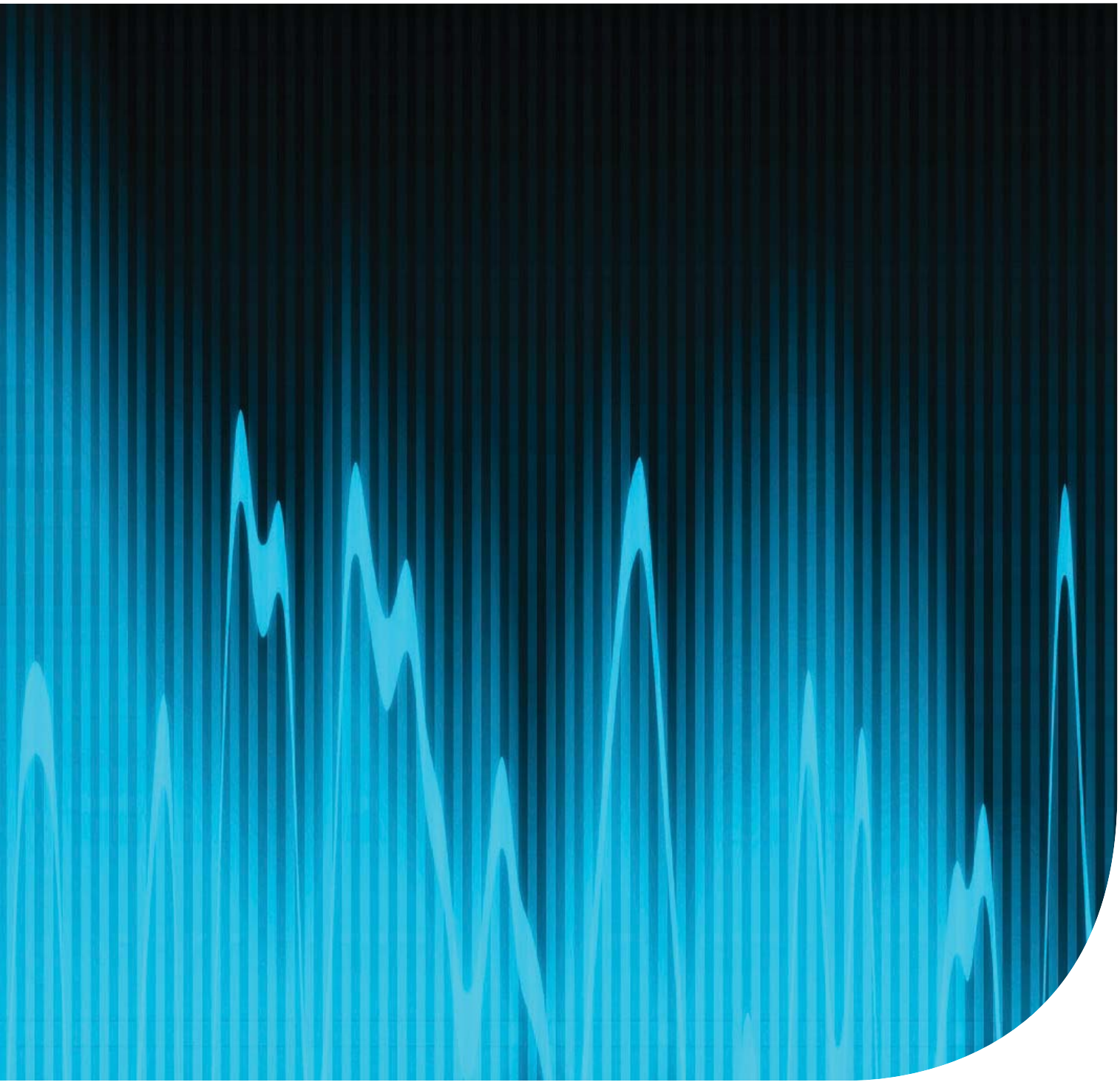
APPENDIX J

Noise and vibration impact assessment

New England Solar Farm

Noise and vibration impact assessment

Prepared for UPC Renewables Australia Pty Ltd | 16 November 2018



New England Solar Farm

Noise and vibration impact assessment

Prepared for UPC Renewables Australia Pty Ltd | 16 November 2018

Suite 6, Level 1, 146 Hunter Street
Newcastle NSW 2300

T +61 (0)2 4907 4800
F +61 (0)2 4907 4899
E info@emmconsulting.com.au

www.emmconsulting.com.au

New England Solar Farm

Final

Report J17300RP1 | Prepared for UPC Renewables Australia Pty Ltd | 16 November 2018

Prepared by	**Lucas Adamson**	Approved by	**Najah Ishac**
Position	Acoustic Consultant	Position	Director
Signature		Signature	
Date	16 November 2018	Date	16 November 2018

Document Control

Version	Date	Prepared by	Reviewed by
V1	21 September 2018	Lucas Adamson	David Richards Carl Fokkema Najah Ishac Claire Burnes
V2	12 October 2018	Lucas Adamson	David Richards Claire Burnes
V3	16 November 2018	Lucas Adamson	David Richards Claire Burnes

EMM

T +61 (0)2 4907 4800 | F +61 (0)2 4907 4899

Suite 6 | 146 Hunter Street | Newcastle | New South Wales | 2300 | Australia

www.emmconsulting.com.au

Table of contents

Table of contents *(Cont'd)*

Appendices

Tables

Tables

Figures

1 Introduction

1.1 Overview

UPC Renewables Australia Pty Ltd (UPC) propose to develop the New England Solar Farm; a significant grid-connected solar farm and battery energy storage system (BESS) along with associated infrastructure (the project), approximately 6 kilometres (km) east of the township of Uralla, which lies approximately 19 km south of Armidale in the Uralla Shire local government area (LGA) (Figure 1.1).

The project is a State Significant Development (SSD) under the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). Therefore, a development application (DA) for the project is required to be submitted under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The NSW Minister for Planning (Minister), or the Minister's delegate, is the consent authority.

An environmental impact statement (EIS) is a requirement of the approval process. This noise and vibration impact assessment (NVIA) report forms part of the EIS. It documents the NVIA methods and results, the initiatives built into the project design to avoid and minimise noise and vibration associated impacts, and the additional mitigation and management measures proposed to address any residual impacts not able to be avoided.

1.2 Assessment guidelines and requirements

This NVIA has been prepared in accordance with the relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

The NVIA was prepared with reference to the methods outlined in:

- NSW Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);
- NSW Environment Protection Authority (EPA) 2017, *Noise Policy for Industry* (NPfI);
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP);
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*; and
- Australian Standard AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Sites*.

The NVIA was prepared in accordance with the requirements of the NSW Department of Planning and Environment (DPE). These were set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project, issued on 8 May 2018 and updated on 11 October 2018. The SEARs identify matters which must be addressed in the EIS. A copy of the SEARs is attached to the EIS as Appendix A, while Table 1.1 lists the individual requirements relevant to this NVIA and where they are addressed in this report.

Table 1.1 Relevant SEARs

Requirement	Section addressed
DPE	
Construction noise impacts in accordance with the ICNG	6.4
Construction road traffic noise impact	6.5
Cumulative construction noise impact	6.6
Cumulative traffic noise impact	6.6
Operational noise impacts in accordance with the NPfI	8

To inform preparation of the SEARs, DPE invited other government agencies to recommend matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs. No specific noise or vibration related matters relevant to this NVIA were raised by any other government agencies. Copies of the government agencies' advice to DPE were attached to the SEARs.

Several technical terms are required for the discussion of noise and vibration. These are explained in Appendix A.

Source: EMM (2018); DFSI (2017); GA (2015)

0 10 20 km

GDA 1994 MGA Zone 56

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KEY

- Development footprint
- Project boundary
- Other SSD solar development
- Airport
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- Waterbody
- Local government area
- NPWS reserve
- State forest

Regional context

New England Solar Farm
Noise and vibration impact assessment
Figure 1.1

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2 Project and site description

2.1 Project description

The project involves the development, construction and operation of a solar PV electricity generation facility and BESS, which consists of PV modules, batteries, inverters, transformers and associated infrastructure.

The development footprint provided on Figure 2.1 incorporates the land required for:

- the three solar array areas;
- up to three internal solar array substations and a single grid substation;
- associated BESS(s);
- operations and maintenance (O&M) infrastructure, including:
    - O&M buildings (namely meeting facilities, a temperature-controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure); and
    - car parking facilities;
- connection infrastructure between the three array areas (including electricity transmission lines (ETLs) and underground or overhead cabling); and
- a new internal road network to enable access from surrounding local roads to the three array areas during construction and operations.

In addition, security fencing and creek crossings (should they be required) will be placed within the project boundary.

A construction accommodation village for non-local construction employees may be established as part of the early stages of the project's construction. If constructed, the construction accommodation village may accommodate up to 500 workers and would be on part of Lot 2 of DP 174053 in the northern array area (refer to Figure 2.1). To build the construction accommodation village, topsoil will be stripped where necessary, hardstand constructed and walkways and car parks constructed. The construction accommodation village is expected to be dismantled and its footprint rehabilitated once the project is built and it moves into the operational stage.

Construction of the project will take approximately 36 months from the commencement of site establishment works to commissioning of the three array areas. It is anticipated that the project will be constructed in two stages.

Stage 1 will include complete construction of the northern array area including the grid substation and is anticipated to take approximately 25 months to complete.

Stage 2 will include complete construction of the central array area and southern array area and is anticipated to take approximately 20 months to complete. Stage 2 also includes the construction of the BESS, which is also anticipated to take approximately 20 months to complete.

Stage 2 will commence approximately 12 months after the commencement of site establishment works planned as part of Stage 1.

It should be noted that the exact timing of each stage, including the commencement of Stage 1, the commencement of Stage 2 and the subsequent duration of the overlap between the two stages will be determined during the contracting, detailed design and financing stage of the project following project approval. Similarly, the overall duration of the project's construction will also be confirmed at this time once the preferred engineering and procurement contractor is selected and the detailed construction schedule is confirmed. The timeframes assumed as part of this EIS and supporting technical assessments are indicative only and reflect a conservative upper limit of potential impacts from the project.

Construction activities will be undertaken from 6am to 6pm Monday to Sunday. Exceptions to these hours may be required on limited occasions. Uralla Shire Council and surrounding landholders will be notified of any exceptions. Section 4.2 of this report provides further consideration of the proposed construction hours.

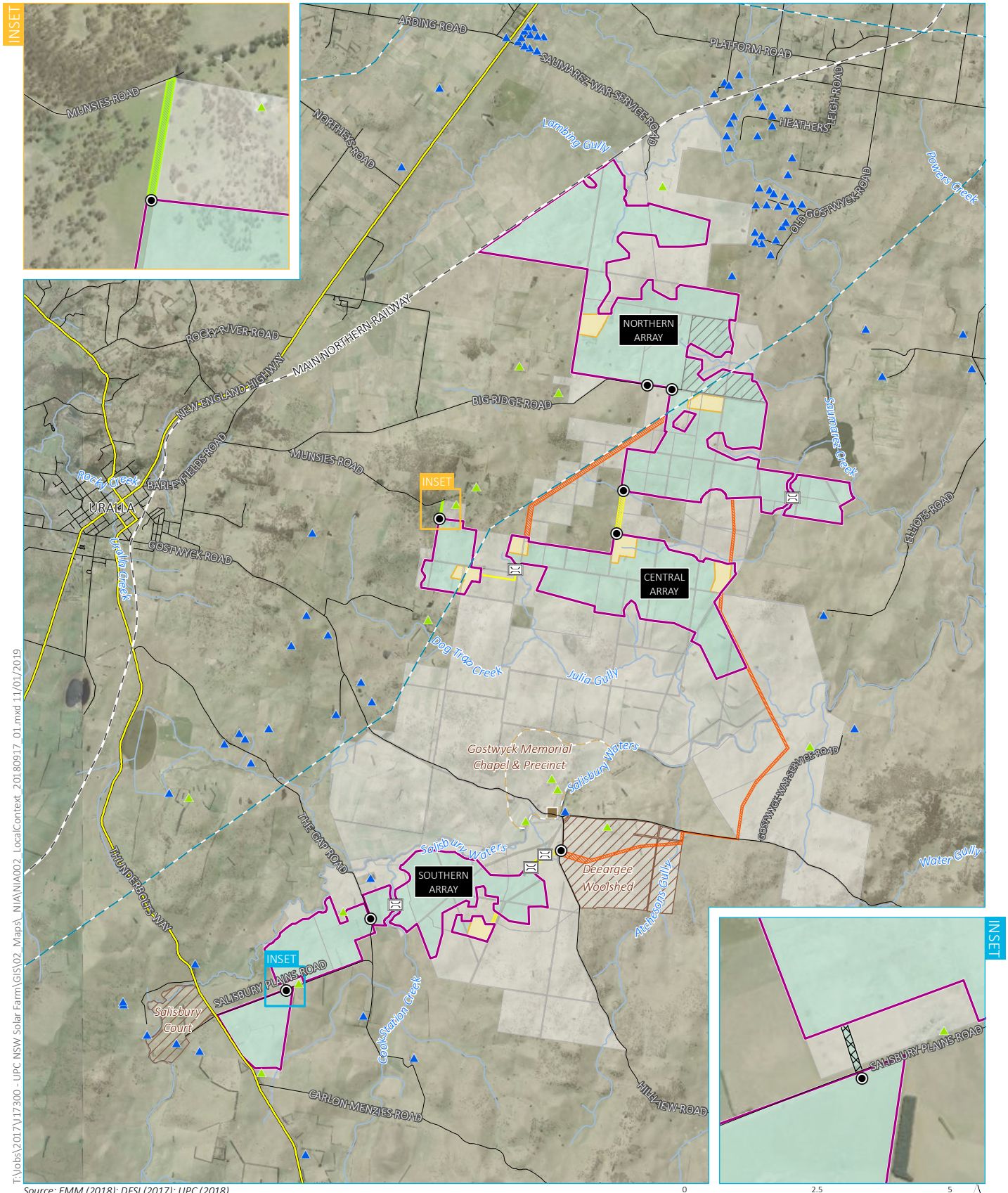
2.2 Site description

The project will be developed within the Uralla Shire LGA. At its closest extent, the project boundary is approximately 6 km east of the township of Uralla, and the northern array area starts approximately 8.6 km south of Armidale. The project boundary, which is defined as the entirety of all the involved lots, presented on Figure 2.1 encompasses 61 lots across a total area of 8,380 ha.

The development footprint is the area within the project boundary on which infrastructure will be located (Figure 2.1). The development footprint encompasses a total area of 2,787 ha, which includes 1,418 ha within the northern array area, 625 ha within the central array area and 653 ha within the southern array area. Within the development footprint, approximately 1,000 ha will be required for the rows of PV modules. The remaining area is associated with power conversion units (PCUs), space between the rows, internal access tracks and associated infrastructure (including substations and BESSs). The development footprint also includes land required for connection infrastructure between the three array areas as well as land required for new internal roads to enable access to the three array areas from the surrounding road network. Subject to detailed design and consultation with the project landholders, security fencing may be required on land outside of the development footprint, but within the project boundary.

The land within the project boundary is zoned RU1 Primary Production under the Uralla Local Environmental Plan 2012 (Uralla LEP). The project boundary encompasses 61 lots, the majority of which have been modified by historical land use practices and past disturbances associated with land clearing, cropping and intensive livestock grazing. The properties within the project boundary are currently primarily used for sheep grazing for production of wool and lambs, with some cattle grazing for beef production.

The project is ideally located close to TransGrid's 330 kilovolt (kV) transmission line, which passes through the northern and central array areas (Figure 2.1). It also has access to the regional road network; including the New England Highway and Thunderbolts Way (Figure 2.1).



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Source: EMM (2018); DFSI (2017); UPC (2018)

0 2.5 5 km

GDA 1994 MGA Zone 56

N

KEY

- 330 kV transmission line
- Main road
- Local road
- Rail line
- Watercourse/drainage line

Historic heritage

- Chapel
- Uralla LEP 2012 heritage item
- Gostwyck Memorial Chapel Precinct

- Project boundary

Development footprint

- Solar array
- Potential ETL easement
- Potential site access corridor
- Potential site access/ETL easement
- Potential substation/BESS footprint
- Potential electrical cabling
- Potential creek crossing

- Primary site access point
- Potential site for construction accommodation village

Sensitive receptors

- Project-related
- Non-project related

Location of the New England Solar Farm

New England Solar Farm
Noise and vibration impact assessment
Figure 2.1

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3 Existing environment

3.1 Assessment locations

The closest assessment locations to the three array areas are residential dwellings. The closest non-project related dwelling, S9, is approximately 240 m north of the development footprint in the southern array area. A further 39 assessment locations are within approximately 2 km of the three array areas (refer Figure 3.1). The majority of these dwellings are within proximity of the northern array area within the suburb of Kellys Plains (refer Figure 3.1).

It is considered that if noise criteria can be satisfied at the assessment locations closest to the development footprint, then noise criteria will be satisfied at other assessment locations that are further from the development footprint.

As part of the NVIA, noise has been assessed at 67 assessment locations to quantify potential noise levels from the project. In addition to residential dwellings, other sensitive land uses identified in the vicinity of the development footprint include three items of local heritage significance (as listed on the Uralla LEP) within proximity of the southern array area, namely:

- Gostwyck Memorial Chapel and precinct (Uralla LEP listing I10) – at its closest point, Gostwyck Memorial Chapel is approximately 1.1 km from the development footprint in the southern array area;
- Deeargee Woolshed (Uralla LEP listing I11) – approximately 970 m from the development footprint in the southern array area; and
- Salisbury Court (Uralla LEP listing I14) – at its closest point, the primary dwelling is approximately 920 m from the development footprint in the southern array area.

In accordance with the applicable ICNG/RNP criteria and due to the separation distances of the development footprint and roads intended to be used during the project's construction period, noise impacts at these three locations are unlikely and have not been assessed further.

Two assessment locations, S11 and N40 (refer Figure 3.1) are rental properties owned by project landholders. At the time of writing, there were no formal negotiated noise agreements in place between the tenants at S11 and N40, the relevant project landholders and UPC. Noise impacts on these properties have been considered as part of this NVIA. Other project-related properties are identified on Figure 2.1.

The assessment locations are listed in Table 3.1 and illustrated in Figure 3.1.

Table 3.1 Noise assessment locations

Location ID	Land use*	Approximate distance from development footprint (km)
C2	Residential	2.1
C3	Residential	2.1
C4	Residential	2.2
C5	Residential	1.7
C6	Residential	2.3
N1	Residential	0.3
N2	Residential	1.0
N3	Residential	1.0
N4	Residential	0.9
N5	Residential	0.9
N6	Residential	1.0
N7	Residential	1.2
N8	Residential	1.3
N9	Residential	1.3
N10	Residential	1.6
N11	Residential	1.3
N12	Residential	1.1
N13	Residential	0.9
N14	Residential	1.1
N15	Residential	1.3
N16	Residential	1.3
N17	Residential	1.5
N18	Residential	1.6
N19	Residential	1.8
N20	Residential	1.4
N21	Residential	1.6
N22	Residential	1.8
N23	Residential	2.0
N24	Residential	2.1
N25	Residential	2.4
N26	Residential	2.4
N27	Residential	2.7
N28	Residential	1.8
N29	Residential	2.1
N30	Residential	2.4
N31	Residential	2.5
N32	Residential	2.3
N33	Residential	2.6
N34	Residential	1.9
N35	Residential	1.7
N36	Residential	2.2
N37	Residential	3.9

Table 3.1 Noise assessment locations

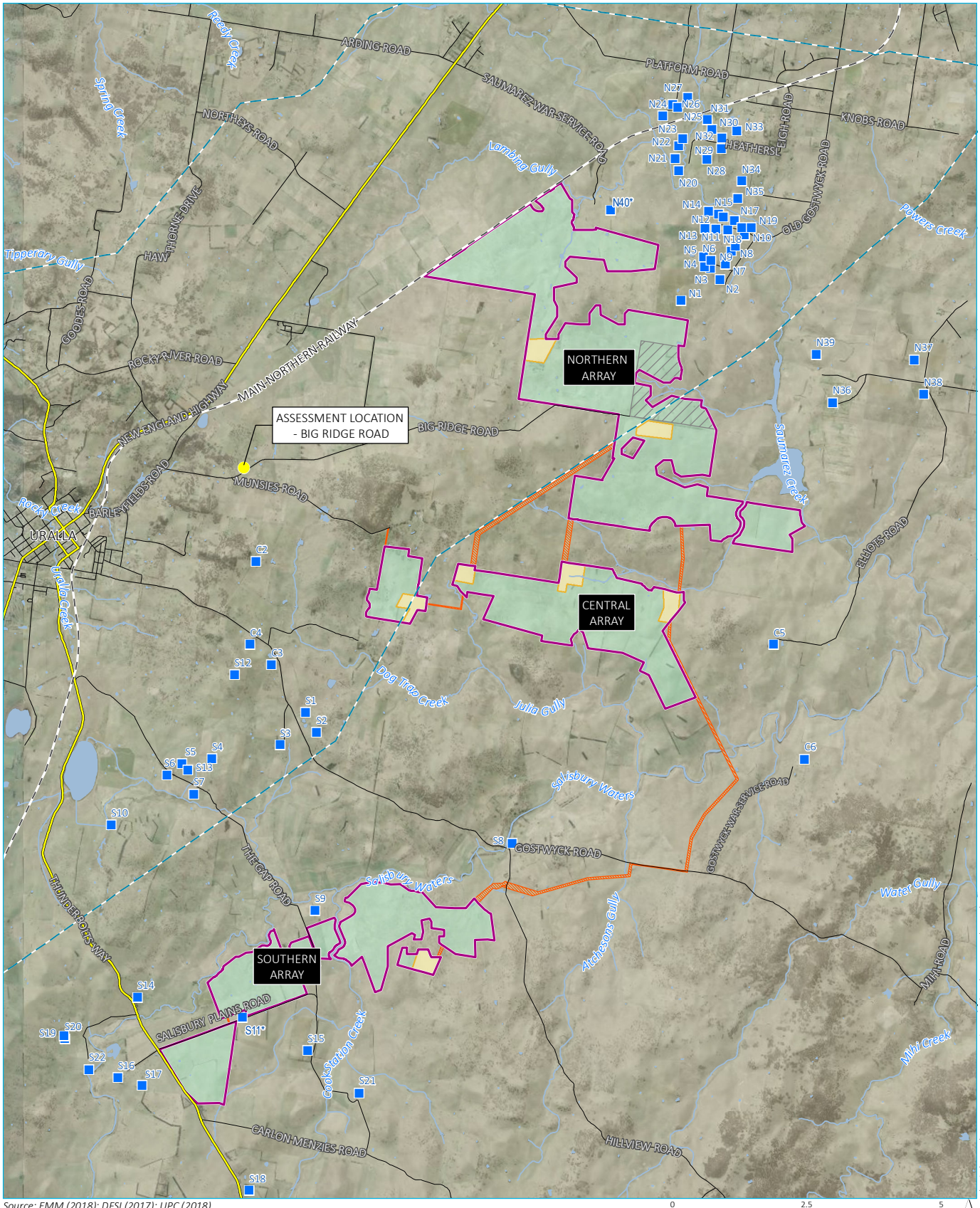
Location ID	Land use*	Approximate distance from development footprint (km)
N38	Residential	3.9
N39	Residential	2.2
N40**	Residential	0.3
S1	Residential	2.1
S2	Residential	2.3
S3	Residential	2.8
S4	Residential	3.4
S5	Residential	3.6
S6	Residential	3.5
S7	Residential	2.8
S8	Residential	0.7
S9	Residential	0.2
S10	Residential	3.3
S11**	Residential	<0.1
S12	Residential	2.6
S13	Residential	3.4
S14	Residential	1.0
S15	Residential	1.0
S16	Residential	0.9
S17	Residential	0.6
S18	Residential	1.7
S19	Residential	1.8
S20	Residential	1.8
S21	Residential	1.8
S22	Residential	1.4

Notes: **As defined in the NSW NPfI and NSW ICNG.*

***The residences at these locations are owned by the project landholders and rented out to members of the local community.*

3.2 Acoustic environment

Given the area and surrounding agricultural land uses, existing ambient noise levels at assessment locations are likely to be dominated by rural noise sources and road traffic noise. The rating background noise levels (RBLs) are expected to be low (30 dB or below) and therefore the NPfI minimum RBLs of 35 dB and 30 dB have been adopted for this assessment for the daytime and evening/night-time periods, respectively in accordance with the NPfI (EPA 2017).



Source: EMM (2018); DFSI (2017); UPC (2018)

0 2.5 5 km

GDA 1994 MGA Zone 56

N

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KEY

- Noise assessment locations*
- Road traffic noise assessment location
- 330 kV transmission line
- Main road
- Local road
- Rail line
- Watercourse/drainage line
- Waterbody

Development footprint

- Solar array
- Potential site access/ETL easement/electrical cabling
- Potential substation/BESS footprint
- Potential site for construction accommodation village

*Noise assessment locations are rental properties owned by project landholders.

Noise assessment locations

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Noise and vibration impact assessment
Figure 3.1

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4 Construction noise guidelines

4.1 Objectives

Construction noise objectives aim to minimise the noise impacts from construction activities on surrounding assessment locations. This section provides a summary of applicable noise objectives for the proposed activities.

These noise objectives were used to derive site specific construction noise management levels (NMLs) to assess the potential noise levels from the proposed works and guide the requirements for mitigation or management thereof.

4.2 Interim construction noise guideline

The assessment and management of noise from construction works is completed using the ICNG (DECC 2009), which provides two methods for the assessment of construction noise emissions:

- quantitative: suited to major construction projects with typical durations of more than three weeks; and
- qualitative: suited to short term construction activity (less than three weeks).

The method for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the nearest assessment locations, whilst the qualitative assessment methodology is a more simplified approach that relies more on noise management strategies.

Due to the anticipated duration of the proposed construction works (ie greater than three weeks), this study has adopted a quantitative assessment approach. The assessment includes quantification of potential noise impacts at assessment locations and provides construction noise criteria for activities that are proposed.

The ICNG recommends that where noise levels from construction during out of hours (OOH) periods are above the noise affected level (RBL + 5 dB) all feasible and reasonable mitigation should be adopted.

The ICNG requires a strong justification for construction works outside of standard construction hours. As described in Section 2.1, it is proposed that construction hours of 6am to 6pm Monday to Sunday be adopted for the project. It is of note that periods of this fall outside of the ICNG (DECC 2009) standard hours, which are Monday to Friday 7 am to 6 pm and Saturday 8 am to 1 pm, with no construction work on Sundays or public holidays.

Utilising every day in the week will significantly shorten the construction program, thereby reducing the project's potential impacts to the local community and demands on local infrastructure. While the lead contractors selected for construction will ultimately determine the extent to which Sundays will be used, approval is being sought for this flexibility should it be required.

Furthermore, as noted in Section 2.1, a construction accommodation village may be constructed in the development footprint for the northern array area. In order for a large proportion of the project's non-local construction workforce to be housed in the construction accommodation village, the mobilised workforce would need to be utilised as efficiently as possible (ie over a seven day working week).

Without this flexibility, it is anticipated that the economic viability of the construction accommodation village would be questionable as there would be higher up-front costs involved.

An influx of a significant number of workers during the project's construction period has the potential to impact social characteristics within the local community such as accommodation, local infrastructure and local businesses, including community services and facilities. As noted in the social impact assessment (Appendix N of the EIS), if required, the construction accommodation village will be scalable and flexible to ensure that it can respond to demand and would mitigate potential for adverse impacts to be experienced within the local community.

As noted in Section 9.3, buffer zones are proposed during OOH periods with the aim of minimising impacts and reducing construction noise levels to below the relevant criteria at select assessment locations. In addition, as part of the preparation of the construction environmental management plan (CEMP), consideration will be given to the construction activities proposed to be undertaken during OOH periods.

Table 4.1 is an extract from the ICNG and provides NMLs for residential assessment locations during and outside of standard construction hours.

Table 4.1 ICNG residential NMLs

Time of day	Management level, $L_{Aeq,15\ minute}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6pm Saturday 8 am to 1 pm No work on Sundays or public holidays.	Noise affected RBL + 10 dB.	The noise affected level represents the point above which there may be some community reaction to noise: • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB.	The highly noise affected level represents the point above which there may be strong community reaction to noise: • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: i) times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences; and ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5 dB.	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community. • Guidance on negotiating agreements is provided in Section 7.2.2 of the ICNG (DECC 2009).

The construction NMLs for this assessment have been based on the adopted NPfI minimum RBL of 35 dB in accordance with the ICNG (DECC 2009).

The NMLs are shown in Table 4.2.

Table 4.2 Project construction residential NMLs

Assessment locations	ICNG Hours	Period[2]	Adopted RBL, dB(A)	NML, $L_{Aeq,15\ minute}$
C2-C6 S1-S22 N1-N40	**Standard hours[1]**	Day	35	45 75 (highly affected)
	Outside of standard hours	Day	35	40 75 (highly affected)
		Evening/Night	30	35 75 (highly affected)

Notes: *1. Standard hours as per the ICNG are Monday to Friday from 7 am to 6 pm, Saturday from 8 am to 1 pm, no work on Sundays and public holidays.*

2. NPfI periods are Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.

4.3 Sleep disturbance

The project is proposing construction hours between 6 am and 6 pm Monday to Sunday, a small part of which (ie 6 am to 7 am) falls within the NPfI designated night-time period (10 pm to 7 am). Therefore, assessment of sleep disturbance is required in accordance with the NPfI.

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where the night-time noise levels at a residential location exceed:

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

Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP calls upon a number of studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the RNP provides the following conclusions from the research on sleep disturbance:

- maximum internal noise levels (L_{Amax}) below 50 to 55 dB are unlikely to awaken people from sleep; and
- one or two noise events per night, with maximum internal noise levels (L_{Amax}) of 65 to 70 dB, are not likely to affect health and wellbeing significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 60 to 65 dB calculated at the facade of a residence is unlikely to cause awakening affects.

If noise levels over the screening criteria are identified, then additional analysis would consider factors such as:

- how often the events would occur;
- the time the events would occur;

- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current scientific literature available regarding the impact of maximum noise level events at night.

Table 4.3 provides the maximum noise level event screening criteria for the residential assessment locations.

Table 4.3 Maximum noise level event screening criteria

Assessment locations	Adopted RBL, dB[1]	Maximum noise level event screening criteria, dB	
		$L_{Aeq,15\ minute}$	L_{Amax}
C2-C6 S1- S22 N1-N40	30[2]	40	52

Notes: 1. RBLs calculated in accordance with the NPfI procedures.

2. Minimum assumed RBL for night-time period as per NPfI procedures

4.4 Road traffic noise

The principle guidance for assessing the impact of road traffic noise on assessment locations is in the NSW EPA's RNP (DECCW 2011).

It is anticipated that road trucks will deliver all equipment and material (eg piles, frames, cables, PV modules, PCUs, etc) to the three array areas. As mentioned above, the project will be constructed in two stages. The Stage 1 and Stage 2 vehicle movement routes are described as follow:

- Stage 1:
  - Route A (1A): Barleyfields Road (north) turning onto Big Ridge Road and travelling to the primary site access points for the northern array. Light vehicles travelling south along the New England Highway from Armidale and all heavy vehicles from the north and south that require access to the northern array area will travel via Barleyfields Road (north); and
  - Route B (1B): Woods Street turning onto Barleyfields Road (south) and then onto Big Ridge Road and travelling on to the primary site access points the northern array. Only light vehicles that require access to the northern array area travelling north along the New England Highway from Uralla will travel via Woods Street and Barleyfields Road (south).
- Stage 2:
  - Route A (2A): Barleyfields Road (north) turning onto Big Ridge Road and then onto Munsies Road for access to the central array. Light vehicles travelling south along the New England Highway from Armidale and all heavy vehicles from the north and south that require access to the central array area will travel via Barleyfields Road (north);
  - Route B (2B): Wood Street turning into Barleyfields Road (south) and then onto Big Ridge Road and Munsies Road for access to the central array. Only light vehicles that require access to the central array area travelling north along the New England Highway from Uralla will travel via Woods Street and Barleyfields Road (south).

- Route C (2C): Vehicle movements via Barleyfields Road (north and south) will be the same as described above for Route A (1A) and Route B (1B). Vehicles will travel from the Big Ridge Road site access points for the northern array to the central array via an internal site access road between the northern and central array areas (this route also accounts for light vehicle movements from the CAV and heavy vehicle deliveries for the BESS).

- Route D (2D): Thunderbolts Way turning onto Salisbury Plains Road to access the primary site access points for the southern array on Salisbury Plains Road or The Gap Road.

- Route E (2E): Gostwyck Road (originates at East St) and turning right onto Hillview Road to access the primary site access point for the southern array.

For the purposes of this assessment, it is assumed that 20% of the peak construction workforce will travel from both Armidale and Tamworth, respectively, and 10% will travel from within the township of Uralla and surrounds. For the purposes of this assessment, it has been assumed that, the remaining 50% will be from outside of these areas and will be accommodated in the CAV.

During the average construction period, it is assumed that the non-local workforce, which will be smaller, will be able to reside within available temporary accommodation within the Armidale (40%), Tamworth (40%) and Uralla Shire (20%) LGAs and will commute to and from these areas on a daily basis.

For heavy vehicles, it is assumed that 50% will originate from Brisbane and 50% will originate from Sydney, with all heavy vehicles travelling to the three array areas via the New England Highway. Subject to further investigations, project infrastructure may also be delivered to Port of Newcastle. Should this occur, heavy vehicles would likely use a combination of either the Pacific Highway or Hunter Expressway and the New England Highway to travel to Uralla and the three array areas. Should project infrastructure be delivered to the Port of Newcastle, the split of heavy vehicles between the Port of Brisbane and Port of Sydney would subsequently be revised.

It is of note that throughout the construction of the project, all project-related heavy vehicles will access Big Ridge Road via the northern intersection of Barleyfields Road and the New England Highway. No heavy vehicles are proposed to utilise Barleyfields Road (south) via Wood Street to access Big Ridge Road. The only exception to this could be in the unforeseeable need to access the northern and central array areas during an emergency or other temporary road closure of Barleyfields Road (north) (eg as part of local road maintenance or improvement works), for which an alternative access approval will be sought. The framework for such exceptions will be identified in consultation with NSW Roads and Maritime Services (RMS) and Uralla Shire Council during preparation of the CEMP.

The sections of the New England Highway, Gostwyck Road and Thunderbolts Way within proximity of the three array areas are classified (as per the RNP) as freeway/arterial road and sub-arterial roads, while Barleyfields, Big Ridge, Munsies, Salisbury Plains, Hillview and The Gap Roads are classified as local roads.

Table 4.4 presents the road noise assessment criteria for these road categories and are reproduced from Table 3 of the RNP (DECCW 2011). It should be noted that such criteria apply to permanent situations and is therefore conservative for the temporary nature of the construction activities proposed as part of the project.

Table 4.4 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria, dB(A)	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,1\ hour}$ 55 (external)	$L_{Aeq,1\ hour}$ 50 (external)

Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB, after consideration of all feasible and reasonable noise mitigation and management measures.

5 Construction vibration criteria

5.1 Human comfort – Assessing vibration a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC 2006) is based on guidelines contained in BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz) (BSI 2008).

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operators negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 5.1.

Table 5.1 Examples of types of vibration

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

The most relevant to the proposed construction activities are continuous and intermittent vibration and these are discussed further in the following sections.

5.1.1 Continuous vibration

Appendix B of the guideline outlines acceptable criteria for human exposure to continuous vibration (1 Hz80 Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 5.2 reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 5.2 Criteria for exposure to continuous vibration

Place	Time	Peak velocity[2] (mm/s)	
		Preferred	Maximum
Critical working Areas (eg hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Day	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or night-time	0.56	1.1

Notes: 1. Root Mean Square (RMS) velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s).

2. Values given for most critical frequency >8 Hz assuming sinusoidal motion.

5.1.2 Intermittent vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (eg an excavator tracking).

Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted root mean square (RMS) acceleration levels over the frequency range 1 Hz80 Hz. To calculate VDV the following formula (refer Section 2.4.1 of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted RMS of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The acceptable VDV for intermittent vibration are reproduced in Table 5.3.

Table 5.3 Acceptable vibration dose values for intermittent vibration

Location	Daytime		Night-time	
	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: *1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

5.2 Structural vibration criteria – DIN 4150

Structural vibration should be assessed at the foundation of a building structure. The German Standard *DIN 4150 - Part 3: 1999* (DIN 1999) provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, or maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 5.4 and shown graphically in Figure 5.1 in the case of foundation levels. For residential and commercial type structures, the standard recommends safe limits as low as 5 mm/s and 20 mm/s respectively. These limits increase with frequency values above 10 Hz. The operational frequency of construction plant typically ranges between 10 Hz–30 Hz, and hence according to DIN 4150, the safe vibration criteria range for dwellings is 5–15 mm/s. For reinforced commercial type buildings the limit range is 20-40 mm/s.

Table 5.4 Structural damage guideline values of vibration velocity – DIN 4150

Line	Type of Structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Plane of floor of uppermost storey
		1Hz to 10Hz	10Hz to 50 Hz	50Hz to 100Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

Notes: *1. "Line" refers to curves in Figure 1 of DIN 4150.*

2. For frequencies above 100Hz the higher values in the 50Hz to 100Hz column should be used.

These levels are 'safe limits', for which damage due to vibration effects is unlikely to occur. 'Damage' is defined in DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Should such damage be observed without vibration levels exceeding the safe limits then it is likely to be attributable to other causes. DIN 4150 also states that when vibration levels higher than the safe limits are present, it does not necessarily follow that damage will occur.

As indicated by the criteria in Table 5.4, high frequency vibration has less potential to cause damage than lower frequencies. Furthermore, the 'point source' nature of vibration from plant causes the vibratory disturbances to arrive at different parts of nearby large structures in an out-of-phase manner, thereby reducing its potential to excite in-phase motion of the low order modes of vibration in such structures.

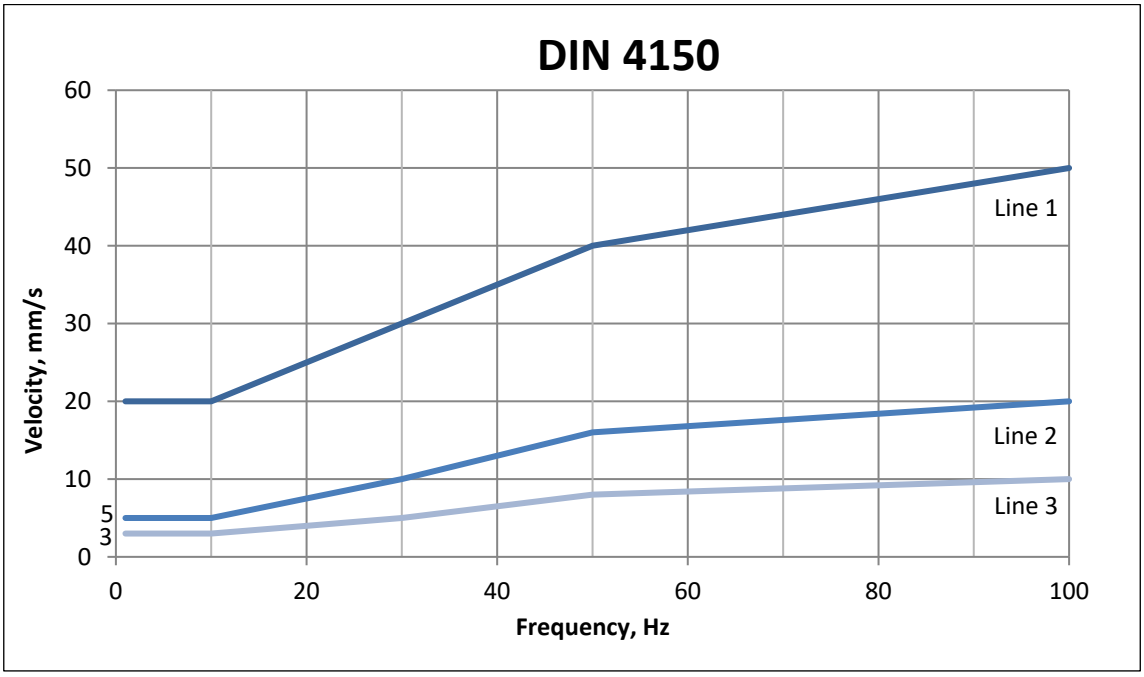


Figure 5.1 DIN 4150 Structural vibration safe limits for buildings

5.3 Ground-borne noise

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. The ICNG provides guidance on the assessment of ground-borne noise and relevant internal noise levels for the evening and night-time periods above which management actions should be implemented.

Table 5.5 outlines the ground-borne noise criteria applicable during the construction period. These ground-borne noise levels are applicable during evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels.

Table 5.5 Ground-borne noise criteria

Period	Ground-borne noise criteria
Day	No criteria applicable
Evening	$L_{Aeq,15\ minute}$ 40 dB
Night	$L_{Aeq,15\ minute}$ 35 dB

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.

During construction works, airborne noise is expected to be the prevailing source of noise. As ground-borne noise criteria are only applicable when ground-borne noise levels are expected to be higher than airborne noise levels, ground-borne noise impacts are not expected to be applicable and as such, are not expected to impact the nearest assessment locations.

6 Construction noise assessment

6.1 Noise modelling methodology

Construction noise levels were modelled using Brüel and Kjær 'Predictor' software. 'Predictor' calculates total noise levels at assessment locations from the concurrent operation of multiple noise sources. The model incorporates the following factors:

- the lateral and vertical location of noise sources;
- source to assessment location distances;
- ground effects;
- atmospheric absorption;
- topography of the development area and immediate surrounds; and
- applicable meteorological conditions.

Predicted noise levels over a typical worst case 15-minute scenario were modelled and assessed for comparison against the relevant NMLs.

6.2 Construction plant and equipment

The construction noise impact assessment has adopted sound power levels from the EMM noise database for plant and equipment items used on similar projects. Plant and equipment items, sound power levels and quantities adopted in the noise modelling are summarised in Table 6.2.

Construction within the three array areas will comprise the installation of PV modules and associated infrastructure. Site preparation will be the starting phase of the construction works. The need for heavy civil works such as grading/levelling and compaction will be minimised as the flattest land areas within the three array areas, which are already mostly cleared of vegetation, have been selected.

Some heavier earth moving will likely be required for certain project infrastructure (eg substations and BESSs) in those instances where a level pad is necessary. In addition, grading around lower order streams and drainage channels within the three array areas may also be required in order to manage erosion during construction.

Site establishment works and preparation for construction may include:

- the establishment of a temporary construction site compound in a fenced-off area within the development footprint including:
  - a site office;
  - containers for storage;
  - parking areas; and
  - temporary laydown areas.

- construction of access tracks and installation of boundary fencing;
- site survey to confirm infrastructure positioning and placement; and
- geotechnical investigations to confirm the ground condition.

Upon completion of the site establishment and pre-construction activities described above, construction will typically be as follows:

- drive or screw piles;
- install mounting structures and tracker tubes;
- secure PV modules to tracker tubes;
- installation of medium voltage and high voltage cables;
- installation of PCUs;
- complete substation augmentation;
- establishment of the BESS compound; and
- test and commission project infrastructure.

As noted in Section 2.1, a construction accommodation village for non-local construction employees may be established as part of the early stages of the project's construction. To build the construction accommodation village, topsoil will be stripped where necessary, hardstand constructed and walkways and car parks constructed.

The assumed list of plant and equipment for each construction scenario provided in Table 6.1 are considered to be representative of a worst-case period of construction in an active works area. However, due to the practicalities of constructing a project of this nature, the plant and equipment quantities may vary from time-to-time to cater for the requirements of the project's construction. If the actual fleet of plant and equipment required varies significantly from that assumed within Table 6.1, a risk assessment of the proposed works will be undertaken to determine the likelihood of noise impacts on surrounding residential receivers. Appropriate management and mitigation measures will be used, where required. As described in Section 9.2, the CEMP will include the risk assessment protocol and detail the management and mitigation measures to be implemented during construction consistent with the best practice requirements outlined in the ICNG (DECC 2009).

Table 6.1 Typical construction plant and equipment

Stage	Plant and equipment items	Quantity (worst case per 15-min period)[1]	A-weighted sound power level, dB
Site preparation works	Excavator	1	104
	Dozer	1	110
	Light vehicle	4	76
	Front End Loader (FEL)	1	105
	Road truck (deliveries)	1	103

Table 6.2 Typical construction plant and equipment

Stage	Plant and equipment items	Quantity (worst case per 15-min period)[1]	A-weighted sound power level, dB
Site preparation works	Dump truck	2	108
	Grader	1	108
	Roller	1	116
	Compactor	1	112
	Crane	1	106
	Forklift	1	106
	Water truck	1	96
	Generator	2	98
Pile driving and foundations for substations, BESS(s) and the construction accommodation village (if required)	Piling rig	1	115[4]
	Road truck (deliveries)	1	103
	Crane	1	106
	Excavator	1	104
	Concrete truck (idling/driving)	1	105[5]
	Concrete truck (slumping)	1	113[5]
	Light vehicle	2	76
Underground cabling	Road truck (deliveries)	1	103
	Cable trenching and laying equipment	1	100
	Light vehicle	2	76
PV modules full installation	Powered hand tools	1	97
	Compressor	1	108
	Pneumatic wrench	2	104[4]
	Generator	1	98
	Crane	1	106
	Road truck (deliveries)	1	103
	Light vehicle	2	76
Installation of O&M buildings and the construction accommodation village (if required)	Crane	1	106
	Forklift	1	106
	Light vehicle	2	76
	Road truck	1	103
	Generator	1	98
Removal of temporary site compound and construction accommodation village (if required)	Crane	1	106
	Forklift	1	106
	Light vehicle	2	76
	Road truck (deliveries)	1	103

Notes: *1. Standard hours: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm and no construction work on Sundays or public holidays.*

2. Plant and equipment items have been assumed to operate continuously in any 15-minute period unless otherwise specified.

3. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.

4. These items are assumed to operate for 50% of the time in any 15-minute period.

5. The concrete truck is assumed to drive/idle on-site for 80% of the time and slump for 20% of the time in any 15-minute period.

6.3 Modelled meteorological conditions

Noise propagation over distance can be significantly affected by the prevailing weather conditions. Of most interest to this assessment are source to receiver winds and the presence of temperature inversions, as these conditions can enhance received noise levels.

6.3.1 Prevailing winds

The NPfI recommends consideration of wind effects if they are “significant”. The NPfI defines “significant” as the presence of source-to-receiver wind speed (measured at 10 m above ground level) of 3 m/s or less, occurring for 30% of the time in any assessment period and season.

This is further clarified by defining source-to-receiver wind direction as being the directional component of wind. The NPfI states that where wind is identified to be a significant feature of the area then assessment of noise impacts should consider the highest wind speed below 3 m/s, which is considered to prevail for at least 30% of the time.

Meteorological data from the nearest Bureau of Meteorology (BoM) Automatic Weather Station (AWS) was analysed. Data recorded between January 2013 and January 2018 (5 years) from the BoM's Armidale Airport AWS (ID 056238) was used for this assessment. The analysis identified that no winds were found to be a feature of the area during the day, evening or night periods and therefore only calm meteorological conditions were adopted for the construction noise modelling.

6.3.2 Temperature inversions

The NPfI states that the assessment of the impact of temperature inversions should be confined to the night-time noise assessment period where temperature inversions occur.

The frequency of temperature inversions was determined based on sigma-theta data obtained from the BoM’s Armidale Airport AWS. Analysis of the data found that F or G stability class (temperature inversions) do not occur for greater than 30% of the night-time period and, as such, has not been considered in the prediction and assessment of noise emissions for the night-time period.

6.3.3 Assessed meteorological conditions

Meteorological conditions adopted for the construction noise modelling are presented in Table 6.3.

Table 6.3 Meteorological conditions considered in noise modelling

Assessment period	Meteorological condition	Air temperature	Relative humidity	Wind speed	Wind direction	Stability category
Day[1, 2]	Calm	20°C	70%	0 m/s	All	D class
Night[1, 2]	Calm	10°C	90%	0 m/s	All	D class

Notes: *1. Corresponds to standard construction hours as per the ICNG.*

2. Corresponds to the operational hours of the project.

6.4 Construction noise modelling results

Based on the noise modelling results, the site preparation works have the most potential for noise impacts given the number of plant to be used, their emission levels, duration and locations of other construction activities, and therefore are the focus for the assessment. Noise from other construction activities would result in off-site noise levels that are below those from site preparation works.

Predicted construction noise levels for the site preparation works are presented in Table 6.4. Assessment locations where the relevant NMLs are predicted to be exceeded during any time period have been highlighted in grey and **bolded**.

Table 6.4 Construction noise predictions

Assessment locations	Land use	Predicted construction noise level, dB	Construction NML, dB		
			Standard Hours	Out of Hours	
			Day[1]	Day	Night
C2	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
C3	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
C4	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
C5	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
C6	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N1	Residential	45 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	**40 $L_{Aeq,15\ minute}$**	**35 $L_{Aeq,15\ minute}$**
N2	Residential	36 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
N3	Residential	36 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
N4	Residential	38 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
N5	Residential	38 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
N6	Residential	37 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
N7	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N8	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N9	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N10	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N11	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N12	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N13	Residential	37 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
N14	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N15	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N16	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N17	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$

Table 6.4 Construction noise predictions

Assessment locations	Land use	Predicted construction noise level, dB	Construction NML, dB		
			Standard Hours	Out of Hours	
			Day[1]	Day	Night
N18	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N19	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N20	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N21	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N22	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N23	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N24	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N25	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N26	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N27	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N28	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N29	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N30	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N31	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N32	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N33	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N34	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N35	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N36	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N37	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N38	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N39	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
N40**	Residential	43 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	**40 $L_{Aeq,15\ minute}$**	**35 $L_{Aeq,15\ minute}$**
S1	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S2	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S3	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S4	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S5	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S6	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S7	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S8	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S9	Residential	45 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	**40 $L_{Aeq,15\ minute}$**	**35 $L_{Aeq,15\ minute}$**
S10	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S11**	Residential	51 $L_{Aeq,15\ minute}$	**45 $L_{Aeq,15\ minute}$**	**40 $L_{Aeq,15\ minute}$**	**35 $L_{Aeq,15\ minute}$**
S12	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S13	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S14	Residential	39 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
S15	Residential	38 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**
S16	Residential	39 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	**40 $L_{Aeq,15\ minute}$**	**35 $L_{Aeq,15\ minute}$**
S17	Residential	42 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	**40 $L_{Aeq,15\ minute}$**	**35 $L_{Aeq,15\ minute}$**
S18	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$

Table 6.4 Construction noise predictions

Assessment locations	Land use	Predicted construction noise level, dB	Construction NML, dB		
			Standard Hours	Out of Hours	
			Day[1]	Day	Night
S19	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S20	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S21	Residential	<35 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	35 $L_{Aeq,15\ minute}$
S22	Residential	37 $L_{Aeq,15\ minute}$	45 $L_{Aeq,15\ minute}$	40 $L_{Aeq,15\ minute}$	**35 $L_{Aeq,15\ minute}$**

Notes: 1. Standard hours only: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm and no construction work on Sundays or public holidays.

***The residences at these locations are owned by the project landholders and rented out to members of the local community.*

Construction noise levels are predicted to satisfy the recommended NMLs at most locations during ICNG standard hours. The exception to this is S11, where an exceedance of the recommended NMLs is predicted. Outside of ICNG standard hours, exceedance of the recommended NMLs during the NPfI defined daytime period are predicted at five locations (N1, N40, S9, S11 and S17); and 15 locations (N1-N6, N13, N40, S9, S11, S14-S17, S22) during the NPfI defined night-time shoulder period (6 am to 7 am Monday to Saturday, 6 am to 8 am Sundays and public holidays).

This is not an uncommon finding for construction projects and implies feasible and reasonable mitigation practices should be considered and applied.

Further, given that the predictions assume simultaneous operation of plant and equipment at the nearest locations to the relevant sensitive receptors, it is likely that actual construction noise levels would be less than those predicted.

Notwithstanding, noise mitigation measures and application of good practice noise management have been considered. Noise mitigation and management measures are discussed in Section 9 of this report. If the noise management measures in Section 9 are followed, construction noise levels are predicted to comply with the relevant NMLs at all assessment locations.

6.5 Maximum noise level event assessment

The predicted L_{Amax} noise levels from the construction of project at the nearest assessment locations are presented in Table 6.5.

Typical maximum noise level events, including truck air brakes, excavator/dozer activities and other various activities have been assessed. A worst case maximum noise level event of L_{Amax} 125 dB was adopted to cover any of these possible events.

Assessment locations where the relevant noise levels are predicted to be exceeded have been highlighted in grey and **bolded**.

Table 6.5 Predicted L_{Amax} construction noise levels

Assessment location[1]	Predicted noise levels, dB	Screening criteria, dB
C2	<52 L_{Amax}	52 L_{Amax}
C3	<52 L_{Amax}	52 L_{Amax}
C4	<52 L_{Amax}	52 L_{Amax}
C5	<52 L_{Amax}	52 L_{Amax}
C6	<52 L_{Amax}	52 L_{Amax}
N1	**60 L_{Amax}**	52 L_{Amax}
N2	<52 L_{Amax}	52 L_{Amax}
N3	<52 L_{Amax}	52 L_{Amax}
N4	<52 L_{Amax}	52 L_{Amax}
N5	<52 L_{Amax}	52 L_{Amax}
N6	<52 L_{Amax}	52 L_{Amax}
N7	<52 L_{Amax}	52 L_{Amax}
N8	<52 L_{Amax}	52 L_{Amax}
N9	<52 L_{Amax}	52 L_{Amax}
N10	<52 L_{Amax}	52 L_{Amax}
N11	<52 L_{Amax}	52 L_{Amax}
N12	<52 L_{Amax}	52 L_{Amax}
N13	<52 L_{Amax}	52 L_{Amax}
N14	<52 L_{Amax}	52 L_{Amax}
N15	<52 L_{Amax}	52 L_{Amax}
N16	<52 L_{Amax}	52 L_{Amax}
N17	<52 L_{Amax}	52 L_{Amax}
N18	<52 L_{Amax}	52 L_{Amax}
N19	<52 L_{Amax}	52 L_{Amax}
N20	<52 L_{Amax}	52 L_{Amax}
N21	<52 L_{Amax}	52 L_{Amax}
N22	<52 L_{Amax}	52 L_{Amax}
N23	<52 L_{Amax}	52 L_{Amax}
N24	<52 L_{Amax}	52 L_{Amax}
N25	<52 L_{Amax}	52 L_{Amax}
N26	<52 L_{Amax}	52 L_{Amax}
N27	<52 L_{Amax}	52 L_{Amax}
N28	<52 L_{Amax}	52 L_{Amax}
N29	<52 L_{Amax}	52 L_{Amax}
N30	<52 L_{Amax}	52 L_{Amax}
N31	<52 L_{Amax}	52 L_{Amax}
N32	<52 L_{Amax}	52 L_{Amax}
N33	<52 L_{Amax}	52 L_{Amax}
N34	<52 L_{Amax}	52 L_{Amax}
N35	<52 L_{Amax}	52 L_{Amax}
N36	<52 L_{Amax}	52 L_{Amax}
N37	<52 L_{Amax}	52 L_{Amax}

Table 6.5 Predicted L_{Amax} construction noise levels

Assessment location[1]	Predicted noise levels, dB	Screening criteria, dB
N38	<52 L_{Amax}	52 L_{Amax}
N39	<52 L_{Amax}	52 L_{Amax}
N40**	**54 L_{Amax}**	52 L_{Amax}
S1	<52 L_{Amax}	52 L_{Amax}
S2	<52 L_{Amax}	52 L_{Amax}
S3	<52 L_{Amax}	52 L_{Amax}
S4	<52 L_{Amax}	52 L_{Amax}
S5	<52 L_{Amax}	52 L_{Amax}
S6	<52 L_{Amax}	52 L_{Amax}
S7	<52 L_{Amax}	52 L_{Amax}
S8	<52 L_{Amax}	52 L_{Amax}
S9	**63 L_{Amax}**	52 L_{Amax}
S10	<52 L_{Amax}	52 L_{Amax}
S11**	**72 L_{Amax}**	52 L_{Amax}
S12	<52 L_{Amax}	52 L_{Amax}
S13	<52 L_{Amax}	52 L_{Amax}
S14	<52 L_{Amax}	52 L_{Amax}
S15	<52 L_{Amax}	52 L_{Amax}
S16	<52 L_{Amax}	52 L_{Amax}
S17	**53 L_{Amax}**	52 L_{Amax}
S18	<52 L_{Amax}	52 L_{Amax}
S19	<52 L_{Amax}	52 L_{Amax}
S20	<52 L_{Amax}	52 L_{Amax}
S21	<52 L_{Amax}	52 L_{Amax}
S22	<52 L_{Amax}	52 L_{Amax}

Notes: 1. In accordance with the NPfI, sleep disturbance impacts were only assessed at residential assessment locations.

***The residences at these locations are owned by the project landholders and rented out to members of the local community.*

Noise modelling predicts that, during construction, the L_{Amax} sleep disturbance screening criteria will be satisfied at most assessment locations. The exceptions are assessment locations N1, N40, S9, S11 and S17 which are predicted to be above the L_{Amax} sleep disturbance screening criteria.

It is of note that exceedances of the L_{Amax} screening criteria occur during the NPfI morning shoulder period (6am to 7am) only.

Nonetheless, noise mitigation measures and application of good practice noise management have been considered and are discussed in Section 9 of this report. If the noise management measures in Section 9 are followed, maximum event noise levels during construction are predicted to comply with the relevant L_{Amax} sleep disturbance screening criteria at all assessment locations.

6.6 Road traffic noise during construction

The proposed construction works will include the delivery of all construction plant and equipment and project infrastructure (eg PV modules, mounting frames, PCUs etc) to the three array areas by road trucks. Other traffic movements generated by the project will include light vehicle movements from the construction workforce. As noted in Section 4.3, shuttle buses may also be used to transport the project's construction workforce to and from the three array areas.

Daily average (and peak) traffic movements generated by construction deliveries and the construction workforce are summarised in Table 6.6. Site generated traffic movements will likely be travelling as per the routes described in Section 4.3.

Table 6.6 Daily average traffic movements during construction

Route	Daily heavy vehicles movements		Daily workforce movements (light vehicles)		Total daily movements	
	Average	Peak	Average	Peak	Average	Peak
1A	45	60	64	129	109	189
1B	0	0	86	171	86	171
2A	9	12	12	24	21	36
2B	0	0	18	36	18	36
2C	30	40	100	200	130	240
2D	15	20	50	100	65	120
2E	15	20	50	100	65	120

It is expected that 50% of the construction deliveries will originate from Sydney and arrive from the south via the New England Highway, and 50% will originate from Brisbane and arrive from the north via the New England Highway.

It is of note that throughout the construction of the project, all project related heavy vehicles will access Big Ridge Road via the northern intersection of Barleyfields Road and the New England Highway. No heavy vehicles are proposed to utilise Barleyfields Road (south) to access Big Ridge Road.

For the purposes of this assessment, it is assumed that 20% of the peak construction workforce will travel from both Armidale and Tamworth, respectively, and 10% will travel from within the township of Uralla and surrounds. For the purposes of this assessment, it has been assumed that during peak construction, the remaining 50% will be from outside of these areas and will be accommodated in the CAV.

During the average construction period, it is assumed that the non-local workforce, which will be smaller, will be able to reside within available temporary accommodation within the Armidale (40%), Tamworth (40%) and Uralla Shire (20%) LGAs and will commute to and from these areas on a daily basis.

Table 6.6 outlines the potentially most-affected residences on routes proposed to be utilised by project-related traffic.

Table 6.7 Potentially most affected residences on project routes

Road	Location	Distance from road (m)	Posted speed limit (km/h)	Location
New England Highway	North of Uralla	≥20	80	13 km north of the northern array area
New England Highway	South of Uralla	≥15	50	55 km south west of the southern array area
Thunderbolts Way	South of Hillview Road	≥20	50	5.5 km west of the central array area
Barleyfields Road	North of Big Ridge Road	≥90	50	4.5 km west of the central array area
Barleyfields Road	South of Big Ridge Road	≥18	50	5 km west of the central array area
Big Ridge Road	East of Munsies Road	≥60	100	3 km west of the central array area
Munsies Road	East of Big Ridge Road	≥50	100	3 km west of the central array area
Gostwyck Road	West of Hillview Road	≥20	50	5 km west of the central array area
The Gap Road	East of Thunderbolts Way	≥20	100	3.5 km north west of the southern array area
Salisbury Plains Road	North of Thunderbolts Way	≥18	100	<0.1 km from the southern array area**

*Notes: **The residence at this location is owned by one of the project landholders and is rented out to a member of the local community.*

There are no privately-owned residential receivers located along Salisbury Plains Road or Hillview Road along the proposed routes to be utilised by project-related vehicles. As noted previously, the residence on Salisbury Plains Road (S11) is owned by one of the project landholders and rented out to a member of the local community.

On other parts of the route and further away from the project (towards Armidale, approximately 13 km north of the project's northern array area, or Moonbi, approximately 55 km south-west of the project's, southern array area), nearest residential facades are set back approximately 20 m and 15 m (or greater) from the road in 80 km/h and 50 km/h speed zones, respectively. These distances and speeds have been adopted for the road traffic noise assessment.

Road traffic noise results are based on the peak workforce movements and construction delivery movements during the peak construction scenario and hence this assessment of road traffic noise is considered to be conservative.

Existing traffic data for the New England Highway was obtained from the publicly available NSW Roads and Maritime Services' online database. This data was used to calculate the existing traffic volumes for 2018 assuming a 1% annual traffic growth (linear) for all roads. In addition, EMM completed intersection surveys of the local road network in August 2018, with daily traffic volumes calculated for Barleyfields Road, Big Ridge Road, Munsies Road, Hillview Road, Gostwyck Road, Salisbury Plains Road and The Gap Road.

The estimated existing (2018) average daily traffic volumes on the transport routes can be seen in Table 6.8 below.

Table 6.8 Projected daily traffic volumes

Road	Location	2018 projected daily traffic volume	Average proportion of heavy vehicles
New England Highway	South of Arding Road	6,557	10%
New England Highway	West of Glenburnie Road	3,985	18%
Thunderbolts Way	South of Hillview Road	1,092	10%
Barleyfields Road	North of Big Ridge Road	645	9%
Barleyfields Road	South of Big Ridge Road	740	11%
Big Ridge Road	East of Barleyfields Road	175	11%
Big Ridge Road	East of Munsies Road	115	39%
Munsies Road	East of Big Ridge Road	25	20%
Hillview Road	South of Gostwyck Road	55	0%
Gostwyck Road	West of Hillview Road	115	4%
Gostwyck Road	East of Hillview Road	60	8%
Salisbury Plains Road	East of Thunderbolts Way	25	20%
The Gap Road	East of Thunderbolts Way	46	8%

Notes: 1. For the purposes of this assessment, existing traffic volumes are assumed to be 90% during the day period and 10% during the night-time period.

Road traffic noise levels during construction works are predicted to be below the relevant criteria at the majority of the affected residential dwellings on the surrounding road network, as shown in Table 6.9. Assessment locations where the relevant noise levels are predicted to be exceeded have been highlighted in grey and **bolded**.

Table 6.9 Predicted road traffic noise during peak construction

Road	Period	Road traffic noise level, dB			Criteria, dB
		Calculated existing	Predicted project generated[1]	Future	
Munsies Road	Day	35 $L_{Aeq,1\ hour}$	51 $L_{Aeq,1\ hour}$	51 $L_{Aeq,1\ hour}$	55 $L_{Aeq,1\ hour}$
	Night	<30 $L_{Aeq,1\ hour}$	41 $L_{Aeq,1\ hour}$	42 $L_{Aeq,1\ hour}$	50 $L_{Aeq,1\ hour}$
Big Ridge Road	Day	42 $L_{Aeq,1\ hour}$	57 $L_{Aeq,1\ hour}$	**57 $L_{Aeq,1\ hour}$**	55 $L_{Aeq,1\ hour}$
	Night	35 $L_{Aeq,1\ hour}$	47 $L_{Aeq,1\ hour}$	47 $L_{Aeq,1\ hour}$	50 $L_{Aeq,1\ hour}$
Barleyfields Road North of Big Ridge Road	Day	41 $L_{Aeq,1\ hour}$	51 $L_{Aeq,1\ hour}$	51 $L_{Aeq,1\ hour}$	55 $L_{Aeq,1\ hour}$
	Night	33 $L_{Aeq,1\ hour}$	41 $L_{Aeq,1\ hour}$	42 $L_{Aeq,1\ hour}$	50 $L_{Aeq,1\ hour}$
Barleyfields Road South of Big Ridge Road	Day	50 $L_{Aeq,1\ hour}$	54 $L_{Aeq,1\ hour}$	55 $L_{Aeq,1\ hour}$	55 $L_{Aeq,1\ hour}$
	Night	43 $L_{Aeq,1\ hour}$	45 $L_{Aeq,1\ hour}$	49 $L_{Aeq,1\ hour}$	50 $L_{Aeq,1\ hour}$
The Gap Road	Day	35 $L_{Aeq,1\ hour}$	52 $L_{Aeq,1\ hour}$	52 $L_{Aeq,1\ hour}$	55 $L_{Aeq,1\ hour}$
	Night	<30 $L_{Aeq,1\ hour}$	42 $L_{Aeq,1\ hour}$	42 $L_{Aeq,1\ hour}$	50 $L_{Aeq,1\ hour}$
Salisbury Plains Road**	Day	38 $L_{Aeq,1\ hour}$	57 $L_{Aeq,1\ hour}$	**57 $L_{Aeq,1\ hour}$**	55 $L_{Aeq,1\ hour}$
	Night	<30 $L_{Aeq,1\ hour}$	48 $L_{Aeq,1\ hour}$	48 $L_{Aeq,1\ hour}$	50 $L_{Aeq,1\ hour}$
Gostwyck Road	Day	39 $L_{Aeq,15\ hour}$	42 $L_{Aeq,15\ hour}$	44 $L_{Aeq,15\ hour}$	60 $L_{Aeq,15\ hour}$
	Night	32 $L_{Aeq,15\ hour}$	35 $L_{Aeq,15\ hour}$	37 $L_{Aeq,15\ hour}$	55 $L_{Aeq,15\ hour}$
Thunderbolts Way	Day	51 $L_{Aeq,15\ hour}$	42 $L_{Aeq,15\ hour}$	51 $L_{Aeq,15\ hour}$	60 $L_{Aeq,15\ hour}$
	Night	43 $L_{Aeq,15\ hour}$	35 $L_{Aeq,15\ hour}$	44 $L_{Aeq,15\ hour}$	55 $L_{Aeq,15\ hour}$
New England Highway North of Uralla	Day	61 $L_{Aeq,15\ hour}$	45 $L_{Aeq,15\ hour}$	61 $L_{Aeq,15\ hour}$	60 $L_{Aeq,15\ hour}$
	Night	54 $L_{Aeq,15\ hour}$	38 $L_{Aeq,15\ hour}$	54 $L_{Aeq,15\ hour}$	55 $L_{Aeq,15\ hour}$
New England Highway South of Uralla	Day	59 $L_{Aeq,15\ hour}$	46 $L_{Aeq,15\ hour}$	59 $L_{Aeq,15\ hour}$	60 $L_{Aeq,15\ hour}$
	Night	52 $L_{Aeq,15\ hour}$	39 $L_{Aeq,15\ hour}$	52 $L_{Aeq,15\ hour}$	55 $L_{Aeq,15\ hour}$

Notes: *1. Based on the peak workforce movements and construction delivery movements.*

2. For the purposes of this assessment, it is assumed that the daily traffic volumes are 90% during the daytime period (7 am-10 pm) and 10% during the night-time period (10 pm-7 am).

***The residence at this location is owned by one of the project landholders and is rented out to a member of the local community.*

Table 6.9 shows that marginal exceedances of 2 dB are predicted during the daytime period at the most affected residence on Big Ridge Road and Salisbury Plains Road (ie S11) (refer Figure 3.1).

The road traffic noise predictions are based on peak construction traffic volumes during the concurrent construction of Stages 1 and 2 of the project and, as such, provide a highly conservative assessment. There is potential for approximately 12 months of concurrent construction and outside of these times, it is likely that road traffic noise levels will satisfy the RNP criteria.

As per the NSW Government's Voluntary Land Acquisition and Mitigation Policy (VLAMP), a noise level of, or less than, 2 dB above the relevant noise goal is considered to have negligible impacts and these exceedances would not be discernible by the average listener. As such, these impacts would not warrant receiver based treatments or controls.

Furthermore, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts possible from construction activities.

6.7 Cumulative construction noise

Neoen Australia Pty Ltd (Neoen) is seeking to develop the Uralla Solar Farm, approximately 5 km north-west of the project. The construction works for the Uralla Solar Farm have potential to occur at the same time as for the project.

Modelling results from the proposed construction works for the project are predicted to satisfy the NMLs at all assessment locations during ICNG standard hours. As noted earlier, the predictions assume plant and equipment are operating simultaneously and at the nearest locations to relevant assessment locations, hence it is likely that actual noise levels from the proposed construction works will be lower than predicted.

Construction noise predictions were not available at the time of this assessment report; however, based on the size of the Uralla Solar Farm, an ICNG standard hours construction schedule, distances of nearest assessment locations, and predicted noise levels for the project (refer Table 6.4), the total cumulative construction noise level from both developments is expected to satisfy the NMLs during ICNG standard hours at the identified assessment locations. Therefore, cumulative noise from the project and the Uralla Solar Farm is not anticipated to cause an impact at nearby identified assessment locations.

It is of note that the predicted exceedances for the New England Solar farm occur outside of the ICNG standard hours and that no exceedances are predicted at assessment locations in the direction of the Uralla Solar Farm.

Further, there is potential for cumulative road traffic movements from both the project and the Uralla Solar Farm. No road traffic noise predictions or volumes were available in the preliminary environmental assessment (PEA) prepared for the Uralla Solar Farm (GHD 2018). Road traffic noise levels for the Uralla Solar Farm have been conservatively predicted by assuming similar traffic volumes to the New England Solar Farm. In reality, the Uralla Solar Farm is a smaller project than the New England Solar Farm and actual road traffic noise levels would likely be much lower than those outlined in Table 6.10.

The results of the cumulative road traffic noise assessment are provided in Table 6.10 for road sections potentially common to both projects, namely the New England Highway north and south of Uralla. As shown in Table 6.10, total cumulative road traffic noise levels are predicted to be below the relevant RNP criteria during a concurrent construction scenario for the project and the Uralla Solar Farm.

Table 6.10 Predicted cumulative road traffic noise during peak construction

Road	Calculated existing traffic noise level, dB	NESF predicted traffic noise level, dB	Uralla predicted traffic noise level, dB[2]	Future cumulative traffic noise level, dB	Criteria, dB
New England Highway North of Uralla	61 $L_{Aeq,15\ hour}$	45 $L_{Aeq,15\ hour}$	<45 $L_{Aeq,15\ hour}$	61 $L_{Aeq,15\ hour}$	60 $L_{Aeq,15\ hour}$
New England Highway South of Uralla	59 $L_{Aeq,15\ hour}$	46 $L_{Aeq,15\ hour}$	<46 $L_{Aeq,15\ hour}$	59 $L_{Aeq,15\ hour}$	60 $L_{Aeq,15\ hour}$

Notes: 1. Based on the peak workforce movements and construction delivery movements.

2. No road traffic noise predictions or volumes were available in the PEA for the Uralla Solar Farm. Road traffic noise levels for the Uralla Solar Farm have been conservatively predicted to be similar to the project.

Based on the information available in the PEA for the Uralla Solar Farm (GHD 2018), there is potential for approximately 12-16 months of concurrent construction activities; however, it is unlikely that construction activities would overlap for this entire period. Furthermore, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts possible from construction activities.

In addition to the Uralla Solar Farm, Clenergy proposes to develop the Metz Solar Farm, a 100 MW solar farm approximately 18 km east of Armidale (refer Figure 1.1). Cumulative noise impacts from this project have not been considered as part of this assessment as it has been assumed that construction of the Metz Solar Farm will be completed prior to the commencement of construction for the project.

7 Construction vibration assessment

The majority of vibration generating activities associated with the proposed construction work utilise a roller and a piling drill rig. As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 7.1. The safe working distances are quoted for both 'Cosmetic Damage' (refer British Standard BS 7385) and 'Human Comfort' (refer British Standard BS 6472-1).

Table 7.1 Recommended safe working distances for vibration intensive plant

Plant item[1]	Rating/description	Minimum safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
Vibratory Roller	<50 kN (typically 1–2 tonnes)	5 m	15 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 tonne excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg - 12 to 18 tonne excavator)	7 m	23 m
Large hydraulic hammer	(1,600 kg - 18 to 34 tonne excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Source: Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007.

Notes: 1. Plant items shown are indicative to illustrate safe working distances, not all plant items will be used.

The safe working distances presented in Table 7.1 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

In relation to human comfort response, the safe working distances in Table 7.1 relate to continuous vibration and apply to residential assessment locations. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, in accordance with BS 6472-1.

The closest receptor, S11, is approximately 40 m from the development footprint in the southern array area at its closest point. Given that large vibratory rollers are not expected to be working within 100 m of S11, if at all, it is unlikely that vibration impacts will occur throughout the construction of the project.

In addition, there are three items of local heritage significance (as listed on the Uralla LEP) within proximity of the southern array area that have been considered as part of this construction vibration assessment, namely:

- Gostwyck Memorial Chapel and precinct (Uralla LEP listing I10) – at its closest point, Gostwyck Memorial Chapel is approximately 1.1 km from the development footprint for the southern array area;

- Deeargee Woolshed (Uralla LEP listing I11) – approximately 970 m from the development footprint for the southern array area; and

- Salisbury Court (Uralla LEP listing I14) – at its closest point, the primary dwelling is approximately 920 m from the development footprint for the southern array area.

Given the distances between the development footprint for the southern array area and the items of local heritage significance listed above greatly exceed the minimum safe working distance for cosmetic damage and human comfort, the assessment predicts no vibration impacts will occur throughout the construction of the project.

8 Operational noise

Noise impact from the general operation of the project was considered at assessment locations outlined in Section 3.1, with the closest residential assessment location (S11) approximately 40 m from the development footprint for the southern array area. A semi-qualitative assessment of the potential impact from operational noise was conducted.

As per Section 6.3, a prevailing winds analysis identified that no winds were found to be a feature of the area during the day, evening or night periods. Further, an analysis of temperature inversions based on sigma-theta data obtained from the Bureau of Meteorology's Armidale Airport weather station found that F or G stability class (temperature inversions) do not occur for greater than 30% of the night-time period.

As part of the detailed design process, the final locations for potential noise-generating infrastructure, in particular the substations and BESS facilities, will consider the distance between this type of infrastructure and nearby non-project related residences, so as to minimise operational noise impacts, where practicable.

Noise sources considered during the operational phase of the project include inverters with integrated transformers, tracker motors (PV modules), substation transformers, BESS components and light vehicles. It is noted that noise from the inverters with integrated transformers can be tonal in nature and therefore a 5 dB penalty has been applied to the predicted noise contributions from this source in accordance with Table C.1 of the NPfI (EPA 2017). Operational noise sources are shown in Table 8.1.

Table 8.1 Operational noise source sound power levels

Noise source	L_{Aeq} sound power level per unit, dB
Tracker motor (NEXtracker or similar)	58
Inverters	99[1]
BESS	101
Light vehicle	76
LV-MV transformer	68
MV-HV transformer (50 MVA)	90
MV-HV transformer (100 MVA)	94
MV-HV transformer (200 MVA)	98
Grid transformer (450 MVA)	103

Notes: 1. This includes a 5 dB adjustment for tonal characteristics as per the NSW NPfI (ie 94 dB + 5 dB = 99 dB)

The semi-qualitative assessment identified that the $L_{Aeq,15\ minute}$ noise levels from the project would satisfy the minimum daytime and evening/night-time NPfI trigger levels of 40 dB and 35 dB, respectively at all assessment locations.

9 Mitigation and management

As outlined in Section 6.4, during limited out of hours (OOH) periods, predicted construction noise levels and maximum event noise levels are above the relevant criteria at a number of the assessment locations considered as part of the construction noise and construction sleep disturbance assessments.

The project's CEMP will include management and mitigation measures consistent with the best practice requirements outlined in the ICNG (DECC 2009).

Section 9.1 provides site-specific noise and vibration mitigation and management measures that are to be considered during construction works while Section 9.2 provides further, general good practice recommendations in this regard. Section 9.3 discusses the implementation of buffer zones during OOH periods to maintain compliance with relevant NMLs at surrounding assessment locations.

9.1 Site-specific mitigation and management

The following measures are recommended to be implemented during construction works with the aim of minimising impacts and reducing construction noise levels below the relevant goals:

- a letter box drop for residences in close proximity of the proposed works to inform residents of planned construction activities, time periods and expected durations, potential impacts and proposed mitigation measures;
- minimise the number of plant items operating concurrently when in close proximity to surrounding receivers;
- planning deliveries and access to occur quietly and efficiently and organising parking only within designated areas away from nearby receivers (where possible); and
- appropriate respite periods to be implemented after high noise and vibration-generating activities are carried out in continuous blocks.

9.2 Adoption of general noise and vibration management practices

AS 2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented during construction are listed below.

9.2.1 Universal work practices

These include:

- regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration;
- regular identification of noisy activities and adoption of improvement techniques;
- developing locations for parking of vehicles to minimise noise;
- minimising the movement of materials and plant and unnecessary metal-on-metal contact;
- minimising truck movements; and

- scheduling respite periods for intensive works including consultation with potentially affected neighbours.

9.2.2 Plant and equipment

Additional measures for plant and equipment include:

- choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
- operating plant and equipment in the quietest and most efficient manner; and
- regularly inspecting and maintaining plant and equipment to minimise noise and vibration level increases and to ensure that all noise and vibration reduction devices are operating effectively.

9.2.3 Work scheduling

Additional measures for work scheduling include:

- scheduling high noise-generating work to coincide with less sensitive periods, where possible (for example, where residents in close proximity could be expected to be at work);
- scheduling work during OOH periods to exclude work within OOH buffer zones outlined in Section 9.3 of this report;
- undertaking risk assessment of potential noise impacts on surrounding residential receivers if plant and equipment quantities are proposed to vary significantly from those assumed in Table 6.1; and
- optimising the number of deliveries to site by amalgamating loads where possible.

9.2.4 Relative effectiveness of noise controls

Typical noise reductions achieved by some of the noise controls described above are provided in Table 9.1.

Table 9.1 Relative effectiveness of various forms of noise control

Noise control	Nominal noise reduction possible (dB)
Increase source-to-receiver distance	Approximately 6 for each doubling of distance
Screening	Normally 5- 10, maximum 15
Enclosure	Normally 15-25, maximum 50
Silencing (eg exhaust mufflers)	Normally 5-10, maximum 20

Source: AS 2436-2010.

9.3 Buffer zones

The use of buffer distances around these assessment locations is recommended during OOH periods. These buffer distances should be implemented during the various stages of the proposed construction works as applicable, with the aim of minimising impacts and reducing construction noise levels to below the relevant criteria.

Table 9.2 below outlines the proposed buffer distance for each affected assessment location during periods when construction is occurring outside of ICNG standard hours and differentiates between the various stages of construction listed in Table 6.1.

In addition, at S11 (a rental property owned by project landholders), construction noise levels are predicted to be exceeded during ICNG standard hours (refer Section 6.4). At the time of writing, there were no formal negotiated noise agreements in place between the tenants at S11, the relevant project landholder and UPC. It is recommended that potential noise impacts be discussed with the tenants and landholders to identify appropriate mitigation to be adopted at this residence.

Table 9.2 Buffer zones for affected assessment locations

Assessment location	Period	Required buffer distances per construction stage (refer to Table 6.1)				Criteria	
		Site preparation	Pile driving and foundations	PV module installation	Other	NML	L_{Amax}
N1	OOH Day	600 m	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	1.15 km	600 m	470 m	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
N2	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
N3	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
N4	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
N5	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
N6	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
N13	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
N40**	OOH Day	600 m	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	975 m	550 m	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
S9	OOH Day	600 m	350 m	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	1 km	600 m	450 m	350 m	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
S11**	OOH Day	700 m	350 m	200 m	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	1.1 km	600 m	450 m	340 m	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
S14	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
S15	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
S16	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
S17	OOH Day	700 m	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	1 km	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}
S22	OOH Day	Nil	Nil	Nil	Nil	40 $L_{Aeq,15\ minute}$	Nil
	OOH Night	See Note 2	Nil	Nil	Nil	35 $L_{Aeq,15\ minute}$	52 L_{Amax}

Notes: *1.OOH Day: Saturday: 1:00 pm to 6:00 pm, Sunday: 8:00 am to 6:00 pm; Night: Monday to Saturday: 10:00 pm to 7:00 am, Sunday/Public Holidays: 10:00 pm to 8:00 am.*

2. If the buffer distances for nearest assessment locations are adopted, noise levels at these locations will comply with the relevant criteria.

***The residences at these locations are owned by the project landholders and rented out to members of the local community.*

If the proposed buffer distances outlined in Table 9.2 are adopted during the relevant periods, noise levels during construction are predicted to comply with the relevant criteria at all assessment locations.

10 Conclusion

EMM has completed a construction and operational NVIA for the New England Solar Farm, a significant grid-connected solar farm and BESS along with associated infrastructure, approximately 6 km east of the township of Uralla.

The closest assessment location, S11, is approximately 40 m from the development footprint for the southern array area. Modelling has demonstrated that noise levels during peak construction are predicted to satisfy the recommended NMLs at most locations during ICNG standard hours, with the exception of one location (S11).Outside of ICNG standard hours, construction noise levels are predicted to be above the recommended NMLs at five locations during the NPfI defined daytime period and at 15 locations during limited times in the NPfI defined night-time period.

Given that the predictions assume equipment operating simultaneously and at the nearest locations to the relevant residential dwellings, it is likely that actual construction noise levels will be less than those predicted.

Sleep disturbance from construction of the project during the night period has been assessed. Night-time maximum noise level events are predicted to be above the recommended L_{Amax} sleep disturbance screening criteria at five assessment locations.

Notwithstanding, with effective implementation of the mitigation and management measures outlined in Section 9 of this report, construction noise levels and maximum noise level events are predicted to comply with the relevant criteria at all assessment locations, with the exception of S11.

At the time of writing, there were no formal negotiated noise agreements in place between the tenants at S11, the relevant project landholder and UPC. It is recommended that potential construction noise impacts be discussed with the tenants and landholders to identify appropriate mitigation to be adopted at this residence.

The assessment predicts that vibration associated with the proposed construction works will not generate impacts at the nearest assessment locations throughout the approximate 36 month duration of the construction phase of the project.

Traffic generated by the project is expected to comply with the relevant RNP criteria at the majority of the assessment locations. The exceptions are potentially the most affected residences on Big Ridge Road and Salisbury Plains Road, where predicted noise levels are 2 dB above the relevant RNP criteria during the daytime period.

The road traffic noise predictions are based on peak construction traffic volumes and provide a highly conservative assessment. Furthermore, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts possible from construction activities.

Cumulative construction noise impacts from the project and the Uralla Solar Farm were considered in this assessment; however, cumulative impacts during the concurrent construction of the two projects have been identified as unlikely given the distance between the development footprint for the northern array area and the proposed site for the Uralla Solar Farm. Further, construction noise levels from the project are predicted to be well below the relevant NMLs during standard hours at the assessment locations within proximity of the development footprint for the northern array area.

Cumulative road traffic noise generated during the concurrent construction of the project and the Uralla Solar Farm is expected to satisfy relevant RNP criteria for the New England Highway, which is anticipated to be the only relevant road corridor to both projects.

Given the limited emissions during operations, noise levels are expected to satisfy the NPfI noise trigger levels at all assessment locations, during the daytime, evening and night-time periods for the entirety of the project's operations.

References

Australian Standard (AS) 1055-1997, Acoustics - Description and Measurement of Environmental Noise.

Australian Standard (AS) 2436-2010, Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Sites.

British Stardards International (BSI) 2008, BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz)

Deutsches Institut für Normung (DIN) 1999, DIN4150-3:1999, Vibration in buildings – Part 3: Effects on structures.

GHD 2018, *Neoen Uralla Solar Farm Preliminary Environmental Investigation*

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

NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*.

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

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

NSW Government 2014, *NSW Voluntary Land Acquisition and Mitigation Policy*.

NSW Roads and Maritime Services (RMS) 2013, *Guide to Traffic Generating Developments Updated Traffic Surveys*.

Appendix A

Acoustic terms

Several technical terms discussed in this report are explained in Table A.1.

Table A.1 Glossary of acoustic terms

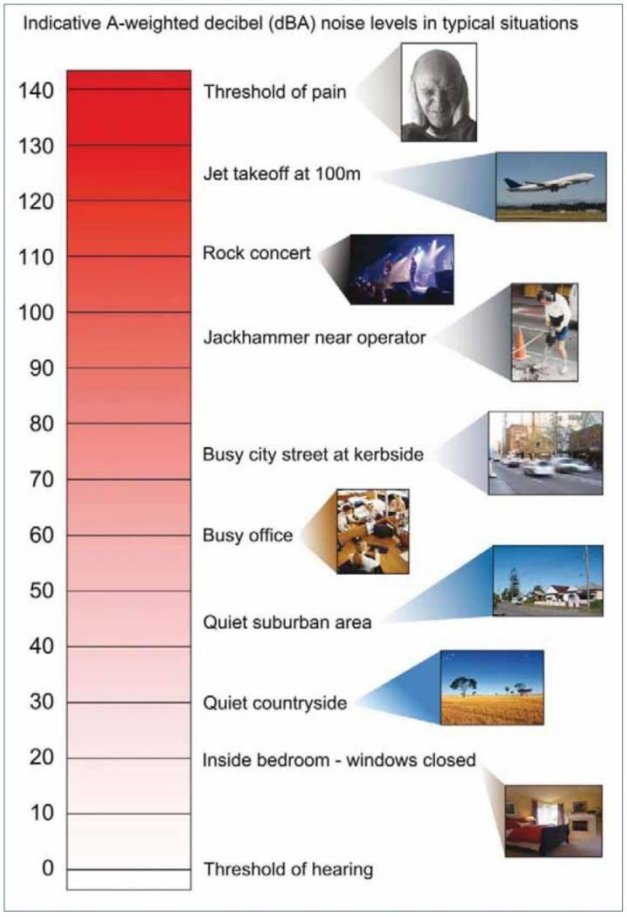
Term	Description
dB	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
L_{A90}	Commonly referred to as the background noise level. The 'A-weighted' noise level exceeded 90% of the time.
L_{Aeq}	The energy average noise from a source. This is the equivalent continuous 'A-weighted' sound pressure level over a given period. The $L_{Aeq,15\ minute}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.
L_{Amax}	The maximum root mean squared 'A-weighted' sound pressure level (or maximum noise level) received during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period.
Sound power level	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Day period	Monday – Saturday: 7 am to 6 pm, on Sundays and Public Holidays: 8 am to 6 pm.
Evening period	Monday – Saturday: 6 pm to 10 pm, on Sundays and Public Holidays: 6 pm to 10 pm.
Night period	Monday – Saturday: 10 pm to 7 am, on Sundays and Public Holidays: 10 pm to 8 am.

It is useful to have an appreciation of decibels (dB), the unit of noise measurement. Table A.2 gives an indication as to what an average person perceives about changes in noise levels.

Table A.2 Perceived change in noise

Change in sound level (dB)	Perceived change in noise
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times (or quarter) as loud

Examples of common noise levels are provided in Figure A.1.



Source: *Road Noise Policy (Department of Environment, Climate Change and Water (DECCW) 2011).*

Figure A.1 Common noise levels

SYDNEY
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St Leonards, New South Wales, 2065
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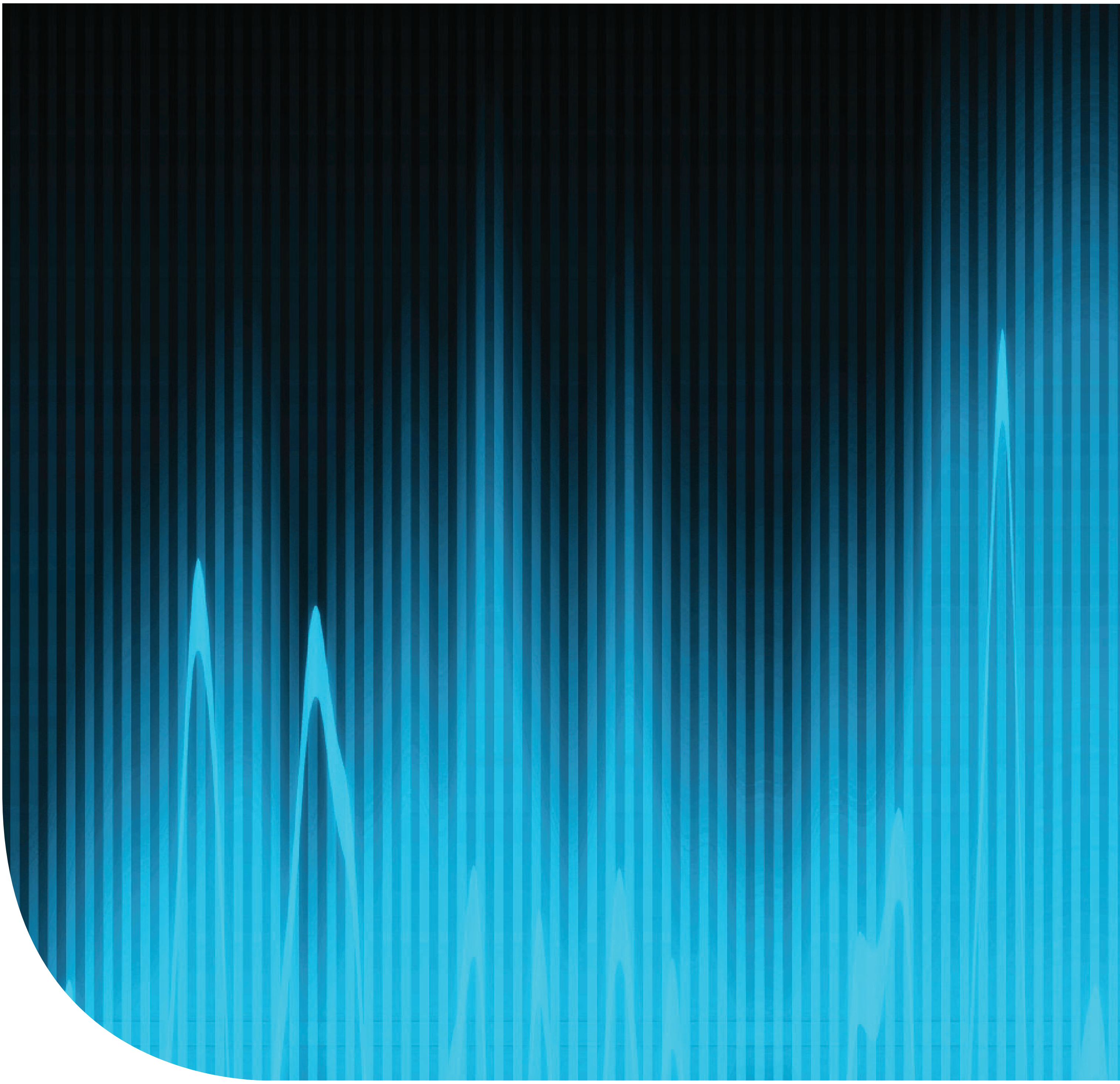

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