

Oven Mountain Pumped Hydro Energy Storage Project Amendment Report - Noise and Vibration Impact Assessment

Prepared for OMPS Pty Ltd

July 2024

Oven Mountain Pumped Hydro Energy Storage Project

Amendment Report - Noise and Vibration Impact Assessment

OMPS Pty Ltd

E230869C Amendment Report - Noise and Vibration Impact Assessment

July 2024

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Executive Summary

ES1 Introduction

Alinta Energy is the owner of OMPS Pty Ltd and propose to develop the Oven Mountain Pumped Hydro Energy Storage Project (the Project), an off-river pumped hydro energy storage system (referred to as the ‘pumped hydro system’) located approximately half-way between Kempsey and Armidale, adjacent to the Macleay River in northern NSW. The Project is located within the New England Renewable Energy Zone (REZ) and the Armidale Regional Local Government Area (LGA), proximate to its border with Kempsey Shire LGA. At a basic level, the Project will consist of upper and lower water reservoirs and an underground tunnel connecting them via a hydro-electric power station. The Project will also include the construction of and upgrades to access roads in the area, the construction of an electrical substation, and the construction of up to two high voltage transmission lines that will connect the pumped hydro system to the existing transmission network.

The Project is a scheme designed to provide utility-scale energy storage. It will provide up to 900 MW of electricity generating capacity and up to eight hours of dispatchable energy to the National Energy Market (NEM) through the New England REZ. The expected operational lifespan of the Project is in excess of 100 years.

The Project has been declared State significant infrastructure (SSI) and critical State significant infrastructure (CSSI) in accordance with the provisions of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The declaration of OMPS as a CSSI project acknowledges that the project is critical to the State for environmental, economic or social reasons.

Following the public exhibition of the EIS, 92 submissions were received, including 16 from special interest groups and 58 from individual community members. In addition, 18 submissions were received from state government agencies and councils. Of the 92 submissions, 22% were in support of the Project, 54% objected to the Project, and the remaining submissions provided comments (24%). A Submissions Report (EMM, 2023) has been prepared to respond to matters raised in these submissions and agency advice.

Since the submission of the EIS, design has been ongoing which has resulted in some amendments to the project. These changes have been assessed as part of an Amendment Report (EMM, 2023b).

The Amendment Report is intended to assist the community, government agencies and the approval authority to understand the implications of the amended project. The Minister for Planning and Public Spaces will subsequently decide whether to grant approval, or to refuse the Project, under the EP&A Act.

The Project amendments required re-assessment of various technical aspects and as such, this Noise and Vibration Impact Assessment (NVIA) has been updated. Amendments to the Project comprise the following:

- realignment of the Eastern Access Road (EAR)
- temporary bridges to facilitate construction - Eastern Access temporary bridge located adjacent to the location of the permanent bridge, and a Western Access temporary bridge located about 600 m north-east of Georges Junction
- Upper Dam Access Road (UDAR) refinement
- up to three additional fly camps located near Smiths Bluff, the intersection of the Main Access Road and the EAR and the upper reservoir, accommodating about 20 workers each and up to 90 workers depending on the ultimate configuration
- four areas used for stockpiling and material laydown
- allowing blasting as a construction method for road works and other above-ground works

- increasing the estimated water requirements from 1 ML/day to 3 ML/day for construction
- allowing sufficient area for retention basins within the construction envelope, in particular for early works
- rock processing/crushing facilities in the lower reservoir (LR) and upper reservoir (UR) areas to process rock for use in dams
- increasing generation capacity to 900 MW and at least eight hours of energy storage.

ES2 Purpose of noise and vibration impact assessment

EMM has prepared this Noise and Vibration Impact Assessment Amendment (NVIA Amendment) as part of the overarching Amendment Report for the Project, to address the effects of the proposed changes of the Project description on the assessment outcomes of the Project.

ES3 Assessment summary

EMM has prepared a NVIA Amendment for the construction and operation of the Oven Mountain Pumped Hydro Energy Storage Project (the Project). The assessment considered the potential for noise and vibration impacts of the Project and has been prepared in accordance with the methodology outlined in the *NSW Noise Policy for Industry* (NPfI), *Interim Construction Noise Guideline* (ICNG) and *NSW Road Noise Policy* (RNP), as well as other relevant guidelines and standards.

Construction noise levels were assessed for the standard daytime and outside of standard construction hours periods during noise-enhancing meteorological conditions. Construction noise levels from the Project are predicted to comply with ICNG noise management levels (NMLs) at most assessment locations, with the exception of assessment locations R2 and R27 where negligible exceedances (as per EPA definitions) are predicted during out of hour work periods during adverse weather conditions. These exceedances are attributed to the proximity of the proposed transmission tower 8 access road to assessment locations.

Feasible and reasonable measures will be adopted in accordance with NSW Environmental Protection Authority (EPA) policy, including the proponent notifying the affected residents of construction works and the potential for noise exceedances and will discuss options for mitigating impacts should they occur. Noise monitoring will be undertaken during the initial stages of construction to determine if actual construction noise levels are above NMLs. If this initial testing identifies exceedances, the contractor will identify further feasible and reasonable mitigation measures or limit use of the transmission tower 8 access road to ICNG standard hours only.

The NVIA Amendment has assessed the potential for sleep disturbance as defined in the NPfI including night-time activities associated with construction works. Predicted noise levels from the Project satisfy the relevant sleep disturbance screening criteria at most assessment locations with the exception of assessment locations R2 and R27. These marginal exceedances (as per EPA definitions) can be attributed to the proximity of the proposed transmission tower 8 access road to assessment locations. As above, further feasible and reasonable mitigation measures will be identified should exceedances occur or construction in these areas will be limited to ICNG standard hours.

Operational noise levels were assessed for the daytime, evening and night-time periods including consideration of noise-enhancing meteorological conditions. The assessment found that noise levels from operation of the Project satisfy relevant targets. Similarly, sleep disturbance impacts from the operation of the Project during the night-time period are not expected.

The assessment considered potential vibration impacts from the Project. Given the distances between the construction work areas and the nearest residences, vibration impacts from the construction of the Project are shown to be unlikely. Further, given that there are no significant vibration generating components included in the operational design of the Project, and the distances between the infrastructure and the nearest residences, vibration impacts from the operation of the Project are also considered unlikely.

The Project would result in additional road traffic movements during the construction period. Road traffic noise levels are predicted to comply with RNP assessment requirements. It is of note that the road traffic noise results are based on light and heavy vehicle movements during the peak construction scenario and, hence, the assessment of road traffic noise is considered to be worst-case. Further, the application of the RNP criteria to construction projects is highly conservative given that the RNP is designed for permanent scenarios and not temporary impacts related to construction activities. Operational road traffic volumes are expected to be less than 2% of the existing road traffic experienced on the nearby roads. As such, adverse noise impacts from operational road traffic noise are considered unlikely.

Blast overpressure and ground vibration levels from the Project are predicted to comply with relevant EPA guidelines. The volumes of maximum instantaneous charge required to meet compliance are not expected to result in any significant constraints to blasting. Notwithstanding, active management and monitoring of blast overpressure and vibration would be in accordance with current best practice to mitigate any issues while maintaining blasting requirements.

A range of project-specific and standard noise and vibration mitigation and consultation measures have been provided in this NVIA Amendment. These measures, if integrated with Project construction and operational environmental management plans and implemented as intended, would moderate the impact of the Project on local receivers to acceptable levels.

Glossary

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

Table G.1 Project and technical terms

Term	Meaning
Accommodation camp	Area used for temporary housing and facilities for construction personnel.
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Amenity noise criteria	The amenity noise criteria relate to existing industrial noise. Where industrial noise approaches base amenity noise criteria, then noise levels from new industries need to demonstrate that they will not be an additional contributor to existing industrial noise.
Day period	Monday-Saturday: 7:00 am to 6:00 pm, on Sundays and public holidays: 8:00 am to 6:00 pm.
dBA	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.
dBc	Noise is measured in units called decibels (dB). There are several scales for describing noise, with the 'C-weighted' scale typically used to assess low frequency noise.
Evening period	Monday-Saturday: 6:00 pm to 10:00 pm, on Sundays and public holidays.
Intrusive noise criteria	The intrusive noise criteria refers to noise that intrudes above the background level by more than 5 dB.
L1	The noise level exceeded for 1% of the time.
L10	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L90	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
Leq	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The $L_{Aeq,15\text{minute}}$ descriptor refers to a L_{Aeq} noise level measured over a 15-minute period.
Linear peak	The peak level of an event is normally measured using a microphone in the same manner as linear noise (i.e. unweighted), at frequencies both in and below the audible range.
Lmax	The maximum sound pressure level received during a measuring interval.
Night period	Monday-Saturday: 10:00 pm to 7:00 am, on Sundays and public holidays: 10:00 pm to 8:00 am.
Project area	The area required to access and build project infrastructure, including surface and tunnel components of the Project
PNTL	The project-noise trigger level (PNTL) is criteria for a particular industrial noise source or industry. The PNTL is the lower of either the intrusive noise criteria or amenity noise criteria.
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
Sound power level (Lw)	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.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.

Common noise levels

It is useful to have an appreciation of the decibel (dB), the unit of noise measurement. Table G.2 gives an indication as to how an average person perceives changes in noise level in the environment. Examples of common noise levels are provided in Figure G.1.

Table G.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 as loud (or quarter) as loud

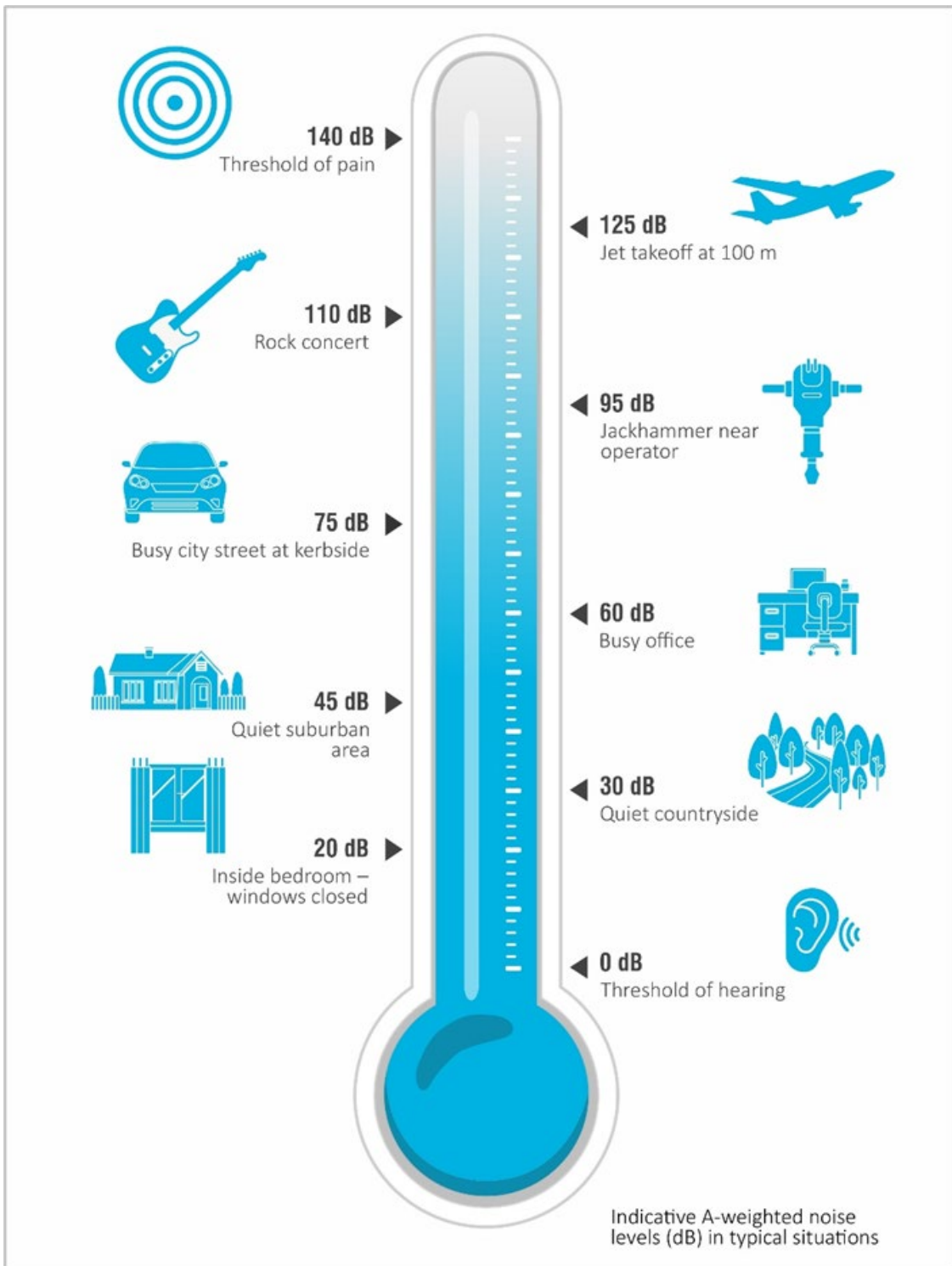


Figure G.1 Common noise levels

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1 Introduction

EMM Consulting Pty Ltd (EMM) has prepared this Noise and Vibration Impact Assessment (NVIA) Amendment for the Oven Mountain Pumped Hydro Energy Storage Project on behalf of Alinta Energy. This Amendment re-assesses impacts and benefits identified in the *Noise and Vibration Impact Assessment: Oven Mountain Pumped Hydro Energy Storage Project* (EIS NVIA, EMM 2023) to address changes to noise and vibration impacts under the amended project description (the amendment). The context for this NVIA Amendment is outlined below.

1.1 Background and previous steps

Alinta Energy are the owners of OMPS Pty Ltd (OMPS) and propose to develop the Oven Mountain Pumped Hydro Energy Storage Project (the Project), an off-river pumped hydro energy storage system (referred to as the 'pumped hydro system') located approximately half-way between Kempsey and Armidale, adjacent to the Macleay River in northern NSW. The Project is located within the New England Renewable Energy Zone (REZ) and the Armidale Regional Local Government Area (LGA), proximate to its border with Kempsey Shire LGA. At a basic level, the Project will consist of upper and lower water reservoirs and an underground tunnel connecting them via a hydro-electric power station. The Project will also include the construction of and upgrades to access roads in the area, the construction of an electrical substation, and the construction of up to two high voltage transmission lines that will connect the pumped hydro system to the existing transmission network.

The Project is a pumped hydro system designed to provide utility-scale energy storage. It will provide up to 900 MW of electricity generating capacity and up to eight hours of dispatchable energy to the National Energy Market (NEM) through the New England REZ. The expected operational lifespan of the Project is in excess of 100 years.

The Project has been declared State significant infrastructure (SSI) and critical State significant infrastructure (CSSI) in accordance with the provisions of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The declaration of OMPS as a CSSI project acknowledges that the Project is critical to the State for environmental, economic or social reasons.

Following the public exhibition of the EIS, submissions were received from state government agencies and councils, special interest groups and community members. A Submissions Report (EMM, 2023) has been prepared to respond to matters raised in these submissions and agency advice, as well as an Amendment Report (EMM, 2023b).

This Amendment Report is intended to assist the community, government agencies and the approval authority to understand the implications of the amended Project. The Minister for Planning and Public Spaces will subsequently decide whether to grant approval, or to refuse the Project, under the EP&A Act.

1.2 Proposed amendments

In response to matters raised in submissions and outcomes of ongoing engagement with the local community, government agencies, project landholders, and other stakeholders, OMPS has made amendments to the Project. These relate to four key areas, as follows:

- underground arrangement and sizing
- construction techniques
- internal roads and bridges
- spoil emplacement.

These amendments are discussed further in Section 2.1.

1.3 Assessment guidelines and requirements

This NVIA amendment report supports the project NVIA prepared for the EIS, in delivering assessment of noise and vibration impacts and benefits in accordance with the Secretary’s Environmental Assessment Requirements (SEARs), as well as relevant government assessment requirements, guidelines, and policies, including:

- NSW Department of Environment Climate Change (DECC) 2009, *The Interim Construction Noise Guideline (ICNG)*
- NSW Environment Protection Authority (EPA) 2017, *NSW Noise Policy for Industry (NPfI)*
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy (RNP)* and associated application notes
- Australian and New Zealand Environment Council 1990, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*
- Department of Environment and Conservation (DEC) NSW 2006, *Assessing Vibration: a technical guideline*
- German Standard DIN 4150 Part 2 1975
- Australian Standard AS 2187.2 – 2006 “*Explosives - Storage and Use - Use of Explosives*”.

Table 1.1 lists the SEARs matters relevant to this assessment and where they are addressed in this report.

Table 1.1 Relevant matters raised in SEARs

Requirement	Section addressed
Amenity:	Chapter 5
<ul style="list-style-type: none"> • an assessment of the: <ul style="list-style-type: none"> – construction, operational and road noise impacts of the Project – blasting impacts of the Project – visual impacts of the project, including lighting impacts and potential impacts on views of the Project from key vantage points including amenity impacts on National Parks and Reserves, Conservation Areas, World Heritage Areas and areas of declared wilderness under the NSW <i>Wilderness Act 1987</i>. 	Sections 5.1–5.2, 5.4–5.5. Section 5.3 Refer to Visual Impact Assessment (EMM 2024) Chapter 6
Potential impacts to the values of a World Heritage Property and National Heritage place. These potential impacts include:	Chapter 5
<ul style="list-style-type: none"> • habitat clearing and fragmentation effects such as increased noise of operation • noise impacts associated with construction and to some extent with operation (all species). 	Refer to Noise and Vibration Impact Assessment (EMM 2024)

1.4 Other relevant reports

This NVIA Amendment Report has been prepared with reference to other technical reports that were prepared as part of the Project EIS and RTS. The other relevant reports referenced in this NVIA Amendment Report are listed below:

- Air Quality Impact Assessment (EMM 2024)
- Historic cultural heritage assessment (EMM 2024)
- Aboriginal cultural heritage assessment (EMM 2024)
- Traffic Impact Assessment (EMM 2024)
- Visual Impact Assessment (EMM 2024).

2 Description of amendments

2.1 Overview of the proposed amendments

Following exhibition of the EIS, OMPS identified amendments to the Project that was presented in the EIS. These amendments provide functional improvements to the Project design, reduce impacts wherever possible, confirm elements of the Project that were highlighted as opportunities in the EIS and considers ongoing development of the construction methodology.

A summary of the amendments and the comparison of the amended project to the project is provided in Table 2.1.

Table 2.1 Overview of the project amendments in comparison to the original project

Project element	Description of change	Summary of the Project as exhibited in the EIS	Summary of the amendments
Internal roads and bridges			
Eastern Access Road (EAR) refinement	Realignment of the EAR to reduce need for earthworks, improve road safety and address drainage issues.	Approximately 11.4 km	Approximately 12.1 km
Temporary bridges	A temporary bridge will be utilised prior to the construction of the two permanent bridges near Smiths Bluff (referred to as Eastern Access Temporary Bridge). A secondary, temporary access is proposed via the construction of a new, temporary bridge crossing of the Macleay River about 600 m and north-east of Georges Junction (referred to as Western Access Temporary Bridge). This amendment is proposed to reduce the period of internal road construction and therefore overall construction period, and improve effectiveness of emergency response measures (access and egress).	One temporary bridge: Eastern Access Temporary Bridge. Two permanent bridges near Smiths Bluff.	Two temporary bridges: Eastern Access Temporary Bridge (EATB) and Western Access Temporary Bridge (WATB). Two permanent bridges near Smiths Bluff.
Upper Dam Access Road (UDAR) refinement	Realignment of the UDAR (including removal of a large north-south connecting section of road) in response to regulator feedback to avoid known habitat and potentially significant impacts to the threatened Brush-tailed Rock Wallaby.	Approximately 7.1 km	Approximately 6.4 km
Construction			
Temporary or fly camps	While fly camps were previously anticipated for the Project, up to three fly camps are confirmed to be required and located near Smiths Bluff (Eastern fly camp), the intersection of the Main Access Road and the EAR (Western fly camp), and the upper reservoir (within spoil emplacement area) (Southern fly camp). The camps will each accommodate about 20 workers and up to 90 workers depending on the ultimate configuration, and would be established within the first year of construction. All services will be trucked in and out of the sites, with no permanent facilities or services proposed.	Temporary or fly camps may be required. The location and size will be documented during the detailed design phase.	Three temporary or fly camps will provide small scale temporary work accommodation for workers completing initial road works until the main accommodation camp is completed. Proposed locations in proximity of EATB, WATB, and Upper reservoir.

Project element	Description of change	Summary of the Project as exhibited in the EIS	Summary of the amendments
Blasting and rock crushing/processing	Allowing blasting as a construction method for road works and other above-ground works. Rock processing/crushing facilities will be required in the lower reservoir (LR) and upper reservoir (UR) areas to process rock for use in dams.	Blasting required for tunnels and portals.	Blasting required for tunnels and portals, reservoirs and road works.
Construction water requirements	Increasing the estimated water requirements for use in construction (e.g. dust suppression, concrete batching).	Approximately 1 ML/day	Approximately 3 ML/day
Construction envelope	Updates to the construction envelope to accommodate stakeholder feedback, design changes and refined construction requirements.	Approximately 780 ha	Approximately 768 ha
Disturbance footprint	Updates to the disturbance footprint to accommodate stakeholder feedback, design changes and refined construction requirements.	Approximately 330 ha	Approximately 367 ha
Spoil and materials			
Laydown/stockpile areas	There will be four areas used for stockpiling and material laydown. One area is located along the main access road (between transmission towers 14–16), one area is located in proximity to the batching plant, one area is located near Georges Junction, and one is located near the Eastern Access Temporary Bridge on the eastern side of the Macleay River. The largest of the four areas has also been flagged as available for other ancillary uses, to provide further flexibility as the detailed design progresses.	There will be two areas used for stockpiling and material laydown, covering a total area of 114,000 m ²	There will be four areas used for stockpiling and material laydown, covering a total area of 119,600 m ²
Spoil emplacement	Revised spoil estimates were derived following changes to the underground arrangement and sizing. This, in addition to incorporating agency feedback, required changes to the conceptual landform design. The conceptual landform design presents reduced height and slopes however requires a greater disturbance area as a result.	Three permanent spoil emplacement locations to store around 2.9 Mm ³ plus dead storage within the reservoirs with approximate capacity 300,000-400,000 m ³ .	Two permanent spoil emplacement locations to store around 3.55 Mm ³ . Use of dead storage in reservoir only if surplus material.
Operational footprint	Updates to the operational footprint to accommodate design changes (including permanent spoil emplacement and transmission alignment along the UDAR).	Approximately 270 ha	Approximately 280 ha
Underground arrangement and sizing			
Underground arrangement and sizing for improved generation capacity	The Project will provide up to around 900 MW of electricity generating capacity and at least eight hours of energy storage at full generating capacity.	Up to 900 MW and between 8 and 12 hours of energy storage. Underground arrangement and tunnel sizes reflect lower energy storage capacity.	Up to 900 MW and at least 8 hours of energy storage. Underground arrangement and tunnel sizes reflect greater energy storage capacity. Re-location of MAT portal to align with amended arrangement.

3 Existing environment

3.1 Site description

The Project area is situated in the Northern Tablelands region of NSW, approximately halfway between Armidale and Kempsey. Armidale is located approximately 60 km to the north-west of the Project and Kempsey approximately 75 km to the south-east. Other relevant communities include Lower Creek which is located approximately 2 km to the north-east, and Bellbrook located approximately 30 km to the east.

The Project is off river, located on an ephemeral tributary of the Macleay River in the south-eastern corner of the Armidale Regional LGA in close proximity to the Kempsey Shire LGA.

The Macleay River borders the Project area to the west, and the Carrai National Park borders the Project area to the south and east. Cunnawarra National Park, Styx River State Forest, Oxley Wild Rivers National Park and the Carrai State Conservation Area are also located in the vicinity of the Project area.

3.2 Noise and vibration assessment locations

The nearest representative noise sensitive locations to the Project have been identified for the purpose of assessing potential noise and vibration impacts. Details are provided in Table 3.1 and their locations are shown in Figure 3.1. They are referred to in this report as assessment locations.

Table 3.1 Noise assessment locations

ID	Description	Classification	Easting	Northing
R1 ¹	Bass Lodge	Accommodation	422514	6597719
R2	Private residence	Residential	422529	6598502
R3	Private residence	Residential	422598	6598811
R4	Private residence	Residential	422443	6599319
R5	Private residence	Residential	422417	6599950
R6	Private residence	Residential	422739	6600164
R7	Private residence	Residential	423207	6601776
R8	Private residence	Residential	424676	6603413
R9	Private residence	Residential	426400	6597192
R10	Private residence	Residential	427522	6604636
R11	Private residence	Residential	427646	6604306
R12	Private residence	Residential	427604	6603794
R13	Private residence	Residential	428102	6602398
R14	Private residence	Residential	428120	6602333
R15	Private residence	Residential	428147	6601596
R16	Private residence	Residential	428526	6602457
R17	Private residence	Residential	428695	6603052
R18	Private residence	Residential	428908	6602853

ID	Description	Classification	Easting	Northing
R19	Private residence	Residential	429920	6602651
R20	Private residence	Residential	428537	6600385
R21	Private residence	Residential	428884	6600566
R22	Private residence	Residential	429257	6600855
R23	Private residence	Residential	428946	6600199
R24	Private residence	Residential	429031	6600010
R25	Private residence	Residential	429101	6599902
R26	Private residence	Residential	429067	6599818
R27	Private residence	Residential	428872	6599753
R28 ¹	Thunggutti Huts	Accommodation	428962	6599430
R29	Private residence	Residential	430329	6599196
R30	Private residence	Residential	430251	6598954
R31	LC RFS shed	Industrial	430607	6598791
R32	Private residence	Residential	430615	6598437
R33	Private residence	Residential	431146	6598478
R34	Private residence	Residential	431350	6598594
R35	Private residence	Residential	431734	6598381
R36	Private residence	Residential	431893	6598659
R37	Private residence	Residential	432598	6598346
R38	Private residence	Residential	433198	6598873
R39	Private residence	Residential	433385	6601521
R40	Private residence	Residential	432640	6596720
R41	Private residence	Residential	433965	6596363
R42	Private residence	Residential	437490	6597271
R43	Private residence	Residential	437679	6597333
R44 ^{1,3}	West Kunderang recreational retreat	Accommodation	411815	6587335
R45 ¹	East Kunderang Homestead	Accommodation	418156	6590435
R46	Private residence	Residential	422532	6587329
R47	Private residence	Residential	422643	6586822
R48	Private residence	Residential	424107	6587990
R49	Private residence	Residential	426007	6589339
R50	Private residence	Residential	426398	6588091
R51	Private residence	Residential	427122	6588819

ID	Description	Classification	Easting	Northing
R52	Private residence	Residential	427459	6586713
R53	Georges Junction campground	Passive recreation	422570	6597557
R54	Cracknback campground	Passive recreation	431335	6598357
R55 ²	Project accommodation camp	N/A	421030	6594163

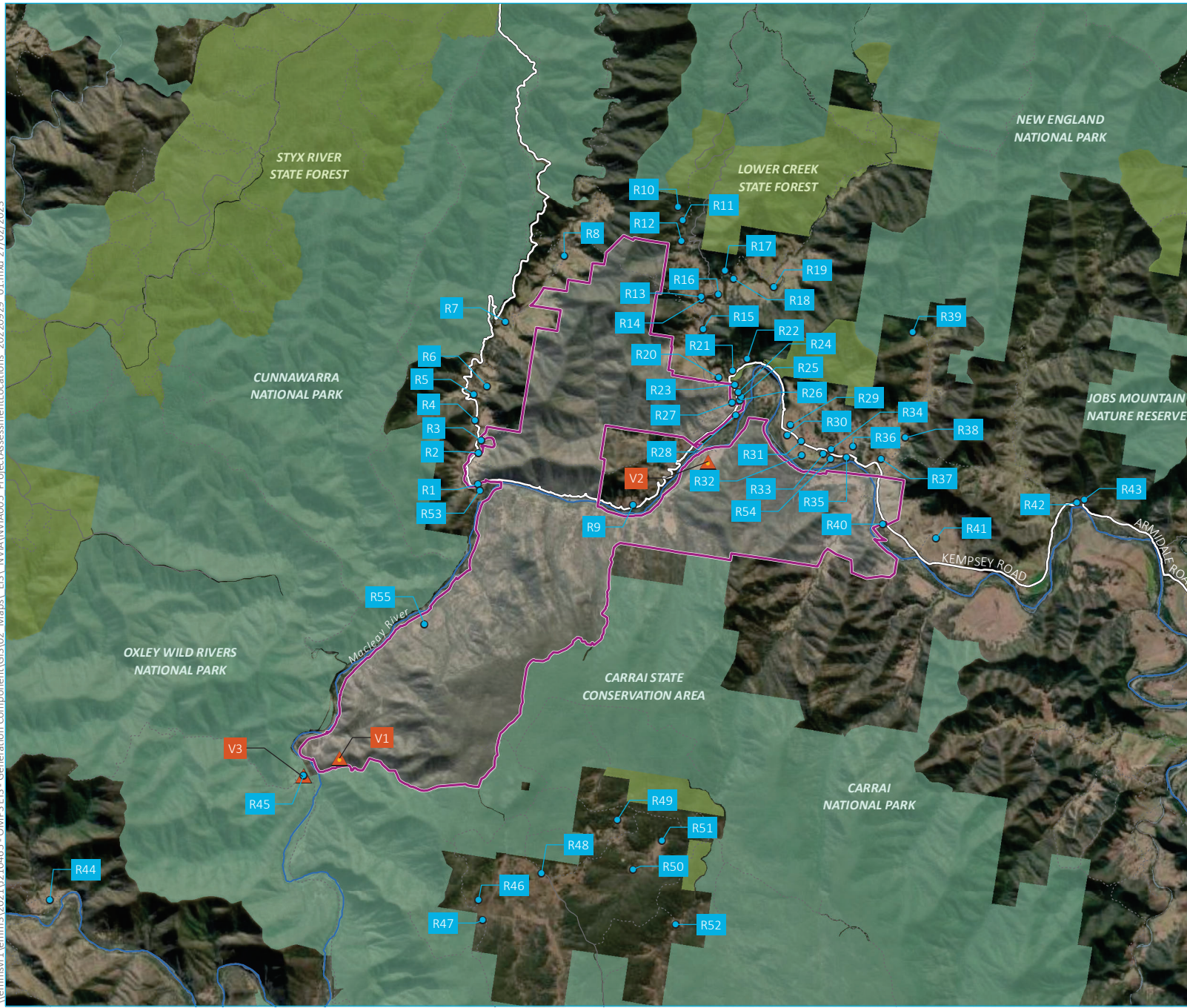
- Notes:
1. Commercial property assessed as internal noise levels in accordance with AS/NZS 2107:2016.
 2. Noise criteria is not strictly applicable to the Project accommodation camp.
 3. The West Kunderang recreational retreat is a privately owned campground. Given this, if the location is compliant in accordance with AS/NZS 2107:2016, it will also be compliant with the relevant passive recreation criteria.

The majority of assessment locations identified in the region of the Project area are residential dwellings in the areas of Jeogla, Lower Creek and Carrai. There are also passive recreation areas in the area surrounding the Project such as West Kunderang recreational retreat (to the south-west), Georges Junction campground (to the north) and Cracknback campgrounds (to the north-east). These assessment locations are shown in Figure 3.1.

The assessment locations most likely to be affected by road traffic noise are residences and campgrounds in the vicinity of Kempsey-Armidale Road between Kempsey and Armidale. These assessment locations are also shown in Figure 3.1.

There are several Aboriginal and historic heritage locations of significance in and surrounding the Project area, which have been considered in this assessment (Figure 3.1).

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- KEY**
- Project area
 - Assessment location
 - ▲ Vibration sensitive site
 - Major road
 - Minor road
 - Vehicular track
 - Macleay River
 - Named waterbody
 - NPWS reserve
 - State forest

Project and assessment locations

Oven Mountain Pumped Hydro Energy Storage Project
 Noise and Vibration Impact Assessment
 OMPS Pty Ltd
 Figure 3.1



Source: EMM (2022); DFSI (2020); GA (2011); SMEC (2022); ESRI (2022)



3.3 Background noise survey

3.3.1 Ambient noise environment

Given the nature of the Project area and its surrounds, existing ambient noise levels at assessment locations are likely to be dominated by rural noise sources and natural elements, with intermittent road traffic noise. The rating background noise levels (RBLs) are expected to be relatively low 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). This is a conventional assumption for such areas and leads to the most stringent noise targets available being applied. A summary of adopted background noise levels is given in Table 3.2.

Table 3.2 Summary of adopted rating background levels

Monitoring location	Period ¹	RBL ² , dB(A)
All residential assessment locations	Day	35
	Evening	30
	Night	30

Notes: 1. Day: 7:00 am to 6:00 pm Monday to Saturday; 8:00 am to 6:00 pm Sundays and public holidays; evening: 6:00 pm to 10:00 pm; night: all other times.
2. The RBL is an NPfI term and is used to represent the background noise level. In accordance with the NPfI, minimum thresholds were adopted given the locality.

3.4 Meteorology

The NPfI (EPA 2017) requires assessment of noise under standard and noise enhancing weather conditions. The NPfI defines these as follows:

- **Standard meteorological conditions:** defined by stability categories A through to D with wind speeds up to 0.5 metres per second (m/s) at 10 m above ground level (AGL) for day, evening and night periods.
- **Noise-enhancing meteorological condition:** defined by stability categories A through to D with light winds (up to 3 m/s at 10 m AGL) for the day and evening periods; and stability categories A through to D with light winds (up to 3 m/s at 10 m AGL) and/or stability category F with winds up to 2 m/s at 10 m AGL.

The NPfI specifies the following two options to consider meteorological effects:

1. adopt the noise-enhancing meteorological conditions for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night, or
2. determine the significance of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F or G. Significance is based on a threshold of occurrence of 30% determined in accordance with the provisions in this policy. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment.

For the purposes of noise modelling, this assessment has adopted the noise-enhancing meteorological conditions as outlined in the NPfI. This approach provides a conservative assessment.

3.4.1 Adopted meteorological conditions

As a conservative approach, this assessment has adopted the meteorological conditions within the International Standard *ISO 9613-2:1996 'Acoustics – Attenuation of sound during propagation outdoors'* (ISO 9613). As per Section 1 of ISO 9613:

The method predicts the equivalent continuous A-weighted sound pressure level (as described in parts 1 to 3 of ISO 1996) under meteorological conditions favourable to propagation from sources of known sound emission.

These conditions are for downwind propagation, as specified in 5.4.3.3 of ISO 1996-2:1987 or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The ISO 9613 meteorological conditions adopted in this assessment to account for the influence of wind and temperature inversion conditions on modelled noise levels are considered to be consistent with the 'noise-enhancing' meteorological conditions shown in Table D1 of the NPfI.

A summary of modelled meteorological conditions is shown in Table 3.3.

Table 3.3 Meteorological parameters adopted for the noise modelling

Assessment period ¹	Meteorological conditions	Air temperature	Relative humidity
Day	ISO 9613	20 °C	70%
Evening	ISO 9613	10 °C	90%
Night	ISO 9613	10 °C	90%

Notes: 1. Day: 7:00 am–6:00 pm Monday to Saturday; 8:00 am–6:00 pm Sundays and public holidays; evening: 6:00 pm–10:00 pm; night: remaining periods.

4 Assessment methodology

The assessment follows the same approach as used in the NVIA for the EIS.

Construction and operational noise modelling has been updated to include the design changes associated with the Amendment report. Construction and operational noise levels from the Project were predicted using a computer-generated model using DGMR iNoise noise modelling software (the model). The construction assessment considered a single scenario, which was determined to be the ‘worst-case’ in terms of the scale of the construction activity. These changes have been assessed in Sections 5.1, 5.2 and 5.5.

The assessment of blasting impacts has been updated to include potential blasting during construction along the alignment of the Eastern Access, Main Access and Upper Dam Access Roads. These changes have been assessed in Section 5.3. It is of note that the assessment of blasting for portal, tunnel and intake excavation has not changed materially due to the amendments and, as such, for blasting in those areas the original EIS NVIA outcomes remain relevant.

The assessment of road traffic noise has been updated to include minor changes in construction traffic volumes on public roads. These changes have been outlined in Table 4.1 and assessed in Section 5.4.

Table 4.1 Summary of daily traffic volumes and increases with construction traffic

Road	Existing daily traffic (all vehicles)	Existing daily traffic (heavy vehicles)	Percentage of heavy vehicles (%)	Additional daily traffic	Percentage of heavy vehicles (%)	Increase (%)
Macleay Valley Way (north)	8295	489	5.9	167 per day	44.3	1.9
Second Lane	4960	352	7.1	167 per day	44.3	3.1
North Street	4200	319	7.6	167 per day	44.3	3.7
Macleay Valley Way (south)	7555	1156	15.3	112 per day	17.0	1.3
Belgrave Street	13755	867	6.3	112 per day	17.0	0.8
River Street	6733	57	0.8	112 per day	17.0	1.5
Kempsey-Armidale Road (Kempsey to Bellbrook)	244	4	1.6	279 per day	33.3	112.5
Kempsey-Armidale Road (Bellbrook to Project area)	244	4	1.6	366 per day	25.4	147.6

Notes: 1. Existing daily vehicle numbers have been sourced from the TIA (EMM 2023).
2. Rounding errors may seem present in the existing daily traffic (heavy vehicles) column given this data was calculated using data from the existing daily traffic (all vehicles) and percentage of heavy vehicles (%) columns.

There are no changes to the construction vibration assessment, operational vibration assessment, or the operational road traffic noise assessment due to the proposed amendments and, as such, outcomes remain as per the NVIA.

5 Impact assessment

5.1 Construction noise

In accordance with procedures outlined in the NVIA, prediction of construction noise levels is provided in Table 5.1 for standard and out of hours (OOH) periods. The level presented for each assessment location represents the energy-average noise level over a 15-minute period and assumes all listed plant operating concurrently. The predicted exceedance of the ICNG noise affected NML at each assessment location is also provided.

A review confirmed that Phase 2 (main construction works) typically resulted in the highest cumulative sound power level from each construction area with the exception of the period of access road construction. Accordingly, the assessment has adopted these source noise levels on the assumption that it represents the worst-case. Cumulative noise contributions from mobilisation/access road construction and rehabilitation activities would typically be lower and of a shorter duration.

Table 5.1 Predicted construction noise levels – Phase 2

Assessment location	Classification	Period	Predicted noise level, $L_{Aeq,15minute}$, dB	Noise affected NML, dB	Highly noise affected NML, dB	Exceedance, dB
R1	Commercial^	Day	41	50	N/A	Nil
		Out of hours	42	45	N/A	Nil
R2	Residential	Day	37	45	75	Nil
		Eve/night	37	35	N/A	2 dB
R3	Residential	Day	33	45	75	Nil
		Eve/night	34	35	N/A	Nil
R4	Residential	Day	<30	45	75	Nil
		Eve/night	30	35	N/A	Nil
R5	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R6	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R7	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R8	Residential	Day	34	45	75	Nil
		Eve/night	35	35	N/A	Nil
R9	Residential	Day	35	45	75	Nil
		Eve/night	35	35	N/A	Nil
R10	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R11	Residential	Day	32	45	75	Nil
		Eve/night	33	35	N/A	Nil
R12	Residential	Day	32	45	75	Nil
		Eve/night	33	35	N/A	Nil

Assessment location	Classification	Period	Predicted noise level, $L_{Aeq,15\text{minute}}$, dB	Noise affected NML, dB	Highly noise affected NML, dB	Exceedance, dB
R13	Residential	Day	31	45	75	Nil
		Eve/night	32	35	N/A	Nil
R14	Residential	Day	30	45	75	Nil
		Eve/night	32	35	N/A	Nil
R15	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R16	Residential	Day	<30	45	75	Nil
		Eve/night	30	35	N/A	Nil
R17	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R18	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R19	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R20	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R21	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R22	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R23	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R24	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R25	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R26	Residential	Day	<30	45	75	Nil
		Eve/night	30	35	N/A	Nil
R27	Residential	Day	37	45	75	Nil
		Eve/night	37	35	N/A	2 dB
R28	Commercial^	Day	<30	50	N/A	Nil
		Out of hours	30	45	N/A	Nil
R29	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R30	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R31	Industrial	When in use	<30	75	N/A	Nil

Assessment location	Classification	Period	Predicted noise level, $L_{Aeq,15\text{minute}}$, dB	Noise affected NML, dB	Highly noise affected NML, dB	Exceedance, dB
R32	Residential	Day	<30	45	75	Nil
		Eve/night	30	35	N/A	Nil
R33	Residential	Day	<30	45	75	Nil
		Eve/night	30	35	N/A	Nil
R34	Residential	Day	<30	45	75	Nil
		Eve/night	30	35	N/A	Nil
R35	Residential	Day	30	45	75	Nil
		Eve/night	31	35	N/A	Nil
R36	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R37	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R38	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R39	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R40	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R41	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R42	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R43	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R44	Commercial^	Day	<30	50	N/A	Nil
		Out of hours	<30	45	N/A	Nil
R45	Commercial^	Day	33	50	N/A	Nil
		Out of hours	34	45	N/A	Nil
R46	Residential	Day	<30	45	N/A	Nil
		Eve/night	<30	45	75	Nil
R47	Residential	Day	<30	35	N/A	Nil
		Eve/night	<30	45	75	Nil
R48	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R49	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil

Assessment location	Classification	Period	Predicted noise level, $L_{Aeq,15minute}$, dB	Noise affected NML, dB	Highly noise affected NML, dB	Exceedance, dB
R50	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R51	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R52	Residential	Day	<30	45	75	Nil
		Eve/night	<30	35	N/A	Nil
R53	Passive Recreation	When in use	42	60	N/A	Nil
R54	Passive Recreation	When in use	32	60	N/A	Nil
R55	Accommodation Camp	When in use	46	50*	N/A	N/A

Notes: ^ Commercial property assessed in accordance with AS/NZS 2107:2016, e.g. 35 dB(A) internal (night-time), becomes 45 dB(A) external accounting for windows open for ventilation.

* Not applicable – accommodation camp as part of OMPS construction works – 50 dB(A) adopted external for internal level of 40 dB(A) naturally ventilated (Provision of alternative ventilation and windows closed would increase allowance for external exposure to 60 dB(A))

Construction noise levels under noise-enhancing weather conditions are predicted to satisfy the relevant NMLs at all assessment locations during ICNG standard construction hours. Outside of standard construction hours, construction noise levels under noise-enhancing weather conditions are predicted to satisfy NMLs at most locations. However, negligible exceedances (2 dB as defined by EPA policy) are predicted at assessment locations R2 and R27, noting 2 dB is less than “just perceptible”. These exceedances can be attributed to the proximity of the assessment locations to the northern transmission access roads.

These results present no material change to the construction noise predictions and, as such, outcomes remain as per the NVIA.

5.2 Sleep disturbance

Predicted maximum noise levels from project construction at residential assessment locations during adverse weather are provided in Table 5.2.

Table 5.2 Predicted maximum noise levels - Phase 2

Assessment location	Sleep disturbance screening criteria, dB		Predicted maximum construction noise level, noise-enhancing weather, dB	
	$L_{Aeq,15minute}$	L_{Amax}	$L_{Aeq,15minute}$	L_{Amax}
R2	40	52	37	56
R3	40	52	34	54
R4	40	52	30	41
R5	40	52	<30	36
R6	40	52	<30	32
R7	40	52	<30	34
R8	40	52	36	38

Assessment location	Sleep disturbance screening criteria, dB		Predicted maximum construction noise level, noise-enhancing weather, dB	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
R9	40	52	36	47
R10	40	52	<30	<30
R11	40	52	33	35
R12	40	52	33	36
R13	40	52	32	35
R14	40	52	32	35
R15	40	52	<30	32
R16	40	52	30	33
R17	40	52	<30	<30
R18	40	52	<30	31
R19	40	52	<30	<30
R20	40	52	<30	33
R21	40	52	<30	43
R22	40	52	<30	38
R23	40	52	<30	48
R24	40	52	<30	48
R25	40	52	<30	51
R26	40	52	30	51
R27	40	52	37	56
R29	40	52	<30	37
R30	40	52	<30	38
R32	40	52	30	41
R33	40	52	30	41
R34	40	52	30	41
R35	40	52	31	44
R36	40	52	<30	39
R37	40	52	<30	40
R38	40	52	<30	32
R39	40	52	<30	<30
R40	40	52	<30	43
R41	40	52	<30	30
R42	40	52	<30	<30
R43	40	52	<30	<30

Assessment location	Sleep disturbance screening criteria, dB		Predicted maximum construction noise level, noise-enhancing weather, dB	
	L _{Aeq,15minute}	L _{Amax}	L _{Aeq,15minute}	L _{Amax}
R46	40	52	<30	<30
R47	40	52	<30	<30
R48	40	52	<30	<30
R49	40	52	<30	<30
R50	40	52	<30	<30
R51	40	52	<30	<30
R52	40	52	<30	<30
R55	N/A	N/A	46	55

Predicted noise levels from the Project satisfy the relevant sleep disturbance screening criteria at most assessment locations except for assessment locations R2 and R27, which are both predicted to exceed the L_{Amax} sleep disturbance screening criteria by 4 dB. These exceedances can be attributed to the proximity of the assessment locations to the transmission tower 8 access road.

These results present no material change to the construction sleep disturbance noise predictions and, as such, outcomes remain as per the NVIA.

5.3 Blasting

A quantitative blast assessment has been undertaken to calculate blast ground vibration and overpressure based on conservative empirical prediction formula provided in the ICI guideline. The following parameters were adopted for access road excavation:

- representative MIC of up to 40 kg
- a K factor of 1,140 (for average rock).

It is of note that the assessment of blasting for portal, tunnel and intake excavation has not changed materially due to the amendments and, as such, the NVIA outcomes remain relevant. A summary of the offset distance required to satisfy blast vibration criteria is provided in Table 5.3.

Table 5.3 Minimum offset distances required to satisfy blast criteria

Activity	Representative MIC (kg)	Receiver type	Allowable exceedance	Criteria		Offset distance required to satisfy criteria – m	
				Ground vibration (PPV)	Air blast, L _{Lin,peak} , dB	Ground vibration	Air blast
Tunnel and access road excavation	40 kg	Residential	5% ²	5 mm/s	115	190	370
			0%	10 mm/s	120	125	235
		Rock structures/transmissions lines/heritage structures	0%	20 mm/s	n/a	80	n/a

Notes: 1. Air blast overpressure is the limiting factor for residential receivers with respect to blast emissions.
2. Allowable exceedance of 5% of the total number of blasts over a 12-month period.

All rock structures/transmission lines/and heritage structures in the vicinity of the proposed blasting areas are confirmed to be located outside the minimum calculated offset distances outlined in Table 5.3.

5.3.1 Summary – residential receivers

Most residential receivers surrounding the Project are well outside the blast offset distances required to maintain acceptable emission levels from portal and tunnel excavation and access road excavation. There are 10 assessment locations located within 370 m of the northern transmission access roads (R2, R3, R20,R25-R28), Eastern Access Road (R40) and the temporary Western Access (R1 and R53) and 6 assessment locations within 235 m of these roads (R1, R2, R25-R28 and R53).

If blasting is required within these offset distances, a range of mitigation measures may be employed to ensure compliance to relevant blast criteria, including reduction of maximum instantaneous charge (MIC), the use of electronic detonators, optimised drill patterns and other factors to optimise blast design and reduce blasting impacts.

Notwithstanding, a suitably qualified and experienced blasting engineer or shot firer will design all blasts to ensure accordance with the ANZECC Blasting Guidelines (1990) to achieve the relevant blast criteria.

5.3.2 Summary – non-residential vibration sensitive receivers

There are no non-residential vibration sensitive assessment locations that fall within the required blast offset distances as outlined in Table 5.3.

i Potential impacts on biodiversity

Casaday and Lehmann, 1967¹ studied animal installations to observe animal behaviour when subjected to sonic booms. Animals observed included up to 10,000 beef cattle, 100 horses, 150 sheep and 320 dairy cattle. During the test period, sonic booms were scheduled at varying intervals during the morning, Monday to Friday of each week.

Study outcomes indicated that reactions of the sheep and horses exposed to sonic booms were minimal in terms of change in behaviour. Similarly, dairy cattle were typically unaffected by sonic booms (125 dB to 136 dB). Less than 20% of booms produced even a mild reaction, as confirmed by a pause in eating, raising of heads, or mild startle effects. Production of milk was unaffected during the study, as evidenced by total and individual milk yield. The researchers summarised that the occasional abnormal behavioural changes observed were well within the range of activity variation to be expected of a group of animals. Changes were defined as horses jumping up and galloping, dairy cattle bellowing, and increased activity by beef cattle. The lowest air blast overpressure exposure adopted in the study was 125 dB and considered conservative in the assessment of livestock impacts.

ii Potential impacts on heritage items

Blast practices should be reviewed when blasting occurs in the vicinity of significant heritage items. This may include limiting the MIC or re-assessing the significance and/or the sensitivity of these items to vibration prior to construction commencing in the area.

¹ Responses of farm animals to sonic booms. Sonic Boom Experiment at Edwards Air Force Base. National Sonic Boom Evaluation Office Interim Report NS BE-1-67 of 28 July, 1967. Annex H.

A number of specific areas of significance have been identified in the Aboriginal Cultural Heritage Assessment (EMM 2022) and Historic Heritage Assessment (EMM 2022) and are considered high value and worthy of protection. The Kunderang East Homestead has also been included. These areas are summarised in Table 5.4 and are located well outside of blast offset zones. However, if work methods and locations change, these areas should be reconsidered and reassessed to safeguard against adverse impacts. If additional vibration sensitive items are identified within the blast offset zone, blast practices should be managed accordingly when in the vicinity.

Table 5.4 Vibration sensitive sites

ID	Description	Easting	Northing
V1	Stone arrangement	419056	6590875
V2	Long Flat Station - chimney and fencing structures	428271	6598280
V3	Kunderang East Homestead	418156	6590435

5.4 Road traffic noise

5.4.1 Construction

The calculated existing and predicted future road traffic noise levels, inclusive of project-related construction traffic, are presented in Table 5.5. They are based on traffic volumes provided in Table 4.1.

Table 5.5 Predicted road traffic noise levels during construction

Receiver location	Location	Distance from road (m)	Period ²	RNP criteria	Road traffic noise level, dB		Change, dB
					Existing	Existing + Construction	
Nearest residence to road	Macleay Valley Way (north)	8	Day	60 L _{Aeq,15hour}	62 L _{Aeq,15hour}	62 L _{Aeq,15hour}	0.3
			Night	55 L _{Aeq,9hour}	59 L _{Aeq,9hour}	59 L _{Aeq,9hour}	0.2
	Second Lane	25	Day	60 L _{Aeq,15hour}	61 L _{Aeq,15hour}	62 L _{Aeq,15hour}	0.5
			Night	55 L _{Aeq,9hour}	58 L _{Aeq,9hour}	58 L _{Aeq,9hour}	0.4
	North Street	16	Day	60 L _{Aeq,15hour}	62 L _{Aeq,15hour}	63 L _{Aeq,15hour}	0.6
			Night	55 L _{Aeq,9hour}	59 L _{Aeq,9hour}	60 L _{Aeq,9hour}	0.4
	Macleay Valley Way (south)	8	Day	60 L _{Aeq,15hour}	64 L _{Aeq,15hour}	64 L _{Aeq,15hour}	0.1
			Night	55 L _{Aeq,9hour}	60 L _{Aeq,9hour}	60 L _{Aeq,9hour}	0.1
	Belgrave Street	17	Day	60 L _{Aeq,15hour}	64 L _{Aeq,15hour}	64 L _{Aeq,15hour}	0.1
			Night	55 L _{Aeq,9hour}	61 L _{Aeq,9hour}	61 L _{Aeq,9hour}	0
	River Street	8	Day	60 L _{Aeq,15hour}	62 L _{Aeq,15hour}	62 L _{Aeq,15hour}	0.1
			Night	55 L _{Aeq,9hour}	58 L _{Aeq,9hour}	58 L _{Aeq,9hour}	0.1

Receiver location	Location	Distance from road (m)	Period ²	RNP criteria	Road traffic noise level, dB		Change, dB
					Existing	Existing + Construction	
	Kempsey-Armidale Road (Kempsey to Bellbrook)	8	Day	60 L _{Aeq,15hour}	50 L _{Aeq,15hour}	59 L _{Aeq,15hour}	8.2
			Night	55 L _{Aeq,9hour}	48 L _{Aeq,9hour}	54 L _{Aeq,9hour}	6.1
	Kempsey-Armidale Road (Bellbrook to Project area)	10	Day	60 L _{Aeq,15hour}	49 L _{Aeq,15hour}	58 L _{Aeq,15hour}	8.4
			Night	55 L _{Aeq,9hour}	47 L _{Aeq,9hour}	54 L _{Aeq,9hour}	6.4

Notes: 1. Predicted noise level includes a 2.5 dB facade correction as required by the RNP.

Road traffic noise levels will increase during the construction of the Project; however, the existing plus construction traffic noise levels are typically less than the RNP residential baseline criteria of L_{Aeq,15hour} 60 dB during the day period and L_{Aeq,9hour} 55 dB during the night-time period (at most locations). Where exceedances of the RNP base criteria are shown for existing road traffic volumes, the predicted noise level increase due to Project traffic satisfies the 2 dB RNP allowance, where applicable. As such, road traffic noise levels are predicted to satisfy the RNP assessment requirements.

These results present no material change to the road traffic noise predictions and, as such, outcomes remain as per the NVIA.

5.5 Operational noise

The modelling results for noise emissions from the Projects' operations are provided in Table 5.6.

Table 5.6 Predicted operational noise levels

Assessment location	Classification	Period	Predicted noise level, L _{Aeq,15minute} , dB	Project Noise Trigger Level (PNTL), L _{Aeq,15minute} , dB	Exceedance, dB
R1	Accommodation	Day	<30	58	Nil
		Evening	<30	53	Nil
		Night	<30	48	Nil
R2	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R3	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R4	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R5	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R6	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R7	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil

Assessment location	Classification	Period	Predicted noise level, $L_{Aeq,15minute}$, dB	Project Noise Trigger Level (PNTL), $L_{Aeq,15minute}$, dB	Exceedance, dB
R8	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R9	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R10	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R11	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R12	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R13	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R14	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R15	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R16	Residential	Day	<30	40	Nil
		Eve/night	<30	35	Nil
R17	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R18	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R19	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R20	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R21	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R22	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R23	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R24	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R25	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil

Assessment location	Classification	Period	Predicted noise level, $L_{Aeq,15minute}$, dB	Project Noise Trigger Level (PNTL), $L_{Aeq,15minute}$, dB	Exceedance, dB
R26	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R27	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R28	Accommodation	Day	<30	58	Nil
		Evening	<30	53	Nil
		Night	<30	48	Nil
R29	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R30	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R31	Industrial	When in use	<30	73	Nil
R32	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R33	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R34	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R35	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R36	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R37	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R38	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R39	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R40	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R41	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R42	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R43	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil

Assessment location	Classification	Period	Predicted noise level, $L_{Aeq,15minute}$, dB	Project Noise Trigger Level (PNTL), $L_{Aeq,15minute}$, dB	Exceedance, dB
R44	Accommodation	Day	<30	58	Nil
		Evening	<30	53	Nil
		Night	<30	48	Nil
R45	Accommodation	Day	<30	58	Nil
		Evening	<30	53	Nil
		Night	<30	48	Nil
R46	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R47	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R48	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R49	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R50	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R51	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R52	Residential	Day	<30	40	Nil
		Eve/Night	<30	35	Nil
R53	Passive Recreation	When in use	<30	53	Nil
R54	Passive Recreation	When in use	<30	53	Nil

The operational noise levels are predicted to be below the relevant NPfI noise trigger levels at all assessment locations for noise enhancing meteorological conditions.

These results present no material change to the operational noise predictions and, as such, outcomes remain as per the NVIA.

6 Management of impacts

Environmental management measures for noise and vibration are provided in Table 6.1.

Table 6.1 Environmental management measures for noise and vibration

Impact	Ref #	Environmental management measures
Construction noise	N1	<p>A construction noise and vibration management plan (CNVMP) that will address noise and vibration management and mitigation options will be prepared prior to construction.</p> <p>The CNVMP will detail how construction noise and vibration impacts will be minimised and managed.</p> <p>The CNVMP will describe how construction noise levels will be managed where predicted noise levels above the NMLs have been identified. The CNVMP would address noise mitigation and management to reduce construction noise levels at the potentially most affected assessment locations based on the findings of this assessment as a minimum.</p> <p>The CNVMP will outline a procedure to:</p> <ul style="list-style-type: none"> • Measure construction noise levels at early stages to validate the predicted construction noise levels. • Re-evaluate the predicted construction noise levels at assessment locations, and where required review noise management and mitigation measures to reduce levels as close to NMLs as possible. This may include (but is not limited to): <ul style="list-style-type: none"> – limiting construction within a certain distance of assessment locations during the evening and night-time period – selecting quieter equipment or reduced equipment fleet – measuring construction noise levels at assessment locations, especially during the evening and night-time period, if relevant, and implementing further noise management and mitigation measures where an exceedance of NMLs is identified – entering into a negotiated agreement with affected landholders. <p>Affected landholders should be consulted prior to and during construction where an exceedance of NMLs has been predicted and should be notified of proposed mitigation measures that will be used to manage construction noise levels to below ICNG NMLs where practicable.</p>

Table 6.1 Environmental management measures for noise and vibration

Impact	Ref #	Environmental management measures
Construction vibration	V1	<p>The CNVMP will include as a minimum:</p> <ul style="list-style-type: none"> • identification of nearby residences and sensitive land uses along with appropriate corresponding vibration criteria • a description of approved hours of work and what work will be undertaken • a description of what work practices will be applied to minimise vibration • a description of the complaints handling process • a description of monitoring that is required. <p>If the safe working distances are encroached, vibration monitoring will be carried out at nearby heritage or infrastructure structures. If required, the monitoring system will be fitted with an auditory and visual alarm that triggers when vibration levels reach the nominated criteria. This would indicate if and when alternate work practices should be adopted (such as decrease vibratory intensity, alternate equipment selection, etc.).</p> <p>Blast practices should be reviewed when blasting occurs within blast offset zones or in the vicinity of significant heritage items. This may include limiting the MIC or re-assessing the significant and/or the sensitivity of these items to vibration prior to construction commencing in the area.</p> <p>The potential for blast impacts on residents during the night period is considered highly unlikely given the location (in tunnel), distance and topographical separation between construction and nearest residences. Notwithstanding, blast practices will be constantly reviewed and adapted if complaints are received from residents due to night blasting.</p> <p>A survey of heritage items and other potential vibration sensitive receivers should be undertaken in the blast offset zone identified around the tunnel excavation portal.</p>
Operational noise	N2	<p>All operational plant and equipment including ventilation, pumps, generators, transformers, VSD or other plant associated with the operation of the Project shall be subject to detailed acoustic review prior to final specification.</p> <p>Design shall be assessed against the requirements of the NPfl and consider the amenity criteria for passive recreation.</p>

7 Conclusion

This NVIA Amendment has been prepared to address the effects of the proposed changes to the Project on the noise and vibration impact assessment outcomes. It has documented the methods and results, the initiatives built into the Project design to avoid and minimise associated impacts, and the mitigation and management measures proposed to address any residual impacts not able to be avoided by applying feasible and reasonable measures.

The amended construction noise, sleep disturbance, operational noise and road traffic noise assessments present no material change to the predictions as outlined in the NVIA and, as such, outcomes outlined in the NVIA remain relevant.

There were no changes to the construction vibration, operational vibration, or operational road traffic noise assessments due to the proposed amendments and, as such, these outcomes remain as per the NVIA.

The assessment of blasting impacts has been updated to include potential blasting during construction along the alignments of the Eastern Access, Main Access and Upper Dam Access Roads. It is of note that the assessment of blasting for portal, tunnel and intake excavation has not changed materially due to the amendments and, as such, for blasting in those areas the NVIA outcomes remain relevant.

Most residential receivers surrounding the Project are well outside the blast offset distances required to maintain acceptable emission levels from access road blasting. There are 10 assessment locations located within 370 m of the northern transmission access roads (R2, R3, R20, R25–R28), Eastern Access Road (R40) and the temporary Western Access (R1 and R53) and six assessment locations within 235 m of these roads (R1, R2, R25–R28 and R53).

If blasting is required within these offset distances, a range of mitigation measures may be employed to ensure compliance to relevant blast criteria, including reduction of maximum instantaneous charge (MIC), the use of electronic detonators, optimised drill patterns and other factors to optimise blast design and reduce blasting impacts.

Notwithstanding, a suitably qualified and experienced blasting engineer or shot firer will design all blasts to ensure accordance with the ANZECC Blasting Guidelines (1990) to achieve the relevant blast criteria.

With the effective management and incorporation of mitigation measures listed in Chapter 6, noise and vibration emissions from the Project are generally predicted to satisfy relevant guidelines, standards and policies.

References

Aloui, Bleuzen Essefi and Abbed 2016, *Ground Vibrations and Air Blast Effects Induced by Blasting in Open Pit Mines: Case of Metlaoui Mining Basin, Southwestern Tunisia*.

Australian and New Zealand Environment Council 1990, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*

Australian Standard AS 2187.2 - 2006 "Explosives - Storage and Use - Use of Explosives"

BS 6472 – 2008 "Evaluation of human exposure to vibration in buildings (1-80Hz)"

BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2"

Casady and Lehmann 1967, *Responses of farm animals to sonic booms. Sonic Boom Experiment at Edwards Air Force Base*.

Department of Environment and Conservation NSW 2006, *Assessing Vibration: a technical guideline*

Department of Environment, Food and Rural Affairs (DEFRA) 2005, *Update of Noise Database for Prediction of Noise on Construction and Open Sites*

German Standard DIN 4150 Part 2 1975

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

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

NSW Environmental Protection Authority (EPA) 2009, *The Interim Construction Noise Guideline (ICNG)*

Parris and McCauley, 2016, *Noise pollution and the environment*.

Radle 2007, *The effect of noise on wildlife: A literature review*.

Abbreviations

Abbreviation	Term
ARL	Acoustic Research Laboratories
AGL	above ground level
ANZEC	Australian and New Zealand Environment Council
ABL	Assessment background level
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CoRTN	Calculation of Road Traffic Noise
DECC	Department of Environment and Climate Change
DEC	Department of Environment and Conservation
DEFRA	Department of Environment, Food and Rural Affairs
D&B	Drill and blast
DP&E	Department of Planning and Environment
EPA	Environmental Protection Authority
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Limited
HV	Heavy vehicle
ICNG	Interim Construction Noise Guideline
LGAs	local government areas
LV	Light vehicle
MAT	Main Access Tunnel
MW	megawatts
NATA	National Association of Testing Authorities
NPfi	Noise Policy for Industry
NML	Noise management level
OMPS	Oven Mountain Pumped Storage
OOH	Out of hours
PPV	Peak particle velocity
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
PNTL	Project Noise Trigger Level
RBL	Rating Background Level
RNP	Road Noise Policy
RMS	Root mean square

Abbreviation	Term
SEARs	Secretary's environmental assessment requirements
VDV	Vibration dose value

Appendix A

Construction plant and equipment

Table A.1 Plant and equipment schedule

Construction activity	Applicable location and phase	Period	Item	Quantity	Sound power level (dB(A) per item)	Sound power level (dB(A) per activity)
Eastern Access Road (Transport)	Eastern Access Road Phases 2 and 3	Day	Heavy vehicle	6	103	112
			Light vehicle	15	96	
		Evening/Night	Heavy vehicle	5	103	113
			Light vehicle	23	96	
Western Access Road (Transport)	Western Access Road Phases 2 and 3	Day	Heavy vehicle	1	103	106
			Light vehicle	2	96	
		Evening/Night	Heavy vehicle	1	103	106
			Light vehicle	3	96	
Main Access Road After Eastern & Western Access Roads converge (Transport)	Main Access Road After Eastern & Western Access Roads converge Phases 2 and 3	Day	Heavy vehicle	7	103	113
			Light vehicle	17	96	
		Evening/Night	Heavy vehicle	6	103	113
			Light vehicle	26	96	
Northern Transmission Access Road (Transport)	Northern Transmission Access Road Phases 2 and 3	Day, Evening or Night	Heavy vehicle	1	103	105
			Light vehicle	3	96	
Transmission Tower 8 Access Road (Transport)	Transmission Tower 8 Access Road Phases 2 and 3	Day, Evening or Night	Heavy vehicle	1	103	103
Upper Reservoir Road (Transport)	Upper Reservoir Road Phases 2 and 3	Day, Evening or Night	Heavy vehicle	1	103	106
			Light vehicle	1	96	
Lower Reservoir Road (Transport)	Lower Reservoir Road Phases 2 and 3	Day, Evening or Night	Heavy vehicle	1	103	106
			Light vehicle	1	96	
MAT Portal Road (Transport)	MAT Portal Road Phases 2 and 3	Day, Evening or Night	Heavy vehicle	1	103	106
			Light vehicle	1	96	

Table A.1 Plant and equipment schedule

Construction activity	Applicable location and phase	Period	Item	Quantity	Sound power level (dB(A) per item)	Sound power level (dB(A) per activity)
Site clearing/stripping	Upper Reservoir Lower Reservoir Macleay Pump Station Switchyard Area Stockpile Area Dam Construction Area Phase 2	Day, Evening or Night	Excavator (20t)	3	110	122
			Rock breaker (medium)	1	117	
			Dozer (D10)	1	116	
			Roller	1	103	
			40t ADT composite	4	107	
			Heavy vehicle (truck and dog)	2	103	
Camp/office/workshop construction	Fly Camps Phase 1	Day, Evening or Night	Generator	2	102	117
			Concrete truck (agitator)	2	108	
	Site Offices Phases 1 and 2		Heavy vehicle (deliveries)	2	103	
			Accommodation Camp Mechanical Workshop Area Phases 1, 2 and 3	Watercart	2	
	EWP			2	94	
	Telehandler			1	107	
			Upright trench rammer	1	108	
			Light tower	2	93	
			Bobcat	1	95	
			Hand tools	4	101	
			Crane 50t Mobile	1	104	
			Crane 15t Mobile	1	98	
Bulk Earthworks		Upper Reservoir Phase 3	Day, Evening or Night	Excavator (20t)	4	110
	Dozer (D10)			1	116	
	Roller			1	103	
	40t ADT composite			6	107	
	Heavy vehicle (truck and dog)			2	103	

Table A.1 Plant and equipment schedule

Construction activity	Applicable location and phase	Period	Item	Quantity	Sound power level (dB(A) per item)	Sound power level (dB(A) per activity)
Road construction (Gravel)	Eastern Access Road Main Access Road Upper Reservoir Road Lower Reservoir Road MAT Portal Road Phase 1	Day, Evening or Night	Excavator (20t)	1	110	116
			Concrete truck (agitator)	1	108	
			40t ADT composite	4	107	
			Heavy vehicle (truck and dog)	2	103	
Tunnel works (Drill and Blast)	MAT Portal ECVT Portal Phases 2 and 3	Day, Evening or Night	Drill (Jumbo 3 Boom)	2	114	119
			Concrete truck (agitator)	1	108	
			Shotcrete robot/pump	2	106	
			Grout pump	1	106	
			Compressor	2	103	
			Generator	2	102	
Spoil emplacement areas	Spoil Area (Upper Reservoir) Phases 2 and 3 Spoil Area (Lower Reservoir) Phase 2	Day, Evening or Night	Dozer (D10)	1	116	116
			Heavy vehicles (truck and dog)	2	103	
Transmission tower erection works	Transmission Towers Phase 2	Day, Evening or Night	Hand tools	4	101	115
			EWP	2	94	
			Heavy vehicle (deliveries)	2	103	
			Crane 50t Mobile	1	104	
			Excavator (20t)	1	110	
			Generator	1	102	
			Concrete truck (agitator)	1	108	
Concrete Batching Plant	Mechanical Workshop Area Phases 2 and 3	Day, Evening or Night	Concrete batching plant	1	116	116

Table A.1 Plant and equipment schedule

Construction activity	Applicable location and phase	Period	Item	Quantity	Sound power level (dB(A) per item)	Sound power level (dB(A) per activity)
Stockpile Areas	Stockpile Areas Phases 2 and 3	Day, Evening or Night	Excavator (20t)	1	110	112
			Front End Loader	1	104	
			Heavy vehicles (truck and dog)	2	103	

Notes: Sourced from United Kingdom Department of Environment, Food and Rural Affairs (DEFRA) 2005, Update of Noise Database for Prediction of Noise on Construction and Open Sites

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