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GOULBURN RIVER SOLAR FARM

Noise and Vibration Impact Assessment

FINAL

April 2023

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Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Lightsource bp

Project Director:	Malinda Facey
Project Manager:	Caitlin Adcock
Technical Director:	Tim Procter
Technical Manager:	Ben Carlyle
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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

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1.0 Introduction

Lightsource Development Services Australia Pty Ltd (Lightsource bp) is seeking to develop the Goulburn River Solar Farm (the 'Project') in the Upper Hunter Region of New South Wales (NSW), approximately 28 kilometres (km) south of the township of Merriwa within the Upper Hunter Local Government Area (LGA) (refer to **Figure 1.1**).

This Noise and Vibration Impact Assessment (NVIA) has been prepared by Umwelt to assess the potential noise and vibration impacts associated with the construction, operation and decommissioning of the Project and to recommend mitigation measures where required.

1.1 Overview of the Project

The Project will involve the construction, operation and decommissioning of approximately 550-megawatt peak (MWp) of solar photovoltaic (PV) generation as well as a Battery Energy Storage System (BESS) with 280 MWp / 570 megawatt hour (MWh) capacity. The Project will also include a substation and connection to an existing 500 kilovolt (kV) transmission line. The Project will include various associated infrastructure, including road upgrades to Ringwood Road, temporary construction facilities, operation and maintenance buildings, internal access roads, civil works and electrical infrastructure to connect the Project to the existing transmission line which passes through the Project Area. The conceptual layout for the Project is shown in **Figure 1.2**.

The Project is expected to operate for 40 years following an approximately 27-month construction period. The proposed construction hours for the Project are 6:00 am to 6:00 pm Monday to Saturday. After the initial 40-year operating period, the solar farm would either be decommissioned, removing all infrastructure and returning the site to its existing land capability, or repurposed with new equipment subject to technical feasibility and planning consents.

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP) as the capital value of the Project is over $30 million. A development application (DA) for the Project is required to be submitted under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

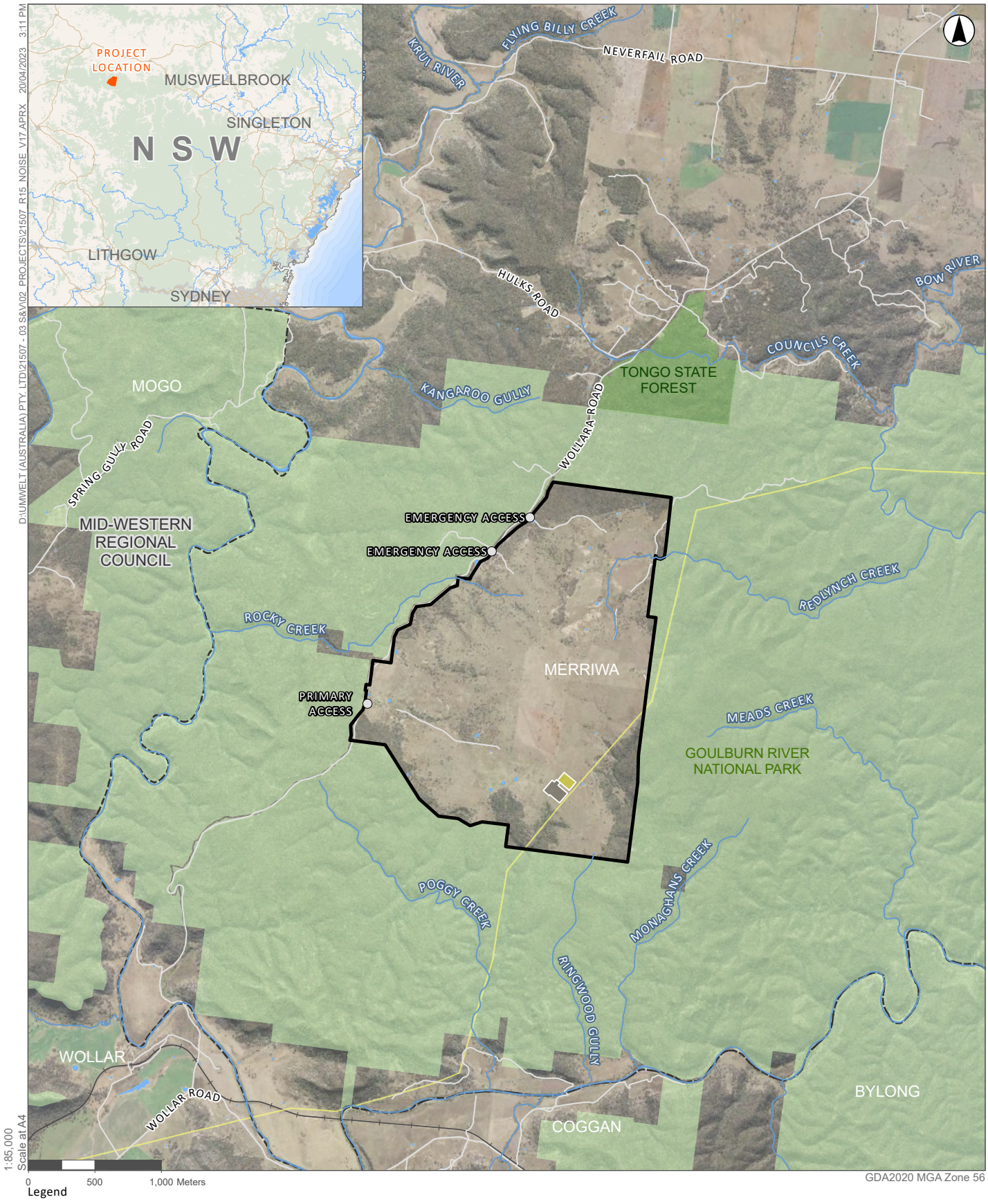


FIGURE 1.1

Location and Regional Context

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

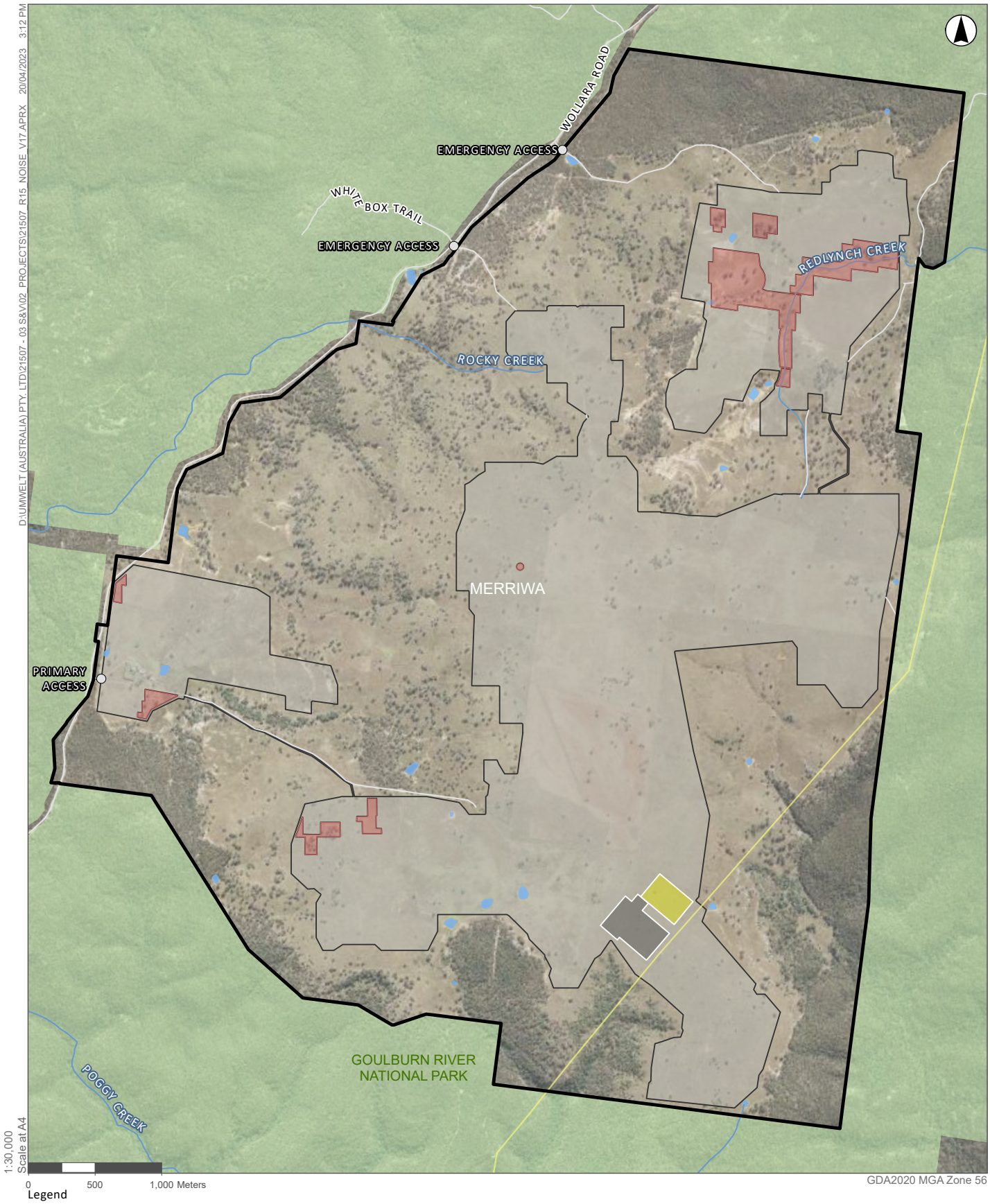


FIGURE 1.2

Indicative Project Layout

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

2.0 Assessment Framework and Methodology

2.1 Assessment Framework

The Planning Secretary's Environmental Assessment Requirements (SEARs) for the Project (SSD-33964533) identify matters that must be addressed in the Environmental Impact Statement (EIS). **Table 2.1** specifically lists the requirements relevant to the noise assessment:

Table 2.1 SEARs

SSD-33964533 – Requirement	Section Addressed
Noise – including an assessment of the construction noise impacts of the development in accordance with the *Interim Construction Noise Guideline* (ICNG), operational noise impacts in accordance with the *NSW Noise Policy for Industry* (2017), cumulative noise impacts (considering other developments in the area), and a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria.	Construction noise **Section 5.0**. Operational noise **Section 6.0**. Cumulative noise **Section 8.0**. Draft Construction Noise and Vibration Management Plan provided in **Appendix B** for Ringwood Road Upgrades. Solar Farm and BESS construction not predicted to exceed noise management levels.

This NVIA has been prepared in accordance with the following guidelines and legislative requirements:

- *Noise Policy for Industry* (NPfI), NSW Environment Protection Authority (EPA), 2017.
- *Interim Construction Noise Guideline* (ICNG), NSW Department of Environment and Climate Change (DECC), 2009.
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011.
- *Assessing Vibration: A Technical Guideline* (the Vibration Guideline), Department of Environment and Conservation (DEC), 2006.
- *Large-Scale Solar Energy Guideline for State Significant Development*, NSW Department of Planning and Environment (DPE), 2018.

2.2 Modelling Methodology

Prediction of the operation and construction noise levels was undertaken with the proprietary computer noise modelling software CadnaA (Version 2021 MR 2), using the CONCAWE noise prediction algorithms.

The CadnaA software is approved for use by the DPE and EPA. The software utilises terrain data, source and receptor locations and heights, source sound power levels (in octave or 1/3 octave frequency bands) and input meteorological conditions to predict noise levels. The CONCAWE prediction method accounts for the influence of noise propagation from atmospheric temperature, atmospheric relative humidity, wind speed, wind direction and Atmospheric Pasquill Stability Class (for defining the presence and strength of temperature inversions).

Operational noise impacts were predicted based on indicative sound power level data provided by Lightsource bp for the proposed equipment. Construction noise impacts were predicted based on several construction activities and associated plant and equipment.

3.0 Existing Environment

3.1 Background and Ambient Noise

The site is located within a rural environment with typically low background noise levels. The Project Area is surrounded by Goulburn River National Park (zoned C1) and rural residential land (zoned RU1 Primary Production). Given the rural environment, background noise level monitoring was not undertaken, and minimum background noise levels have been adopted in accordance with the NPfI.

As the Project Area is in a rural region, it is assumed that the Rating Background Level (RBL) at all receivers during the day will be less than 35 dB(A) and less than 30 dB(A) during the evening and night periods. The minimum RBLs of 35 dB(A) for the day and 30 dB(A) for the evening and night periods are set in accordance with the requirements of the NPfI. The adopted background noise levels are presented in **Table 3.1**.

Table 3.1 Adopted Background Noise Levels

Receiver Category/Land-use	Adopted RBLs [1], dB(A)		
	Day 7.00 am–6.00 pm	Evening 6.00 pm–10.00 pm	Night 10.00 pm–7.00 am
Rural Residential: RU1 Primary Production	35	30	30

Note: [1] Values shown represent the minimum RBLs for each period in accordance with the NPfI.

3.2 Sensitive Receivers

The Project Area is located within a rural setting with a number of residential receivers located on the northern, southern and western side of the Goulburn River National Park. The nearest sensitive receiver is located approximately 1.7 km north of the Project Area with dense bushland in the national park as a buffer between the Project and nearest receiver. There are no other sensitive land uses (such as schools or places of worship) within or surrounding the Project Area.

One residential receiver is located within the Project Area. This is an involved dwelling (the host receiver) and is not considered as a sensitive receiver. Another dwelling (abandoned) is located within the Project Area, but this structure is not fit for occupancy and is not considered a sensitive receiver.

The nearest receivers in the area surrounding the Project are presented in **Table 3.2**, **Figure 3.1** and **Figure 3.2**).

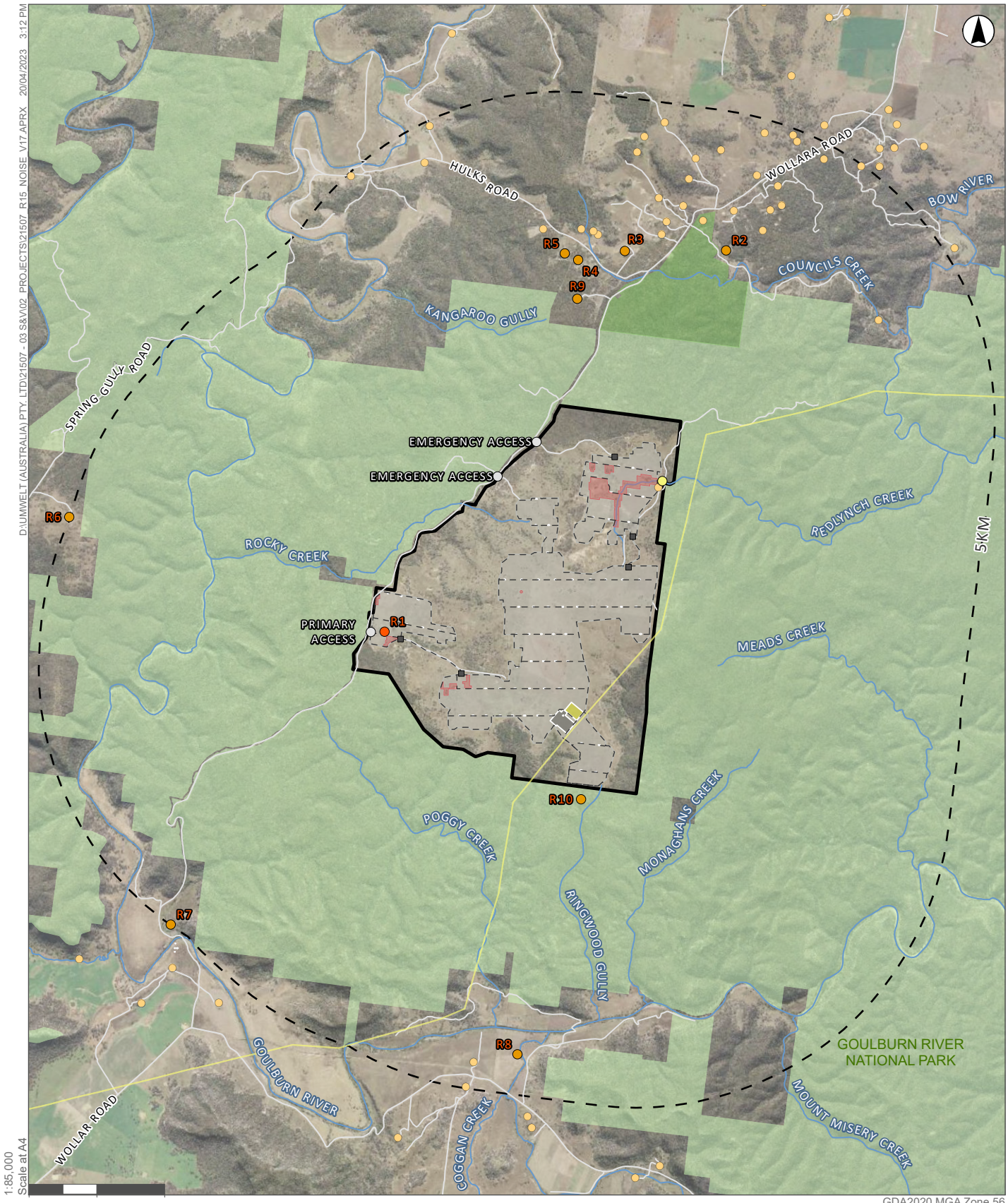
Table 3.2 Nearest Receivers

Receiver ID	Receiver Type	Address / Description	Approximate Distance (km) and direction from the Project Area
R01 (host receiver)	Residential	2771 Wollara Road, Merriwa (Lot 58 DP750956)	Within Project Area
R02	Residential	1893 Wollara Road, Merriwa (Lot 13 DP731205)	2.8 km north
R03	Residential	54 Hulks Road, Merriwa (Lot 12 DP746396)	2.5 km north
R04	Residential	54 Hulks Road, Merriwa (Lot 14 DP746396)	2.3 km north
R05	Residential	153 Hulks Road, Merriwa (Lot 16 DP746396)	2.4 km north
R06	Residential	1324 Mogo Rd, Mogo (Lot 12 DP610756)	5.1 km west
R07	Residential	3483–3492 Wollara Road, Merriwa (Lot 14 DP750966)	5.4 km southwest
R08	Residential	5657 Wollar Road, Coggan (Lot 45 DP755421)	4.5 km south
R09	Residential	2076 Wollar Road, Merriwa (Lot 15 746396)	1.7 km north
R10 [2]	Passive Recreation	Goulburn River National Park	Adjacent to Project Area in all directions
R11 [3]	Residential	549 Ringwood Road, Merriwa	15 km northeast

Notes: [1] *Receiver R01 is involved in the Project (host receiver) and therefore are not considered sensitive.*

[2] *For the Goulburn River National Park, given the vastness of the park and available bushwalking area, a receiver point 200 m from the Project Area was adopted for noise prediction purposes. For the predictions, the receiver point was located in proximity to the substation and BESS (the highest noise emitting source on site).*

[3] *This receiver is included for the assessment of road traffic noise only.*



Legend

- Host Receiver
- Sensitive Receiver
- Dwelling (abandoned)
- Dwellings
- Access Points
- Gate
- Proposed Access Tracks
- Electricity Transmission Line
- Watercourse
- Roads and Tracks
- Project Area (5km buffer)
- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Battery Energy Storage System
- Battery Substation
- Inverters
- NSW National Parks
- NSW State Forests
- Development Footprint

FIGURE 3.1

Sensitive Receivers

For the Goulburn River National Park (R10), given the vastness of the park and available bushwalking area, a receiver point 200 m from the Project Area was adopted for noise prediction purposes.
For the predictions, the receiver point was located proximity to the substation and BESS (the highest noise emitting source on site)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

FIGURE 3.2

Sensitive Receivers – Solar Farm and BESS Road Traffic Noise Assessment

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

4.0 Noise and Vibration Criteria

4.1 Construction Noise and Vibration Criteria

4.1.1 Construction Noise Criteria

Assessment levels for noise from construction activities, excluding noise from construction-related traffic on public roads, are defined in the ICNG.

The RBLs for the receivers surrounding the Project Area have been adopted from the minimum background noise levels presented in **Section 3.0**.

Table 4.1 presents the ICNG Construction Noise Management Levels for representative receivers surrounding the Project Area. The assessment levels are intended to guide the need for and the selection of feasible and reasonable work practices to minimise construction noise impacts.

Table 4.1 ICNG Construction Noise Management Levels, dB(A)

Land use	Construction Time	Noise Management Level $L_{Aeq(15\ min)}$
Residential	**Recommended Standard Hours** Monday to Friday – 7:00 am to 6:00 pm Saturday – 8:00 am to 1:00 pm No work on Sundays or Public Holidays	Noise affected: RBL + 10 dB(A)
		Highly noise affected: 75 dB(A)
	Outside recommended standard hours	Noise affected: RBL + 5 dB(A)
Passive Recreation	All construction hours	60 dB(A) [1]

Note: [1] *Management level only applies when properties are being used.*

The Construction Noise Management Levels for the receivers are summarised in **Table 4.2** based on the adopted RBLs presented in **Table 3.1**.

Table 4.2 Project Construction Noise Management Levels

Receiver	Noise Management Levels (NML), dB(A)			
	Standard hours of Construction[1]		Outside Standard hours of Construction[1]	
	Noise Affected $L_{Aeq(15\ min)}$	Highly Noise Affected $L_{Aeq(15\ min)}$	Noise Affected $L_{Aeq(15\ min)}$	
			Day	Evening & Night
All Residences[2]	45	75	40	35
Passive Recreation	60	-[3]	60	

Notes: [1] *Recommended standard hours: Monday to Friday 7.00 am–6.00 pm; Saturday 8.00 am–1.00 pm.*

[2] *Residential receiver R01 is involved in the Project (host receiver) and the NMLs are not applicable.*

[3] *Highly noise affected criteria not applicable for non-residential receivers.*

4.1.2 Construction Vibration Criteria

4.1.2.1 Vibration Effects on Structures

Criteria for vibration effects on building structures recommended in the DEC's *Assessing Vibration: A Technical Guideline* (the Vibration Guideline) are based on British Standard *BS7385 (1993) Part 2 Evaluation and measurement of vibration in buildings* (BS7385). The criteria in BS7385 are given in terms of peak component (x-, y- or z-axes separately) vibration velocity values from transient (impulsive) vibration events. The criteria for continuous vibration are recommended to be 50% lower than for impulsive vibration. The vibration criteria for the protection of structures and buildings from cosmetic damage (e.g., hairline cracks in drywalls, etc.) are given in **Table 4.3**.

Table 4.3 BS 7385 Vibration Criteria for Cosmetic Damage to Structures

Type of Structure	Peak Component Particle Velocity (mm/s)		
	4 Hz–15 Hz	15 Hz–40 Hz	40 Hz and above
Reinforced or framed structures **Industrial and heavy commercial buildings**	50 (transient (impulsive) vibration) 25 (continuous vibration)		
Un-reinforced or light framed structures **Residential or light commercial type buildings**	15–20 (transient (impulsive) vibration) 7.5–10 (continuous vibration)	20–50 (transient (impulsive) vibration) 10–25 (continuous vibration)	50 (transient (impulsive) vibration) 25 (continuous vibration)

4.1.2.2 Heritage Structures

Assessment guidelines for vibration damage to heritage-protected structures are commonly referenced from the German Institute for Standardisation *DIN 4150-3:1999-02 Structural vibration – Effects of vibration on structures* (DIN4150). This standard differentiates between short-term and long-term vibration, where short-term vibration is caused by sources such as drop-hammers, impact piling, etc. All other sources of vibration are considered to be long-term.

The guideline value for heritage-protected structures for short-term and long-term vibration is respectively 3 mm/s peak partial velocity (PPV) and 2.5 mm/s PPV in the horizontal plane at all frequencies. This guideline value is primarily intended for older, sensitive, above-ground structures (typically buildings).

In regard to heritage buildings, *BS7385 Part 2 (1993)* notes that a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

No listed heritage items were identified in the EIS Historical Heritage Assessment (Umwelt 2022) but an original slab hut was identified as having high archaeological potential. Whilst the heritage structure criterion does not apply to the original slab but because it not a 'protected' heritage item, the criterion has been provided for information and guidance. Refer to **Section 5.2.2** for further details.

4.1.2.3 Human Perception of Vibration

Criteria for the human perception of vibration from construction activities are given in the *Assessing Vibration: A Technical Guideline* (the Vibration Guideline). The criteria in the vibration guideline are given for continuous vibration, impulsive vibration and for intermittent vibration. For continuous and impulsive vibration, the criteria are given in terms of root-mean-square (rms) vibration acceleration (m/s^2) in the frequency range 1–80 Hertz (Hz). For intermittent vibration, the criteria are given in terms of vibration dose value (VDV), which is a parameter used for assessing the combined magnitude and the total duration of vibration impacts.

The criteria given in the vibration guideline for continuous or impulsive vibration relevant to the receivers in the area are given in **Table 4.4**. The frequency weightings are given in the vibration guideline in Appendix B3.

Table 4.4 The Vibration Guideline Values for Continuous and Impulsive Vibration for Human Comfort

Location	Assessment Period [1]	Weighted Vibration Acceleration (m/s^2 at 1-80 Hz)			
		Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous Vibration					
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Impulsive Vibration					
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14

Note: [1] Day time period is 7.00 am – 10.00 pm. Night period is 10.00 pm – 7.00 am.

The criteria for intermittent vibration given in the vibration guideline for the relevant receivers in the area are shown in **Table 4.5**. The vibration dose value (VDV) is calculated using the frequency-weighted rms acceleration as described in the vibration guideline.

Table 4.5 The Vibration Guideline Acceptable Vibration Dose Values for Intermittent Vibration for Human Comfort (VDV $m/s^{1.75}$)

Location	Daytime period [1]		Night-time period [1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26

Note: [1] Day time period is 7.00 am – 10.00 pm. Night period is 10.00 pm – 7.00 am.

According to the vibration guideline, the 'preferred' vibration limits are not mandatory but should be sought to be achieved through reasonable mitigation measures. Where all possible and reasonable measures have been applied, values up to the 'maximum' value may be used if they can be justified. For values beyond the maximum value, direct negotiation with the affected receivers must be carried out.

4.2 Operational Noise Criteria

The operational noise criteria applicable to the Project have been derived in accordance with the NPfI, based on adopted background noise levels presented in **Section 3.0**.

The NPfI sets out two noise criteria to assess the potential noise impacts resulting from industrial activity. The first is used to control short-term intrusive noise and its impacts on residences whilst the second is used to protect against cumulative noise impacts and maintain noise level amenity for particular land uses including residences.

The Project Noise Trigger Levels (PNTLs) derived in accordance with the NPfI are the lower (that is, the more stringent) values of the Project Intrusiveness Noise Level (PINL) and Project Amenity Noise Level (PANL) determined in the NPfI Section 2.3 and Section 2.4. Applying the more stringent of the two as the PNTL ensures that intrusive noise is limited, and amenity is protected and that no single industry can unacceptably change the noise level of an area.

The PNTLs provide a benchmark or objective for assessing a proposal or site. They are not intended for use as a mandatory requirement. The PNTL is a level that, if exceeded, would indicate a potential noise impact on the community, and so 'trigger' a management response, for example, further investigation of mitigation measures.

The PNTL, feasible and reasonable mitigation, and consideration of residual noise impacts are used together to assess noise impact and manage the noise from a proposal or site.

4.2.1 Project Intrusiveness Noise Level

The PINL $L_{Aeq(15\ minute)}$ is defined as the RBL + 5 dB. The RBL is determined by measurement of the long-term background noise level L_{A90} and calculated in accordance with the NPfI Fact Sheets A and B.

The derived PINLs are presented in **Table 4.6**, based on the adopted background noise levels presented in **Section 3.0**.

Table 4.6 NPfI Derived Project Intrusiveness Noise Levels, dB(A)

Receiver	Rating Background Level [1,2,3]			Project Intrusiveness Noise Level [1] $L_{Aeq(15\ min)}$		
	Day	Evening	Night	Day	Evening	Night
All residential receivers [4]	35	30	30	40	35	35

Notes: [1] *Day period is 7.00 am–6.00 pm Monday-Saturday and 8.00 am–6.00 pm Sunday and Public Holidays, evening period is 6.00 pm–10.00 pm and night period is 10.00 pm to commencement of day period.*

[2] *Where the day ABL is less than 35 dB(A) then RBL is set at 35 dB(A).*

[3] *Where the evening or night ABLs are less than 30 dB(A) then RBL is set at 30 dB(A).*

[4] *Residential receiver R01 is involved in the Project (host receiver)* and the PINLs are not applicable.

4.2.2 Project Amenity Noise Level

Given there are no other industries present in the area and cumulative industrial noise is not a necessary consideration, the PANLs $L_{Aeq(period)}$ at receivers have been defined as the recommended amenity noise levels taken from NPfI Table 2.2. For derivation of the PNTLs, the PANLs $L_{Aeq(period)}$ are converted to $L_{Aeq(15\ minute)}$ by the addition of 3 dB(A). The PANL at a receiver depends on the type of receiver and the noise amenity area of each receiver.

The residential receivers surrounding the Project are zoned RU1 Primary Production which is typical of a rural environment. Based on Table 2.3 of the NPfI, all residential receivers potentially affected by the Project have been assigned a Rural Residential amenity.

The PANLs for all receivers surrounding the Project Area are shown in **Table 4.7**.

Table 4.7 NPfI Derived Project Amenity Noise Levels, dB(A)

Receiver / land use category	Time of day [1]	Recommended amenity noise level $L_{Aeq(period)}$	Project amenity noise level [3] $L_{Aeq(period)}$	Project amenity noise level $L_{Aeq(15\ min)}$
All residential receivers / Rural Residential [2]	Day	50	50	53
	Evening	45	45	48
	Night	40	40	43
Passive recreation area	When in use	50	50	53

Notes: [1] *Day period is 7.00 am–6.00 pm Monday-Saturday and 8.00 am–6.00 pm Sunday and Public Holidays, evening period is 6.00 pm–10.00 pm and night period is 10.00 pm to commencement of day period.*

[2] *Residential receiver R01 is involved in the Project (host receiver) and the PANLs are not applicable.*

[3] *Given there are no other industries present in the area, the recommended amenity criteria has been assigned as the PANL.*

4.2.3 Project Noise Trigger Level

The PNTLs are defined as the lower of the PINL and the PANL in terms of $L_{Aeq(15\ minute)}$ noise levels. The PNTLs for residential receivers are shown in **Table 4.8**.

Table 4.8 Project Noise Trigger Levels – Residential Receivers, $L_{Aeq(15\ minute)}$, dB(A)

Receiver	Time of day [1]	PINL	PANL	PNTL
All residential receivers [2]	Day	40	53	**40**
	Evening	35	48	**35**
	Night	35	43	**35**
Passive recreation area	When in use	-	53	**53**

Notes: [1] *Day period is 7.00 am–6.00 pm Monday-Saturday and 8.00 am–6.00 pm Sunday and Public Holidays, evening period is 6.00 pm–10.00 pm and night period is 10.00 pm to commencement of day period.*

[2] *Residential receiver R01 is involved in the Project (host receiver) and the PNTLs are not applicable.*

4.3 Road Traffic Noise Criteria

An assessment of potential noise levels from Project-related traffic on Ringwood Road/Wollara Road is required. The NSW *Road Noise Policy (RNP) (DECCW)* sets out criteria for road traffic noise through the provision of a framework that addresses traffic noise issues associated with new developments, new or upgraded road developments, or planned building developments. Based on functionality, Ringwood Road/ Wollara Road is classified as a sub-arterial road. **Table 4.9** outlines the road traffic noise criteria for residential land uses along Ringwood Road/Wollara Road.

Table 4.9 Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project/Land Use	Assessment Criteria dB(A)	
		Day 7:00 am–10:00 pm	Night 10:00 pm–7:00 am
Freeway/arterial/ sub-arterial road	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,(15\ hour)}$ 60 (external)	$L_{Aeq,(9\ hour)}$ 55 (external)

Additionally, Section 3.4 of the RNP notes that where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of a project by applying the relative increase criteria.

The EPA publication Applying the NSW Road Noise Policy states:

> *"…for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."*

In assessing noise impact, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

5.0 Construction Noise and Vibration Assessment

5.1 Construction Noise

5.1.1 Construction Staging

Noise and vibration associated with the road upgrades is not assessed in this section but is assessed separately in **Section 5.3**.

The construction period for the Project will be undertaken across multiple stages. The total construction timeframe is anticipated to be approximately 27 months.

The construction activities will broadly include the following scenarios:

1. Site establishment and civil works.
2. Piling and foundations.
3. Assembly of all equipment (trackers, inverters, modules, balance of system).
4. Underground cabling.
5. Commissioning.
6. Site rehabilitation, removal of temporary construction facilities.

It is likely that some of these activities may occur simultaneously through the progression of the construction program.

5.1.2 Construction Hours

Construction activities are proposed to be undertaken both during and outside standard construction hours specified in the ICNG. The proposed construction hours are as follows:

- Monday to Friday: 6.00 am–6.00 pm (note that the period 6:00 am–7:00 am is outside the ICNG standard hours).
- Saturday: 6.00 am–6.00 pm (note that the periods 6:00 am–8:00 am and 1:00 pm–6:00 pm are outside the ICNG standard hours).
- Sunday and public holidays: No work.

Exceptions to the above hours may occur, however would be limited to activities with low noise generation where practicable. These activities would be assessed on a case-by-case basis prior to the commencement of those activities. The Upper Hunter Council would be notified of any foreseeable exceptions. This would include justifying why works are required outside the standard hours and outlining the timing, duration and potentially expected noise levels.

5.1.3 Construction Equipment

The typical construction activities (Scenarios 1 to 6) and associated equipment and respective sound power levels (SWLs) of equipment are outlined in **Table 5.1**. Typical sound power levels have been sourced from the *Roads and Maritime Construction Noise Estimator Tool* and Umwelt's noise source library.

Table 5.1 Indicative Construction Scenarios, Equipment and Sound Power Levels

Construction Stages / Scenarios	Activity description	Equipment	Sound Power Levels $L_{Aeq(15\ min)}$ dB(A)/ unit	Combined Sound Power Level $L_{Aeq(15\ min)}$ dB(A)
Sc.1	Site establishment and civil works	Asphalt paver	114	120
		Grader	113	
		Dozer	110	
		Dump truck	110	
		Roller	109	
		Delivery trucks	108	
		Water truck	107	
		Excavator	106	
		Compactor	106	
		Bobcat	104	
		Generator	103	
		Mobile crane / telehandler	98	
		Light vehicle	90	
Sc.2	Piling and foundations	Pneumatic pile driving rig	117 (112 + 5) [1]	118
		Concrete truck	109	
		Excavator	106	
		Bobcat	104	
		Mobile crane / telehandler	98	
		Light vehicle	90	
Sc.3	Assembly of all equipment (trackers, inverters, modules, balance of system)	Pneumatic wrench	113	116
		Powered hand tools	110	
		Truck	108	
		Mobile crane 130T	105	
		Compressor	103	
		Generator	103	
		Mobile crane / telehandler	98	
		Light vehicle	90	

Construction Stages / Scenarios	Activity description	Equipment	Sound Power Levels $L_{Aeq(15\ min)}$ dB(A)/ unit	Combined Sound Power Level $L_{Aeq(15\ min)}$ dB(A)
Sc.4	Underground cabling	Loader	112	113
		Bobcat/trencher	104	
		Cable trenching and laying equipment	100	
		Light vehicle	90	
Sc.5	Commissioning	Power hand tools	110	113
		Electrical works/testing	110	
		Mobile crane	98	
		Light vehicle	90	
Sc.6	Site rehabilitation, removal of temporary construction facilities	Dump truck	110	113
		Truck	108	
		Forklift	100	
		Mobile crane / telehandler	98	
		Light vehicle	90	

Note: [1] *Includes a +5 dB penalty for impulsiveness characteristics.*

5.1.4 Construction Noise Levels

Prediction of the construction noise levels was undertaken with the proprietary computer noise modelling software CadnaA (Version 2021 MR 2), using the CONCAWE noise prediction algorithms. Default worst-case noise-enhancing meteorological conditions (D-class with 3 m/s windspeed or F-class with 2 m/s windspeed) in accordance with the NPfI, have been utilised for the assessment.

Construction noise levels have been predicted for the six (6) indicative construction scenarios described in **Section 5.1.1** and **Table 5.1**. The predictions are conservative and assume all equipment associated with each scenario is operating simultaneously at the closest point within the development boundary to the respective residential receiver location. In reality, a receiver would experience a range of construction noise levels, dependent upon the number of plant items operating at any one time and their precise location on site.

For the Goulburn River National Park, given the vastness of the park and the unlikely chance of park use (i.e., bush walking) occurring at the same time as construction operating near the development boundary, a receiver point 200 m from the Project Area was adopted for noise prediction purposes. This is represented as R10 in **Figure 3.1**.

Results for each construction scenario (Sc.1 to Sc.6) for the identified receivers are presented in **Table 5.2**.

The predicted noise level contours for the worst-case scenario (Sc. 1) are presented graphically in **Figure 5.1**.

The construction noise levels are predicted to comply with the noise management levels at all sensitive receivers not involved with the Project. Reasonable and feasible noise mitigation and management strategies have been provided in **Section 5.3**. Whilst it is not essential to adopt these measures, in accordance with the ICNG, it is considered best practice to minimise construction noise as much as possible.

Table 5.2 Predicted Construction Noise Levels, dB(A)

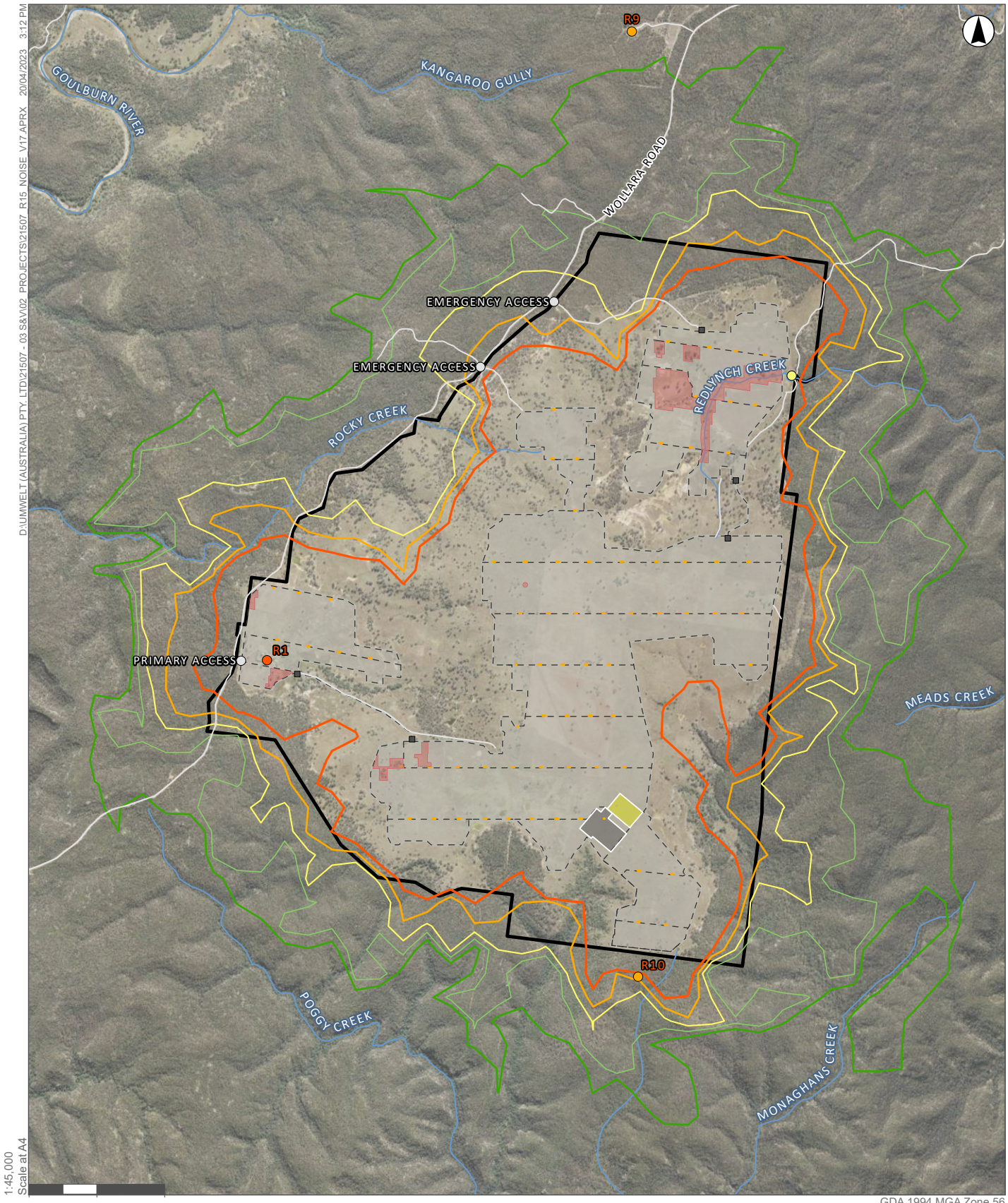
Receiver ID	Noise Management Level, LAeq(15 min)		Construction Scenario Noise Prediction, LAeq(15 min)					
	Standard Hours	Outside Standard Hours (D/E/N) [4]	Sc.1	Sc.2	Sc.3	Sc.4	Sc.5	Sc.6
R01 (host receiver)[1]	-	-	61	59	57	54	54	54
R02	45	40/35/35	<20	<20	<20	<20	<20	<20
R03	45	40/35/35	31	29	27	24	24	24
R04	45	40/35/35	31	29	27	24	24	24
R05	45	40/35/35	30	28	26	23	23	23
R06	45	40/35/35	24	22	20	<20	<20	<20
R07	45	40/35/35	<20	<20	<20	<20	<20	<20
R08	45	40/35/35	<20	<20	<20	<20	<20	<20
R09	45	40/35/35	27	25	23	<20	<20	<20
R10 [2]	60		52	50	48	45	45	45

Notes: *[1] Residential receiver R01 is involved in the Project (host receiver) and the Noise Management Levels are not applicable.*

[2] This is a worst-case representative location for passive recreational users of the National Park.

[3] Predictions below 20 dB(A) have been presented as <20.

[4] Day period is 7.00 am–6.00 pm; Evening period is 6.00 pm–10.00 pm and night period is 10.00 pm–7.00 am.



Legend

- Host Receiver
- Sensitive Receiver
- Dwelling (abandoned)
- Gate
- Access Points
- Roads and Tracks
- Watercourse
- Project Area
- Battery Energy Storage System
- Battery Substation
- Inverters
- Exclusion Zones - Environmentally Sensitive Areas
- Development Footprint

Predicted Noise Levels

- Noise Contour Level 35 dB(A)
- Noise Contour Level 40 dB(A)
- Noise Contour Level 45 dB(A)
- Noise Contour Level 50 dB(A)
- Noise Contour Level 55 dB(A)

FIGURE 5.1

Construction Scenario 1 Predicted Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

For the Goulburn River National Park (R10), given the vastness of the park and available bushwalking area, a receiver point 200 m from the Project Area was adopted for noise prediction purposes. For the predictions, the receiver point was located proximity to the substation and BESS (the highest noise emitting source on site)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

5.2 Construction Vibration

Potential vibration impacts associated with the road upgrades is not assessed in this section but is assessed separately in **Section 5.3**.

Many items of construction equipment generate vibration that may cause structural damage to buildings or other structures.

As outlined in **Section 4.1.2.2**, due to large separation distances, human annoyance at surrounding buildings due to vibration-generating construction activities is anticipated to be negligible. Section 2.3 of the EIS Historical Heritage Assessment (Umwelt 2022) states that there are no listed historical heritage items within or in proximity to the Project Area. However, an original slab hut located near the centre of the Project Area was identified as having high archaeological potential.

Accordingly, the types of vibration-sensitive receivers in the Project Area include:

- residential dwellings (the landowner)
- commercial/agricultural buildings
- original slab hut.

5.2.1 Residential and Commercial / Agricultural Buildings

The commercial/agricultural buildings in the area are assumed to be structurally similar to residential buildings, therefore the assessment for residential buildings is considered to be relevant for the commercial/agricultural buildings as well.

Recommended safe working distances for vibration-generating equipment from sensitive receivers (i.e., the receiver building or its occupants) are given in Table 2 of the NSW *Construction Noise and Vibration Guideline* (CNVG) (RMS, 2016) reproduced below in **Table 5.3**.

Table 5.3 Recommended Minimum Working Distances for Vibration Generating Plant from a Residential Sensitive Receiver (CNVG Table 2)

Plant Item	Rating/Description	Minimum Working Distance [1, 2]	
		Cosmetic Damage (Residential Building)	Human Response
Vibratory Roller	< 50 kN (Typically 1–2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2–4 tonnes)	6 m	20 m
	< 200 kN (Typically 4–6 tonnes)	12 m	40 m
	< 300 kN (Typically 7–13 tonnes)	15 m	100 m
	> 300 kN (Typically 13–18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	300 kg – 5 to 12 t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg – 12 to 18 t excavator	7 m	23 m

Plant Item	Rating/Description	Minimum Working Distance [1, 2]	
		Cosmetic Damage (Residential Building)	Human Response
Large Hydraulic Hammer	1600 kg – 18 to 34 t excavator	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	4 m
Jackhammer	Handheld	1 m (nominal)	2 m

Notes: [1] *For alternative equipment with higher vibration levels, larger minimum working distances are required.*

[2] *More stringent conditions may apply to heritage or other sensitive structures.*

Due to the large separation distances between the Project and the sensitive receivers (excluding host receiver) (i.e., approximately 1.7 km), vibration impacts from construction activities associated with the Solar Farm and BESS are anticipated to be negligible.

5.2.2 Original Slab Hut

As identified in the EIS Historical Heritage Assessment (Umwelt 2022) no listed heritage items were identified but an original slab hut was identified as having high archaeological potential. The original slab hut is limited to five erect timber posts, dismantled burnt timber sleepers and some scattered worked stone blocks. Whilst this structure is not heritage listed, recommended safe working distances based on a heritage item has been provided for information and guidance.

As discussed in **Section 4.1**, heritage structures can be more sensitive to vibration impacts than modern structures and therefore have a more stringent vibration screening limit of 2.5 mm/s PPV. The safe working distances presented in **Table 5.3** for residential structures have been scaled to allow for heritage structures through the application of the vibration scaling method presented in the Federal Transit Administration's Transit Noise and Vibration Impact Assessment Manual. The safe working distances for the original slab hut is presented in **Table 5.4**.

The minimum distance of the proposed infrastructure and machinery from the original slab hut is 20 metres. This falls outside of the minimum working distances with **Table 5.4**.

Table 5.4 Recommended Minimum Working Distances for Vibration Generating Plant from a Heritage Receiver (CNVG Table 2)

Plant Item	Rating/Description	Minimum Working Distance
		Cosmetic Damage (Heritage Structures)
Vibratory Roller	< 50 kN (Typically 1–2 tonnes)	12 m
	< 100 kN (Typically 2–4 tonnes)	15 m
	< 200 kN (Typically 4–6 tonnes)	25 m
	< 300 kN (Typically 7–13 tonnes)	35 m
	> 300 kN (Typically 13–18 tonnes)	45 m
	> 300 kN (> 18 tonnes)	55 m

Plant Item	Rating/Description	Minimum Working Distance
		Cosmetic Damage (Heritage Structures)
Small Hydraulic Hammer	300 kg – 5 to 12 t excavator	5 m
Medium Hydraulic Hammer	900 kg – 12 to 18 t excavator	15 m
Large Hydraulic Hammer	1600 kg – 18 to 34 t excavator	50 m
Vibratory Pile Driver	Sheet piles	45 m
Pile Boring	≤ 800 mm	5 m
Jackhammer	Handheld	35 m

5.3 Ringwood Road Upgrades Construction Noise and Vibration Assessment

5.3.1 Description of Works

Road repairs and upgrades are proposed outside of the Project Area. The following works are proposed:

- **Work Area 1** – Culvert upgrade along Ringwood Road at Bow River.
- **Work Area 2** – Road repairs along Ringwood Road – 1.8 km section to be widened and resealed between Bow River and Killoe Creek.
- **Work Area 3** – Culvert upgrades along Ringwood Road at Killoe Creek.

The location of the works areas are shown in **Figure 5.2**. The works are anticipated to be completed within a 3-month construction period.

5.3.2 Receivers and Noise Management Levels

Residences within 2 km of the work areas have been identified and are shown in **Figure 5.2**. The nearest two (2) receivers to each of the work areas are shown in **Table 5.5**.

Table 5.5 Nearest Residential Receivers

Work Area	Receiver ID	Address / Description	Approximate Distance (m) from works
Work Area 1	R11	549 Ringwood Road, Merriwa	550 m
	R15	552 Ringwood Road, Merriwa	550 m
Work Area 2	R11	549 Ringwood Road, Merriwa	70 m
	R15	552 Ringwood Road, Merriwa	85 m
Work Area 3	R13	812 Ringwood Road, Merriwa	1,100 m
	R14	704 Ringwood Road, Merriwa	450 m

The receivers surrounding the works are located within RU1 rural residential land (zoned RU1 Primary Production). Given the rural environment, background noise level monitoring was not undertaken, and minimum background noise levels have been adopted in accordance with the NPfI. The adopted construction noise management levels for standard construction hours are shown within **Table 4.2**. These levels are consistent with the rest of the Project.

5.3.3 Construction Hours

Construction hours for the road upgrades are different to the solar farm. For the road upgrades, construction activities are proposed to be undertaken during standard construction hours specified in the ICNG. The proposed construction hours are as follows:

- Monday to Friday: 7.00 am–6.00 pm.
- Saturday: 8.00 am–1.00 pm.
- Sunday and public holidays: No work.

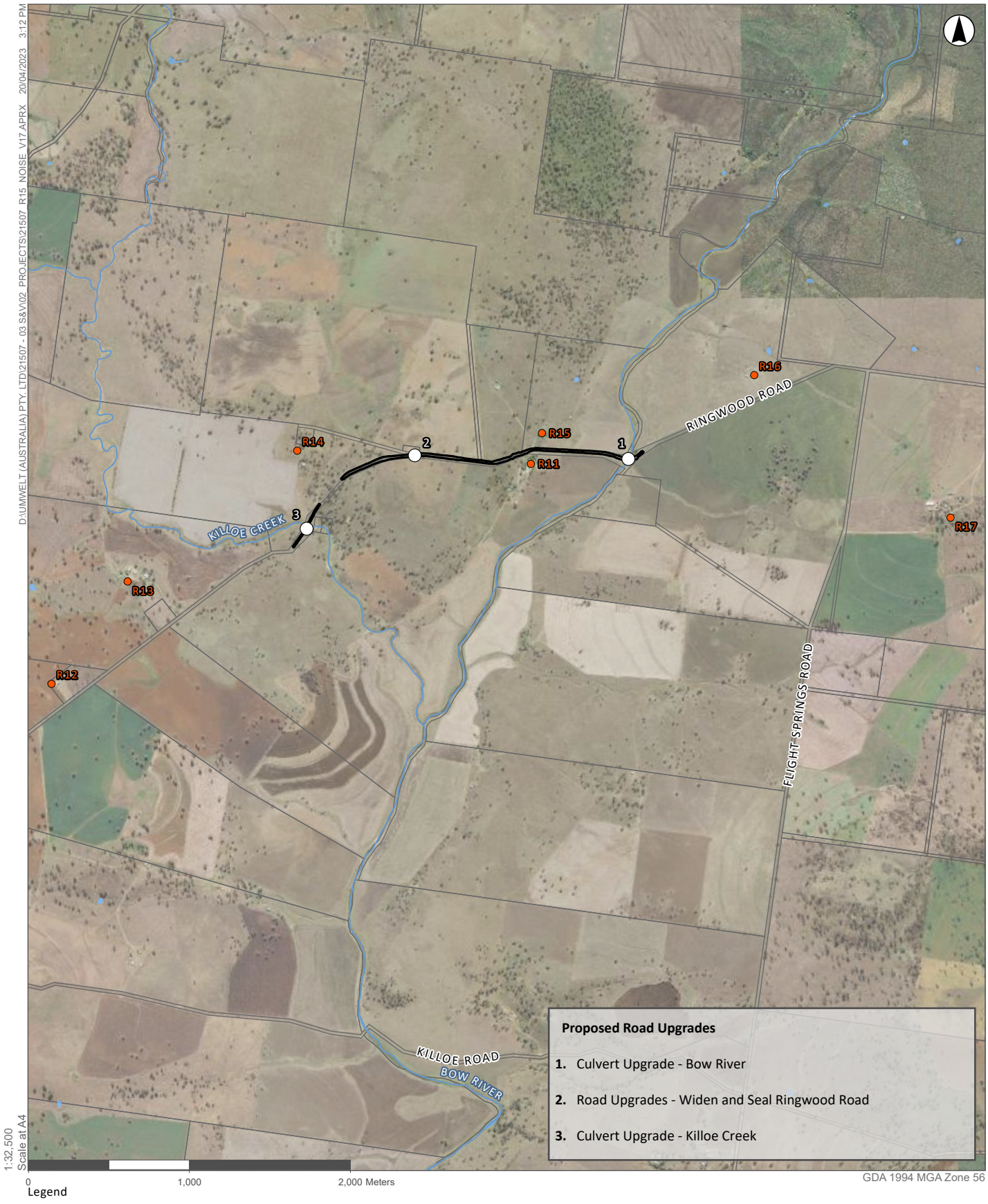


FIGURE 5.2

Road Upgrade Work Areas and Sensitive Receivers

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

5.3.4 Equipment

The typical construction activities (Scenarios 7 to 11) and associated equipment and respective sound power levels (SWLs) of equipment are outlined in **Table 5.6**. Typical sound power levels have been sourced from the *Roads and Maritime Construction Noise Estimator Tool* and Umwelt's noise source library. Note, Scenario 9 (Culvert works) is not applicable for Work Areas 2 and 4.

Table 5.6 Indicative Construction Scenarios, Equipment and Sound Power Levels

Construction Stages / Scenarios	Activity description	Equipment	Sound Power Levels $L_{Aeq(15\ min)}$ dB(A)/ unit	Combined Sound Power Level $L_{Aeq(15\ min)}$ dB(A)	
				All equipment	All equipment without high noise emitting plant [2]
Sc.7	Vegetation Clearing	Tub Grinder	121 [2]	123	117
		Chainsaw	115 [2]		
		Dozer	110		
		Truck	108		
		Excavator	106		
Sc.8	Bulk earthworks	Excavator with hammer	122 (117 + 5) [1, 2]	123	117
		Grader	113		
		Dozer	110		
		Roller	109		
		Truck	108		
		Water truck	107		
		Excavator	106		
Sc.9	Culvert works	Jackhammer	117 (112 + 5) [1, 2]	119	114
		Powered hand tools	110		
		Concrete Truck	108		
		Mobile crane 60T	105		
		Compressor	103		
		Generator	103		
		Mobile crane/ telehandler	98		
Sc.10	Paving / asphalting (including concrete saw)	Concrete saw	122 (117 + 5) [1, 2]	123	117
		Asphalt paver	114		
		Roller	109		
		Trucks	108		
		Trencher	106		
		Bobcat	104		

Construction Stages / Scenarios	Activity description	Equipment	Sound Power Levels $L_{Aeq(15\ min)}$ dB(A)/ unit	Combined Sound Power Level $L_{Aeq(15\ min)}$ dB(A)	
				All equipment	All equipment without high noise emitting plant [2]
Sc.11	Road furniture installation	Power hand tools	110	113	113
		Line marking truck	108		
		Truck	98		
		Mobile crane / telehandler	98		
		Scissor Lift	98		

Notes: [1] *Includes a +5 dB penalty for impulsiveness characteristics.*

[2] *For this assessment high noise emitting plant considered to be tub grinder, chainsaw, rock hammers, jackhammers and concrete saws.*

5.3.5 Construction Noise Levels

Prediction of the construction noise levels was undertaken with CadnaA under worst-case noise-enhancing meteorological conditions (D-class with 3 m/s windspeed or F-class with 2 m/s windspeed).

Construction noise levels have been predicted for the five (5) indicative construction scenarios described in **Table 5.6**. The predictions are conservative and assume all equipment associated with each scenario is operating simultaneously at the closest point to the receiver. In reality, a receiver would experience a range of construction noise levels, dependent upon the number of plant items operating at any one time and their location as the works progress along the roadway.

For each work area, the results for each construction scenario (Sc.7 to Sc.11) for the identified receivers are presented in **Table 5.7** for all equipment operating. Also presented, is predicted noise levels for all equipment operating except for high noise emitting plant (i.e., tub grinder, chainsaw, rock hammers, jackhammers and concrete saw).

For each work area, the predicted noise level contours for the worst-case scenario(s) with all equipment operating (Sc. 7, Sc. 8 and Sc. 10) are presented graphically in **Figure 5.3** to **Figure 5.5**.

The construction noise levels are predicted to exceed the noise management levels at some receivers for some of the work areas and scenarios. However, no receivers are predicted to be highly noise affected (i.e., exposed to construction noise levels greater than 75 dB(A)).

Reasonable and feasible noise mitigation and management strategies have been provided in **Section 5.3**.

Table 5.7 Predicted Construction Noise Levels, dB(A)

Receiver ID	Noise Management Level, LAeq(15 min)	Construction Scenario Noise Prediction, LAeq(15 min)																	
		Work Area 1						Work Area 2						Work Area 3					
	Standard Hours	Sc.7, 8 &10		Sc.9		Sc.11		Sc.7, 8 &10		Sc.9 [2]		Sc.11		Sc.7, 8 &10		Sc.9		Sc.11	
		H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
R11	45	**53**	**47**	**49**	44	n/a	43	**73**	**67**	n/a	n/a	n/a	**63**	24	<20	20	<20	n/a	<20
R12	45	21	<20	<20	<20	n/a	<20	35	29	n/a	n/a	n/a	25	30	24	26	21	n/a	20
R13	45	21	<20	<20	<20	n/a	<20	43	37	n/a	n/a	n/a	33	41	35	37	32	n/a	31
R14	45	23	<20	<20	<20	n/a	<20	**60**	**54**	n/a	n/a	n/a	**50**	**55**	**49**	**51**	**46**	n/a	45
R15	45	**53**	**47**	**49**	44	n/a	43	**72**	**66**	n/a	n/a	n/a	**62**	24	<20	20	<20	n/a	<20
R16	45	39	33	35	30	n/a	29	42	36	n/a	n/a	n/a	32	<20	<20	<20	<20	n/a	<20
R17	45	26	20	22	<20	n/a	<20	27	21	n/a	n/a	n/a	<20	20	<20	<20	<20	n/a	<20

Notes: *[1] Predictions below 20 dB(A) have been presented as <20.*

[2] Scenario not applicable for work area.

[3] H – Includes high noise emitting plant (i.e., tub grinder, chainsaw, rock hammers, jackhammers and concrete saws).

[4] L – Excludes high noise emitting plant (i.e., tub grinder, chainsaw, rock hammers, jackhammers and concrete saws).

*[5] Predicted exceedances are in **Red**.*

[6] Receivers outside of the assessment area have been excluded from this table.

Legend

- Sensitive Receivers
- Road Upgrades
- Watercourse
- Lot Boundary
- Proposed Road Upgrades

Predicted Noise Levels

- Noise Contour Level 45 dB(A)
- Noise Contour Level 50 dB(A)
- Noise Contour Level 55 dB(A)

FIGURE 5.3

Work Area 1 - Construction Scenario 7, 8 and 10 – Predicted Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

FIGURE 5.4

Work Area 2 - Construction Scenario 7, 8 and 10 – Predicted Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

FIGURE 5.5

Work Area 3 - Construction Scenario 7, 8 and 10 – Predicted Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

5.3.6 Construction Vibration Levels

Recommended safe working distances for vibration-generating equipment from sensitive receivers (i.e. the receiver building or its occupants) were provided in **Table 5.3**.

Except for receiver R11 and R15, all the identified residential dwellings fall outside of the minimum working distances. For Work Area 2, receiver R11 and R15 fall within the minimum working for human response for some plant items (i.e., vibratory roller >7 tonnes and large hydraulic hammer >18 tonnes). However, given the transient nature of the works, human disturbance impacts are anticipated to be low.

Construction vibration mitigation strategies are provided in **Section 5.4**.

5.4 Construction Mitigation Measures and Strategies

The construction noise levels for the Ringwood Road Repairs and Culvert Upgrades were predicted to exceed the nominated noise management levels. As shown in **Table 5.7,** for work Area 1 exceedances were predicted at R11 and R15 of up to 8 dB(A). For work Area 2, exceedances of up to 28 dB(A), 15 dB(A) and 27 dB(A) were respectively predicted at R11, R14 and R15. For work Area 3, exceedances of up to 10 dB(A) were predicted at R14.

The noise and vibration mitigation measures in **Section 5.4.1** and **Section 5.4.2** should be implemented during the road upgrade works.

The construction noise levels for the Solar Farm and BESS are predicted to comply with the nominated noise management levels. Whilst it is not essential to adopt the below measures, in accordance with the ICNG, it is considered best practice to minimise construction noise as much as possible. The vibration measures should be considered for identified structures within the Project Area.

5.4.1 Noise Mitigation Measures and Strategies

- A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the Construction Environmental Management Plan (CEMP). The NVMP will generally follow the approach in the ICNG and identify:
    - all potential significant noise and vibration generating activities associated with the Project
    - feasible and reasonable mitigation measures to be implemented
    - a monitoring program to assess performance against relevant noise and vibration criteria
    - arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures
    - contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.

For best practice, the additional mitigation measures outlined in the Transport for NSW (TfNSW) *Construction Noise and Vibration Guideline* (CNVG, August 2016) should be adopted.

- All sensitive receivers likely to be affected should be notified at least 7 days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification should include:
    - details of the Project
    - the construction period and construction hours
    - contact information for Project management staff
    - complaint and incident reporting
    - how to obtain further information.
- All employees, contractors and subcontractors are to receive an environmental induction. The induction must include at a minimum, all applicable mitigation measures; hours of works; any limitations on high noise-generating activities; location of nearest sensitive receivers; designated parking areas; relevant approval conditions and incident procedures.
- Contractors should keep noise to a minimum, including limiting the use of loud stereos/radios, shouting on site and car door slams.
- Where practical, no dropping of materials from height or throwing of metal items.
- If required a noise verification program should be carried out in accordance with the NVMP for the Project (note, verification not applicable for projects less than 3 weeks). The draft CNVMP within **Appendix B**, details what scenarios and receivers are triggered for verification monitoring.
- The noise levels of plant and equipment should have operating sound power levels consistent with those nominated in **Table 5.1**.
- Noise emitting plant to be directed away from sensitive receivers and to be throttled down or shut down when not in use.
- Non-tonal reversing beepers could be fitted and used on construction vehicles and mobile plant used regularly on site and for any out of hours work.
- Limit the use of engine compression brakes.
- Where feasible and reasonable, work generating high noise and/or vibration should be scheduled during less sensitive time periods.

5.4.1.1 Noise Monitoring

The following approach should be adopted with regard to noise monitoring procedures during the construction works:

- Where potential noise impacts are predicted to be 10 dB(A) above the noise criteria during standard construction hours, the potential construction noise nuisance is considered to be moderate. Reasonable and feasible noise reduction measures must be investigated, where necessary. Noise monitoring should be carried out to verify background noise level and construction noise level. The draft CNVMP within **Appendix B**, details what scenarios and receivers are triggered for verification monitoring. Note this is not required for projects less than 3 weeks in duration unless to assist in managing complaints.
- In the event of a reasonable noise compliant, noise monitoring should be carried out to confirm predicted noise levels. Reasonable and feasible noise reduction measures must be investigated, where necessary.

5.4.2 Construction Vibration Mitigation Strategies

The actual construction equipment to be used on site would be confirmed by the construction contractor during the detailed design phase. For any vibration-generating plant not listed in **Table 5.3**, minimum working distances would need to be established.

In the event that any vibration-generating equipment would be used within the recommended safe working distances nominated in **Table 5.3** and **Table 5.4**, the following is recommended:

- An independent specific structural assessment is undertaken on the structure to ascertain the structural integrity and its ability to withstand vibration, and establishment of an appropriate vibration criterion.
- A dilapidation survey is undertaken on the structure prior to works commencing, and regular inspection of the structure throughout the construction activities.
- Establish site specific vibration minimum working distances for the nominated equipment on site.
- Where appropriate, continuous vibration monitoring is conducted on the structure for the duration of the period of construction while vibration generating equipment is used. The vibration logger should be equipped with the facility to remotely alert the site to reduce or cease construction activities if vibration levels are approaching the criterion threshold.

6.0 Operational Noise Assessment

6.1 Modelling Methodology

Prediction of the operational noise levels was undertaken with the proprietary computer noise modelling software CadnaA (Version 2021 MR 2), using the CONCAWE noise prediction algorithms. The operational noise model was developed using 3-Dimensional terrain data (10 m contour interval). Ground absorption for the area was modelled as acoustically soft ground.

6.2 Noise Source Data

Lightsource bp has provided indicative reference noise data for the proposed equipment/plant to be installed on site for the Project. This has been supplemented with additional source data from Umwelt's noise source library. The proposed equipment, utilisation, quantities and sound power levels are summarised in **Table 6.1**.

Table 6.1 Indicative Equipment Quantities and Sound Power Levels

Plant Item	Quantity	Indicative Sound Power Level per unit, dB(A)	Assumed utilisation per unit per 15-minute period
Tracker motor	12,558	78 [2]	7% (1 minute per 15 minutes)
PV Inverters	140	99 (94 dB(A) + 5 dB) [3]	100%
BESS Inverters	33	99 (94 dB(A) + 5 dB) [3]	100%
BESS	33 [1]	91 [2]	100%
Substation (270 MVA transformer)	2	105	100%
HVAC (O&M building and control room)	2	72 [2]	100%
Light vehicle	2	89 [2]	100%

Notes: [1] *An approximation.*

[2] *Assumed sound power level sourced from Umwelt noise source library.*

[3] *Includes an assumed +5 dB penalty for tonality.*

6.3 Operational Noise Levels

The noise levels have been predicted under default worst-case meteorological conditions (D-class with 3 m/s windspeed or F-class with 2 m/s windspeed) in accordance with the NPfI. For a conservative assessment against the night-time noise goal, it was assumed that all plant and equipment within **Table 6.1**, would be operating concurrently at 100% capacity.

The predicted operational noise levels at the identified receivers are presented in **Table 6.2** and shown graphically as noise contours in **Figure 6.1**.

The operational noise levels are predicted to comply with the day, evening and night-time noise limits at all external sensitive receivers not involved with the Project.

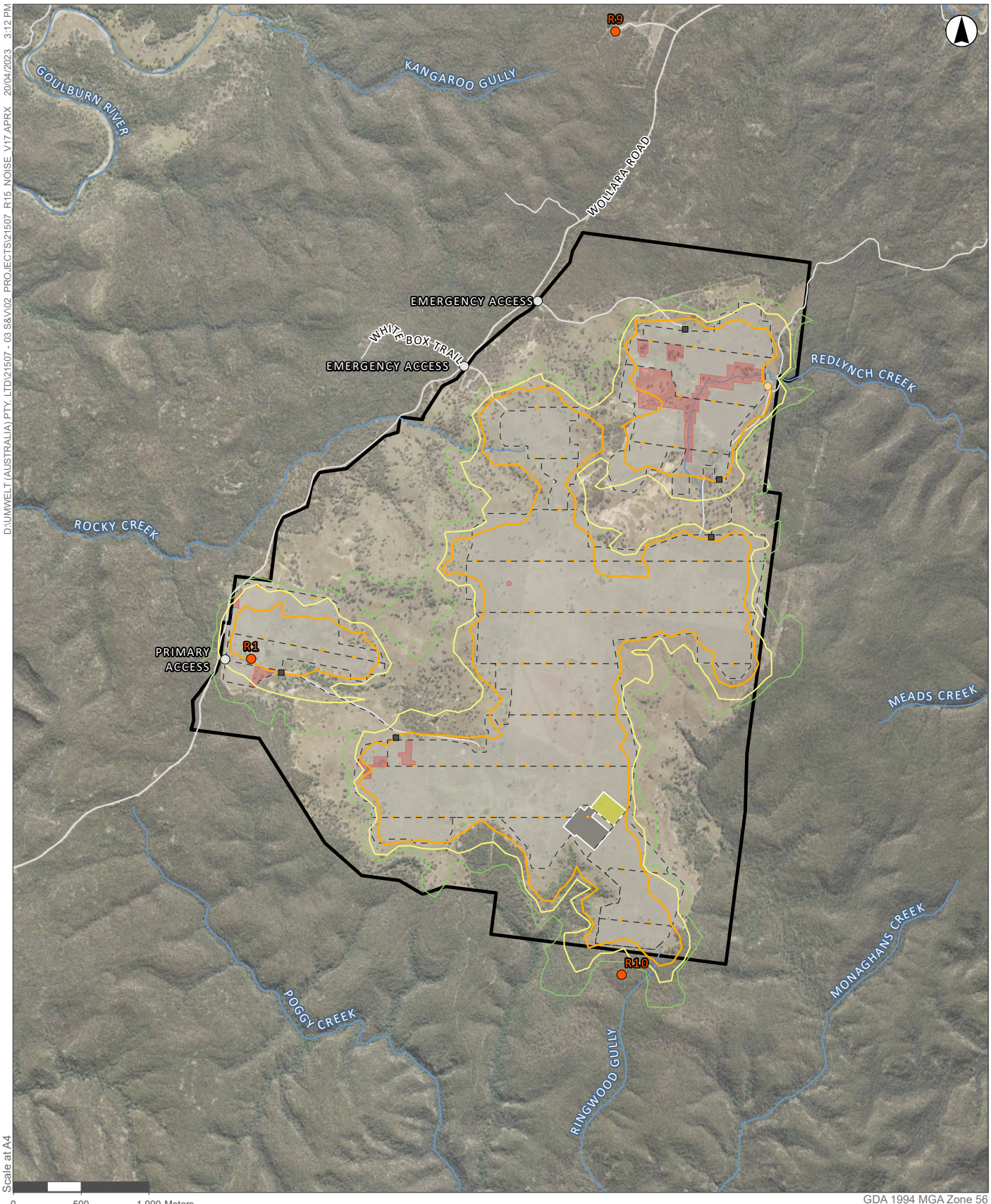
Table 6.2 Predicted Operational Noise Levels, dB(A)

Rec ID	Predicted Noise Level, $L_{Aeq(15\ min)}$	Night-time PNTL, $L_{Aeq(15\ min)}$
R01 (host receiver) [1]	46	-
R02	<20	35
R03	<20	35
R04	<20	35
R05	<20	35
R06	<20	35
R07	<20	35
R08	<20	35
R09	<20	35
R10 [2]	38	53

Notes: [1] *Residential receiver R01 is involved in the Project (host receiver) and the PNTLs are not applicable.*

[2] *This is a worst-case representative location for passive recreational users of the National Park.*

[3] *Predictions below 20 dB(A) have been presented as <20.*



Legend

- Sensitive Receivers
- Dwellings
- Gate
- Access Points
- Proposed Access Tracks
- Watercourse
- Roads and Tracks

Predicted Noise Levels

- Noise Contour Level 35 dB(A)
- Noise Contour Level 40 dB(A)
- Noise Contour Level 45 dB(A)

- Project Area
- Exclusion Zones - Environmentally Sensitive Areas
- Battery Energy Storage System
- Battery Substation
- Inverters
- Development Footprint

FIGURE 6.1

Predicted Operational Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

For the Goulburn River National Park (R10), given the vastness of the park and available bushwalking area, a receiver point 200 m from the Project Area was adopted for noise prediction purposes. For the predictions, the receiver point was located proximity to the substation and BESS (the highest noise emitting source on site)

Image Source: ESRI Basemap (2021) **Data source:** NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019); Lightsource BP (2022)

7.0 Road Traffic Noise Assessment

7.1 Construction Traffic

Construction material and equipment would typically be transported via road from the Port of Newcastle, then the Golden Highway and Ringwood Road/Wollara Road to the Project Area.

The following assumptions have been applied in evaluating the potential traffic noise impacts:

- Given existing traffic volume along the Golden Highway (Average Annual Daily Traffic (AADT) 3,810 vehicles [ref: TfNSW 2007 Station ID 92456]), Project related traffic noise impacts at receivers located along this road, are anticipated to be negligible.
- The existing traffic volumes for Ringwood Road/Wollara Road have been derived from local traffic counts conducted in 2022, as provided in the Traffic Impact Assessment (Turnbull Engineering, 2022).
- According to the Turnbull Engineering traffic report *Goulburn River Solar Farm – Traffic and Transport Impact Assessment, Revision 1.0*, dated 2 June 2022 (Traffic Impact Assessment), the predicted daily traffic generated during peak construction will be 60 light vehicles (120 movements), 15 shuttle buses (30 movements) and 55 heavy vehicles (110 movements).
- The following assumptions in relation to traffic movements have been made:
    - 50% of the daily Project-related light-vehicle movements will be on the roads travelling to the Project Area during the night period (i.e., prior to 7.00 am).
    - 50% of the daily Project-related shuttle buses will be on the roads travelling to the Project Area during the night period (i.e., prior to 7.00 am). The shuttle buses for construction workers have been assessed as heavy vehicles.
    - Daily Project-related heavy-vehicle movements will be spread evenly throughout the day (i.e., averaged on an hourly basis).
    - The daily Project-related movements will travel to the Project Area from the north.
    - A Ringwood Road/Wollara Road traffic speed of 80 km/h has been adopted, which is based on the measured 85th percentile speed data.
- The nearest and potentially most affected receiver is Receiver R11 (549 Ringwood Road, Merriwa) shown on **Figure 3.2**. R11 is located approximately 70 metres from the carriageway of Ringwood Rd/Wollara Rd.
- Based on the above inputs and assumptions, the indicative construction-related traffic volumes adopted for the noise assessment are presented in **Table 7.1**.

Table 7.1 Indicative Construction Related Traffic Volumes

Location	Period	Parameter	Existing traffic volume (without Project) [1]	Project Related traffic volume [2]	Combined traffic volume (Existing + Project)
Ringwood Rd/ Wollara Rd	Day (7.00 am–10.00 pm)	Light Vehicles	157	60	217
		Heavy Vehicles	49	116 [3]	165
		Total	206	176	382
	Night (10.00 pm–7.00 am)	Light Vehicles	16	60	76
		Heavy Vehicles	1	24 [3]	25
		Total	17	84	101

Notes: [1] *Provided by Turnbull Engineering.*

[2] *Based on the Traffic Impact Assessment.*

[3] *The shuttle buses for construction workers have been assessed as heavy vehicles.*

Road traffic noise calculations were performed with CadnaA (Version 2021 MR 2), using the Calculation of Road Traffic Noise (CoRTN) algorithms.

Based upon the traffic volumes in **Table 7.1**, the predicted traffic noise levels for the nearest receiver located along Ringwood Road/Wollara Road is shown in **Table 7.2**.

Table 7.2 Predicted Traffic Noise levels, L_{Aeq}, dB(A)

Receiver	Time Period	RNP criteria	Existing traffic noise levels	Combined traffic noise levels	Noise Level Change due to Project	Comply / Exceed
549 Ringwood Rd, Merriwa	Day - $L_{Aeq(15\ hour)}$ (7.00 am–10.00 pm)	60	45	50	N/A [1]	Complies
	Night - $L_{Aeq(9\ hour)}$ (10.00 pm–7.00 am)	55	34	44	N/A [1]	Complies

Note: [1] *Change in noise level assessment is not applicable if the predicted noise level is below the noise limit.*

As shown in **Table 7.2** the construction traffic noise levels are predicted to comply with the criteria. In accordance with the RNP the Project construction traffic noise is predicted to be acceptable and have minor impact. Further, given the number of trucks associated with the Ringwood Road upgrade works is anticipated to be substantially lower (i.e., 60 movements per day), compliance is also predicted to be achieved.

7.2 Operational Traffic

Operational traffic movements are expected to be in the order of up to 10 two-way vehicles trips per day, therefore road traffic noise from operational traffic is anticipated to be negligible.

8.0 Cumulative Assessment

There are three open cut coal mines located within the vicinity of the study area: Ulan Mine, located 28 km west; Moolarben Mine, located 26 km west; and Wilpinjong Mine, located 16 km south-west. Noise and vibration sources associated with the operation of these mines include blasting and operation of heavy machinery.

There are numerous existing and proposed renewable energy projects located within the vicinity of the study area. Wollar Solar Farm is the closest, which is located 16 km south-west of the Project Area. Others include Merriwa Solar Farm, Stubbo Solar Farm, Beryl Solar Farm, Tallawang Solar Farm, Barneys Reef Wind Farm, Birrawa Solar Farm and Dunedoo Solar Farm but these are located greater than 45 km west of the Project Area.

The significant separation distances mean that these other projects and operations would not contribute acoustically to the established noise criteria and noise management levels of the sensitive receivers in proximity to the Project Area.

Furthermore, in regard to operational noise, as specified in the NPfI, where a PANL set 5 dB below the recommended amenity noise level can be met, no additional consideration of cumulative industrial noise is required. Based on the noise predictions in **Table 6.2**, the Project can readily achieve the PANL minus 5 dB.

Therefore, no cumulative noise impact is anticipated due to the construction and operation of the above listed existing and approved projects.

9.0 Decommissioning

The decommissioning of the Project would involve undertaking the construction activities in reverse. From a noise and vibration generating perspective, the decommissioning activities will be less intensive than the construction activities, given relatively intensive activities such as piling and civil works are not required. Noise emissions during decommissioning activities are therefore expected to be less than the construction activities and would comply with the nominated noise management levels.

10.0 Conclusion

An assessment of the potential noise and vibration impacts has been prepared for the proposed Goulburn River Solar Farm located near Merriwa, NSW.

Potential construction noise and vibration impacts have been assessed in accordance with the *Interim Construction Noise Guideline* (ICNG, 2009). For the solar farm and BESS, the assessment found that construction noise levels are predicted to comply with the established noise management levels. For the road upgrades, construction noise levels were predicted to exceed the established NMLs at some receivers. Noise and vibration mitigation measures and strategies were provided within.

Potential operational noise levels have been assessed in accordance with the *Noise Policy for Industry* (NPfI, 2017). This assessment found that the Project is expected to comply with the applicable day, evening and night-time noise limits at nearby sensitive receivers not involved with the Project. Therefore, no additional noise mitigation is anticipated to be required for the operation of the Project.

Construction-related road traffic noise has been assessed and was found to comply at the nearest most potentially affected dwelling. In accordance with the RNP the Project construction traffic noise is predicted to be acceptable and have minor impact.

Cumulative noise impacts from existing and approved projects in the area are not anticipated due to large separation distances and therefore comply with the NPfI requirements.

Noise emissions during decommissioning activities are expected to be less than construction activities and therefore would comply with the noise management levels for construction.

11.0 References

Noise Policy for Industry, Environment Protection Authority, 2017 (NPfI, EPA).

Interim Construction Noise Guideline NSW Department of Environment and Climate Change, 2009 (ICNG, DECC).

NSW Road Noise Policy, Department of Environment, Climate Change and Water, 2011 (RNP, DECCW).

Construction Noise Estimator Tool, Roads and Maritime, version 4/08/2016.

Construction Noise and Vibration Guideline, Roads and Maritime, v 1.0, 2016.

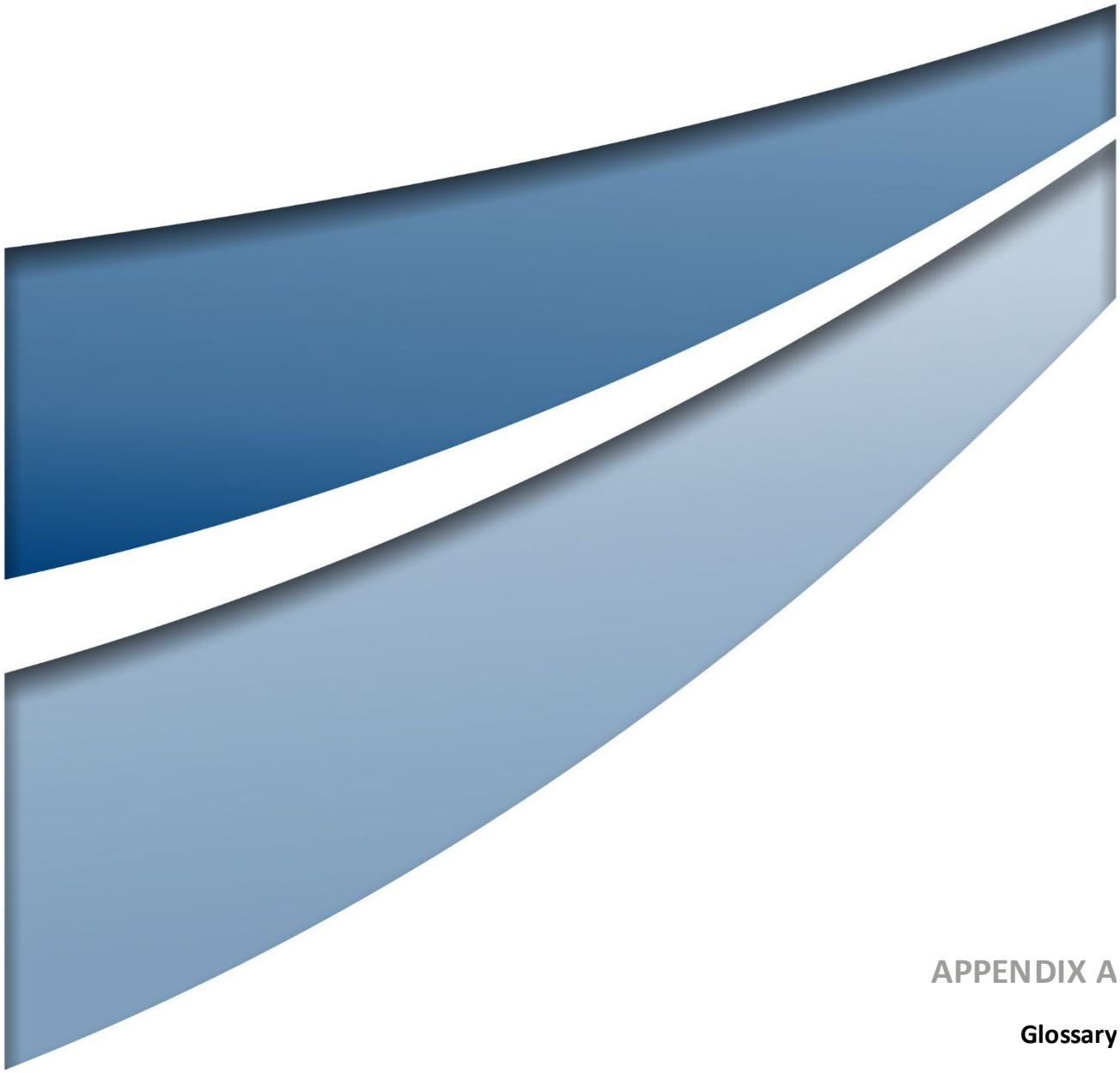
German Standard (Deutsche Norm) DIN 4150-3:1999-02 Structural Vibration Part 3: Effects of vibration on structures.

British Standard BS7385-2:1993 Evaluation and measurement for vibration in buildings Part 2. Guide to damage levels from groundborne vibration.

Australian Standard AS2436-2010 (R2016) Guide to Noise Control on Construction, Demolition and Maintenance Sites.

Large-Scale Solar Energy Guideline for State Significant Development, 2018 (DPE).

Goulburn River Solar Farm Scoping Report (Umwelt 2021).



APPENDIX A

Glossary

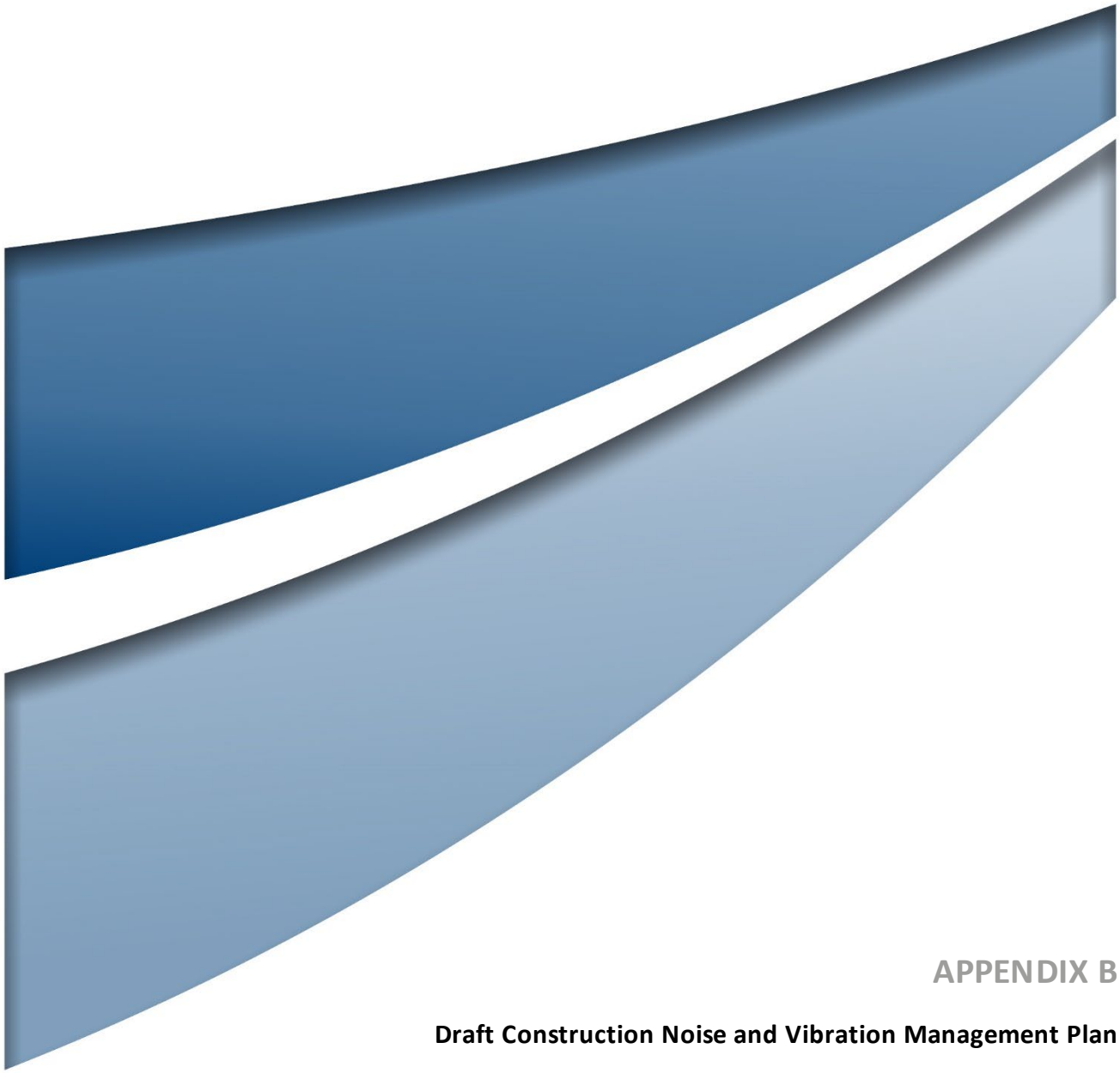
Glossary

Table A.1 provides descriptions of terms and abbreviations which may be used in this report.

Table A.1 Glossary of Terms and Abbreviations

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 – a single-figure background noise level representing each assessment period – day, evening and night (that is, three assessment background levels are determined for each 24-hour period of the monitoring period). It is determined by taking the lowest 10th percentile of the L_{90} level for each assessment period.
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.
Recommended Amenity Noise Level	Recommended noise levels scaled to reflect the perceived differential expectations and ambient noise environments of rural, suburban and urban communities for sensitive receivers.
Assessment Background Level (ABL)	The single-figure background level representing each assessment period: day, evening and night (that is, three assessment background levels are determined for each 24-hour period of the monitoring period). Its determination is by the methods described in Fact Sheet B.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dB(A), dBA	Decibels A-weighted.
dB(C), dBC	Decibels C-weighted.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Day	The period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays.
Decibel (dB)	The units of sound level and noise exposure measurement where a step of 10 dB is a ten-fold increase in intensity or sound energy and actually sounds a little more than twice as loud.
Evening	Refers to the period from 6 pm to 10 pm.
Hertz (Hz)	The measure of the frequency of sound wave oscillations per second – 1 oscillation per second equals 1 hertz.
L_{A10}	The percentile sound pressure level exceeded for 10% of the measurement period with 'A' frequency weighting calculated by statistical analysis. Typically used to assess the impact of an existing operation on a receiver area and is referred to as the cumulative noise levels at the receiver attributable to the noise source.

Term	Description
L_{A90}	Background Noise Level. The percentile sound pressure level exceeded for 90% of the measurement period with 'A' frequency weighting calculated by statistical analysis.
L_{Amax}	The maximum of the sound pressure levels recorded over an interval of 1 second.
$L_{A1,1minute}$	The measure of the short duration high-level noises that cause sleep arousal. The noise level is measured as the percentile sound pressure level that is exceeded 1% of measurement period with 'A' frequency weighting calculated by statistical analysis during a measurement time interval of 1 minute.
$L_{Aeq,t}$	Equivalent continuous sound pressure level – the value of the sound pressure level of a continuous steady noise that, a measurement interval of time (t), has the same mean square sound pressure as the sound under consideration whose level varies with time. Usually measured in dB with 'A' weighting.
L_{An}	Percentile level. A measure of the fluctuation of the sound pressure level which is exceeded 'n' percent of the observation time.
Morning Shoulder Period	Refers to the period from 6 am to 7 am.
Night	The period between 10 am and 7 pm.
Project Noise Trigger Levels (PNTL)	Target noise levels for a particular noise-generating facility. They are based on the most stringent of the project intrusiveness noise level or the project amenity noise level.
Project Amenity Noise Levels	The project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Calculated as the recommended amenity noise level less 5 decibels and refers to the day, evening and night periods.
Project Intrusive Noise Levels	The project intrusiveness noise level aims to protect against significant changes in noise levels. Calculated as rated background level plus 5 decibels and refers to a 15-minute period.
Receiver	The noise-sensitive land use at which noise from a development can potentially be heard.
Rating Background Noise level (RBL)	The overall single figure background level representing each assessment period over the whole monitoring period determined by taking the median of the ABLs found for each assessment period.
Sleep Disturbance	Awakenings and disturbance to sleep stages.
Sound Pressure Level (dBA)	The basic measure of noise loudness. The level of the root-mean-square sound pressure in decibels given by: $SPL = 10.\log10\ (p/po)^2$ where p is the rms sound pressure in pascals and po is the sound reference pressure at 20 uPa db.
Sound Power Level	A measure of the energy emitted from a source as sound and is given by: $SWL = 10.\log10\ (W/Wo)$ where W is the sound power in watts and Wo is the sound reference power at 10^{-12} watts.
Temperature Inversion	An atmospheric condition in which temperature increases with height above the ground.



APPENDIX B

Draft Construction Noise and Vibration Management Plan

umwelt
Environmental & Social Consultants

lightsource bp

GOULBURN RIVER SOLAR FARM NSW

Draft Construction Noise and Vibration Management Plan – Ringwood Road Upgrades

DRAFT

April 2023

lightsource bp

GOULBURN RIVER SOLAR FARM NSW

Draft Construction Noise and Vibration Management Plan – Ringwood Road Upgrades

DRAFT

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Lightsource Development Services Australia Pty Ltd

Project Director: Malinda Facey
Project Manager: Jessica Henderson Wilson
Technical Director: Tim Procter
Technical Manager: Ben Carlyle
Report No. 21507/R15/Appendix B
Date: April 2023

umwelt
Environmental & Social Consultants

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Draft V0	Tim Procter	16/12/2022	Malinda Facey	16/12/2022
Draft V1	Tim Procter	1/2/2023	Malinda Facey	2/02/2023
Draft V2	Tim Procter	16/03/2023	Malinda Facey	16/03/2023
Draft V3	Tim Procter	17/4/2023	Malinda Facey	17/04/2023

Table of Contents

Figures

Tables

Disclaimer

This is a draft management plan and will be updated prior to the commencement of the construction, as part of the development of the Construction Environmental Management Plan (CEMP).

1.0 Introduction

Lightsource Development Services Australia Pty Ltd (Lightsource bp) is seeking to develop the Goulburn River Solar Farm in the Upper Hunter Region of New South Wales (NSW), approximately 28 kilometres (km) south of the township of Merriwa within the Upper Hunter Local Government Area (LGA) (refer to **Figure 1.1**) (the 'Project').

This Draft Construction Noise and Vibration Management Plan (DCNVMP) has been prepared by Umwelt to guide the management of potential noise and vibration impacts associated with Ringwood Road Upgrade works, and details mitigation measures / controls where required. The DCNVMP also identifies the location of sensitive receivers.

The Noise Impact Assessment determined that Goulburn River Solar Farm, substation and Battery Energy Storage System (BESS) construction was not predicted to exceed the noise management levels.
In accordance with the SEARs a DCNVMP is not required for these components.

1.1 Project Overview

The Project will involve the construction, operation and decommissioning of approximately 550-megawatt peak (MWp) of solar photovoltaic (PV) generation as well as a Battery Energy Storage System (BESS) with 280 MWp / 570 megawatt hour (MWh) capacity. The Project will also include a substation and connection to an existing 500 kilovolt (kV) transmission line. The Project will include various associated infrastructure, including road repairs and upgrades to Ringwood Road, temporary construction facilities, operation and maintenance buildings, internal access roads, civil works and electrical infrastructure to connect the Project to the existing transmission line which passes through the Project Area.

Works along Ringwood Road form the basis of this DCVNMP and are described as follows:

- **Work Area 1** – Culvert upgrade along Ringwood Road at Bow River.
- **Work Area 2** – Road repairs along Ringwood Road – 1.8 km section to be widened and resealed between Bow River and Killoe Creek.
- **Work Area 3** – Culvert upgrades along Ringwood Road at Killoe Creek.

The location of the works is shown in **Figure 1.2**.

The works are anticipated to be completed within a 3-month construction period.

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP) as the capital value of the Project is over $30 million. A development application (DA) for the Project is required to be submitted under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.1.1 Construction Hours

Construction activities for the road upgrades are proposed to be undertaken during standard construction hours specified in the Interim Construction Noise Guideline (ICNG) (DECC 2009). The proposed construction hours are as follows:

- Monday to Friday: 7.00 am–6.00 pm.
- Saturday: 8.00 am–1.00 pm.
- Sunday and public holidays: No work.

Exceptions to the above hours may occur, however would be limited to activities with low noise generation where practicable. These activities would be assessed on a case-by-case basis prior to the commencement of those activities. The Upper Hunter Shire Council and surrounding landholders would be notified of any foreseeable exceptions. This would include justifying why works are required outside the standard hours and outlining the timing, duration and potentially expected noise levels.

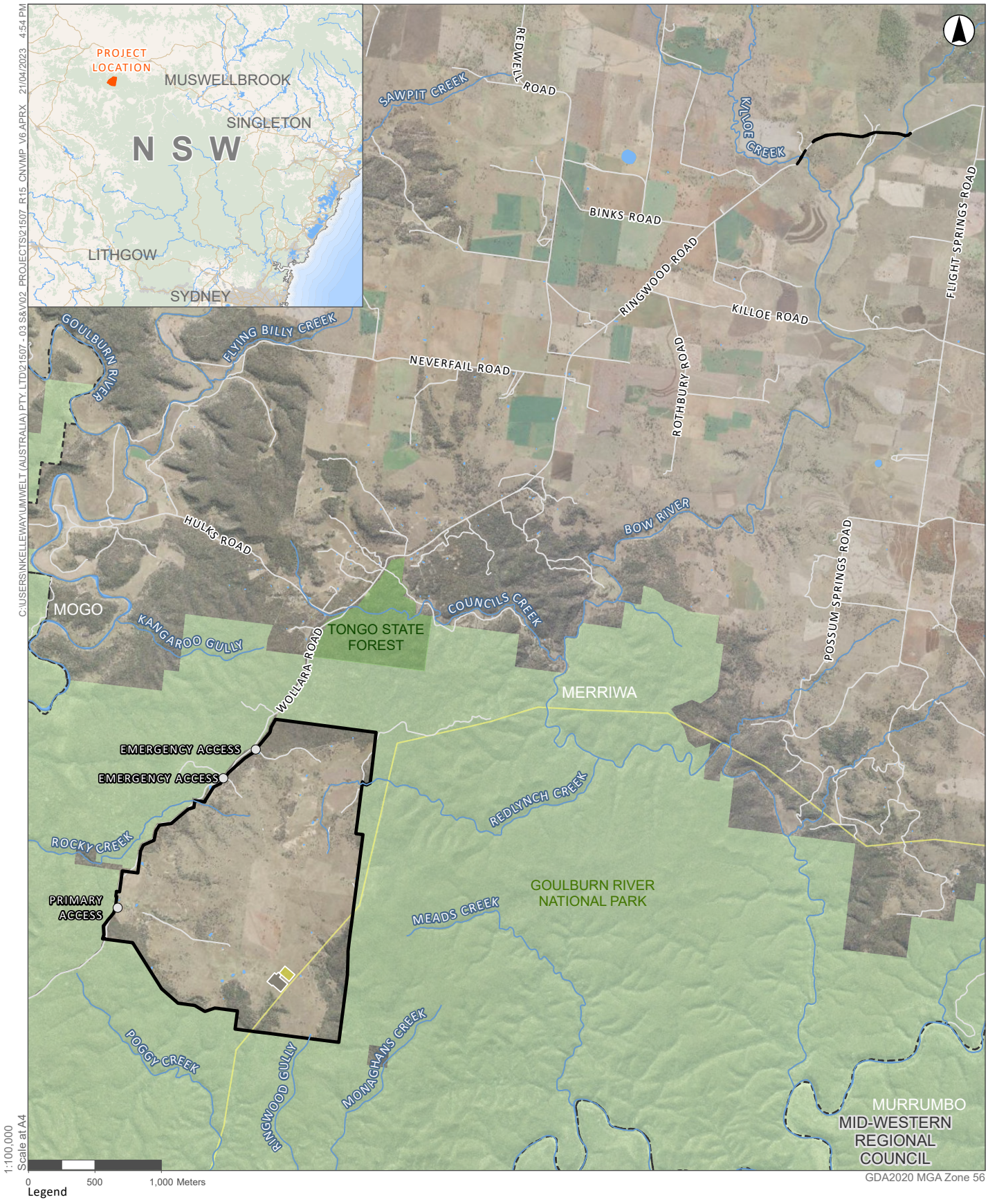


FIGURE 1.1

Location and Regional Context

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

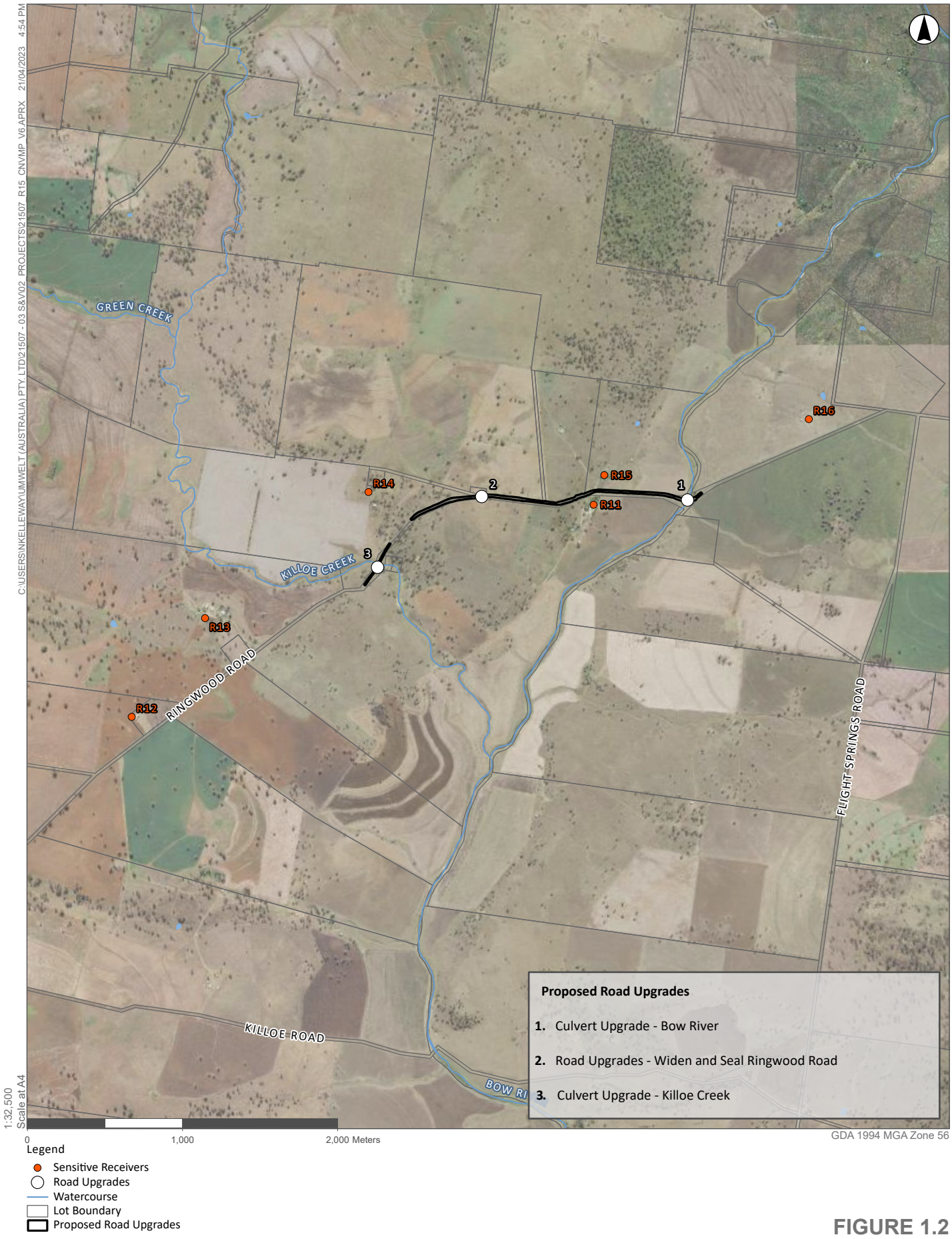


FIGURE 1.2

Road Upgrade Work Areas and Sensitive Receivers

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

2.0 Existing Environment

2.1 Background and Ambient Noise

The site is located within a rural environment with typically low background noise levels. The road upgrade works are surrounded by rural residential land (zoned RU1 Primary Production). Given the rural environment, background noise level monitoring was not undertaken, and minimum background noise levels have been adopted in accordance with the Noise Policy for Industry (NPfI) (EPA, 2017).

As the road upgrade works area is in a rural region, it is assumed that the Rating Background Level (RBL) at all receivers during the day will be less than 35 dB(A) and less than 30 dB(A) during the evening and night periods. The minimum RBLs of 35 dB(A) for the day and 30 dB(A) for the evening and night periods are set in accordance with the requirements of the NPfI. The adopted background noise levels are presented in **Table 2.1**.

Table 2.1 Adopted Background Noise Levels

Receiver Category/Land-use	Adopted RBLs [1], dB(A)		
	Day 7.00 am–6.00 pm	Evening 6.00 pm–10.00 pm	Night 10.00 pm–7.00 am
Rural Residential: RU1 Primary Production	35	30	30

Note: [1] Values shown represent the minimum RBLs for each period in accordance with the NPfI.

2.2 Sensitive Receivers

Residences within 2 km of the work areas have been identified and are shown in **Figure 1.2**. The nearest two (2) receivers to each of the work areas are shown in **Table 2.2**.

Table 2.2 Nearest Residential Receivers

Work Area	Receiver ID	Address / Description	Approximate Distance (m) from works
Work Area 1	R11	549 Ringwood Road, Merriwa	550 m
	R15	552 Ringwood Road, Merriwa	550 m
Work Area 2	R11	549 Ringwood Road, Merriwa	70 m
	R15	552 Ringwood Road, Merriwa	85 m
Work Area 3	R13	812 Ringwood Road, Merriwa	1,100 m
	R14	704 Ringwood Road, Merriwa	450 m

3.0 Legislative Requirements

3.1 Relevant Noise Guidelines and Polices

The policies, guidelines and standards that apply to this DCNVMP include:

- Interim Construction Noise Guideline *(ICNG) (DECC, 2009).*
- Noise Policy for Industry *(NPfI) (NSW EPA, 2017).*
- NSW Road Noise Policy *(RNP) (DECCW, 2011).*
- Assessing Vibration – A Technical Guideline *(the Vibration Guideline) (DEC, 2006).*
- NSW Construction Noise and Vibration Guideline *(CNVG) (RMS, 2016).*

4.0 Noise and Vibration Management Levels

4.1 Construction Noise Criteria

Assessment levels for noise from construction activities, excluding noise from construction-related traffic on public roads, are defined in the ICNG.

The RBLs for the receivers surrounding the works have been adopted from the minimum background noise levels presented in **Section 2.0**.

Table 4.1 presents the ICNG Construction Noise Management Levels for representative receivers surrounding the road upgrade works area. The assessment levels are intended to guide the need for and the selection of feasible and reasonable work practices to minimise construction noise impacts.

Table 4.1 ICNG Construction Noise Management Levels, dB(A)

Land Use	Construction Time	Noise Management Level $L_{Aeq(15\ min)}$
Residential	**Recommended Standard Hours** Monday to Friday – 7:00 am to 6:00 pm Saturday – 8:00 am to 1:00 pm No work on Sundays or Public Holidays	Noise affected: RBL + 10 dB(A)
		Highly noise affected: 75 dB(A)
	Outside recommended standard hours	Noise affected: RBL + 5 dB(A)

Additionally, the ICNG states the following with respect to the potential for sleep disturbance:

> *Where construction works are planned to extend over more than two consecutive nights, and a quantitative assessment method is used, the analysis should cover the maximum noise level, and the extent and the number of times that the maximum noise level exceeds the RBL. Some guidance indicating the potential for sleep disturbance is in the NSW Environmental Criteria for Road Traffic Noise (EPA 1999).*

As noted above, the ICNG recommends that where construction works are planned to extend over two or more consecutive nights, the Project should consider maximum noise levels and the extent and frequency of the maximum noise level events exceeding the RBL. The potential for both sleep disturbance and awakenings has been considered using a contemporary approach as nominated in the NPfI. The NPfI approach to assessing maximum noise level events for industrial noise sources includes a screening level test based on the following:

- 52 dB(A) L_{Amax} (typically represented by the $L_{A1(1\ min)}$ parameter) or the prevailing ambient RBL noise level by more than 15 dB, whichever is greater.

For the purposes of this assessment, the 52 dB(A) $L_{A1(1\ min)}$ parameter has been adopted to assess the potential for sleep disturbance from the construction noise during the night-time period.

The Construction Noise Management Levels for the receivers and different periods are summarised in **Table 4.2** based on the adopted RBLs presented in **Table 2.1**.

Table 4.2 Project Construction Noise Management Levels

Receiver	Noise Management Levels (NML), dB(A)				
	Standard hours of Construction [1]		Outside Standard hours of Construction		
	Noise Affected	Highly Noise Affected	Evening	Night	
	LAeq(15 min)	LAeq(15 min)	LAeq(15 min)	LAeq(15 min)	LA1(1 min)
All Residences	45	75	35	35	52

Note: [1] Recommended standard hours: Monday to Friday 7 am–6 pm; Saturday 8 am–1 pm.

4.1.1 Construction Vibration Criteria

4.1.1.1 Vibration Effects on Structures

Criteria for vibration effects on building structures recommended in the DEC's *Assessing Vibration: A Technical Guideline* (the Vibration Guideline) are based on British Standard *BS7385 (1993) Part 2 Evaluation and measurement of vibration in buildings* (BS7385). The criteria in BS7385 are given in terms of peak component (x-, y- or z-axes separately) vibration velocity values from transient (impulsive) vibration events. The criteria for continuous vibration are recommended to be 50 % lower than for impulsive vibration. The vibration criteria for the protection of structures and buildings from cosmetic damage (e.g., hairline cracks in drywalls, etc.) are given in **Table 4.3**.

Table 4.3 BS 7385 Vibration Criteria for Cosmetic Damage to Structures

Type of Structure	Peak Component Particle Velocity (mm/s)		
	4 Hz–15 Hz	15 Hz–40 Hz	40 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 (transient (impulsive) vibration) 25 (continuous vibration)		
Un-reinforced or light framed structures Residential or light commercial type buildings	15–20 (transient (impulsive) vibration) 7.5–10 (continuous vibration)	20–50 (transient (impulsive) vibration) 10–25 (continuous vibration)	50 (transient (impulsive) vibration) 25 (continuous vibration)

4.1.1.2 Heritage Structures

Assessment guidelines for vibration damage to heritage-protected structures are commonly referenced from the German Institute for Standardisation *DIN 4150-3:1999-02 Structural vibration – Effects of vibration on structures* (DIN4150). This standard differentiates between short-term and long-term vibration, where short-term vibration is caused by sources such as drop-hammers, impact piling, etc. All other sources of vibration are considered to be long-term.

The guideline value for heritage-protected structures for short-term and long-term vibration is respectively 3 mm/s peak partial velocity (PPV) and 2.5 mm/s PPV in the horizontal plane at all frequencies. This guideline value is primarily intended for older, sensitive, above-ground structures (typically buildings).

In regard to heritage buildings, *BS7385 Part 2 (1993)* notes that a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

4.1.1.3 Human Perception of Vibration

Criteria for the human perception of vibration from construction activities are given in the *Assessing Vibration: A Technical Guideline* (the Vibration Guideline). The criteria in the vibration guideline are given for continuous vibration, impulsive vibration and for intermittent vibration. For continuous and impulsive vibration, the criteria are given in terms of root-mean-square (rms) vibration acceleration (m/s^2) in the frequency range 1–80 Hertz (Hz). For intermittent vibration, the criteria are given in terms of vibration dose value (VDV), which is a parameter used for assessing the combined magnitude and the total duration of vibration impacts.

The criteria given in the vibration guideline for continuous or impulsive vibration relevant to the receivers in the area are given in **Table 4.4**. The frequency weightings are given in the vibration guideline in Appendix B3.

Table 4.4 The Vibration Guideline Values for Continuous and Impulsive Vibration for Human Comfort

Location	Assessment Period [1]	Weighted Vibration Acceleration (m/s^2 at 1-80 Hz)			
		Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous Vibration					
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Impulsive Vibration					
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14

Note: [1] Day time period is 7.00 am–10.00 pm. Night period is 10.00 pm–7.00 am.

The criteria for intermittent vibration given in the vibration guideline for the relevant receivers in the area are shown in **Table 4.5**. The vibration dose value (VDV) is calculated using the frequency-weighted rms acceleration as described in the vibration guideline.

Table 4.5 The Vibration Guideline Acceptable Vibration Dose Values for Intermittent Vibration for Human Comfort (VDV $m/s^{1.75}$)

Location	Daytime Period [1]		Night-Time Period [1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26

Note: [1] Day time period is 7.00 am–10.00 pm. Night period is 10.00 pm–7.00 am.

According to the vibration guideline, the 'preferred' vibration limits are not mandatory but should be sought to be achieved through reasonable mitigation measures. Where all possible and reasonable measures have been applied, values up to the 'maximum' value may be used if they can be justified. For values beyond the maximum value, direct negotiation with the affected receivers must be carried out.

5.0 Project Construction Activities

5.1 Work Areas

The following works are proposed:

- **Work Area 1** – Culvert upgrade along Ringwood Road at Bow River.
- **Work Area 2** – Road repairs along Ringwood Road – 1.8 km section to be widened and resealed between Bow River and Killoe Creek.
- **Work Area 3** – Culvert upgrades along Ringwood Road at Killoe Creek.

The location of the works areas is shown in **Figure 1.2**.

5.2 Equipment

The typical construction activities (Scenarios 1 to 5) and associated equipment and respective sound power levels (SWLs) of equipment are outlined in **Table 5.1**. Typical sound power levels have been sourced from the *Roads and Maritime Construction Noise Estimator Tool* and Umwelt's noise source library. Note, Scenario 3 (Culvert works) is not applicable for Work Areas 2 and 4.

Table 5.1 Indicative Construction Scenarios, Equipment and Sound Power Levels

Construction Stages / Scenarios	Activity description	Equipment	Sound Power Levels $L_{Aeq(15\ min)}$ dB(A)/ unit	Combined Sound Power Level $L_{Aeq(15\ min)}$ dB(A)	
				All equipment	All equipment without high noise emitting plant [2]
Sc.1	Vegetation Clearing	Tub Grinder	121 [2]	123	117
		Chainsaw	115 [2]		
		Dozer	110		
		Truck	108		
		Excavator	106		
Sc.2	Bulk earthworks	Excavator with hammer	122 (117 + 5) [1, 2]	123	117
		Grader	113		
		Dozer	110		
		Roller	109		
		Truck	108		
		Water truck	107		
		Excavator	106		
Sc.3	Culvert works	Jackhammer	117 (112 + 5) [1, 2]	119	114
		Powered hand tools	110		

Construction Stages / Scenarios	Activity description	Equipment	Sound Power Levels $L_{Aeq(15\ min)}$ dB(A)/ unit	Combined Sound Power Level $L_{Aeq(15\ min)}$ dB(A)	
				All equipment	All equipment without high noise emitting plant [2]
		Concrete Truck	108		
		Mobile crane 60T	105		
		Compressor	103		
		Generator	103		
		Mobile crane / telehandler	98		
Sc.4	Paving / asphalting (including concrete saw)	Concrete saw	122 (117 + 5) [1, 2]	123	117
		Asphalt paver	114		
		Roller	109		
		Trucks	108		
		Trencher	106		
		Bobcat	104		
Sc.5	Road furniture installation	Power hand tools	110	113	113
		Line marking truck	108		
		Truck	98		
		Mobile crane / telehandler	98		
		Scissor Lift	98		

Notes: [1] *Includes a +5 dB penalty for impulsiveness characteristics.*

[2] *For this assessment high noise emitting plant considered to be tub grinder, chainsaw, rock hammers, jackhammers and concrete saws.*

5.3 Construction Noise Assessment

Noise levels were predicted using the CadnaA proprietary environmental noise modelling software package, under worst-case noise-enhancing meteorological conditions (D-class with 3 m/s).

The noise prediction model considers:

- location of noise sources and sensitive receiver locations
- heights of sources and receivers
- separation distances between sources and receivers
- ground type and reflections between sources and receivers
- geometric spreading and air absorption
- attenuation from natural terrain.

Construction noise levels have been predicted for the five (5) indicative construction scenarios described in **Table 5.1**. The predictions are conservative and assume all equipment associated with each scenario is operating simultaneously at the closest point to the receiver. In reality, a receiver would experience a range of construction noise levels, dependent upon the number of plant items operating at any one time and their location as the works progress along the roadway.

For each work area, the results for each construction scenario (Sc.1 to Sc.5) for the identified receivers are presented in **Table 5.2** for all equipment operating. Also presented, is predicted noise levels for all equipment operating except for high noise emitting plant (i.e., tub grinder, chainsaw, rock hammers, jackhammers and concrete saw).

For each work area, the predicted noise level contours for the worst-case scenario(s) with all equipment operating (Sc. 1, Sc. 2 and Sc. 4) are presented graphically in **Figure 5.1** to **Figure 5.3**.

The construction noise levels are predicted to exceed the noise management levels at some receivers for some of the work areas and scenarios. However, no receivers are predicted to be highly noise affected (i.e., exposed to construction noise levels greater than 75 dB(A)).

Reasonable and feasible noise mitigation and management strategies have been provided in **Section 8.0**.

Table 5.2 Predicted Construction Noise Levels, dB(A)

Receiver ID	Noise Management Level, LAeq(15 min)	Construction Scenario Noise Prediction, LAeq(15 min)																	
		Work Area 1						Work Area 2						Work Area 3					
	Standard Hours	Sc.7, 8 &10		Sc.9		Sc.11		Sc.7, 8 &10		Sc.9 [2]		Sc.11		Sc.7, 8 &10		Sc.9		Sc.11	
		H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
R11	45	**53**	**47**	**49**	44	n/a	43	**73**	**67**	n/a	n/a	n/a	**63**	24	<20	20	<20	n/a	<20
R12	45	21	<20	<20	<20	n/a	<20	35	29	n/a	n/a	n/a	25	30	24	26	21	n/a	20
R13	45	21	<20	<20	<20	n/a	<20	43	37	n/a	n/a	n/a	33	41	35	37	32	n/a	31
R14	45	23	<20	<20	<20	n/a	<20	**60**	**54**	n/a	n/a	n/a	**50**	**55**	**49**	**51**	**46**	n/a	45
R15	45	**53**	**47**	**49**	44	n/a	43	**72**	**66**	n/a	n/a	n/a	**62**	24	<20	20	<20	n/a	<20
R16	45	39	33	35	30	n/a	29	42	36	n/a	n/a	n/a	32	<20	<20	<20	<20	n/a	<20
R17	45	26	20	22	<20	n/a	<20	27	21	n/a	n/a	n/a	<20	20	<20	<20	<20	n/a	<20

Notes: *[1] Predictions below 20 dB(A) have been presented as <20.*

[2] Scenario not applicable for work area.

[3] H - Includes high noise emitting plant (i.e., tub grinder, chainsaw, rock hammers, jackhammers and concrete saws).

[4] L - Excludes high noise emitting plant (i.e., tub grinder, chainsaw, rock hammers, jackhammers and concrete saws).

*[5] Predicted exceedances are in **Red**.*

[6] Receivers outside of the assessment area have been excluded from this table.

FIGURE 5.1

Work Area 1 - Construction Scenario 1, 2 and 4 – Predicted Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

FIGURE 5.2

Work Area 2 - Construction Scenario 1, 2 and 4 – Predicted Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

FIGURE 5.3

Work Area 3 - Construction Scenario 1, 2 and 4 – Predicted Noise Levels Under Enhanced Meteorological Conditions, LAeq(15 min) dB(A)

Image Source: ESRI Basemap (2022) **Data source:** NSW LPI (2022), NSW DSFI (2022); NPWS Estate (2022); Lightsource BP (2022)

6.0 Vibration Risk Profile

Many items of construction equipment generate vibration that may cause structural damage to buildings or other structures.

The types of vibration-sensitive receivers in the surrounding area likely include:

- residential dwellings
- commercial/agricultural buildings.

The commercial/agricultural buildings in the area are assumed to be structurally similar to residential buildings, therefore the assessment for residential buildings is considered to be relevant for the commercial/agricultural buildings as well.

Recommended safe working distances for vibration-generating equipment from sensitive receivers (i.e., the receiver building or its occupants) are given in Table 2 of the NSW *Construction Noise and Vibration Guideline* (CNVG) (RMS, 2016) reproduced below in **Table 6.1**.

Table 6.1 Recommended Minimum Working Distances for Vibration Generating Plant from a Residential Sensitive Receiver (CNVG Table 2)

Plant Item	Rating/Description	Minimum Working Distance [1,2]	
		Cosmetic Damage (Residential Building)	Human Response
Vibratory Roller	< 50 kN (Typically 1–2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2–4 tonnes)	6 m	20 m
	< 200 kN (Typically 4–6 tonnes)	12 m	40 m
	< 300 kN (Typically 7–13 tonnes)	15 m	100 m
	> 300 kN (Typically 13–18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	300 kg – 5 to 12 t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg – 12 to 18 t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg – 18 to 34 t excavator	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	4 m
Jackhammer	Handheld	1 m (nominal)	2 m

Notes: [1] *For alternative equipment with higher vibration levels, larger minimum working distances are required.*

[2] *More stringent conditions may apply to heritage or other sensitive structures.*

Except for receiver R11 and R15, all the identified residential dwellings fall outside of the minimum working distances. For Work Area 2, receiver R11 and R15 fall within the minimum working for human response for some plant items (i.e., vibratory roller >7 tonnes and large hydraulic hammer >18 tonnes). However, given the transient nature of the works, human disturbance impacts are anticipated to be low.

Construction vibration mitigation strategies are provided in **Section 8.0**.

7.0 Road Traffic Noise

Construction-related road traffic noise was evaluated within Section 7 of the Noise Impact Assessment. The assessment was based on 60 movements per day.

The assessment concluded that construction traffic noise levels comply with the established NSW Road Noise Policy (RNP, 2011) criteria and that project construction traffic noise is predicted to be acceptable.

Accordingly, no additional reasonable and feasible mitigation measures are required, however, heavy vehicle operators should be instructed to limit the use of engine compression brakes when travelling to and from the works.

8.0 Management and Mitigation Strategies

8.1 Construction Environmental Management Plan

This draft CNVMP will be updated and implemented as a part of the Construction Environmental Management Plan (CEMP).

This would comprise at a minimum the following elements:

- Management responsibilities:
    - Identification of key environmental risks.
    - Work Method Statement for Key activities.
    - Performance criteria.
- Training:
    - Relevant workforce education and training.
- Compliance:
    - Lightsource bp will be responsible for the development and implementation of the CEMP including compliance by contractors and staff.
- Corrective Actions.
- Reporting:
    - Establish performance criteria.
    - Conditions of consent.

8.2 Noise Mitigation Measures and Strategies

As demonstrated in **Section 5.3**, the unmitigated construction noise levels are predicted to exceed the noise management level at nearby sensitive receivers. Reasonable and feasible noise mitigation and/or management strategies will be considered in accordance with the ICNG.

The management and mitigation strategies will vary on a case-by-case basis, however these may include a range and combination of measures, such as:

- engineering noise controls including attenuators, temporary barriers, enclosures
- management strategies including scheduling of noise activities
- substitution of equipment and/or processes
- commercial agreements with affected landholders.

The overall effectiveness of these mitigation measures vary depending on a range of factors including equipment selections, landform/terrain, separation distance, machine utilisation, meteorological conditions and are generally evaluated on a case-by-case basis.

The typical effectiveness of noise mitigation measures is discussed in *AS2436-2010 (2016) Guide to Noise Control on Construction, Demolition and Maintenance Sites (AS2436)*. This standard provides a guide to the typical reduction that can be expected from different noise control methods (refer to **Table 8.1**).

Table 8.1 Typical Effectiveness of Mitigation Measures

Control Method	Likely Noise Reduction, dB(A)
Separation Distance	An increase of separation distance reduces noise levels at a rate of 6 dB(A) per doubling of distance
Screening	5 to 10 dB(A)
Enclosure	15 to 25 dB(A)
Silencing	5 to 10 dB(A)

Noise and vibration mitigation measures to be implemented during construction of the Project include:

- All sensitive receivers likely to be affected should be notified at least 7 days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact.
  The notification should include:
  - details of the Project
  - the construction period and construction hours
  - contact information for project management staff
  - complaint and incident reporting
  - how to obtain further information.
- All employees, contractors and subcontractors are to receive an environmental induction.
  The induction must include at a minimum, all applicable mitigation measures; hours of works; any limitations on high noise-generating activities; location of nearest sensitive receivers; designated parking areas; relevant approval conditions and incident procedures.
- Contractors should keep noise to a minimum, including limiting the use of loud stereos/radios, shouting on site and car door slams.
- Where practical, no dropping of materials from height or throwing of metal items.
- The noise levels of plant and equipment should have operating sound power levels consistent with those nominated in **Table 5.1**.
- Noise emitting plant to be directed away from sensitive receivers and to be throttled down or shut down when not in use.

- Non-tonal reversing beepers could be fitted and used on construction vehicles and mobile plant used regularly on site and for any out of hours work.
- Limit the use of engine compression brakes.
- Where feasible and reasonable, work generating high noise and/or vibration should be scheduled during less sensitive time periods.

8.2.1 Additional Noise Mitigation Measures

As some predicted noise levels exceed the NML during standard hours, additional noise mitigation measures should be implemented wherever reasonable and feasible. These are to be considered after the standard construction noise mitigation measures have been applied.

The mitigation measures required to be implemented are determined by the exceedance above the NML at each receiver and will be determined in accordance with Appendix C of the CNVG for specific construction activities during the detailed design and the construction phases of a proposal.

The recommended additional non-standard noise mitigation measures given in CNVG Table C-1 are reproduced in **Table 8.2**. Descriptions of the additional measures relevant to day period construction works follow after **Table 8.2**.

Table 8.2 CNVG Table C-1: Triggers for Additional Mitigation Measures – Airborne Noise

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures	
Perception	dB(A) above RBL	dB(A) above NML	type[1]:	Mitigation Levels[2]:
All hours				
75dBA or greater			N, V, PC, RO	HA
Standard Hours: Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun/Pub Hol (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly Audible	10 to 20	< 10	-	NML
Moderately intrusive	20 to 30	10 to 20	N, V	NML+10
Highly intrusive	> 30	> 20	N, V	NML+20
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Hol (8am – 6pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly Audible	10 to 20	5 to 15	N, R1, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, N, R1, DR	NML+15
Highly intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML+25
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Pub Hol (6pm – 7am)				
Noticeable	5 to 10	< 5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML+15
Highly intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML+25

Notes (refer to detailed descriptions):

1 AA = Alternative Accommodation; V = Verification; IB = Individual briefings; N = Notification; R2 = Respite Period 2; DR = Duration Respite; R1 = Respite Period 1; PC = Phone calls; SN = Specific notifications; Perception = relates to level above RBL

2 NML = Noise Management Level (see Appendix D); HA = Highly Affected (> 75 dB(A) - applies to residences only)

Where standard mitigation measures have been implemented and where noise levels still exceed the NMLs, the CNVG also provides additional mitigation measures to be adopted. The range of additional measures is described below.

Notification (Letterbox Drop or Equivalent) (N)

Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activity, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of seven calendar days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them.

Phone Calls (PC)

Phone calls (PC) detailing relevant information made to identified/affected stakeholders within seven calendar days of proposed work. PC provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.

Respite Offers (RO)

Respite Offers (RO) should be considered where there are high noise and vibration generating activities near receivers. As a guide, work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers.
The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis and may not be applicable to all projects.

Verification (V)

Verification (V) of noise and vibration levels is in the form of routine checks of noise levels or following reasonable complaints. Verification should include measurement of the background noise level and construction noise. Note this is not required for projects less than 3 weeks unless to assist in managing complaints.

8.2.1.1 Additional Mitigation Measures – Ringwood Road Upgrade works

Table 8.3 shows that additional mitigation measures of Notification (N) and Verification (V) are triggered at some of the receivers for particular scenarios.

No receivers were determined to be highly affected for any of the works.

Table 8.3 Predicted Construction Noise Levels, dB(A)

Receiver ID	Noise Management Level, $L_{Aeq(15\ min)}$	Construction Scenario Noise Prediction, $L_{Aeq(15\ min)}$																	
		Work Area 1						Work Area 2						Work Area 3					
	Standard Hours	Sc.7, 8 &10		Sc.9		Sc.11		Sc.7, 8 &10		Sc.9 [2]		Sc.11		Sc.7, 8 &10		Sc.9		Sc.11	
		H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
R11	45	-	-	-	-	n/a	-	**N, V**	**N, V**	n/a	n/a	n/a	**N, V**	-	-	-	-	n/a	-
R12	45	-	-	-	-	n/a	-	-	-	n/a	n/a	n/a	-	-	-	-	-	n/a	-
R13	45	-	-	-	-	n/a	-	-	-	n/a	n/a	n/a	-	-	-	-	-	n/a	-
R14	45	-	-	-	-	n/a	-	**N, V**	-	n/a	n/a	n/a	-	-	-	-	-	n/a	-
R15	45	-	-	-	-	n/a	-	**N, V**	**N, V**	n/a	n/a	n/a	**N, V**	-	-	-	-	n/a	-
R16	45	-	-	-	-	n/a	-	-	-	n/a	n/a	n/a	-	-	-	-	-	n/a	-
R17	45	-	-	-	-	n/a	-	-	-	n/a	n/a	n/a	-	-	-	-	-	n/a	-
R2	45	n/a [3]																	
R3	45																		
R4	45																		
R5	45																		
R9	45																		
R18	45																		
R19	45																		
R20	45																		
R21	45																		
R22	45																		
R23	45																		
R24	45																		
R25	45																		
R26	45																		
R27	45																		
R28	45	n/a [3]																	
R29	45																		
R30	45																		
R31	45																		
R32	45																		
R33	45																		
R34	45																		
R35	45																		
R36	45																		
R37	45																		
R38	45																		
R39	45																		

Receiver ID	Noise Management Level, $L_{Aeq(15\ min)}$	Construction Scenario Noise Prediction, $L_{Aeq(15\ min)}$																	
		Work Area 1						Work Area 2						Work Area 3					
	Standard Hours	Sc.7, 8 &10		Sc.9		Sc.11		Sc.7, 8 &10		Sc.9 [2]		Sc.11		Sc.7, 8 &10		Sc.9		Sc.11	
		H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
R40	45																		
R41	45																		
R42	45																		
R43	45																		
R44	45																		
R45	45																		

Notes: [1] *Predictions below 20 dB(A) have been presented as <20.*

[2] *Scenario not applicable for work area.*

[3] *Receivers outside of assessment area for work area.*

[4] *H - Includes high noise emitting plant (i.e. tub grinder, chainsaw, rock hammers, jackhammers and concrete saws).*

[5] *L - Excludes high noise emitting plant (i.e. tub grinder, chainsaw, rock hammers, jackhammers and concrete saws).*

8.3 Construction Vibration Mitigation Strategies

Section 6.0 has identified that only R11 and R15 fall within the minimum working for human response for some plant items (i.e., vibratory roller >7 tonnes and large hydraulic hammer >18 tonnes). The actual construction equipment to be used on site would be confirmed by the construction contractor during the detailed design phase. For any vibration-generating plant not listed in **Table 6.1**, minimum working distances would need to be established.

In the event that any vibration-generating equipment would be used within the recommended safe working distances nominated in **Table 6.1**, the following is recommended:

- An independent specific structural assessment is undertaken on the structure to ascertain the structural integrity and its ability to withstand vibration, and establishment of an appropriate vibration criterion.
- A dilapidation survey is undertaken on the structure prior to works commencing, and regular inspection of the structure throughout the construction activities.
- Establish site specific vibration minimum working distances for the nominated equipment on site.
- Where appropriate, continuous vibration monitoring is conducted on the structure for the duration of the period of construction while vibration generating equipment is used. The vibration logger should be equipped with the facility to remotely alert the site to reduce or cease construction activities if vibration levels are approaching the criterion threshold.

8.4 Complaint Management

In the event of a reasonable noise compliant, noise monitoring should be carried out to confirm predicted noise levels. Reasonable and feasible noise reduction measures must be investigated, where necessary.

Complaints will be managed in accordance with the Construction Environmental Management Plan (CEMP). The CEMP should define the standard processes and obligations that must be adhered to ensure the project is controlled in an efficient manner. A compliant register with public access is to be provided.

9.0 References

Noise Policy for Industry, Environment Protection Authority, 2017 (NPfI, EPA).

Interim Construction Noise Guideline, NSW Department of Environment and Climate Change, 2009 (ICNG, DECC).

NSW Road Noise Policy, Department of Environment, Climate Change and Water, 2011 (RNP, DECCW).

Construction Noise Estimator Tool, Roads and Maritime, version 4/08/2016.

Construction Noise and Vibration Guideline, Roads and Maritime, v 1.0, 2016.

German Standard (Deutsche Norm) DIN 4150-3:1999-02 Structural Vibration Part 3: Effects of vibration on structures.

British Standard BS7385-2:1993 Evaluation and measurement for vibration in buildings Part 2. Guide to damage levels from groundborne vibration.

Australian Standard AS2436-2010 (2016) Guide to Noise Control on Construction, Demolition and Maintenance Sites.

Umwelt (Australia) Pty Limited

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au