CLYDESDALE ROAD QUARRY PROJECT

Grass Valley
Blasting Assessment

Prepared for:

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Resource Group WA Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
675.11334-R03-v2.0	22 December 2021	Martin Davenport	Luke Zoontjens	Martin Davenport
675.11334-R03-v1.0	21 October 2019	Martin Davenport	Mark Russell	Martin Davenport

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DOCUMENT REFERENCES

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1 Introduction

Resource Group WA (Resource Group) is seeking approval of a quarry development at Lot 150 DP300080 (C/T Vol 1778 Fol:760), Clydesdale Road, Grass Valley within the Shire of Northam, Western Australia (the Project).

SLR Consulting Australia Pty Limited (SLR) has been commissioned to undertake a desktop assessment of blasting effects associated with the Project.

SLR prepared an Blasting Assessment report in 2019 for this Project based on a site plan that included quarrying in four pits (Pit 1 to Pit 4). That report was submitted to the Department of Water and Environmental Regulation (DWER) to supporting the Development Application (DA) for this Project.

Resource Group has revised the proposed site plan, with the following key changes relevant to the blasting assessment:

- Removal of Pit 1 and Pit 2.

2 Project Overview

2.1 Site Locality

The Project is located to the north of the Clydesdale Road and surrounded by a mixture of agricultural and undeveloped land, as shown in the site locality of the quarry in **Figure 1**. The Project comprises of four quarry pits, one crushing plant operation area, a stockpile zone, a site office and a workshop.

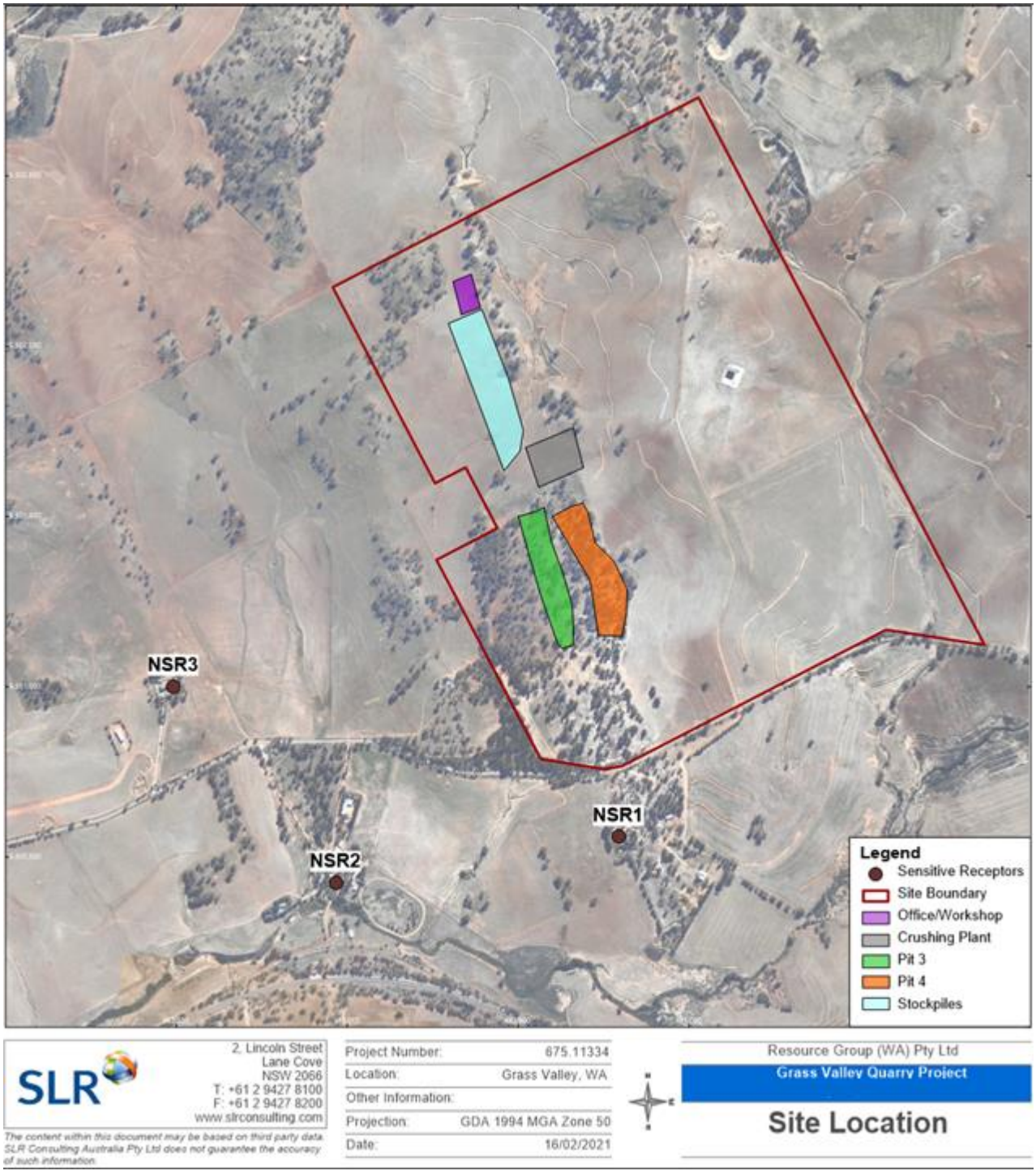
The nearest airblast and vibration sensitive receptors are residential properties located approximately 563 m south east of Pit 3 (NSR1), 917 meters southwest of Pit 3 (NSR2) and 1,102 m west of Pit 3 (NSR3).

2.2 Proposed Quarry Blasting Operations

The resource to be quarried would generally require blasting principally to achieve the required level of fragmentation to enable the resource to be recovered and processed. The Project proposes a production period of 3 – 4 months per year where drill and blast production would be carried out. This would be followed by a non-production sales period for the remaining 8 – 9 months per year.

Blast hole drilling would be undertaken by a production drill with burden and spacing for each blast adjusted to reflect the rock type to be blasted and any inherent features present. The typical maximum instantaneous charge (MIC) would be in the order of 15.5 kg for production blasting.

Figure 1 Site Locality and Sensitive Receptors



3 Blasting Assessment Criteria

3.1 Human Comfort Ground Vibration and Airblast Overpressure Criteria

Ground vibration and airblast overpressure levels which cause human discomfort are lower than recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria generally ensures that the potential to cause structural damage is negligible.

Noise emitted by blasting is governed by the *Environmental Protection (Noise) Regulations 1997*. Regulation 11 is relevant to airblast levels due to blasting between the hours of 7:00 am and 6:00 pm on any day. For assessing airblast at the nearest residential properties the criteria contained in Regulation 11 is summarised in **Table 1**.

Table 1 Human Comfort Airblast Criteria - Regulation 11

Receiver Location 7:00 am to 6:00 pm on any day	Airblast Level dB L_{Zpeak}	
	Not to be Exceeded[1]	Not to be Exceeded for 9 in any 10 Consecutive Blasts[1]
Sensitive Site	120	115

Note 1: Criteria only applicable if a person is present at the time of the blast.

Australian Standard AS:2187: *Part 2-2006 Explosives - Storage and Use - Part 2: Use of Explosives* (AS 2187), provides guidance in assessing blast-induced ground (and structural) vibration and airblast overpressure effects on buildings and their occupants. Vibration criteria with respect to human comfort is provided in AS 2187 Appendix J, Table J4.5(A). The ANZEC *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* dated September 1990 for assessing potential annoyance from blasting during daytime hours. The ANZEC criteria are generally consistent with AS 2187 for sensitive sites and are as follows:

- The recommended maximum for ground vibration is 5mm/s, Peak Vector Sum (PVS) vibration velocity. It is recommended however, that 2mm/s PVS be considered as a long-term regulatory goal for the control of ground vibration.
- The ground vibration level of 5mm/s (PVS) may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10mm/s (PVS) at any time.

3.2 Building Damage Ground Vibration and Airblast Overpressure Criteria

3.2.1 Building Damage Airblast Overpressure Criteria

In relation to building damage airblast overpressure criteria, AS 2187 Appendix J, Table J5.4(B) recommends a maximum airblast overpressure of 133 dB Linear Peak.

3.2.2 Building Damage Vibration Criteria

The applicable building damage vibration criteria AS 2187: Part 2-2006 Appendix J, Table J4.5(B) is derived from British Standard 7385: Part 2-1993 Evaluation and Measurement for Vibration in Buildings Part 2 - Guideline to damage levels from ground-borne vibration. The standard sets guideline values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels have been established to give a minimum risk of vibration induced damage, where "minimum risk" for a named effect is usually taken as equating to a 95% probability of no effect.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extraction or construction excavation), demolition, piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 2**.

Table 2 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Type of Building	Vibration PCPV[1] in Frequency Range of Predominant Pulse	
	4 to 15 Hz	15 Hz and Above
Reinforced of framed structures - Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures - Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

1. Peak Component Particle Velocity

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 2** and major damage to a building structure may occur at vibration magnitudes greater than four times the tabulated values. It is noteworthy that additional to the guide values nominated in **Table 2**, the standard states that:

> *Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.*

Also that:

> *A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.*

Based on the foregoing, a conservative vibration (PCPV) damage assessment criterion of 12.5 mm/s would be applicable to all privately-owned residences in the vicinity of the Project.

3.3 Infrastructure Vibration Damage Criteria

Infrastructure located in the vicinity of the Project includes power transmission lines, as well as roads and tracks. Accordingly, consideration has been given to potential vibration effects on such infrastructure.

The German Standard DIN 4150-3:2016 Vibrations in Buildings Part 3: Effects on Structures (Section 5.2) provides guideline values for evaluating the effect of short term vibration on massive structural components and underground structures. The values are based on the assumption that the structures have been manufactured and applied using current technology. Based on the guideline values, the recommended short term vibration assessment criteria to ensure minimal risk of damage are:

- ACARP report C14057 "Effect of blasting on infrastructure" recommends 100 mm/s for transmission line steel towers. A conservative vibration (PCPV) damage assessment criterion of 50 mm/s has been adopted for power transmission lines.
- Roadway and track infrastructure (i.e culverts and abutments) comprise mainly reinforced concrete and similar materials and a vibration (PCPV) damage assessment criterion of 80 mm/s would be applicable.
- Based on similar projects, a vibration (PCPV) damage criterion of 50 mm/s has been adopted for the assessment of telecommunications cables.

3.4 Archaeological/Geological Vibration Damage Criteria

There are no regulatory criteria nominated in Australia for the assessment of damage to archaeological/geological structures from vibration. Research, however, has been undertaken by the United States (US) Army Corps of Engineers into the effects of large surface blasts on the dynamic stability of nearby unlined tunnels of various diameters in sandstone and granite (Blast Vibration Monitoring and Control [Dowding, 1985]). The results of the research indicated that intermittent rock fall or observable damage was not observed until vibration levels exceeded 460 mm/s.

This assessment therefore adopts a conservative safe blast design vibration criterion of 250 mm/s (5% exceedance) as being applicable to archaeological/geological structures and Aboriginal heritage sites (i.e. rock shelters or the like), if present.

4 Blasting Vibration Assessment

4.1 Blast Prediction Methodology

In the absence of field data it is possible to predict airblast overpressure levels and ground vibration and using generic site law models established in accordance with AS 2187: Part 2-2006 Appendix J Section J7.2 and J7.3 with appropriate site constants as follows:

$$PVS\ (50\%\ exceedance) = 1140\left(\frac{\mathrm{R}}{\sqrt{\mathrm{Q}}}\right)^{-1.6}$$

$$PVS\ (5\%\ exceedance) = 3272\left(\frac{\mathrm{D}}{\sqrt{\mathrm{Q}}}\right)^{-1.6}$$

$$SPL\ (50\%\ exceedance) = 164.3 - 24\left(\log(\mathrm{R}) - \frac{1}{3}\log(Q)\right)$$

$$SPL\ (10\%\ exceedance) = 171.5 - 24\left(\log(\mathrm{R}) - \frac{1}{3}\log(Q)\right)$$

Where,

PVS = Vibration velocity Peak Vector Sum (PVS) (mm/s)

SPL = Airblast overpressure Level Linear Peak (dB L_{zpeak} re 20 µPa).

R = Distance between charge and receiver (m)

Q = MIC (kg) being the charge mass per delay (detonated within 8 milliseconds)

4.2 Blasting Impact Assessment

4.2.1 Privately Owned Residences

Using the ground vibration and airblast overpressure site laws described in **Section 4.1** above, blast emission levels were predicted at the nearest privately-owned residences in the vicinity of the Project assuming the blast was initiated at the closest point to each residence. The predicted percentage exceedance ground vibration and airblast overpressure levels are presented in **Table 3**.

Table 3 Predicted Ground Vibration and Airblast Overpressure Levels

Location	Minimum Distance to Extraction Area (m)	Typical Blast (MIC 15.5 kg)			
		Vibration (mm/s)		Airblast (dB L_{zpeak})	
		50%	5%	50%	10%
NSR1	563	0.4	1.2	108	115
NSR2	917	0.2	0.5	103	110
NSR3	1102	0.1	0.4	101	108

Typical production blast designs with MIC of 15.5 kg are predicted to comply with the human comfort criteria of 5mm/s and 115 dB L_{zpeak} at all residential locations. Given that the proposed human comfort criteria is predicted to be met at the nearest residential receivers the potential for blasting to cause structural damage is negligible.

4.2.2 Safe Working Distances

Safe working distances for infrastructure and geological structures are outlined in **Table 4**. The assessment has been based on a MIC of 15.5 kg which is consistent with the assessment for privately owned residences. When applying safe working distances, the existence of major alterations to a structure can be a specific cause of an increased rate of damage. If a structure is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground borne disturbance and such, a reduced safe working distance would need to be considered. Where the structure is a privately-owned utility, the utility owner should be engaged prior to blasting to determine the applicable criteria.

Table 4 Safe Working Distances

Infrastructure/Geological Structure	Safe Working Distances (m) 5% Blast Vibration Exceedance Level
Power transmission line and telecommunications cable 50 mm/s	54 m
Roadway (culvert) Vibration 80 mm/s	40 m
Archaeological/Geological Structure Vibration 250 mm/s	26 m

5 Recommendations

Ground vibration and airblast overpressure levels would be managed by Resources Group in accordance with an approved Blast Management Plan (BMP) to ensure that ground vibration and potential blast emission impacts are minimised. The BMP shall include the implementation of a blast emission monitoring programme and the establishment and maintenance of ground vibration and airblast overpressure site-laws for the Quarry to enable key blast design parameters, including any potential increase to MIC due to the blast location, to be modified and ensure compliance with the criteria.

6 Conclusion

SLR Consulting Australia Pty Limited (SLR) has been commissioned to undertake a desktop assessment of blasting effects associated with the Project.

Blasting emissions from the Project are predicted to comply with the human comfort criteria of 5mm/s and 115 dB L_{Zpeak} at all residential locations. Given that the proposed human comfort criteria is predicted to be met at the nearest residential receivers the potential for blasting to cause structural damage is negligible. Generalised safe working distances to typical infrastructure and or geological structures have been presented should these items be identified in the vicinity of the Project.

It is recommended that a Blast Management Plan be implemented to enable the establishment and maintenance of ground vibration and airblast overpressure site-laws for the Quarry to enable key blast design parameters, including any potential increase to MIC due to the blast location, to be modified and ensure compliance with the criteria and any potential blast emission impacts are minimised.

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