



Sand Extractive Industry – Stirling Estate

Environmental Noise Assessment

Dunkley Holdings Pty Ltd

286 Mallokup Rd
Stirling Estate WA 6271

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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Dunkley Holdings 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.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.



Executive Summary

SLR Consulting Australia Pty Ltd (SLR) has undertaken an environmental noise assessment to evaluate the potential noise emissions associated with proposed sand extraction operations at Mallokup Road, Stirling Estate. The assessment has been completed to determine compliance with the *Environmental Protection (Noise) Regulations 1997* (the 'Regulations').

Five worst-case operational scenarios (Scenarios 1 to 5), representing the progression of the extraction works across Areas 1 to 5 of the site, were modelled under a flat terrain assumption. In each scenario, operational activities involving the truck, bulldozer, crusher, screen, loader, watercart and excavator were simulated within the respective extraction area to assess noise levels at the nearest receivers

Noise levels were predicted at four residential receivers located near the site, accounting for the time-varying nature of moving environmental noise sources in accordance with published DWER guidelines.

In terms of results,

- Under Scenario 1 and the large majority of operations, noise emissions are predicted to comply with the assigned noise level limits at both receivers.
- Under Scenario 2 and the large majority of operations, noise emissions are predicted to comply with the assigned noise level limits at both receivers.
- Under Scenario 3 and the large majority of operations, noise emissions are predicted to comply with the assigned noise level limits at both receivers.
- Under Scenario 4 and the large majority of operations, noise emissions are predicted to comply with the assigned noise level limits at both receivers.
- For Scenario 5, noise emissions are predicted to generally comply at all receivers; however, at receiver R-4, the predicted noise level is marginal, being within 1 dB of the assigned L_{A10} limit.

The 1 dB difference at R-4 falls within the typical variability of site operations and modelling and is practicably manageable. Compliance can be achieved by repositioning the crusher approximately 15 m to the east, closer to the haulage route, or by constructing a 3 m high bund (or shipping container) adjacent to the crusher on the side facing the receiver.

Overall, the assessment indicates that the proposed sand extraction activities **can practicably comply** with the Regulations.

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1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR Consulting) has been commissioned by Element on behalf of Dunkley Holdings Pty Ltd to undertake an assessment of sand extraction activities proposed at Mallokup Road, Stirling Estate .

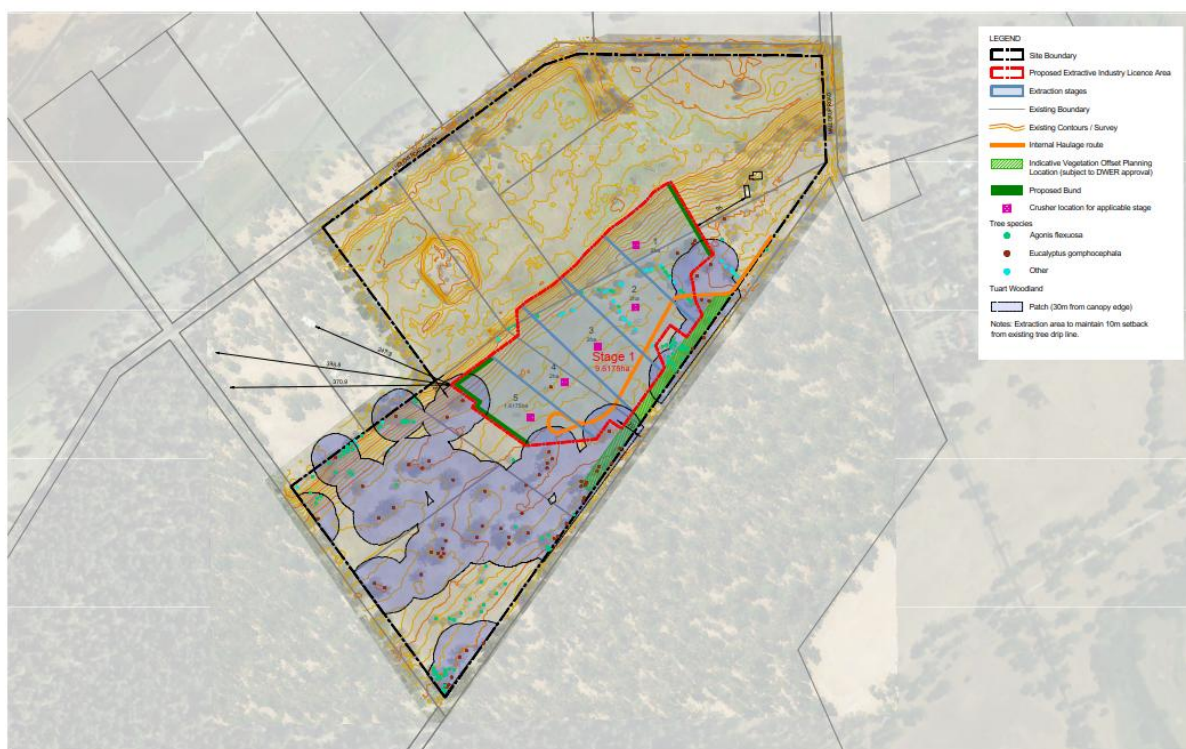
The proposed extraction operations will operate from 7am to 6pm Monday to Friday and from 7am to 12pm on Saturdays. No operations would occur on Sundays or Public Holidays.

The project site is shown in **Figure 1**. We understand that extraction operations are proposed on this site using a front-end loader, an excavator, a bulldozer, a watercart, a limestone crusher, screen and trucks. The nearest residential premise is located 70 meters to the northeast of the proposed extraction.

This report documents the predicted noise emissions associated with operation of the proposed facility.

A glossary of terminology is provided in **Appendix A** to assist the interpretation of this report.

Figure 1: Locality of the Project - Overview



Excavation Works Plan
Mallokup Road, Stirling Estate

2.0 Criteria

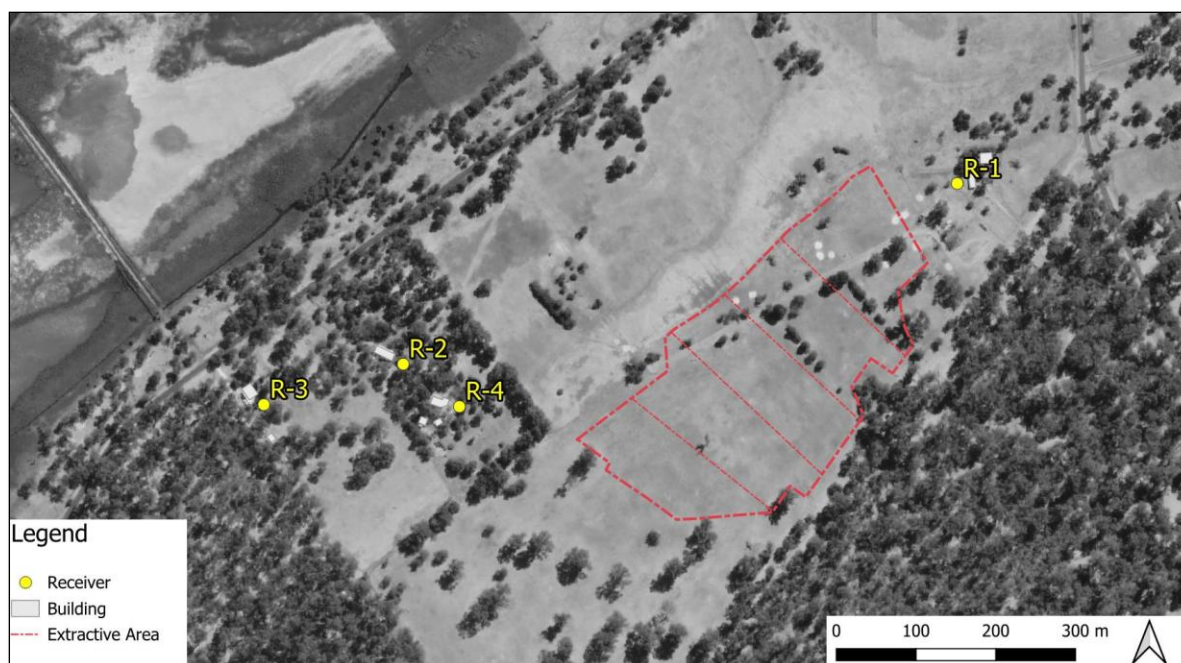
For industrial premises, site noise emissions are required to meet **the Regulations**. Under **the Regulations**, noise levels at nearby residential areas from extraction operations are not to exceed defined limits (“Assigned Levels”). For the nearest noise sensitive receptor, the ‘Assigned Levels’ are described in **Table A**.

Table A: Assigned noise level summary

Part of premises receiver noise	Time of day	Assigned Noise Level, dB		
		L _{A10}	L _{A1}	L _{Amax}
Noise Sensitive premises at locations within 15 m of a building directly associated with a noise sensitive use	7.00 am to 7.00 pm Monday to Saturday ('Day')	45 + IF	55 + IF	65 + IF
	9.00 am to 7.00 pm Sunday and public holidays ('Sundays')	40 + IF	50 + IF	65 + IF
	7.00 pm to 10.00 pm all days ('Evening')	40 + IF	50 + IF	55 + IF
	10.00 pm on any day to 7.00 am Monday to Saturday and 9.00 am Sunday and public holidays ('Night')	35 + IF	45 + IF	55 + IF

The noise sensitive receivers are presented in **Figure 2**.

Figure 2 Noise sensitive receivers



At the R-1 receiver location, the inner circle(100m) falls entirely within the project area and therefore comprises 100% industrial premises. The outer circle(450m) comprises 55% industrial premises.

At the R-2 receiver location, the outer circle comprises 40% industrial premises, while the inner circle comprises 2% industrial premises.

At the R-3 receiver location, the outer circle comprises 18% industrial premises.

At the R-4 receiver location, the outer circle comprises 50% industrial premises, while the inner circle comprises 10% industrial premises

The relevant assigned levels are therefore summarised in **Table B**.

Table B Sensitive receptors and Assigned Levels

Locality	Influencing Factor, dB	L _{A10} , dB	L _{A1} , dB	L _{Amax} , dB
R-1 (363 Mallokup Rd.)	16	61	71	81
R-2 (1092/1 Ludlow Rd.)	4	49	59	69
R-3 (1034 Ludlow Rd.)	2	47	57	67
R-4 (1092/2 Ludlow Rd.)	6	51	61	71

Table C summarises applicable adjustments for intrusive or annoying characteristics. No intrusive characteristics are assumed on the basis that the method of sand extraction and transfer to the truck can be reasonably undertaken without leading to these characteristics being present at the point of noise reception.

Table C Adjustment for Intrusive Noise Characteristics

Noise characteristic	Definition	Adjustment if present (Note ¹)
Tones	Where the difference between the A weighted sound pressure level in any one third octave band and the arithmetic average of the A weighted sound pressure levels in the two adjacent one third octave bands is greater than 3 dB in terms of L _{Aeq,T} where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as L _{ASlow} levels.	+5 dB
Modulation	A variation in the emission of noise that – <ul style="list-style-type: none"> • Is more than 3 dB L_{AFast} or is more than 3 dB L_{AFast} in any one third octave band; • Is present for at least 10% of the representative assessment period; and, • Is regular, cyclic and audible. 	+5 dB
Impulsiveness	Present where the difference between the L _{APeak} and L _{Amax} is more than 15 dB when determined for single representative event.	+10 dB

Note 1 where noise emission is not music, these adjustments are cumulative to a maximum of 15 dB.

3.0 Methodology

3.1 Scenarios

As the nearest noise-sensitive receivers are located at the north-eastern and north-western extents of the extraction area, a series of scenarios have been developed to represent the worst-case conditions of the proposed sand extraction activities across the site.

In all scenarios, the limestone crusher and screen have been modelled as a fixed point source located at the positions shown in **Figure 1**. Mobile plant, including the dozer, excavator, loader, watercart and trucks, have been modelled to operate around the crusher, representing typical operational movement within each extraction area.

- Scenario 1 – Operations are modelled within Area 1 (2ha)
- Scenario 2 – Operations are modelled within Area 2 (2ha)
- Scenario 3 – Operations are modelled within Area 3 (2ha)
- Scenario 4 – Operations are modelled within Area 4 (2ha)
- Scenario 5 – Operations are modelled within Area 5 (1.6ha)

The loader and bulldozer have been modelled as moving sources, representing their full operational movement within the extraction area. The trucks and watercart have been modelled as moving sources operating continuously along the haulage route between the screen and the site entrance. The excavator has been modelled as a fixed-point source operating at a single location. The change in noise level over time has been directly modelled by accounting for the duration each noise source spends at each position, allowing the results to be directly compared with the assigned noise levels.

The following bunding configurations have been included in the model as part of the assessment:

- Scenario 1: 2m bund at the north-eastern boundary
- Scenario 2: No bunding
- Scenario 3: 2m bund at the north-western boundary
- Scenario 4: 3.5m bund along the northern and western boundaries
- Scenario 5: 3.5m bund along the northern and western boundaries

The scenarios and bunds are presented in **Figure 3**, **Figure 4**, **Figure 5**, **Figure 6** and **Figure 7**.

Figure 3 Sources in Scenario 1

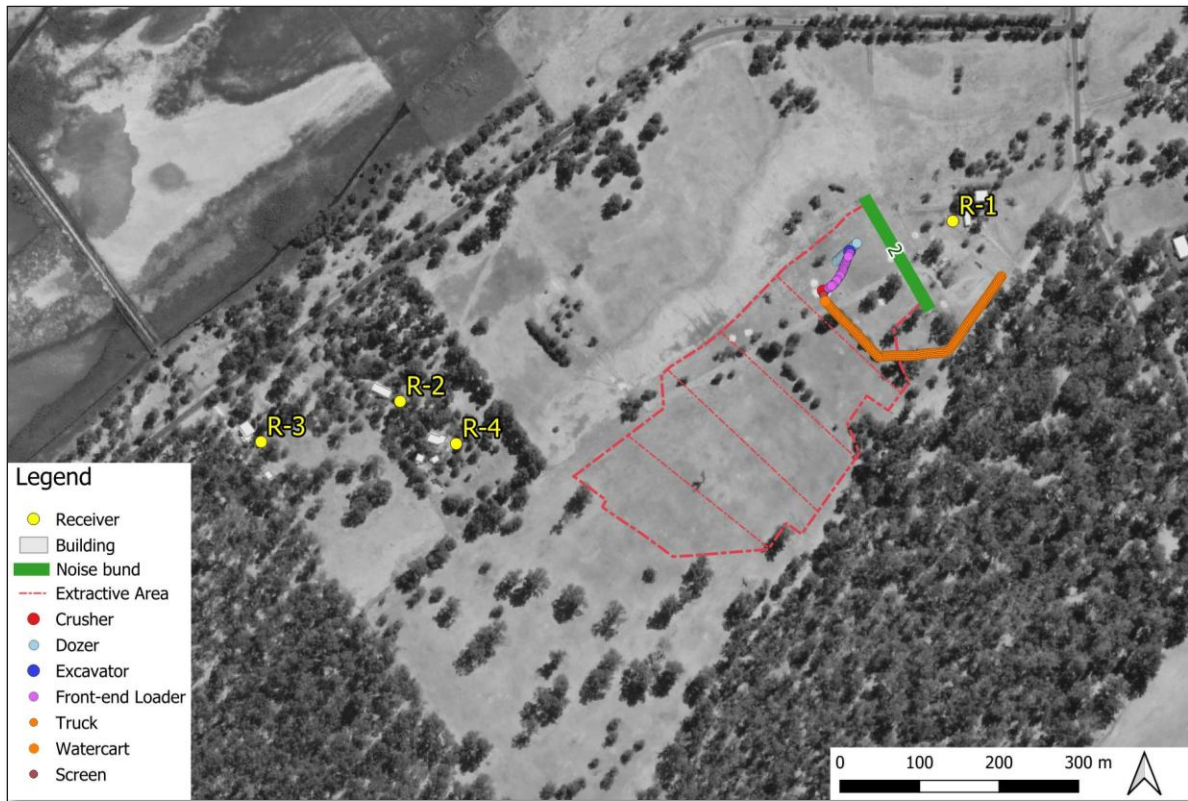


Figure 4 Sources in Scenario 2

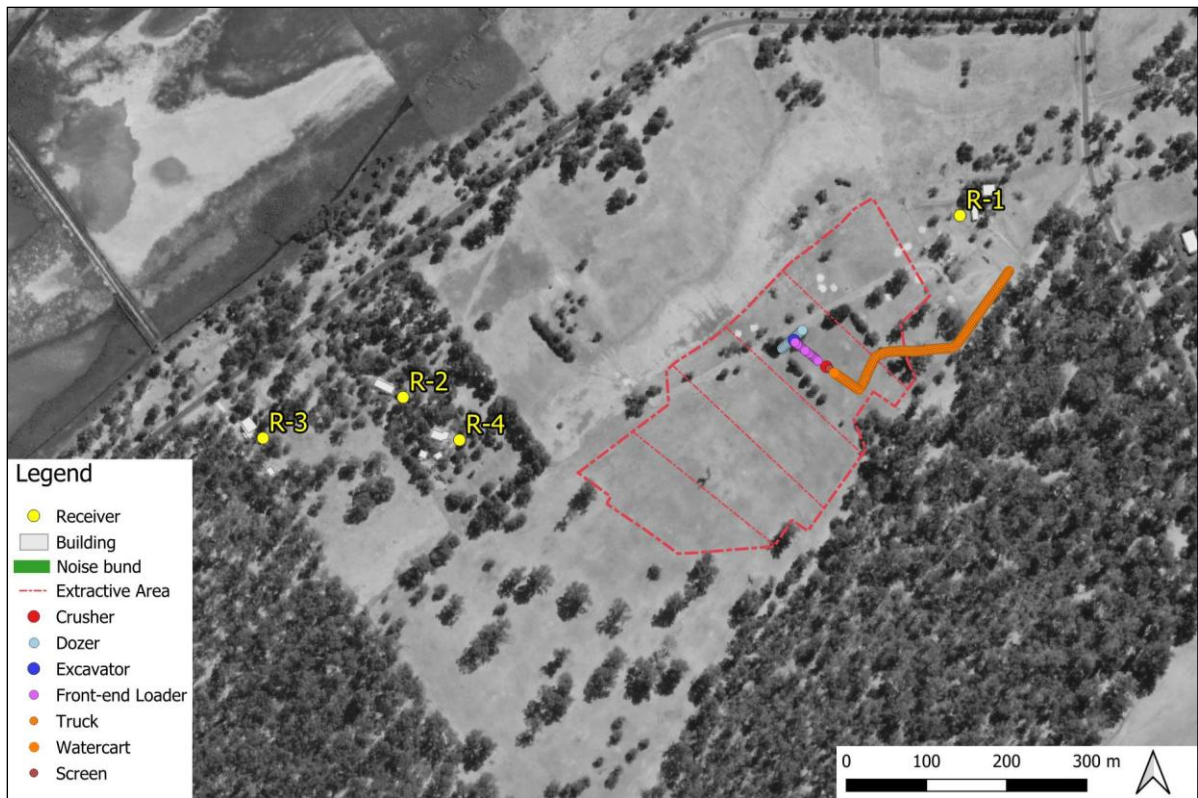


Figure 5 Sources in Scenario 3

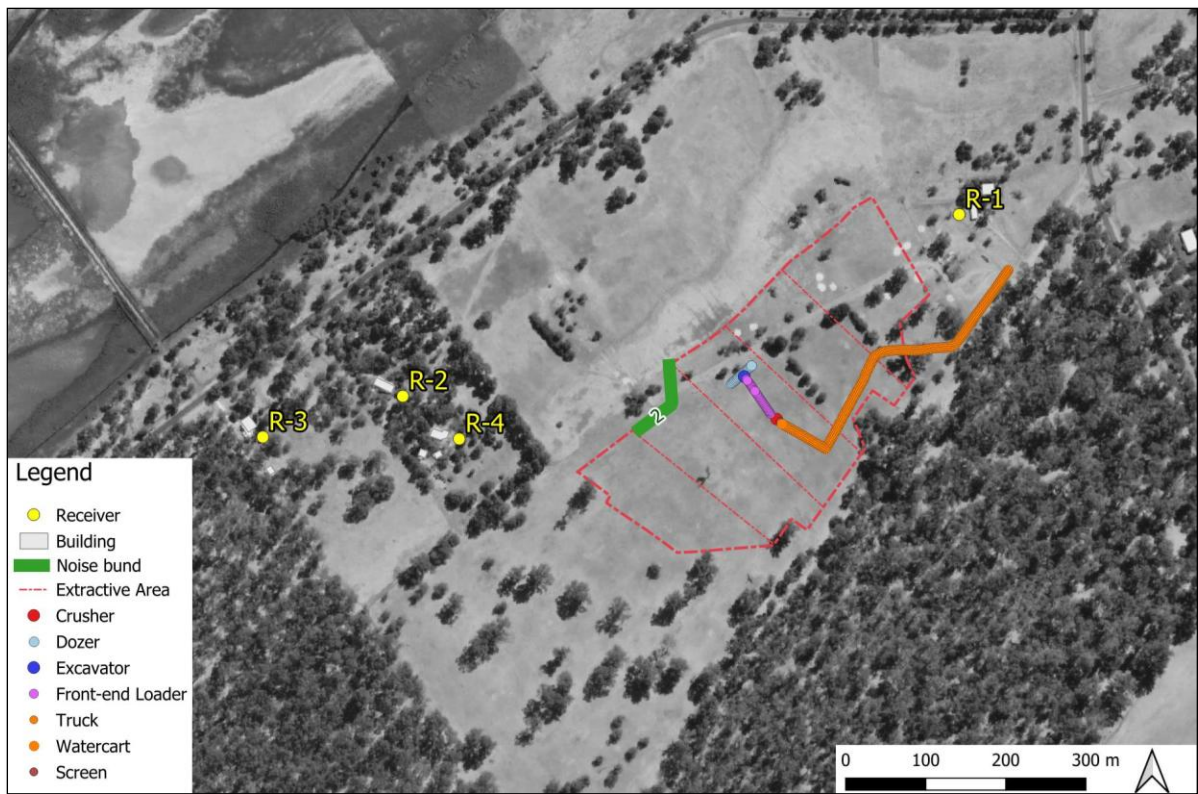
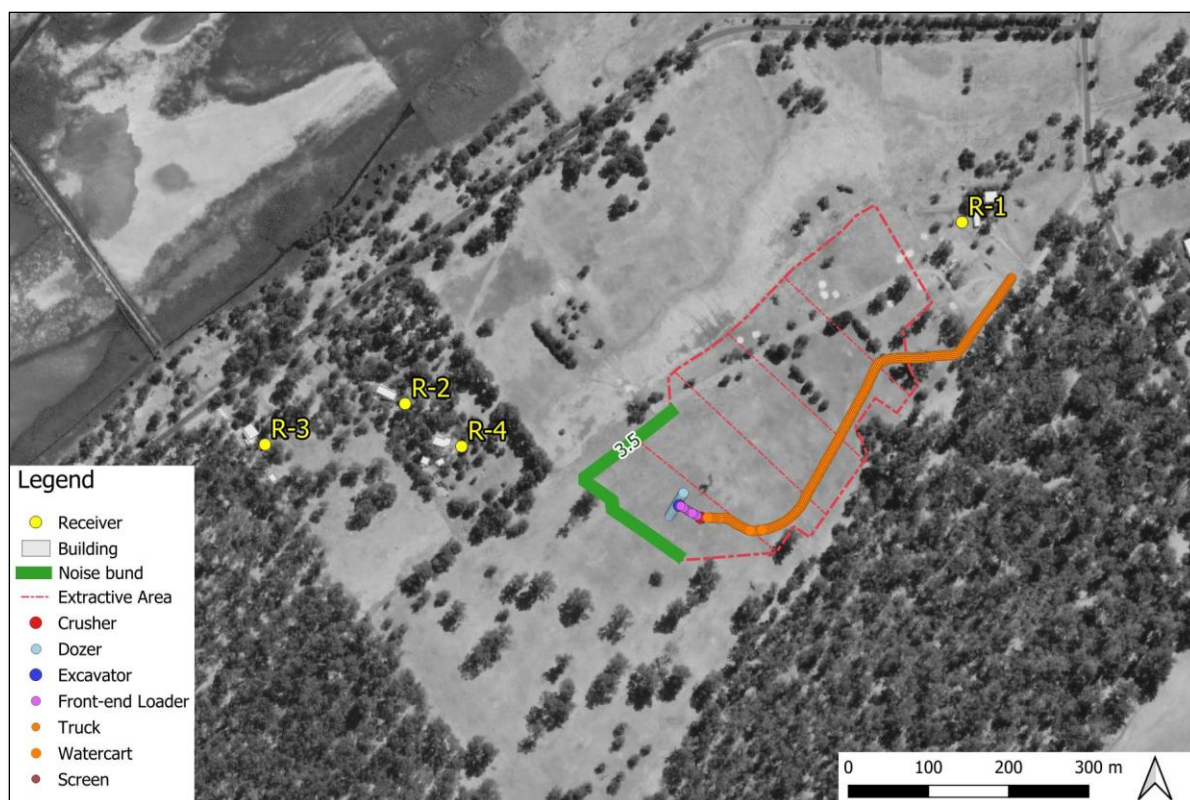


Figure 6 Sources in Scenario 4



Figure 7 Sources in Scenario 5



The following methodology was applied in both scenarios to assess the predicted noise impacts:

- The sound power levels for the loader, crusher, screen, excavator, watercart, bulldozer and truck were obtained from BS 5228¹ standard data, as presented in **Table D**;
- Noise emissions from the site were modelled utilising sound propagation software SoundPLAN (Version 9.1). The noise model accounts for the effects of terrain, buildings and structures;
- The model implements ISO 9613-2:2024. The method accounts for atmospheric absorption, ground effects and screening from terrain and buildings;
- A receptor was placed at the nearest outdoor positions representative of each noise sensitive receiver;
- The time-varying noise levels at these locations were predicted using the model over a minimum time period of 15 minutes. In accordance with **the Regulations**, it was assumed that during the 15-minute assessment period, trucks and the watercart operate along the haulage route and undertake loading activities, while the loader, bulldozer, limestone crusher and screen operate continuously. The noise levels exceeded for 10% of the 900-second assessment period were assessed as LA₁₀; and
- The predicted noise levels from both scenarios were assessed against the relevant assessment criteria.

¹ BS 5228-1:2009+A1:2014 : Code of practice for noise and vibration control on construction and open sites - Part 1 : Noise

3.2 Source levels

Table D Modelled sound power level of key equipment, dB re 1 pW

Source	Height (m)	L _{WA} (dB)	Full octave band centre frequency, Hz							
			63	125	250	500	1k	2k	4k	8k
Truck- Movement	1.0	111	115	113	111	109	106	102	99	94
Loader- Movement	1.0	110	120	112	111	105	104	102	99	90
Limestone Crusher	2.0	114	119	116	114	111	108	105	103	98
Screen	1.5	110	120	112	111	105	104	102	99	90
Excavator Movement	1.0	108	110	115	110	105	100	98	94	87
Watercart Movement	0.8	104	108	109	103	107	101	102	98	93
Bulldozer Movement	1.0	114	107	115	107	106	110	108	100	94

The activity involves sand being separated from the surface by an excavator, collected by the loader, and then loaded into trucks for transport to the crusher and screen, where the material is processed and separated. A bulldozer operates within the extraction area to level and prepare the working surface, while a watercart is used for dust suppression across internal roads and active work areas. These operations do not generate distinct impulsive noise. Therefore, no impulsive adjustment has been applied in the assessment.

3.3 Uncertainty of prediction

The expected level of system prediction uncertainty as estimated according to the ISO Guide to Measurement Uncertainty is outlined in **Table 5**.

Table 5 Estimated prediction uncertainty by system

Parameter	System	U ₉₅ (Note 1)	Student's t-factor
Airborne noise L _{Aeq} , L _{A10} , L _{A1}	ISO 9613	3.0 dB	2.00

Note 1 The U₉₅ is the expanded uncertainty of measurement for a 95% confidence interval. It represents the estimated range in which the true value lies for 95 out of 100 repeated events.

4.0 Results and discussion

All scenarios have been assessed against the daytime assigned levels. The predicted noise emissions at the key receiver locations are presented in **Table F** and corresponding noise contour maps (L_{Aeq} basis) are illustrated in **Appendix B**.

In addition, the noise generated from loader, crusher, screen, excavator, watercart, sand loading and truck movements is generally broadband in nature, and does not exhibit prominent tonal characteristics or amplitude modulation at the distances of interest.

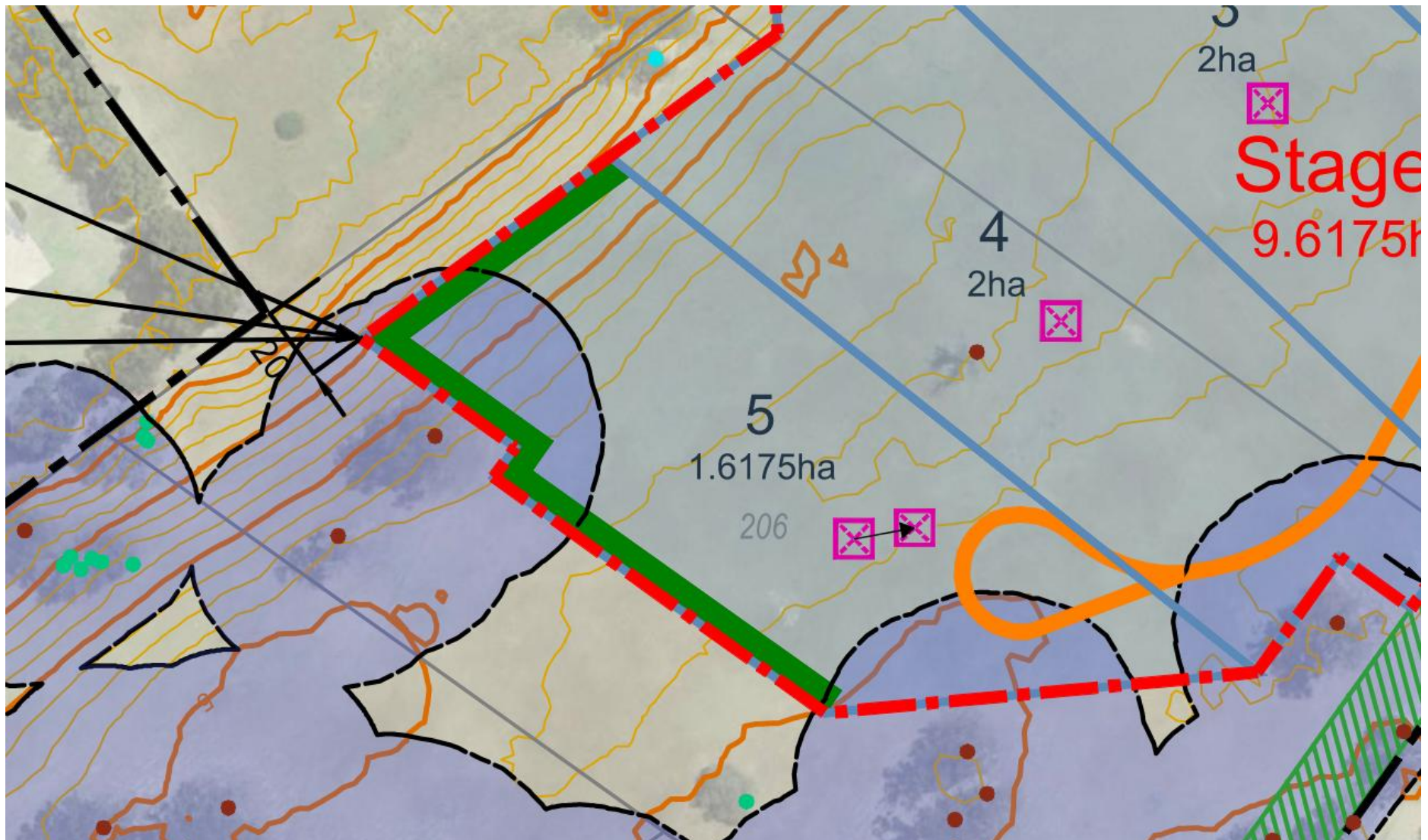
Table F: Predicted Operational Noise levels and Assessment, L_{A10} dB

Scenario	Location	Predicted noise emission	Adjustment (Table C)	Adjusted noise level	Assigned noise level (Table B)	Predicted outcome
Scenario 1	R-1	59	-	59	61	Compliant
	R-2	47	-	47	49	Compliant
	R-3	44	-	44	47	Compliant
	R-4	48	-	48	51	Compliant
Scenario 2	R-1	58	-	58	61	Compliant
	R-2	49	-	49	49	Compliant
	R-3	45	-	45	47	Compliant
	R-4	51	-	51	51	Compliant
Scenario 3	R-1	55	-	55	61	Compliant
	R-2	47	-	47	49	Compliant
	R-3	43	-	43	47	Compliant
	R-4	49	-	49	51	Compliant
Scenario 4	R-1	54	-	54	61	Compliant
	R-2	49	-	49	49	Compliant
	R-3	44	-	44	47	Compliant
	R-4	51	-	51	51	Compliant
Scenario 5	R-1	53	-	53	61	Compliant
	R-2	49	-	49	49	Compliant
	R-3	44	-	44	47	Compliant
	R-4	52	-	52	51	Marginal

Under Scenario 5, predicted noise levels at the Receiver R-4 marginally exceed the assigned level. Although this exceedance is minor, it is noted that there are many practicable mitigation options if required. These options would include but are not limited to:

- Repositioning the crusher approximately 15 m to the east, closer to the haulage route, as shown **Figure 8**; or
- Constructing a 3 m high bund or placing a shipping container adjacent to the crusher such that it screens noise from the crusher in the direction of the nearest noise sensitive receivers.

Figure 8 The new crusher location



5.0 Summary

SLR Consulting Australia Pty Ltd (SLR Consulting) has undertaken a noise assessment to evaluate the noise levels from the proposed sand extraction operations at the nearby noise-sensitive receivers. The assessment focusses on the receivers located closest to the site to determine the level of compliance at all nearby noise-sensitive premises.

Based on the assessment of five different scenarios, noise emissions associated with the proposed sand extraction activities are generally predicted to comply with the applicable daytime assigned noise levels at the nearest noise-sensitive receivers under the modelled worst-case conditions. Implementation of the recommendations outlined in **Section 4.0** will address any potential marginal exceedance.

Overall, the proposed operations are assessed as able to practicably comply with the relevant regulatory requirements.



Appendix A Terminology

Terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dB, which if there is a subscript 'A' is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dB level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness.

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear' or 'Z' weighted.

3. Sound Power Level

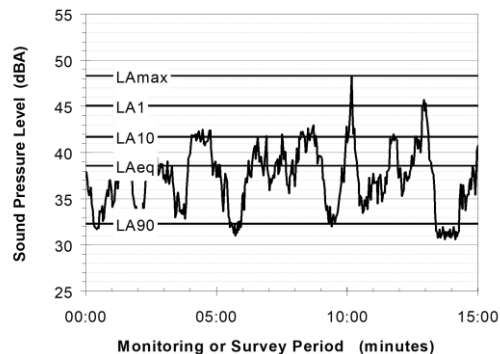
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are also expressed in decibels (dB), but in practice may be identified with a 'w' subscript, e.g. SWL, PWL or L_w , and by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minutes interval.

LA10 The noise level exceeded for 10% of the 15 minutes interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

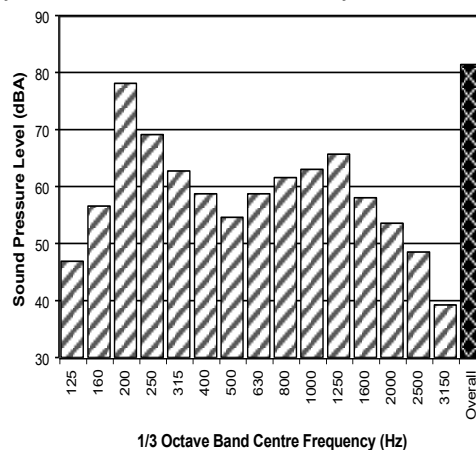
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

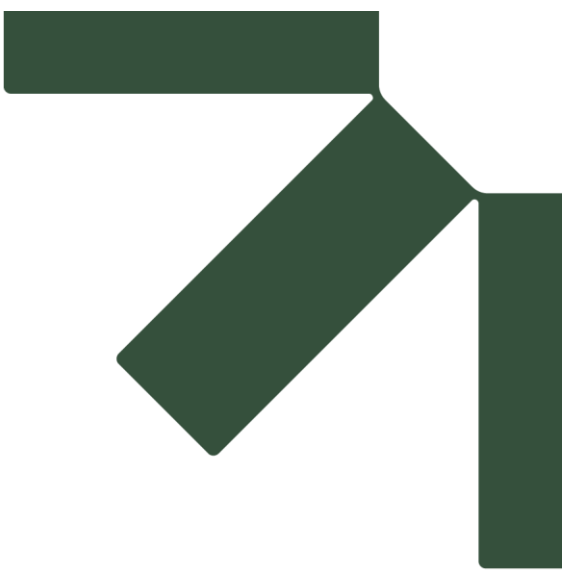
The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band.





Appendix B Grid Noise Maps

Figure 9: Grid noise map of Scenario 1, LAeq dB

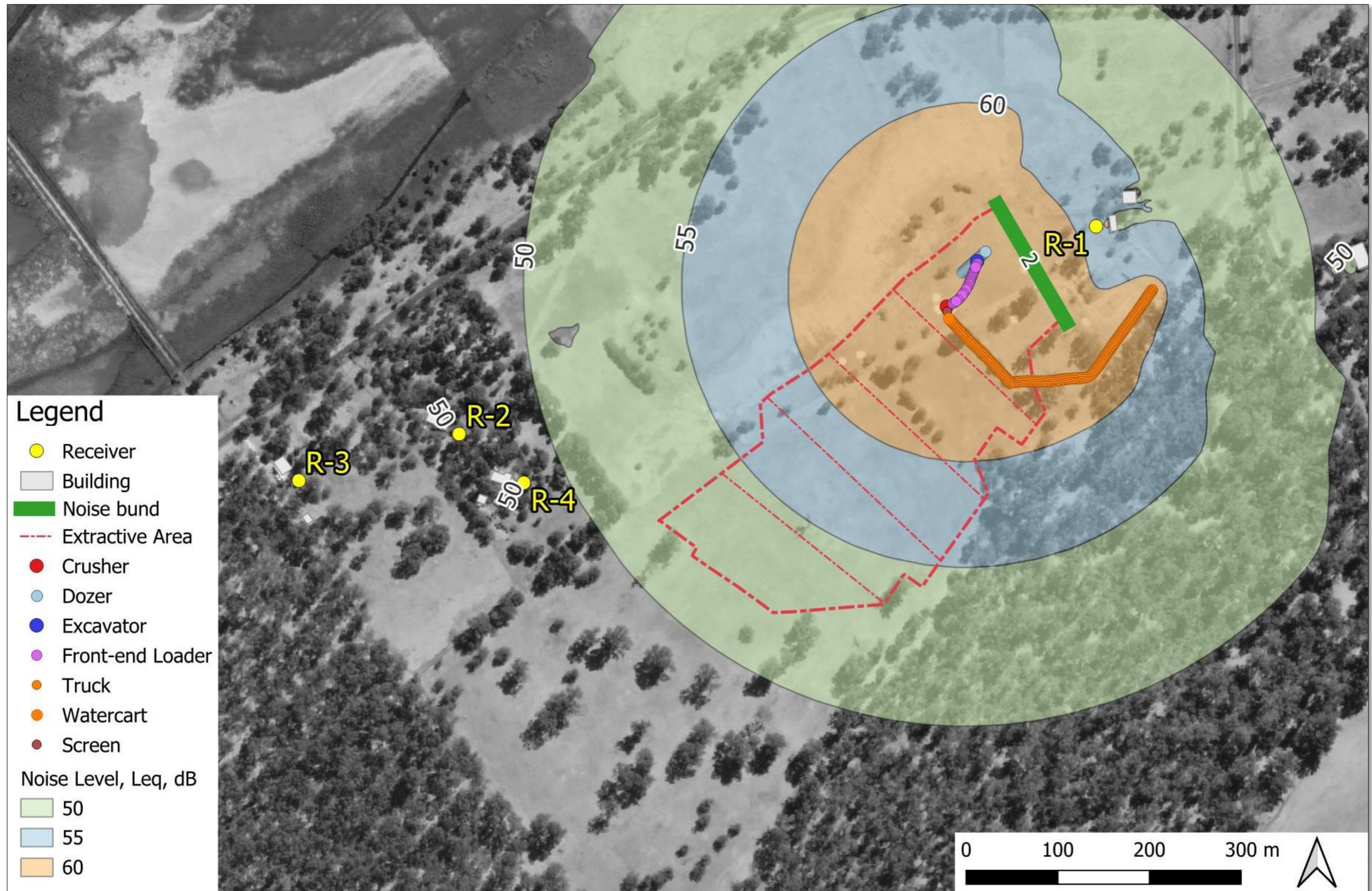


Figure 10: Grid noise map of Scenario 2, LAeq dB

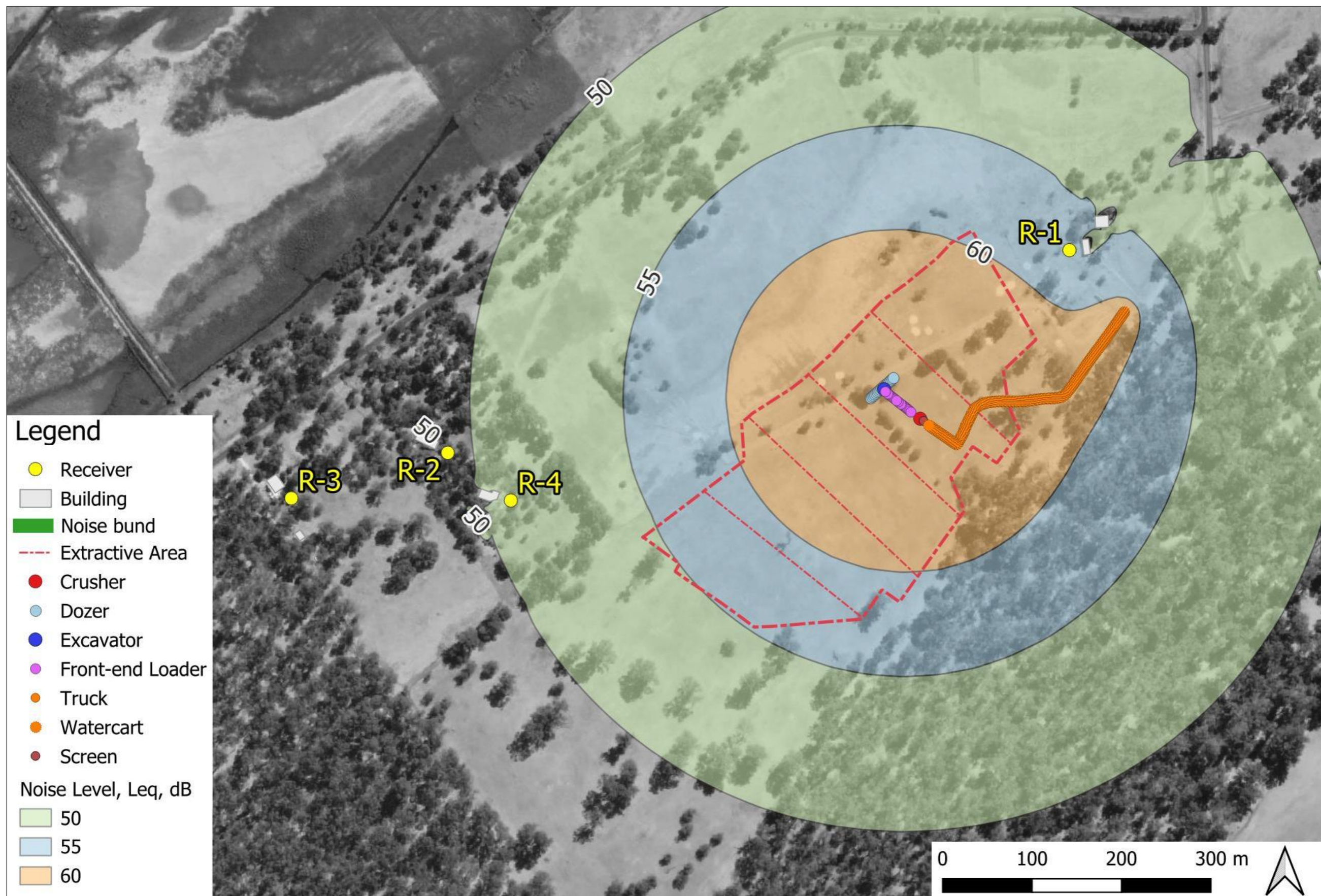


Figure 11: Grid noise map of Scenario 3, LAeq dB

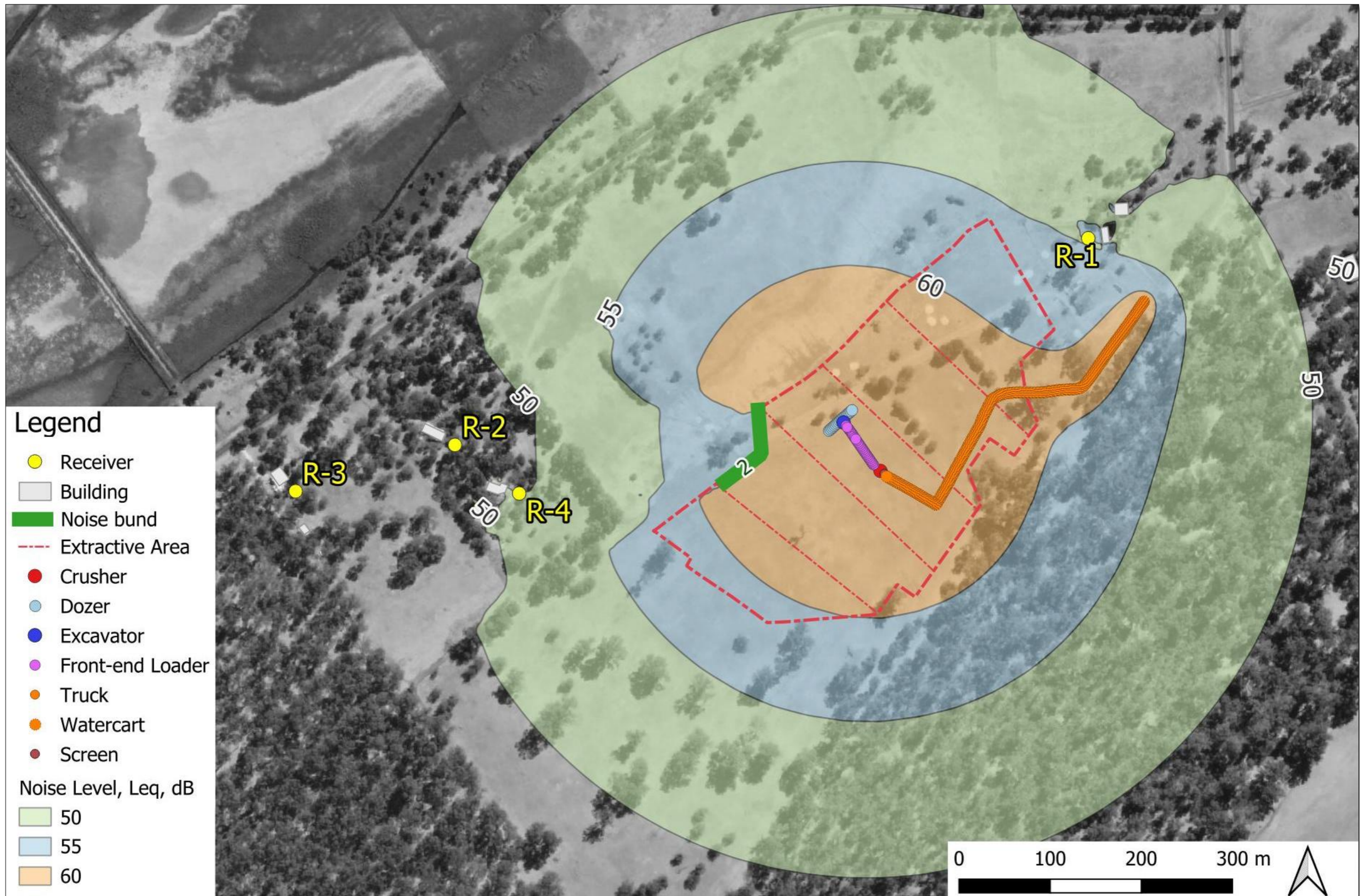


Figure 12: Grid noise map of Scenario 4, LAeq dB

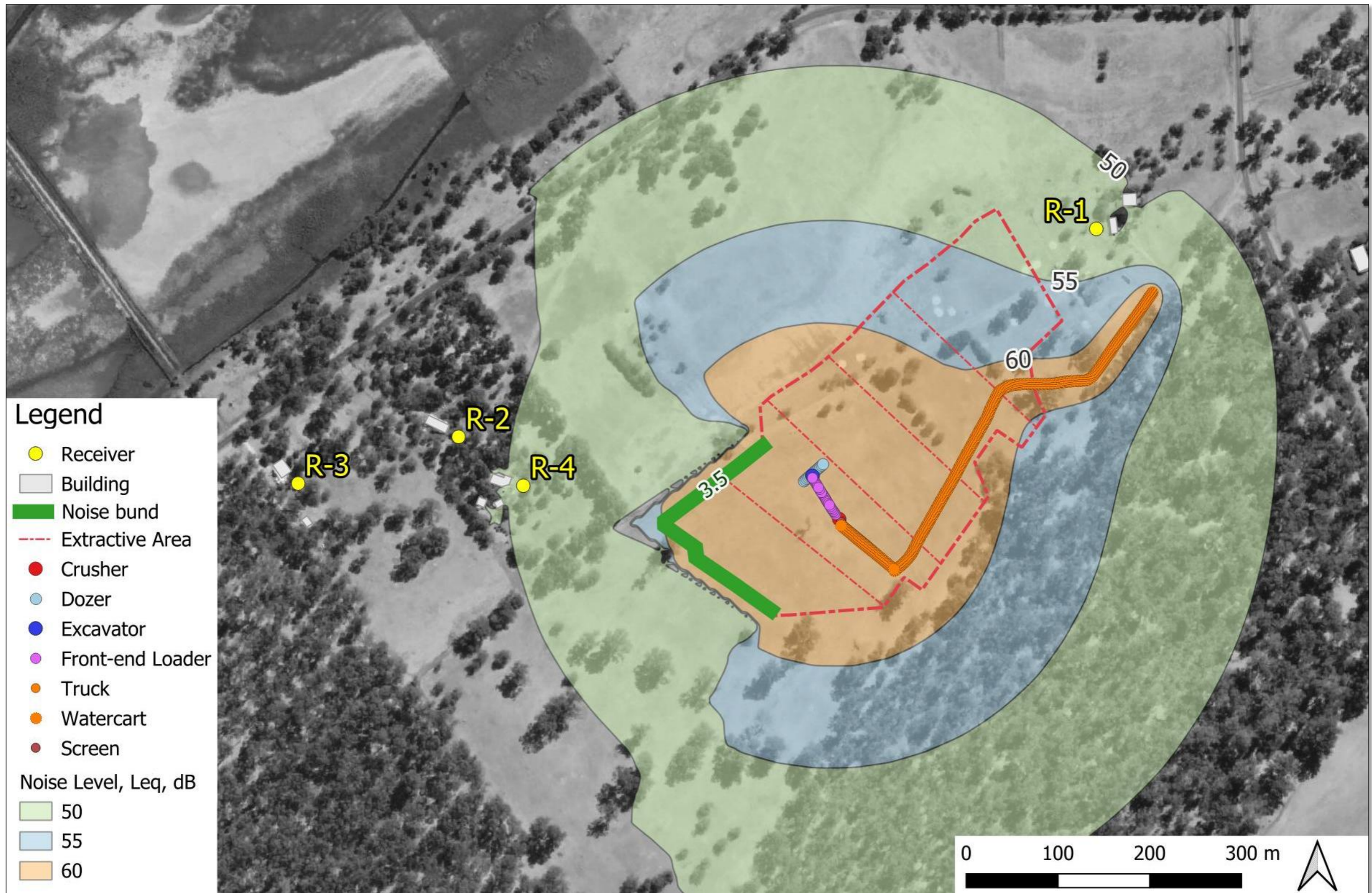
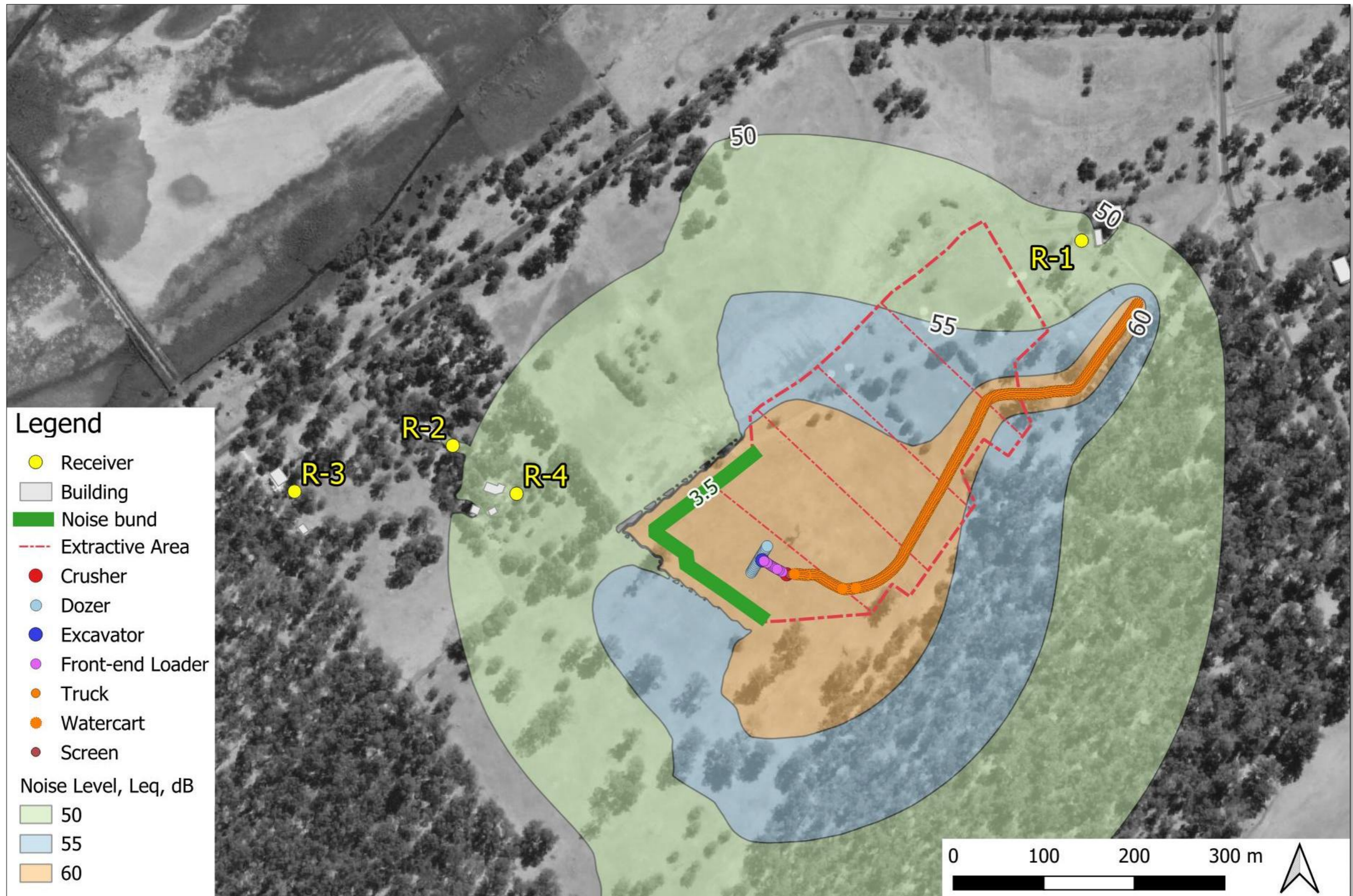
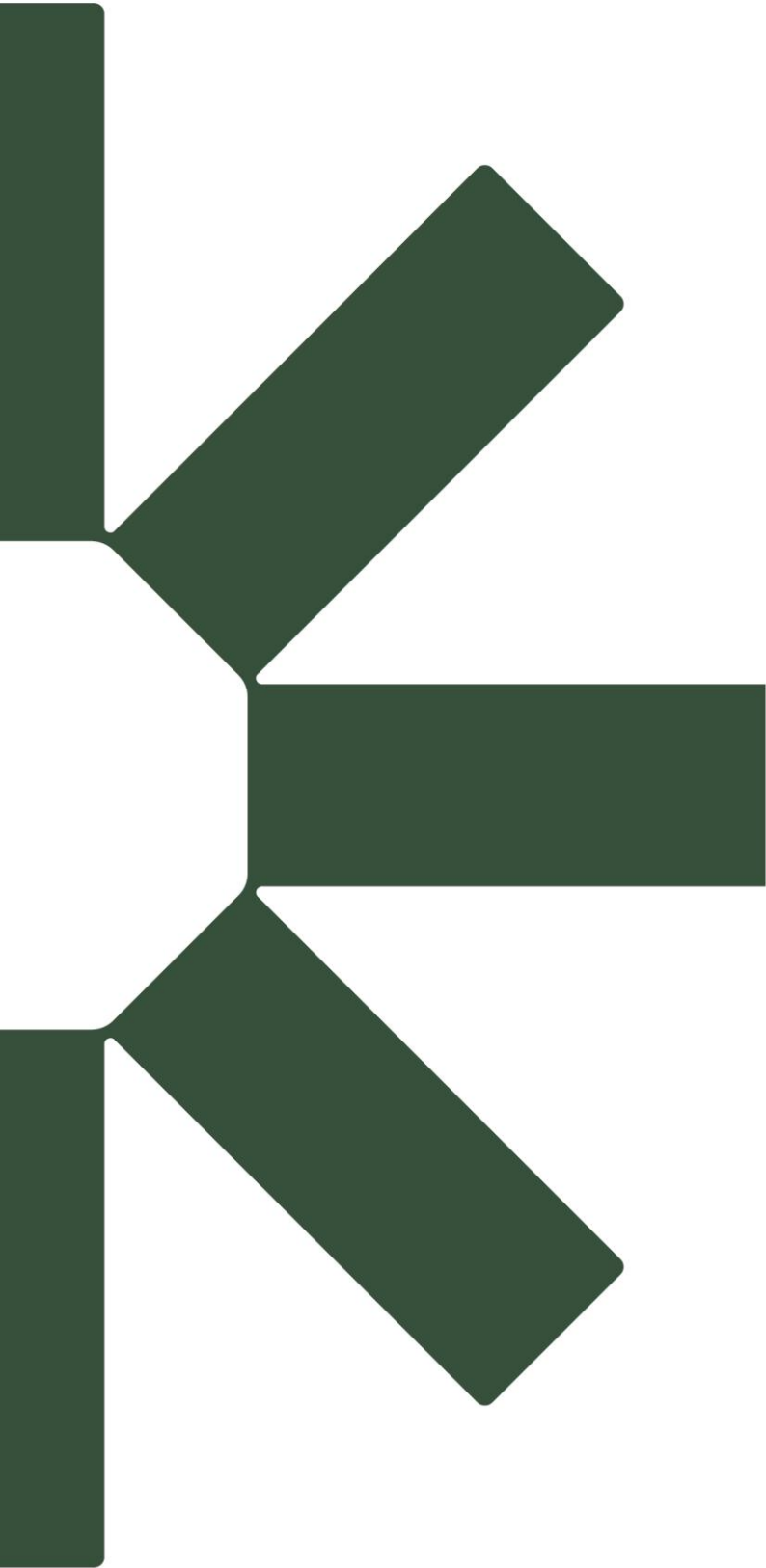


Figure 13: Grid noise map of Scenario 5, LAeq dB





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