▪ The proposed development may result in an increase in traffic movements. The number of traffic movements associated with the proposal should be quantified and the potential noise impacts associated with these traffic movements need to be assessed in accordance with the NSW Road Noise Policy (DECCW, 2011).	Section 5.3
▪ An assessment of vibration from all activities (including construction and operation) to be undertaken on the premises and this should be assessed using the guidelines contained in the document Assessing Vibration: a technical guideline (DEC 2006).	Section 5.4
▪ An assessment of potential blast impacts should be undertaken and this should be assessed against the guidelines contained in the document Australian and New Zealand Environment Council - Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZECC, 1990).	Section 5.4



REFERENCE

- Quarry Site Boundary
- Current Limit of Disturbance
- Current Limit of Extraction
- Oversize Stockpile Area
- Office/Amenties
- Quarry Access Road
- Internal Road
- 180 Contour (mAHD)(Interval = 1m)
- +175 Spot Height (mAHD)
- Buckingbong Trig Station

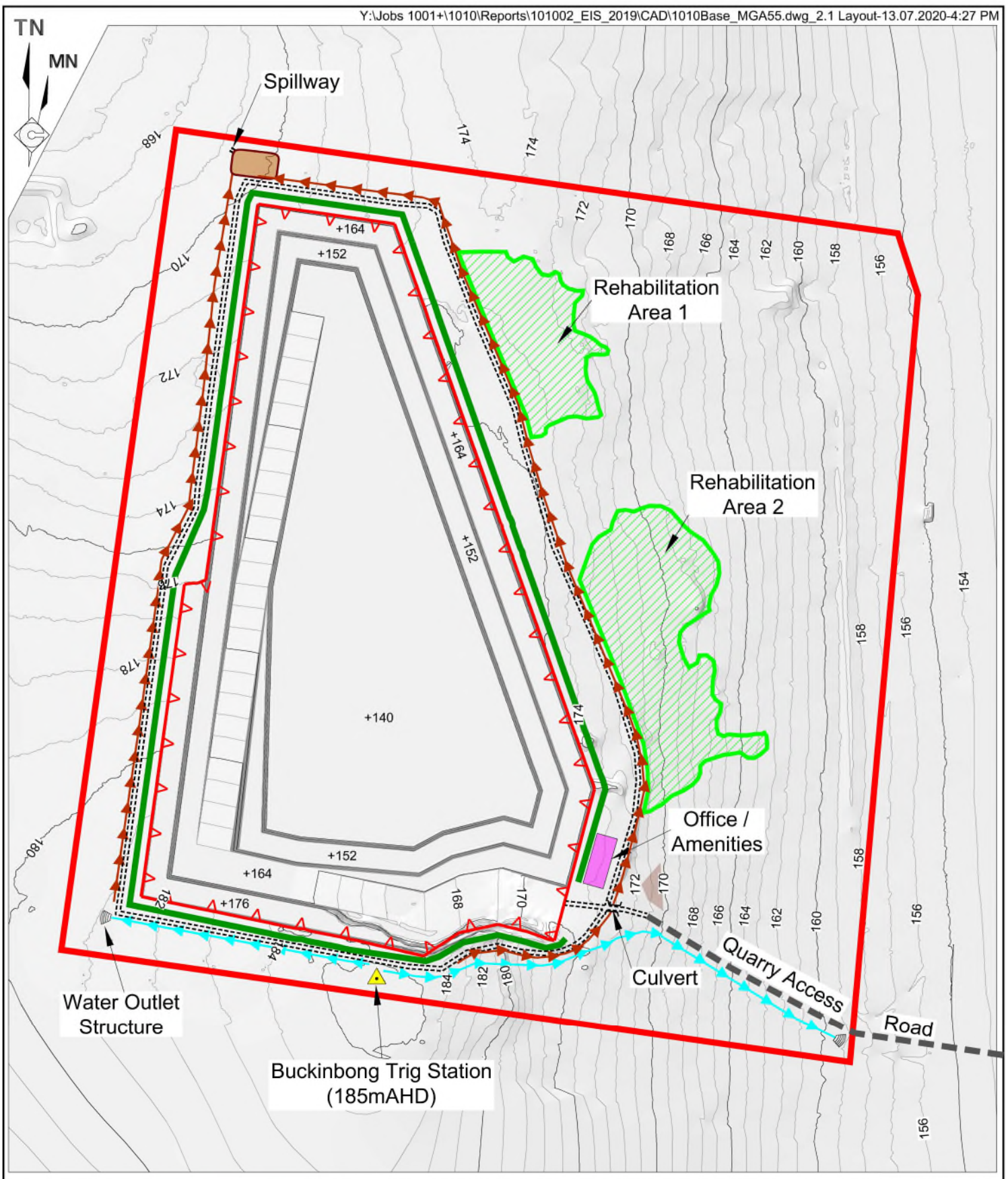
SCALE 1:3 000 (A4)

50 0 50 100 150m

Base Map Source: RPAS Australia - 27 April 2019

Figure 2

Existing Quarry Layout



REFERENCE

- Quarry Site Boundary
- Proposed Limit of Extraction
- Office/Amenities
- Rehabilitation Area
- Quarry Access Road
- Internal Road
- 180 Contour (mAHD)(Interval = 1m)
- +175 Spot Height (mAHD)
- Buckingbong Trig Station
- Sediment Basin
- Clean Water Diversion Drain
- Dirty Water Collection Drain
- Perimeter Safety Bund

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Base Map Source: RPAS Australia - 27 April 2019

Figure 3

Proposed Quarry Layout

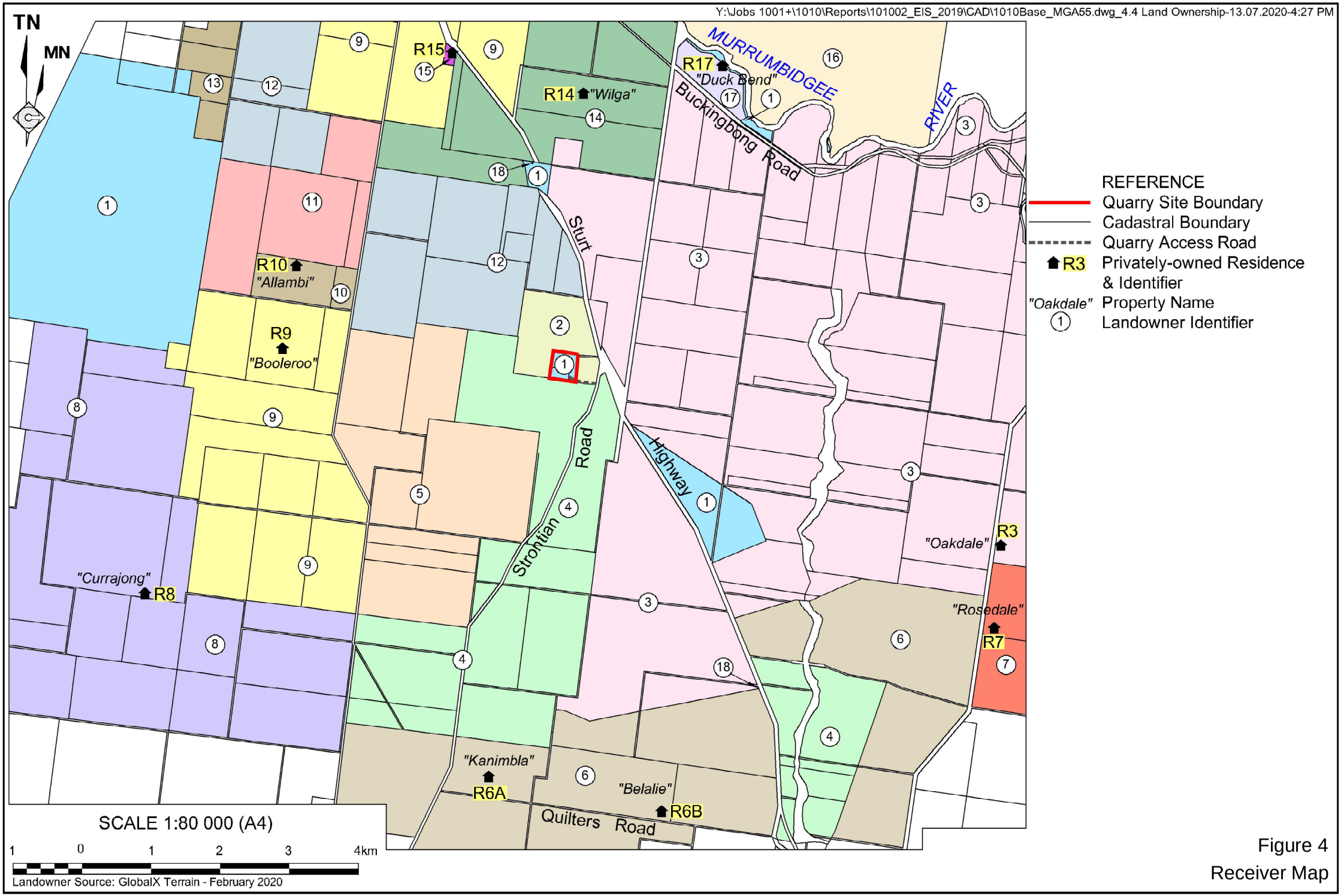

Figure 4
Receiver Map

2 Noise and Blasting Policy and Guidelines

The following section summarises relevant policy and guidelines pertinent to undertaking a noise and blasting impact assessment for this type of project.

2.1 Interim Construction Noise Guideline

The assessment and management of noise from construction work is completed with reference to the Interim Construction Noise Guideline (ICNG). The ICNG is specifically aimed at managing noise from construction work regulated by the EPA and is used to assist in setting statutory conditions in licences or other regulatory instruments.

The ICNG sets out procedures to identify and address the impacts of construction noise on residences and other sensitive land uses.

2.1.1 Standard Hours for Construction

Table 4 summaries the recommended standard and out of hours periods for construction. Note, although not mandatory, strong justification is required to work outside of normal construction hours.

Table 4 Recommended Hours for Construction

Hour Commencing	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Monday	OOH Period 2							Standard Hours											OOH Period 1					
Tuesday																								
Wednesday																								
Thursday																								
Friday																								
Saturday																								
Sunday								OOH Period 1											OOH Period 2					
Public Holiday																								

The recommended hours do not apply in the event of direction from police, or other relevant authorities, for safety reasons or where required in an emergency to avoid the loss of lives, property and / or to prevent environmental harm.

The proposed construction hours would be from 6am to 6pm Monday to Friday and 8am to 5pm Saturdays. Hence, construction activities may be undertaken during out of hours work periods.

2.1.2 Construction Noise Management Levels

Table 5 reproduces the ICNG management levels for residential receivers. The construction noise management levels are the sum of the management level and relevant rating background level (RBL) for each specific assessment period.

Table 5 Noise Management Levels		
Time of Day	Management Level $LA_{eq,15min}$ [1]	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB.	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of work to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA.	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account times identified by the community when they are less sensitive to noise (such as before and after school for work near schools, or mid-morning or mid-afternoon for work near residences; and if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5dB.	A strong justification would typically be required for work outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction noise management levels for noise assessment purposes and is the median of the ABL's.

2.2 Noise Policy for Industry

The EPA released the Noise Policy for Industry (NPI) in October 2017 which provides a process for establishing noise criteria for consents and licenses enabling the EPA to regulate noise emissions from scheduled premises under the Protection of the Environment Operations Act 1997.

The objectives of the NPI are to:

- provide noise criteria that is used to assess the change in both short term and long term noise levels;
- provide a clear and consistent framework for assessing environmental noise impacts from industrial premises and industrial development proposals;
- promote the use of best-practice noise mitigation measures that are feasible and reasonable where potential impacts have been identified; and
- support a process to guide the determination of achievable noise limits for planning approvals and/or licences, considering the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

The policy sets out a process for industrial noise management involving the following key steps:

1. Determine the Project Noise Trigger Levels (PNTLs) (ie criteria) for a development. These are the levels (criteria), above which noise management measures are required to be considered. They are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment; and maintaining the noise amenity of an area.
2. Predict or measure the noise levels produced by the development with regard to the presence of annoying noise characteristics and meteorological effects such as temperature inversions and wind.
3. Compare the predicted or measured noise level with the PNTL, assessing impacts and the need for noise mitigation and management measures.
4. Consider residual noise impacts - that is, where noise levels exceed the PNTLs after the application of feasible and reasonable noise mitigation measures. This may involve balancing economic, social and environmental costs and benefits from the proposed development against the noise impacts, including consultation with the affected community where impacts are expected to be significant.

5. Set statutory compliance levels that reflect the best achievable and agreed noise limits for the development.

6. Monitor and report environmental noise levels from the development.

2.2.1 Project Noise Trigger Levels

The policy sets out the procedure to determine the PNTLs relevant to an industrial development. The PNTL is the lower (ie, the more stringent) of the **Project Intrusiveness Noise Level** (PINL) and **Project Amenity Noise Level** (PANL) determined in accordance with Section 2.3 and Section 2.4 of the NPI.

2.2.2 Project Intrusiveness Noise Level (PINL)

The PINL ($LA_{eq(15min)}$) is the RBL + 5dB and seeks to limit the degree of change a new noise source introduces to an existing environment. Hence, when assessing intrusiveness, background noise levels need to be measured.

For low noise environments, such as rural environments, minimum assumed RBLs apply within the NPI and can be adopted in lieu of completing background noise measurements. This is considered the most conservative method for establishing noise criteria for a project. These result in minimum intrusiveness noise levels as follows:

- Minimum Day RBL = 35dBA;
- Minimum Evening RBL = 30dBA; and
- Minimum Night RBL = 30dBA.

Due to the rural nature of the locality, the PINLs for the Quarry have been determined based on the minimum RBL+5dBA.

2.2.3 Project Amenity Noise Level (PANL)

The PANL is relevant to a specific land use or locality. To limit continuing increases in intrusiveness levels, the ambient noise level within an area from all combined industrial sources should remain below the recommended amenity noise levels specified in Table 2.2 (of the NPI). The NPI defines two categories of amenity noise levels:

- **Amenity Noise Levels (ANL)** – are determined considering all current and future industrial noise within a receiver area; and
- **Project Amenity Noise Level (PANL)** – is the recommended level for a receiver area, specifically focusing the project being assessed.

Additionally, Section 2.4 of the NPI states: "*to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows*":

PANL for new industrial developments = recommended **ANL** minus 5dBA.

The following exceptions apply when deriving the PANL:

- areas with high traffic noise levels;
- proposed developments in major industrial clusters;
- existing industrial noise and cumulative industrial noise effects; and
- greenfield sites.

Furthermore, where the PANL is applicable and can be satisfied, the assessment of cumulative industrial noise is not required.

The recommended amenity noise levels as per Table 2.2 of the NPI are reproduced in **Table 6**.

Table 6 Amenity Criteria

Receiver Type	Noise Amenity Area	Time of day	Recommended amenity noise level dB LAeq(period)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks.	See column 4	See column 4	5dB above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School Classroom	All	Noisiest 1-hour period when in use	35 (internal) 45 (external)
Hospital ward			
- internal	All	Noisiest 1-hour	35
- external	All	Noisiest 1-hour	50
Place of worship - internal	All	When in use	40
Passive Recreation	All	When in use	50
Active Recreation	All	When in use	55
Commercial premises	All	When in use	65
Industrial	All	When in use	70

Notes: The recommended amenity noise levels refer only to noise from industrial noise sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as rural residential; suburban residential; urban residential; industrial interface; commercial; industrial – see Table 2.3 and Section 2.7 of the NPI.

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

2.2.4 Maximum Noise Level Assessment

The potential for sleep disturbance from maximum noise level events from a project during the night-time period needs to be considered. The NPI considers sleep disturbance to be both awakenings and disturbance to sleep stages.

Where night-time noise levels from a development/premises at a residential location exceed the following criteria, a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq(15min)}$ 40dB or the prevailing RBL plus 5dBA, whichever is the greater, and/or
- L_{Amax} 52dB or the prevailing RBL plus 15dBA, whichever is the greater.

A detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Other factors that may be important in assessing the impacts on sleep disturbance include:

- how often the events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the development;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current understanding of effects of maximum noise level events at night.

2.3 Road Noise Policy

The road traffic noise criteria are provided in the Department of Environment, Climate Change and Water NSW (DECCW), Road Noise Policy (RNP), 2011. The policy sets out noise criteria that provide for a degree of amenity appropriate for the land use and road category.

For some industries such as mines and extractive industries, that are not served by arterial roads, a principal haulage route may be identified. The RNP indicates that where local authorities identify a 'principal haulage route', the noise criteria for the route should match those for arterial/sub-arterial roads, recognising that they carry a different level and mix of traffic to local roads.

2.4 ANZECC Blasting Guidelines

Noise and vibration levels from blasting are assessable against criteria established in the Australian and New Zealand Environment Conservation Council (ANZECC) – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration. The blasting limits are generally consistent with the guideline levels contained within AS2187:2006 Part 2 – Explosives - Storage and Usage – Part 2. Where compliance is achieved, the risk of human annoyance is minimised.

Furthermore, for damage induced vibration, German Standard DIN 4150 - Part 3: 1999 provides the strictest guideline levels of vibration velocity for evaluating the effects of vibration in structures. Blasting and vibration induced damage criteria relevant to this assessment are presented in detail in Section 3.4.

The guidelines recommend that blasting should generally be permitted during the hours of 9am to 5pm Monday to Saturday only. Blasting should not occur on Sundays or Public Holidays. Furthermore, blasting should generally take place no more than once per day.

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3 Assessment Criteria

The following sections summarise the relevant noise and blasting criteria for this type of project.

3.1 Construction Noise Management Levels

Noise Management Levels (NMLs) for construction activities for all residential receivers are 45dB $LA_{eq(15min)}$ (RBL +10dB). Construction activities are planned for standard hours, however the relevant NML standard construction hours and out of hours periods are summarised in **Table 7**.

Table 7 Construction Noise Management Levels

Location	Assessment Period	RBL dBA	NML dB $LA_{eq(15min)}$
All Residential Receivers	Day (Standard Hours)	35	45 (RBL+10dBA)
	Evening (OOH Period 1)	30	35 (RBL+5dBA)
	Night (OOH Period 2)	30	35 (RBL+5dBA)

3.2 Operational Criteria

3.2.1 Project Intrusiveness Noise Levels

The PINLs for the Project are presented in **Table 8** and have been determined based on the RBL +5dBA.

Table 8 Intrusiveness Noise Levels

Receiver Type	Period[1]	Adopted RBL[2] dB LA_{90}	PINL dB $LA_{eq(15min)}$
Residential	Morning Shoulder	30	35
	Day	35	40

Note 1: Morning Shoulder – the period from 6am to 7am Monday to Saturday; Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays.

Note 2: Minimum RBLs adopted.

3.2.2 Project Amenity Noise Levels

The PANLs for residential receivers potentially affected by the Project are presented in **Table 9**.

Table 9 Project Amenity Noise Levels

Receiver Type	Noise Amenity Area	Assessment Period[1]	Recommended ANL dB $LA_{eq(period)}$[2]	PANL dB $LA_{eq(15min)}$[4]
Residential Receivers	Rural	Morning Shoulder	40	43
		Day	50	53

Note 1: Morning Shoulder – the period from 6am to 7am Monday to Saturday; Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays.

Note 2: Recommended amenity noise levels as per Table 2.2 of the NPI.

Note 3: Includes a +3dB adjustment to the amenity period level to convert to a 15-minute assessment period as per Section 2.2 of the NPI.

3.2.3 Project Noise Trigger Levels

The PNTLs are the lower of either the PINL or the PANL. **Table 10** presents the derivation of the PNTL in accordance with the methodologies outlined in the NPI.

Table 10 Project Noise Trigger Levels

Receiver Type	Period[1]	RBL	PINL dB $LA_{eq(15min)}$	PANL dB $LA_{eq(15min)}$	PNTL dB $LA_{eq(15min)}$
Residential	Morning Shoulder	30	35	43	**35**
	Day	35	40	53	**40**

Note 1: Morning Shoulder – the period from 6am to 7am Monday to Saturday; Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays.

3.2.4 Maximum Noise Level Criteria

The maximum noise trigger levels shown in **Table 11** are based on night time RBLs and trigger levels as per Section 2.5 of the NPI. The trigger levels will be applied to transient noise events that have the potential to cause sleep disturbance.

Table 11 Maximum Noise Assessment Trigger Levels

Residential Receivers			
$LA_{eq(15min)}$		LA_{max}	
40dB $LA_{eq(15min)}$ or RBL + 5dB		52dB LA_{max} or RBL + 15dB	
Trigger	40	Trigger	52
RBL 30+5dB	35	RBL 30+15dB	45
Highest	**40**	**Highest**	**52**

Note: Monday to Saturday; Night 10pm to 7am. On Sundays and Public Holidays; Night 10pm to 8pm.

Note: As per Section 2.5 of the NPI, the highest of the two criteria are adopted as the trigger level.

3.3 Road Traffic Noise Criteria

In accordance with the RNP, this assessment has adopted the 'Freeway/arterial/sub-arterial road' category for the designated inbound and outbound transport routes, consistent with the classification of the haulage route as a 'principal haulage route'. **Table 12** reproduces the road traffic noise assessment criteria relevant for this road type.

Table 12 Road Traffic Noise Assessment Criteria for Residential Land Uses

Road category	Type of Project/development	Assessment Criteria - dB(A)	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub-arterial road	Existing residences affected by additional traffic on existing freeways/sub-arterial/roads generated by land use developments	60dB(A) $L_{Aeq(15hr)}$	55dB(A) $L_{Aeq(9hr)}$

Note: For road noise assessments, the day period is from 7am to 10pm (ie there is no evening assessment period as there is with operational noise). Night is from 10pm to 7am.

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dB, which is generally accepted as the threshold of perceptibility to a change in noise level.

3.3.1 Relative Increase Criteria

In addition to meeting the assessment criteria, any significant increase in total traffic noise at receivers must be considered. Receivers experiencing increases in total traffic noise levels above those presented in **Table 13** due to the addition of project vehicles on the Sturt Highway should be considered for mitigation.

Table 13 Increase Criteria for Residential Land Uses

Road Category	Type of Project/Development	Total Traffic Noise Level Increase, dB(A)	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub-arterial roads and transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq(15hr)}$ +12dB (external)	Existing traffic $L_{Aeq(9hr)}$ +12dB (external)

3.4 ANZECC Guideline Blasting Limits

The ANZECC blasting limits for air-blast overpressure and ground vibration are presented in **Table 14**.

Table 14 ANZECC Guideline Blasting Limits

	Overpressure dB (Linear Peak)	Ground Vibration PPV (mm/s)
Recommended Maximum (95% of all blasts)	115	5
Level not to be exceeded	120	10
Long term goal for ground vibration	N/A	2

4 Noise Assessment Methodology

A computer model was developed to quantify quarry noise emissions to neighbouring receivers for typical construction activities and operations. DGMR (iNoise, Version 2020) noise modelling software was used to quantify noise emissions from typical construction activities and operations. iNoise is a new intuitive and quality assured software for industrial noise calculations in the environment. 3D noise modelling is considered industry best practice for assessing noise emissions from projects.

The model incorporated a three-dimensional digital terrain map giving all relevant topographic information used in the modelling process. Additionally, the model uses relevant noise source data, ground type, attenuation from barrier or buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation'. The ISO 9613 standard from 1996 is the most used noise prediction method worldwide. Many countries refer to ISO 9613 in their noise legislation. However, the ISO 9613 standard does not contain guidelines for quality assured software implementation, which leads to differences between applications in calculated results. In 2015 this changed with the release of ISO/TR 17534-3. This quality standard gives clear recommendations for interpreting the ISO 9613 method. iNoise fully supports these recommendations. The models and results for the 19 test cases are included in the software.

4.1 Construction Noise Assessment

MAC understands that construction activities associated with the relocation of the office and amenities, excavation and/or construction of erosion and sediment controls and roadworks associated with upgrades to Strontian Road and the intersection of the Quarry Access Road and Strontian Road would be undertaken during Stage 1 during periods of reduced or no production.

It is understood that the roadworks, which are anticipated to occur over a period of approximately one (1) week, would be undertaken using earthmoving equipment consistent with that to be used on site. An asphalt truck and sprayer would also be brought in to apply a spray seal. It is noted that the sound power level of an asphalt truck and sprayer is 103dBA. Preliminary modelling indicates that noise levels at the most affected residential receivers during the application of the spray seal would remain below 30dBA. It is therefore anticipated that the construction activities would not contribute to noise levels above the noise goals, hence, no further assessment of construction activities is required.

4.2 Operational Noise Modelling Parameters

The model incorporated three-dimensional digitised ground contours for the fixed plant and surrounding area, as derived from proposed Project plans superimposed onto the surrounding land base topography. Where relevant, modifying factors in accordance with Fact Sheet C of the NPI have been applied to calculations.

4.2.1 Meteorological Analysis

Noise emissions from industry can be significantly affected by prevailing weather conditions. Wind has the potential to increase noise at a receiver when it is at low velocities and travels from the direction of the noise source. As the strength of the wind increases, the noise produced by the wind will mask the audibility of most industrial sources.

Meteorological conditions that enhance received noise levels include source to receiver winds and the presence of temperature inversions. To account for potential enhancements, the NPI specifies that the source to the receiver wind component speeds up to 3m/s for 30% or more of the time in any seasonal period (i.e. day, evening or night), is considered to be a feature wind and predictions must incorporate these conditions.

To determine the prevailing conditions for the quarry, weather data during the period September 2017 to September 2019 was obtained from the Bureau of Meteorology's (BOM) Narrandera Airport AWS (074148) weather station located approximately 15km north-north west of the quarry site. The data was analysed using the EPA's Noise Enhancement Wind Analysis (NEWA) program in order to determine the frequency of occurrence of winds of speeds up to 3m/s in each season.

Table 15 summarises the results of the wind analysis and includes the dominant wind direction and percentage occurrence during each season for each assessment period. The results of the detailed analysis of meteorological data is presented in Appendix B.

Table 15 Seasonal Frequency of Occurrence Wind Speed Intervals			
Season	Period[1]	Wind Direction ±(45°)	% Wind Speeds (m/s)
			0.5 to 3 m/s
Summer	Day	SW	9
	Evening	SSW	16
	Night	ESE	15
Autumn	Day	SW, WSW	14
	Evening	WSW	17
	Night	ESE	18
Winter	Day	SSW, SW	13
	Evening	SE	13
	Night	ESE, SE	16
Spring	Day	SW, WSW, W	9
	Evening	SW	14
	Night	ESE	16

Based on the results of this analysis, prevailing winds are not applicable for the assessment and the relevant meteorological conditions adopted are summarised in **Table 16**.

Table 16 Modelled Site Specific Meteorological Parameters				
Assessment Condition	Temperature	Wind Speed / Direction	Relative Humidity	Stability Class
Morning Shoulder - Inversion	10°C	n/a	90%	F
Day - Calm	20°C	n/a	60%	n/a

Note: Morning Shoulder 6am to 7am; Day 7am to 6pm.

4.2.2 Operational Noise Modelling Scenarios

It is anticipated that the extraction sequence for the Quarry would incorporate three stages. Stage 1 would involve the progressive development across the entire footprint of the proposed extraction area to an elevation of 164m AHD. At the completion of Stage 1, the footprint of the extraction area would reach its full extent with no further lateral development of the extraction area during Stages 2 and 3.

Stage 2 extraction operations would involve the progressive development of the extraction area to an elevation of approximately 152m AHD, while Stage 3 would continue vertical development to approximately 140m AHD. It is therefore considered that the Stage 1 development of the Quarry would represent the worst-case operational conditions.

Based on the proposed extraction sequence, one (1) modelling scenario has been adopted for the operation of the Quarry. The scenario is summarised as:

- Overburden would be progressively pushed to the edge of the active extraction area using a bulldozer or excavator to provide access to the targeted resource;
- Overburden would be used to progressively construct the perimeter safety bund around the edge of the active extraction area;
- Following removal of the overburden, indurated sandstone material would be extracted using drill and blast methods; and
- Fragmented rock material would be fed into the in-pit mobile processing plant prior to loading and despatch in road registered vehicles.

Quarrying, material processing and despatch operations would occur Monday to Friday 6am to 6pm and Saturdays 8am to 5pm.

4.2.3 Sound Power Levels - Operation

Mobile plant noise emission data used in modelling for this assessment were obtained from the MAC noise database for relevant noise sources that are proposed to be used in the Quarry. The noise emission levels used in modelling are summarised in **Table 17**.

Table 17 Single Octave Equipment Sound Power Levels, dB $LA_{eq(15min)}$ ($re10^{-12}W$)

Noise Source/Item	Octave Band Centre Frequency, Hz								Total, dBA
	63	125	250	500	1000	2000	4000	8000	
Mobile Equipment									
Bulldozer	86	95	99	107	103	102	100	90	110
Drill Rig	81	103	104	106	109	108	100	92	114
Excavator	79	99	100	99	100	96	91	82	106
Loader (x2)	79	89	95	100	100	100	92	84	106
Water Truck	81	82	89	91	95	97	89	81	101
Road Trucks	89	95	90	89	93	97	92	85	102
Processing Plant									
Impact Crusher	99	98	99	111	108	106	100	92	114
Processing Plant	97	100	102	108	109	108	103	94	114
Sleep Disturbance Assessment (LA_{max})									
Loading sandstone into road truck	91	101	107	112	112	112	104	96	117

Note: Source - MAC database.

4.3 Road Noise Assessment Methodology

The United States (US) Environment Protection Agency's road traffic calculation method is used to predict the LA_{eq} noise levels from Project related trucks travelling past existing receivers adjacent to the haul routes. This method is an internationally accepted theoretical traffic noise prediction model and is ideal for calculating road traffic noise where relatively small traffic flows are encountered.

MAC understands that extracted material would typically be transported from the Quarry Site using the Applicant's fleet of truck and dog trailers with a maximum capacity of 38t. During operation of the Quarry the average number of laden truck movements would be 14 trips per day, with a maximum of 12 laden truck trips per hour and up to 48 laden truck trips per day.

It is anticipated that approximately 85% of laden trucks departing the Quarry Site would turn left at the intersection of the Quarry Access Road and Strontian Road towards the Sturt Highway. Approximately 70% of these laden trucks would turn left and travel northwards on the Sturt Highway towards Narrandera, with the remaining 30% of laden trucks travelling southwards towards Wagga Wagga. On an annual basis, approximately 15% of laden trucks would turn right from the Quarry Access Road onto Strontian Road towards Boree Creek.

The closest offset distances to receivers along the haulage route are provided in **Table 18**.

Table 18 Closest Offset Distances – Road Traffic Assessment

Travel Route	Address	Offset Distance (m)
Sturt Hwy North	9119 Sturt Hwy	75
Sturt Hwy South	7481 Sturt Hwy	20
Strontian Rd South	3493 Strontian Rd	40

Existing road traffic volumes for the Sturt Highway and Strontian Road were measured by The Transport Planning Partnership using automatic tube counters from 16 February 2020 to 22 February 2020. The daily average traffic volumes are provided in **Table 19**.

Table 19 Measured Existing Traffic Volumes

	Strontian Road		Sturt Highway	
	Total Vehicles	% Heavy Vehicles	Total Vehicles	% Heavy Vehicles
Total Vehicles	91	20%	2259	31%
Day Period (15 hour)	85	20%	2031	28%
Night Period (9 hour)	6	5%	227	61%

4.4 Blasting and Vibration Assessment Methodology

4.4.1 Air-Blast Overpressure

Calculation of overpressure has been completed using the following AS2187.2 equation:

$$\mathrm{P} = K_a \left(\frac{R}{(Q^{1/3})}\right)^a$$

Where:

P = Pressure, in kilopascals;

Q = Effective explosives charge mass, in kilograms (MIC);

R = Distance from charge, in metres;

K_a = Site constant, a conservative value of 25 was adopted; and

a = Site exponent, a value of -1.45 was adopted.

The conversion of 'P' to unweighted decibels (dBZ) is completed using the following formula:

$$\mathrm{SPL} = 10\ x \log\left(\frac{P}{P_0}\right)^2$$

4.4.2 Ground-Borne Vibration

Preliminary estimations for vibration have been completed using the following AS2187.2 equation:

$$\mathrm{V} = K_g \left(\frac{R}{(Q^{1/2})}\right)^{-B}$$

Where:

V = ground vibration as vector peak particle velocity, in mm/s;

R = distance between charge and point of measurement, in m;

Q = maximum instantaneous charge (effective charge mass per delay), in kg;

K_g = a constant related to site and rock properties for estimation purposes, a value of 1140 was adopted as per AS2187.2 to predict the 50% chance of exceedance in "average conditions"; and

B = a constant related to site and rock properties for estimation purposes, a value of 1.6 was adopted.

5 Noise Modelling Results and Discussion

5.1 Operational Noise Results

Predicted Quarry operations include extraction, processing, product loading and transportation. The predicted noise levels at each receiver during calm and prevailing meteorological conditions are provided in **Table 20**. The noise contour maps for the quarry operations are provided in **Appendix C**.

The results of the predictive modelling show that noise emissions from the Quarry satisfy the PNTL at all residential receivers under normal operating conditions. The assessment considered both calm and adverse meteorological scenarios.

Table 20 Predicted Operational Noise Levels

Receiver	Period	Predicted Noise Level dB $LA_{eq(15min)}$	PNTL dB $LA_{eq(15min)}$	Compliant
R3	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R6A	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R6B	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R7	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R8	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R9	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R10	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R14	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R15	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓
R17	Morning Shoulder[1]	<30	35	✓
	Day	<30	40	✓

Note: Morning Shoulder – the period from 6am to 7am Monday to Saturday or 5am to 8am Sundays and public holidays; Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays.

Note 1: Assessed during inversion conditions.

5.2 Maximum Noise Level Assessment

In assessing sleep disturbance, a typical L_{Amax} noise source of 117dB was used to represent transient events such as loading trucks with quarry material, to the nearest residential receivers, under F Class stability conditions (ie worst case).

The results of the analysis identify that maximum noise trigger level will be satisfied for all residential receivers, hence no further assessment or detailed analysis is required. Predicted noise levels from L_{Amax} events are presented in **Table 21**.

Table 21 Predicted Operational Noise Levels

Receiver	Period	Noise Predictions dB L_{Amax}	Sleep Disturbance Trigger Level, dB L_{Amax}	Compliant
R3	Morning Shoulder	<30	52	✓
R6A		<30	52	✓
R6B		<30	52	✓
R7		<30	52	✓
R8		<30	52	✓
R9		<30	52	✓
R10		<30	52	✓
R14		<30	52	✓
R15		<30	52	✓
R17		<30	52	✓

Note: Morning Shoulder – the period from 5am to 7am Monday to Saturday or 5am to 8am Sundays and public holidays; Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays.

5.3 Traffic Noise Results

The results of the traffic noise calculations for typical operational road traffic are presented in **Table 22** for the closest residential receivers to Strontian Road and the Sturt Highway. The traffic noise contribution from the Quarry is predicted to remain below the relevant day and night assessment criteria for dwellings situated on Strontian Road and the Sturt Highway and is demonstrated to satisfy the RNPs relative increase criteria.

Table 22 Operational Road Traffic Noise Levels – Residential Receivers				
Offset Distance (m)	Assessment Criteria[1]	Traffic Noise dB $LA_{eq(period)}$		
		Existing Traffic Noise	Future Traffic Noise	Total Change
Sturt Highway (Northbound)				
75	Day 60 dB $LA_{eq(15hr)}$	42.1	42.2	0.1
	Night 55 dB $LA_{eq(9hr)}$	37.7	37.9	0.2
Sturt Highway (Southbound)				
20	Day 60 dB $LA_{eq(15hr)}$	56.2	56.3	0.1
	Night 55 dB $LA_{eq(9hr)}$	52.1	52.2	0.1
Strontian Road				
40	Day 60 dB $LA_{eq(15hr)}$	32.1	33.4	1.3
	Night 55 dB $LA_{eq(9hr)}$	23.6	27.7	4.1

Note 1: Day 7am to 10pm. Night 10pm to 7am.

5.4 Blasting Results

Blast overpressure and vibration have been calculated to each assessed receiver for the Quarry adopting an MIC of up to 168kg.

Calculated levels for overpressure and vibration have been compared to the relevant ANZECC criteria and are presented in **Table 23**. Results identify blasts of MICs up to 168kgs would satisfy relevant ANZECC overpressure and vibration criteria.

Notwithstanding, the proposed MIC blast patterns should be designed specifically to meet the relevant ANZECC guidelines at receivers and be completed in conjunction with an appropriate blast monitoring program.

Table 23 Blasting Emissions			
Receiver ID	Distance to Charge, m	Airblast Overpressure dBZ Peak	Ground Vibration mm/s
R3	6,890	92.1	0.08
R6A	5,980	93.9	0.10
R6B	6,590	92.7	0.08
R7	7,280	91.5	0.07
R8	6,780	92.4	0.08
R9	3,950	99.2	0.19
R10	4,050	98.8	0.18
R14	4,030	98.9	0.19
R15	4,810	96.7	0.14
R17	5,010	96.1	0.13

5.4.1 Effects of Vibration on Infrastructure from Blasting

The nearest infrastructure to blasting is the Sturt Highway, where vibration levels are calculated to be below 5mm/s. Hence there are no significant vibration effects from blasting on infrastructure which are typically less sensitive to vibration than residential receivers.

6 Noise Monitoring and Management

6.1 Noise Management Measures

Although it is demonstrated that noise levels are predicted to meet the relevant noise goals and no further mitigation measures are required, to proactively address any residual noise impacts, the Applicant would assemble a comprehensive Environmental Management Plan for the ongoing management of the relevant environmental issues at the Quarry. The Plan would incorporate an overall Environmental Management Strategy and include a separate section relating to Noise Management. These may include:

- Siting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area.
- Keeping equipment well maintained and operating it in a proper and efficient manner.
- Employing 'quiet' practices when operating equipment, for example, positioning idling trucks in appropriate areas.
- Running staff-education programs and regular tool box talks on the effects of noise and the use of quiet work practices.

The Plan may also address the use of best available technology including alternatives to tonal reversing alarms, efficient muffler design, and using enclosures, as well as reducing noise in transmission or at the receiver.

6.2 Noise Monitoring

It is recommended that the Plan includes a provision for attended noise monitoring within the community in response to received complaints, if any. The operator attended noise measurements and recordings would be conducted to quantify noise emissions from the Quarry as well as the overall level of ambient noise.

When required, the operator shall quantify and characterise the energy equivalent (LAeq) intrusive noise level from the project over a 15-minute measurement period. In addition, the operator shall quantify and characterise the overall levels of ambient noise over the 15-minute measurement interval. It is recommended that instrumentation used during the monitoring is to be equivalent to a Type 1 meter with 1/3 octave band analysis and have audio recording functionality for post processing source identification. It is noted that 1/3 octave band analysis is required to establish whether modification factors in accordance with the NPI are to be applied.

All acoustic instrumentation used as part of the attended monitoring program must been designed to comply with the requirements of AS IEC 61672.1-2019, Electroacoustics - Sound level meters - Specifications and shall have current calibration certificates. All instrumentation shall be programmed to record statistical noise level indices in 15-minute intervals including L_{Amax}, L_{Amin} and L_{Aeq}.

Instrument calibration shall be checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA. The measurement position(s) should be selected considering:

- weather conditions such as rain and wind, insect noise;
- the location and direction of any noise source/s;
- the most sensitive position at the affected receiver; and
- the need to avoid reflecting surfaces (where possible).

7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has conducted a NVIA of potential impacts associated with the continued operation and extension of the Strontian Quarry southeast of Narrandera, NSW. The assessment has quantified potential operational noise emissions pertaining to extraction, processing and dispatch of Quarry products via road trucks, as well as blasting noise and vibration emissions.

The results of the NVIA demonstrate that operational noise levels (including minor construction activities) comply with the relevant NPI criteria for all assessment periods at the most affected sensitive receiver locations.

Results of the maximum noise level assessment are identified to remain below the sleep disturbance trigger level at all residential receivers. Therefore, sleep disturbance due to noise sources within the Quarry are unlikely to cause awakening reactions to adjacent receivers.

Additionally, the NVIA demonstrates that the road noise criteria as specified in the RNP will be satisfied at the nearest potentially affected receivers for worst case operational road traffic.

Airblast overpressure and vibration levels are also predicted to meet the criteria at all assessed receivers for blasts up to 168kg MIC.

Based on the NVIA results, there are no noise or vibration related issues which would prevent the approval of the extension of the Quarry. The results of the assessment show compliance with the relevant operational and road noise criteria. Additionally, the results of the assessment demonstrate compliance with the relevant EPA and DECCW policies, without ameliorative measures being required.

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Appendix A – Glossary of Terms

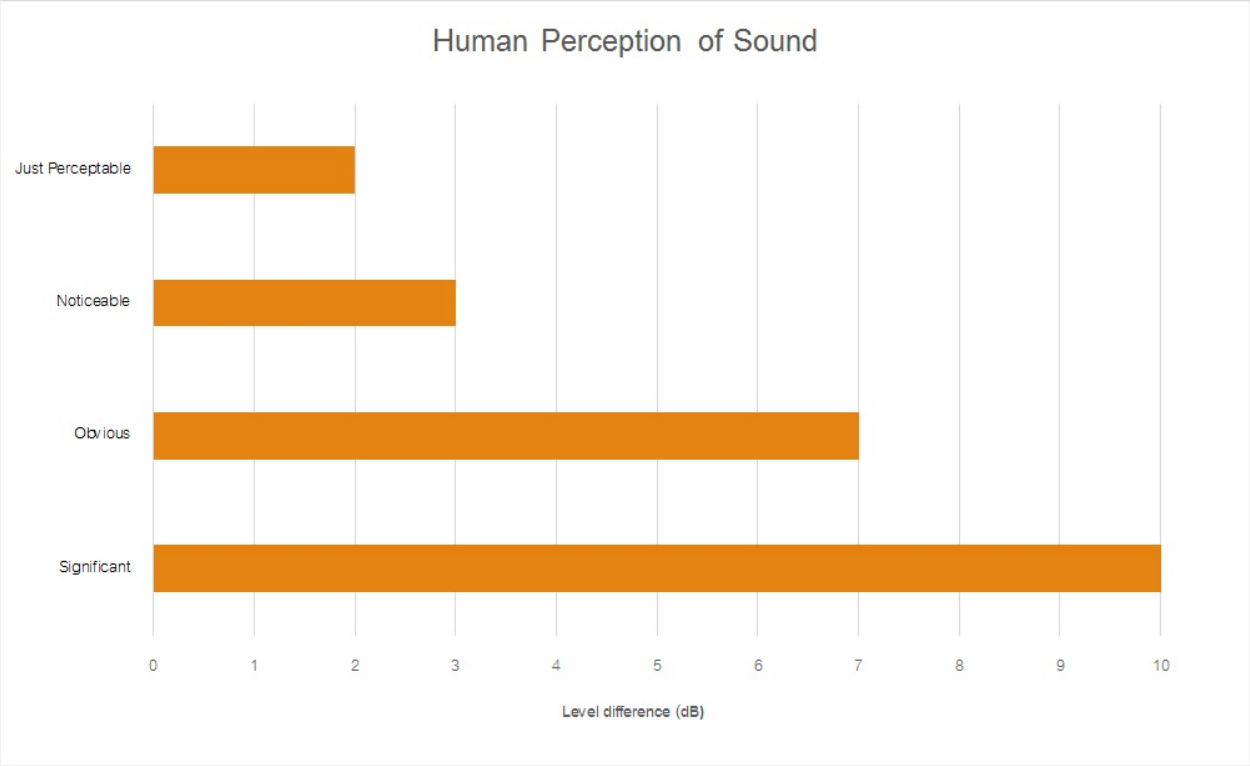
Table A1 provides a number of technical terms have been used in this report.

Table A1 Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA_{90} statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear. In some cases the overall change in noise level is described in dB rather than dB(A), or dB(Z) which relates to the weighted scale.
dB(Z)	Linear Z-weighted decibels.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA_{10}	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA_{90}	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LA_{eq}	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LA_{max}	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by : = 10.log10 (W/Wo) Where : W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dB(A)	
Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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Appendix B – NEWA Analysed Meteorology

Table B1 NEWA Analysed Daytime Meteorological Conditions, Narrandera Airport AWS NSW					
Direction ± 45°	Season	Day Percentage Occurrence %	Direction	Season	Day Percentage Occurrence %
0	Summer	5	180	Summer	6
0	Autumn	5	180	Autumn	10
0	Winter	7	180	Winter	10
0	Spring	5	180	Spring	5
22.5	Summer	5	202.5	Summer	8
22.5	Autumn	6	202.5	Autumn	13
22.5	Winter	7	202.5	Winter	13
22.5	Spring	5	202.5	Spring	7
45	Summer	6	225	Summer	9
45	Autumn	7	225	Autumn	14
45	Winter	9	225	Winter	13
45	Spring	5	225	Spring	9
67.5	Summer	6	247.5	Summer	8
67.5	Autumn	8	247.5	Autumn	14
67.5	Winter	9	247.5	Winter	12
67.5	Spring	5	247.5	Spring	9
90	Summer	6	270	Summer	7
90	Autumn	8	270	Autumn	11
90	Winter	10	270	Winter	10
90	Spring	4	270	Spring	9
112.5	Summer	6	292.5	Summer	7
112.5	Autumn	9	292.5	Autumn	9
112.5	Winter	11	292.5	Winter	10
112.5	Spring	5	292.5	Spring	8
135	Summer	5	315	Summer	6
135	Autumn	6	315	Autumn	7
135	Winter	9	315	Winter	8
135	Spring	4	315	Spring	6
157.5	Summer	3	337.5	Summer	5
157.5	Autumn	4	337.5	Autumn	5
157.5	Winter	6	337.5	Winter	8
157.5	Spring	3	337.5	Spring	5

Table B2 NEWA Analysed Evening Meteorological Conditions, Narrandera Airport AWS NSW					
Direction ± 45°	Season	Evening Percentage Occurrence %	Direction	Season	Evening Percentage Occurrence %
0	Summer	4	180	Summer	15
0	Autumn	3	180	Autumn	11
0	Winter	6	180	Winter	8
0	Spring	4	180	Spring	11
22.5	Summer	6	202.5	Summer	16
22.5	Autumn	3	202.5	Autumn	15
22.5	Winter	4	202.5	Winter	8
22.5	Spring	5	202.5	Spring	12
45	Summer	6	225	Summer	14
45	Autumn	4	225	Autumn	16
45	Winter	5	225	Winter	9
45	Spring	6	225	Spring	14
67.5	Summer	6	247.5	Summer	13
67.5	Autumn	5	247.5	Autumn	17
67.5	Winter	7	247.5	Winter	10
67.5	Spring	7	247.5	Spring	13
90	Summer	8	270	Summer	10
90	Autumn	7	270	Autumn	14
90	Winter	11	270	Winter	10
90	Spring	8	270	Spring	10
112.5	Summer	9	292.5	Summer	8
112.5	Autumn	8	292.5	Autumn	10
112.5	Winter	12	292.5	Winter	11
112.5	Spring	10	292.5	Spring	6
135	Summer	10	315	Summer	5
135	Autumn	6	315	Autumn	5
135	Winter	13	315	Winter	8
135	Spring	10	315	Spring	3
157.5	Summer	8	337.5	Summer	3
157.5	Autumn	5	337.5	Autumn	4
157.5	Winter	9	337.5	Winter	8
157.5	Spring	7	337.5	Spring	4

Table B3 NEWA Analysed Night time Meteorological Conditions, Narrandera Airport AWS NSW					
Direction ± 45°	Season	Night Percentage Occurrence %	Direction	Season	Night Percentage Occurrence %
0	Summer	4	180	Summer	9
0	Autumn	3	180	Autumn	9
0	Winter	7	180	Winter	7
0	Spring	3	180	Spring	8
22.5	Summer	4	202.5	Summer	9
22.5	Autumn	3	202.5	Autumn	8
22.5	Winter	4	202.5	Winter	6
22.5	Spring	3	202.5	Spring	8
45	Summer	8	225	Summer	7
45	Autumn	7	225	Autumn	8
45	Winter	6	225	Winter	6
45	Spring	6	225	Spring	9
67.5	Summer	9	247.5	Summer	6
67.5	Autumn	10	247.5	Autumn	8
67.5	Winter	8	247.5	Winter	7
67.5	Spring	9	247.5	Spring	8
90	Summer	12	270	Summer	6
90	Autumn	14	270	Autumn	7
90	Winter	13	270	Winter	9
90	Spring	13	270	Spring	6
112.5	Summer	15	292.5	Summer	5
112.5	Autumn	18	292.5	Autumn	7
112.5	Winter	16	292.5	Winter	11
112.5	Spring	16	292.5	Spring	5
135	Summer	13	315	Summer	4
135	Autumn	17	315	Autumn	5
135	Winter	16	315	Winter	9
135	Spring	14	315	Spring	4
157.5	Summer	9	337.5	Summer	4
157.5	Autumn	10	337.5	Autumn	4
157.5	Winter	12	337.5	Winter	9
157.5	Spring	9	337.5	Spring	3

Appendix C – Noise Model Contours

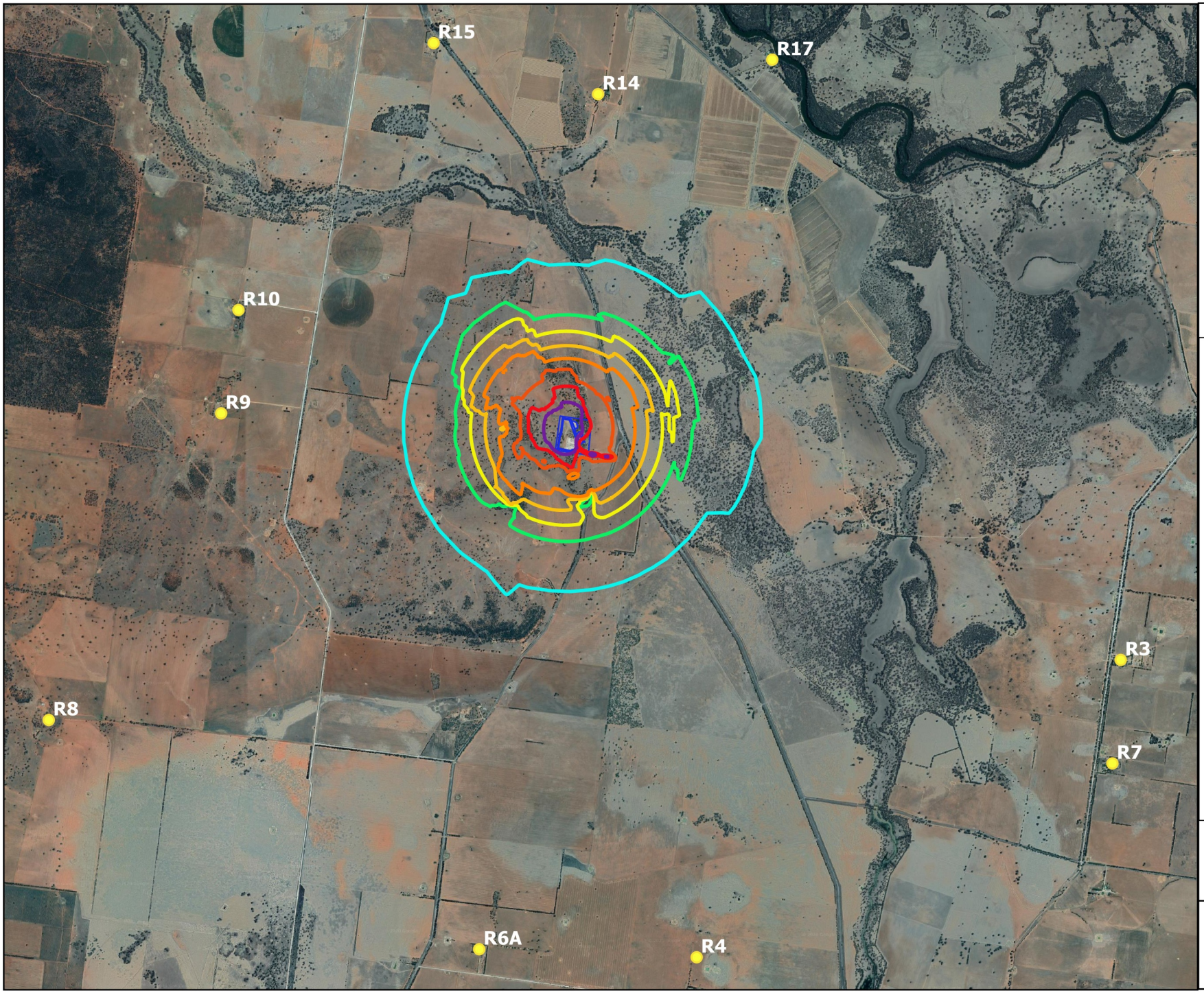

FIGURE C1

LAeq(15min) Noise Contours

Morning Shoulder

MAC191007-02

KEY

Quarry Site

Receivers

Noise Contours

35

40

42

44

46

50

55

60

0 500 1000 1500 2000 m

N

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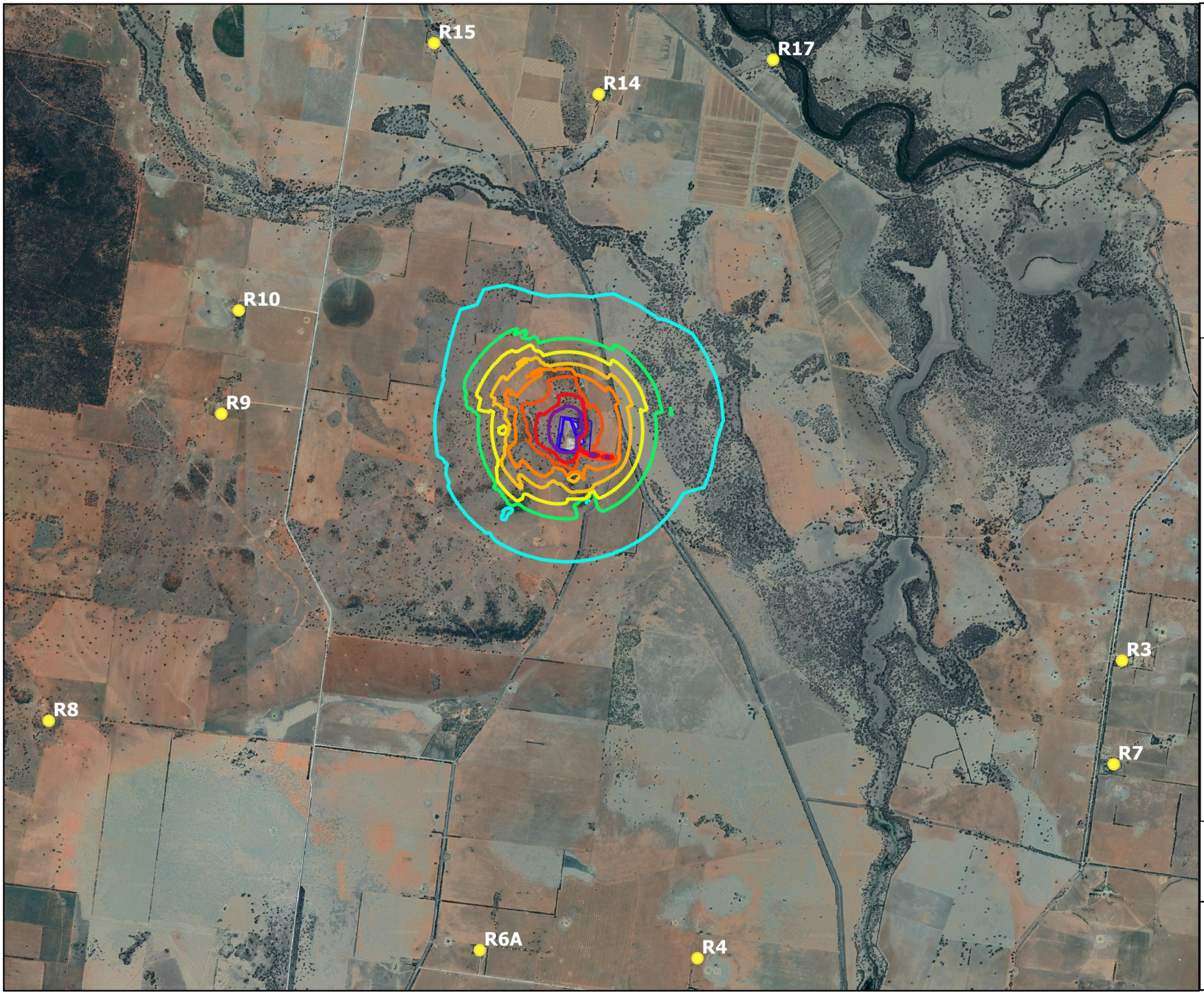

FIGURE C2

LAeq(15min) Noise Contours

Day Period

MAC191007-02

KEY

Quarry Site

Receivers

Noise Contours

35

40

42

44

46

50

55

60

0 500 1000 1500 2000 m

N

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