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Acoustics 

GRIFFITH BESS
NOISE AND VIBRATION ASSESSMENT
Rp 002 20250205 | 12 November 2025

Project: **GRIFFITH BESS**

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Report No.: **Rp 002 20250205**

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EXECUTIVE SUMMARY

Ekus Energy on behalf of Griffith BESS Co Pty Ltd (Proponent) proposes to develop a utility-scale battery energy storage system (BESS) within, but separate to, the approved Yoogali Solar Farm. The BESS is known as Griffith BESS (Project)

Marshall Day Acoustics (Australia) Pty Ltd (MDA) has been engaged by the Proponent to prepare this noise and vibration assessment in support of the environmental impact statement (EIS) for the Project, as prepared by Cogency Australia Pty Ltd (Cogency).

This report presents the results of an assessment of noise and vibration associated with the operation, construction and decommissioning of the Project. The assessment has been undertaken in accordance with the applicable Planning Secretary's Environmental Assessment requirements (SEARs) (SSD-85372970) dated 23 June 2025, referred to herein as the Project SEARs.

Operational noise from the Project has been assessed in accordance with the NPfl.¹ Predicted noise levels at all receivers are below the most stringent project noise trigger level (applicable during the evening and night periods) of 35 dB $L_{Aeq, 15 \text{ min}}$, by a minimum margin of 1 dB.

Cumulative operational noise has also been assessed, considering other developments in the area, as identified by Cogency. These include the existing Griffith Solar Farm and Transgrid Griffith Substation, as well as the proposed Yoogali Solar Farm, Riverina Solar Farm and Hawkins Road Solar Farm & BESS. The outcomes of the assessment indicate that cumulative noise levels are expected to be below the recommended amenity noise level for the applicable receiver category, which satisfies the intent of the NPfl with respect to cumulative industrial noise.

The findings of the operational noise assessment therefore demonstrate that the Project is capable of being designed and operated to comply with the Project SEARs for operational noise. Regardless, it is recommended that the predicted noise levels for all components of the operational noise assessment be updated following detailed design, once the final Project configuration and equipment selections are known. This is in order to verify compliance with the project noise trigger levels prior to the commencement of construction.

A preliminary assessment of on-site construction noise has been conducted, accounting for typical equipment items and work practices, as well as the details of relevant NSW guidelines and preliminary noise management recommendations. The assessment was undertaken primarily in accordance with the ICNG, as well as other supporting NSW guidelines.²

The outcomes of the construction noise assessment indicate that noise may be above the noise affected management level for all construction stages. This would trigger a need to establish site and process specific noise management work practices to mitigate the impact of construction noise activities.

Measures for the management of construction noise and vibration would be implemented through a Construction Noise and Vibration Management Plan (CNVMP). The CNVMP is to be prepared during the detailed design phase of the Project, when a construction contractor has been selected, and specialised construction planning for the site has been developed. This would comprise a detailed noise and vibration assessment, as well as project specific noise mitigating work practices and physical noise controls (if required).

The current conceptual construction noise assessment is conservative, and multiple management methods and noise control solutions are likely to be available during construction. On this basis it is expected that construction noise and vibration can be appropriately managed using standard good practice management and mitigation measures.

¹ NSW Environment Protection Authority, *Noise Policy for Industry*, October 2017 (NPfl)

² NSW Department of Environment and Climate Change, *Interim Construction Noise Guideline*, July 2009 (ICNG)

An assessment of traffic noise associated with construction traffic movements on nearby roads has been conducted in accordance with the RNP.³

The assessment established setback distances for local and freeway/arterial/sub-arterial roads within which applicable traffic noise criteria may be exceeded. Up to 5 receivers were identified to be within the defined setback distances. An assessment for sleep disturbance was also included which predicted up to 5 receivers that could potentially be affected. These receivers should be consulted prior to and during construction activities to manage impacts and considered in more detail as part of a future CNVMP.

Overall, the assessment provided herein demonstrates that the construction, operation and decommissioning of the Project can be designed and executed such that associated noise is capable of complying with the relevant guidelines and assessment documents set out in the Project SEARs.

³ NSW Department of Environment, Climate Change and Water, *Road Noise Policy*, March 2011 (RNP)

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1.0 INTRODUCTION

Ekus Energy on behalf of Griffith BESS Co Pty Ltd (Proponent) proposes to develop a utility-scale battery energy storage system (BESS) within, but separate to, the approved Yoogali Solar Farm. The BESS is known as Griffith BESS (Project).

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This report presents the results of an assessment of noise and vibration associated with the operation, construction and decommissioning of the Project. The assessment has been undertaken in accordance with the applicable Planning Secretary's Environmental Assessment requirements (SEARs) (SSD-85372970) dated 23 June 2025, referred to herein as the Project SEARs.

The Project SEARs require the following matters be addressed:

- Operational noise in accordance with the NPfI – refer to Section 6.0.⁴
- Construction noise in accordance with the ICNG – refer to Section 8.0.⁵
- Traffic noise in accordance with the RNP - Section 9.0.⁶
- Cumulative noise impacts (considering other developments in the area) – refer to Section 7.0.

The noise assessments presented within this report are based on:

- Noise limits determined in accordance with applicable regulatory documents.
- Predicted operational noise levels, based on the proposed site layout and equipment noise emission data.
- Predicted construction noise levels, based on noise data detailed in relevant standards.
- Predicted traffic noise levels due to additional road traffic during construction and operation, based on traffic data provided by a third party.

A glossary of acoustic terminology is provided in Appendix A with general information regarding the description of sound provided in Appendix B.

⁴ NSW Environment Protection Authority, *Noise Policy for Industry*, October 2017 (NPfI)

⁵ NSW Department of Environment and Climate Change, *Interim Construction Noise Guideline*, July 2009 (ICNG)

⁶ NSW Department of Environment, Climate Change and Water, *Road Noise Policy*, March 2011 (RNP)

2.0 PROJECT OVERVIEW

2.1 Description

The Project comprises the construction, operation and decommissioning of a utility-scale BESS with a nominal capacity to supply up to 100 MW to the NEM for up to 10 hours (i.e. up to 1000 MWh). It will be developed with a direct connection to the existing Griffith Substation.

The Project is located at 15 Bob Irvin Road, Yoogali on approximately 6 hectares of land (Project Site). It is approximately 7 km southeast from the Griffith town centre, 3 km southeast of the Yoogali village centre, and 500 m south of the Griffith Substation.

The key components of the Project include:

- BESS compounds (batteries, inverters and medium voltage (MV) transformer units)
- on-site substation/high voltage (HV) transformer
- transmission connection infrastructure consisting of a 132kV cable connecting to the existing nearby Griffith Substation
- operation & maintenance building – inclusive of control room
- construction laydown area (temporary)
- retention basin
- asset protection zone
- new crossover and site access.

A layout depicting the BESS area in relation to nearby receivers is shown in Figure 1.

The topography of the Project Site and surrounding area is depicted in the elevation map provided in Appendix C

2.2 Receivers

Throughout this report, the term receiver is used to identify any noise-sensitive land use in the vicinity of the Project. Noise sensitive land uses have been determined in accordance with the requirements of the NPfI.

A total of 48 receivers have been identified by Cogency within 2 km of the BESS area (as shown in Figure 1) and are relevant for noise assessment.

All receivers are identified as residences.

The coordinates of the receivers identified within 2 km of the BESS area are tabulated in Appendix D.

Figure 1: Receiver layout



3.0 NEW SOUTH WALES POLICY & GUIDELINES

The following documents are explicitly referenced within the Project SEARS and must be referred to for noise assessment for the Project:

- NPfI
- ICNG
- RNP

In addition, it is common practice for the following document to be referred to for the assessment of vibration:

- AVTG⁷

Details of the guidance and noise criteria provided by these publications are provided in the following sections.

3.1 Noise Policy for Industry (NPfI)

The NPfI is the applicable guideline for assessing operational noise associated with the proposed Project.

The NPfI provides a method for determining project noise trigger levels that are used for assessing the potential impact of noise from industry at existing receivers. Specifically, the project noise trigger levels provide a benchmark or objective for assessing a proposal or site. The NPfI states that the project noise trigger levels are not intended for use as mandatory requirements, but represent the levels that, if exceeded, would indicate a potential noise impact on the community, and so 'trigger' a management response; for example, further investigation of mitigation measures.

The project noise trigger levels are derived from an analysis of the background noise environment and zoning information, accounting for acoustic amenity (described as project amenity noise levels) and, in the case of residential receivers, accounting for intrusiveness (described as project intrusiveness noise levels). The project noise trigger levels are defined as the minimum of the project amenity noise level and the project intrusiveness noise level (where applicable).

Additional trigger levels are defined for the assessment of maximum noise level events. This is typically associated with sleep disturbance arising from noise sources that are characterised by transient events i.e. brief periods of increased noise levels and applies during the night-time period only.

The following subsections describe the amenity and intrusiveness noise levels used to determine the project noise trigger levels. Further details on the derivation of project noise trigger levels for the assessment of operational noise levels from the Project are provided in Section 6.1 and Appendix E.

⁷ NSW Department of Environment and Conservation, *Assessing Vibration: A Technical Guideline*, February 2006 (AVTG)

3.1.1 Project amenity noise levels

Project amenity noise levels are designed to prevent industrial noise continually increasing above an acceptable level over time with the expansion of infrastructure and development. The NPfI provides recommended amenity noise levels based on receiver categories and typical planning zones, from which the project amenity noise levels are derived.

The recommended amenity noise levels outlined in the NPfI have been determined on the basis of studies that relate industrial noise to annoyance in communities and have been subjectively scaled to reflect the perceived differential expectations and ambient noise environments of rural, suburban, and urban communities for residential receivers. They are based on protecting the majority of the community (90%) from being highly annoyed by industrial noise.

The recommended amenity levels defined in the NPfI relate to total industry noise levels. The project amenity noise levels for an individual industry, i.e. the Project, are set at a level 5 dB below the recommended amenity levels to provide a margin for cumulative industry noise.

A further modification is made to standardise the amenity assessment time period to align with the intrusiveness assessment.

3.1.2 Project intrusiveness noise levels

The intrusiveness noise assessment is applicable to residential receivers and is based on knowledge of the background noise level at the receiver. The background noise levels are referred to as the rating background noise level (RBL) in the NPfI.

The intrusiveness noise level is the RBL at the nearest noise sensitive location plus 5 dB. Therefore, the noise emissions from the subject industry, i.e. the Project, are considered to be intrusive if the source noise level ($L_{Aeq, 15 \text{ min}}$) is greater than the RBL (L_{A90}) plus 5 dB.

3.2 Interim Construction Noise Guideline (ICNG)

The ICNG aims to provide a clear understanding of ways to identify and minimise noise from construction works through applying all 'feasible' and 'reasonable' work practices to control noise impacts. The guideline identifies sensitive land uses and recommends construction hours, provides quantitative and qualitative assessment methods, and subsequently advises on appropriate work practices.

The ICNG recommended standard construction hours are detailed in Table 1.

Table 1: ICNG recommended standard hours of work

Work type	Recommended standard hours of work	
Normal construction	Monday to Friday	07:00 to 18:00
	Saturday	08:00 to 13:00
	No work on Sundays or public holidays	

In relation to residential receivers considered in this assessment, and based on the recommended standard hours, the ICNG provides two primary management levels for consideration in the assessment of noise at residential receivers:

- The noise affected management level ($L_{Aeq, 15 \text{ min}}$) is the NPfI's rating background noise level plus 10 dB.
- The highly noise affected management level is prescriptively set at 75 dB $L_{Aeq, 15 \text{ min}}$.

Where noise from construction works is above the noise affected management level, all feasible and reasonable work practices should be applied. Where the noise from construction works is above highly noise affected management level, restrictions to the hours of construction may be required.

The ICNG also defines the following 5 categories of works that might be undertaken outside the recommended standard hours:

- the delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- public infrastructure works that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

The ICNG defines additional assessment and reporting requirements that apply if out of hours work is proposed, including justification of the need to work during these periods, including additional management levels for ground borne noise from construction vibration.

General construction works associated with the Project are only expected to occur during standard working hours. On this basis a detailed assessment of out of hours construction activity is not included in this report.

While not currently planned or scheduled, unavoidable works outside of standard hours could conceptually comprise the delivery of over-size/over-mass (OSOM) components at times selected to minimise traffic disruption associated with intersection closures and unloading or installation of oversize equipment, such as power transformers.

Should out of hours works be required, a detailed out of hours construction noise and vibration assessment should be conducted during the detailed design stage. However, the potential for traffic noise impacts associated with OSOM vehicle movements is considered as part of the traffic noise assessment, to provide an early evaluation of risks at later stages of project development.

3.3 Road Noise Policy (RNP)

The Project SEARs indicate that additional traffic on public roads due to construction and operation of the Project must be assessed against the requirements of the RNP and relevant application notes.

The RNP provides noise level criteria for increased traffic flow as a result of a land-use development with the potential to create additional traffic, as detailed in Table 2.

Table 2: Road traffic noise assessment criteria for residential land uses

Type of development	Day (07:00-22:00)	Night (22:00-07:00)
Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	60 dB LAeq, 15 hr (external)	55 dB LAeq, 9 hr (external)
Existing residences affected by additional traffic on existing local roads generated by land use developments	55 dB LAeq, 1 hr (external)	50 dB LAeq, 1 hr (external)

Additionally, the RNP requires that the relative increase in noise levels at residential receivers not exceed 12 dB for land use developments with the potential to generate additional traffic on existing freeways, arterial or sub-arterial roads. The relative increase criterion does not apply for local roads.

The RNP notes that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

Where night-time construction traffic is likely to occur, such as OSOM deliveries, an assessment of sleep disturbance is appropriate. The RNP provides guidance on this matter:

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

Based on the assumption that an open window provides 10 dB attenuation (which would be typical of a facade with partially open windows), noise levels below 60 - 65 dB L_{Amax} outside an open bedroom window would be unlikely to cause awakening reactions.

Furthermore, one or two events with a noise level of 75 - 80 dB L_{Amax} outside an open bedroom window would be unlikely to affect health and well-being significantly.

3.4 Assessing Vibration: A Technical Guideline (AVTG)

Although not explicitly required by the Project SEARs, it is common for an assessment of vibration related to the construction and operation of a state significant development (SSD) project to be undertaken in accordance with the AVTG.

The AVTG presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. Preferred and maximum vibration values outlined in the AVTG are taken from BS 6472.⁸

The AVTG identifies three vibration categories:

- *Continuous vibration* – Examples: Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery)
- *Impulsive vibration* – Examples: 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
- *Intermittent vibration* – Examples: Trains, nearby intermittent 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 this would be assessed against impulsive vibration criteria.

Similar to other policy and guideline documentation, the AVTG allows for assessment at various receiver types.

3.4.1 Intermittent vibration

The vibration characteristics of most construction activities, e.g. excavation and piling, are considered to be intermittent. Intermittent vibration can be defined as interrupted periods of continuous vibration, e.g. heavy truck pass-bys or rock breaking, or continuous periods of impulsive vibration, e.g. impact pile driving.

Higher vibration levels are allowed for intermittent vibration compared with continuous vibration on the basis that the higher levels occur over a shorter time period. Hence, for intermittent vibration, human disturbance vibration levels are assessed on the basis of the vibration dose value (VDV), based on the level and the duration of the vibration events. Vibration criteria applicable to residential receivers for intermittent vibration sources are summarised in Table 3.

⁸ British Standard 6472:1992 *Evaluation of human exposure to vibration in buildings* (1 80 Hz) (BS 6472).

Table 3: Preferred and maximum vibration levels for human disturbance limits, VDV ^a

Assessment period ^b	Preferred value	Maximum value
Daytime	0.20	0.40
Night-time	0.13	0.26

a These values are only indicative, and there may be a need to assess to other sensitive areas against the relevant criteria.

b Daytime is 07:00 to 22:00 and night-time is 22:00 to 07:00.

3.4.2 Continuous and impulsive vibration

Vibration criteria applicable to the residential receivers in the vicinity of the Project for continuous and impulsive vibration sources, are summarised in Table 4.

Table 4: Preferred and maximum vibration levels for human disturbance limits, m/s ^a

Vibration type	Assessment period ^b	Preferred values		Maximum values	
		Z axis	X and Y axes	Z axis	X and Y axes
Continuous vibration	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Impulsive vibration	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

a The preferred and maximum values are weighted RMS acceleration values. These values are only indicative, and there may be a need to assess to other sensitive areas against the relevant criteria.

b Daytime is 07:00 to 22:00 and night-time is 22:00 to 07:00.

4.0 NOISE PREDICTION METHOD

4.1 Operational noise

Operational noise levels associated with the Project is predicted using:

- noise emission data for the battery units, inverters, and transformers
- a 3D digital model of the Project and the surrounding environment, using proprietary noise modelling software SoundPLANnoise v9.1
- implementation of the environmental sound propagation method specified in ISO 9613-2:2024.⁹

The implementation of ISO 9613-2:2024 within proprietary noise modelling software enables multiple sound transmission paths, including reflected and screened paths, to be accounted for in the calculated noise levels. ISO 9613-2:2024 was designed to assume conditions that favour the propagation of noise from meteorological effects, described as a slight wind (1 to 5 m/s) blowing from source to receiver, or a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear calm nights.

In lieu of a detailed evaluation of meteorological conditions for the Project Site, noise enhancing meteorological conditions have been assumed for all assessment periods. This aligns with the conservative approach documented in Fact Sheet D of the NPfI.

Calculations under ISO 9613-2024 are expected to satisfy the noise enhancing meteorological parameters described in Fact Sheet D.

Terrain data with a cell size of 1 m was obtained through ELVIS and has been used to develop the topographical model referred to within the context of the noise model.¹⁰

Battery units are modelled with the physical form of the container included in the noise model. This approach allows for the reflections and shielding provided by the battery containers to be appropriately represented. The sole noise source associated with the battery is a cooling system compressor at one end of the battery. The resulting directivity of the battery is represented in the noise model by applying the total battery sound energy to the appropriate subject façade of the battery object in the noise model.

The remaining equipment items are modelled as omnidirectional point sources of noise with associated octave band sound power level noise emissions. This is consistent with the typical directivity of these equipment items.

The ground factor, G , representing the ground attenuation as a result of sound reflected by the ground surface interfering with the sound propagating directly from source to receiver is variable throughout the model being:

- $G = 0$ within BESS and substation areas representing “hard ground” per ISO 9613-2:2024.
- $G = 1$ to all other areas representing porous ground “suitable for growth of vegetation” per ISO 9613-2:2024.

Additional information with respect to general noise modelling factors is provided Appendix F.

⁹ International Organisation for Standardisation 9613-2:2024 Acoustics — *Attenuation of sound during propagation outdoors Part 2: Engineering method for the prediction of sound pressure levels outdoors* (ISO 9613-2:2024)

¹⁰ *Elvis - Elevation and Depth* - Foundation Spatial Data - <https://elevation.fsdf.org.au/>

4.2 Construction noise

Predicted noise levels have been calculated in general accordance with the method detailed in AS 2436.¹¹ This method enables the prediction of noise levels for sound propagation over hard or soft ground but does not provide the ability to calculate predicted noise levels for mixed ground cover with varied soil conditions.

The standard also notes that caution must be applied when considering predicted noise levels at distances beyond 100 m. For these reasons, predicted noise levels have been determined as the arithmetic average of the hard and soft ground prediction methods.

This approach is broadly consistent with the equivalent prediction procedure in BS 5228-1:2009, as referenced in AS 2436.¹² It provides a margin of caution with respect to ground conditions for the typical magnitude of separating distances between construction activities and neighbouring sensitive receivers.

The above general method would also apply to the noise assessment of decommissioning activities.

¹¹ Standards Australia, AS 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*, May 2010 (AS 2436)

¹² BSI, BS 5228 1:2009 *Code of practice for noise and vibration control on construction and open sites: Noise*, January 2009 (BS 5228-1:2009)

5.0 EXISTING NOISE ENVIRONMENT

5.1 Policy

Project noise trigger levels (per the NPfl) and noise management levels (per the ICNG) applicable to operational noise and construction noise assessment are in some cases dependent on background noise levels at a subject receiver, or in the vicinity of a subject site or project.

Background noise levels are referred to as the rating background level (RBL) in the NPfl and ICNG, and are defined in terms of $L_{A90, 15 \text{ min}}$.

Measurement procedures for determining RBLs are set out in Fact Sheet B of the NPfl. Background noise data developed for an NPfl assessment are also suitable for use in an assessment under the ICNG.

5.2 Background noise levels

Background noise levels in rural environments in NSW are typically low, particularly in the evening and night period.

The NPfl recognises that very low RBLs can present challenges with the derivation of reasonable assessment noise levels. Table 2.1 of the NPfl therefore provides minimum assumed RBLs. Where rural background noise levels are below the minimum RBLs, the minimum RBLs must be adopted as a matter of course.

The measurement of background noise levels in rural environments is therefore typically not necessary unless the rural receiver/s may be subject to elevated background noise levels e.g. located close to a highway or other noise source. This does not apply to the Project. The minimum assumed RBLs have therefore been adopted for the Project, being the minimum background noise levels permitted under the policy, and are used for derivation of the NPfl project noise trigger levels referred to in Table 6 and ICNG noise management levels in Table 8.

The minimum assumed RBLs are summarised in Table 5.

Table 5: Minimum assumed RBLs for NPfl and ICNG, dB L_{A90}

Time of day	Minimum assumed RBL
Day	35
Evening	30
Night	30

Time of day is defined as:

Day	07:00 – 18:00 Monday to Saturday and 08:00 – 18:00 Sundays and public holidays
Evening	18:00 – 22:00 Monday to Sunday and public holidays
Night	the remaining periods

6.0 OPERATIONAL NOISE ASSESSMENT

6.1 Project noise trigger levels

Based on the definitions set out in Table 2.3 of the NPfI all receivers considered for assessment have been determined to have a ‘Rural Residential’ receiver category.

On this basis, and considering the minimum assumed RBLs detailed in Table 5, the project noise trigger levels relevant for assessment of operational noise associated with the Project are summarised in Table 6.

Further information with respect to derivation of the project noise trigger levels is provided in Appendix E.

Table 6: Project noise trigger levels, dB $L_{Aeq, 15 \text{ min}}$

Time of day	Project noise trigger level
Day	40
Evening	35
Night	35

The Project infrastructure has the potential to operate under worst-case operational conditions at any time of day, evening or night. This means that operation during the evening or night period – during which the most stringent project noise trigger level of 35 dB $L_{Aeq, 15 \text{ min}}$ applies - will be the controlling the factor for compliance. The noise assessment herein considers this worst-case operation only.

The noise sources associated with the Project typically give rise to steady noise levels and are not typically characterised by brief momentary increases in noise levels. Accordingly, the additional procedures defined in the NPfI for assessing maximum noise level events associated with potential sleep disturbance are not relevant. The assessment is therefore carried out based on noise levels of the equipment assessed in terms of the $L_{Aeq, 15 \text{ min}}$ descriptor, which is adopted by the NPfI for the assessment of average noise energy over a 15-minute period.

6.2 Operational noise sources

Based on information provided by the Proponent, permanent noise generating infrastructure proposed to be developed as part of the Project is limited to:

- Battery units
- Inverters
- MV Transformers
- HV Transformer.

Other proposed permanent ancillary infrastructure e.g. the switchyard and O&M facility, do not typically include significant sources of operational noise and are not considered further.

The location of each of the operational noise sources within the context of the broader Project is shown in Figure 2.

Figure 2: Operational noise source layout



6.2.1 BESS

At this stage of the Project, a detailed project design has not been finalised, however a design concept has been developed by the Proponent for the purposes of the noise assessment.

The discrete position of each equipment item is shown in Figure 2.

A summary of the relevant information provided by the Proponent is shown in Table 7.

Table 7: BESS operational noise source details

Equipment item	Quantity
Battery unit	222
Inverter	37
MV transformer	37

6.2.2 Substation

Operational noise sources associated with the substation are limited to a HV transformer.

The relevant specification of the HV transformer is shown in Table 8.

Table 8: Substation HV transformer specification

Equipment item	Power rating, MVA	Quantity
HV transformer	200	1

6.3 Sound power level data

Sound power levels for the operational noise sources, as used in the noise model, are detailed in Table 9. Data is provided as un-weighted (linear) octave band sound power spectra and A-weighted overall sound power level.

Table 9: Sound power levels for operational noise sources, dB L_w

Item	Octave band centre frequency, Hz							L _{WA}
	63	125	250	500	1000	2000	4000	
Battery unit	72	85	76	73	70	70	66	77
Inverter	87	89	92	80	77	78	80	88
MV transformer	70	72	67	67	61	56	51	68
HV transformer	93	95	90	90	84	79	74	90

Additional information with respect to the source of the data is provided in Table 10.

Table 10: Operational noise source data description

Item	Description
Inverter ^a	<p>Manufacturer third octave band sound power levels measured in accordance with ISO 3744:2010 have been provided by the Proponent.¹³ Extensive specific operating conditions for the test were described in the datasheet including operation with and without a manufacturer designed and provided attenuation kit.</p> <p>For the purposes of this assessment noise data associated with 80% fan speed including the manufacturer’s attenuation kit has been adopted, being the sound power level of greatest magnitude in the provided datasheet with the attenuation kit applied. Based on information provided by the manufacturer it is understood that 100% apparent power is feasible with fan speeds of 80% up to a temperature of 40°C.</p> <p>80% fan speed is therefore the worst case operation of the inverter for the Project.</p>
Battery unit	<p>Manufacturer overall sound power levels measured in accordance with ISO 3746:2010 associated with the battery cooling system have been provided by the Proponent. Based on the information provided within the supplied OEM datasheet it is understood that the adopted sound power levels are associated with the cooling system operating at 80%.</p> <p>The Proponent has advised that this is the worst case cooling system operation for the battery unit in the Project.</p> <p>Frequency/spectral information related to component sound pressure level measurements is also provided in the OEM noise datasheet and referenced within the noise model.</p> <p>Due to commercial sensitivities the specific battery unit manufacturer and model is not detailed in this report but has been confirmed by the Proponent to be representative of the specification required for the Project.</p>
HV/MV transformers	<p>At this stage of the Project, specific details of the transformer makes and models are yet to be finalised.</p> <p>Based on information provided by the Proponent, MDA understands that the HV transformer proposed for the Project is expected to be rated at 200 MVA, with the MV transformers proposed for the Project expected to be rated at 5 MVA.</p> <p>In the absence of measured sound power level data for a specific transformer model, reference has been made to the standard maximum method for estimating overall transformer sound power levels for a given power rating described in AS 60076-10:2009.¹⁴</p> <p>Spectral data for each transformer was then estimated by applying Bies & Hansen corrections from Table 11.27, (Location 1a for outdoor transformer noise) to the determined overall sound power level.¹⁵</p>

¹³ ISO 3744:2010 *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

¹⁴ Standards Australia, Australian Standard AS 60076-10:2023 Part 10: Determination of sound levels (IEC 60076-10:2016 (ED. 2.0) MOD) (AS 60076-10:2023)

¹⁵ Bies, D. H. & Hansen, C. H, *Engineering noise control: theory and practice (Fourth edition.)*. p. 601, 2009

6.4 Noise modelling method

Battery units are modelled with the physical form of the container included in the noise model. This approach allows for the reflections and shielding provided by the battery containers to be appropriately represented.

Information provided in the OEM noise datasheet indicates that the candidate battery unit emits noise primarily in a single direction. This is due to the primary noise source – the cooling system chiller – being located on one façade element of the container. The directivity is represented in the noise model by applying the total battery sound energy to a single façade of the container.

The remaining equipment items are modelled as omnidirectional point sources of noise with associated octave band sound power level noise emissions. This is consistent with the typical directivity of these equipment items.

Additional information with respect to the noise modelling method is provided in Section 4.1 and Appendix F.

6.5 Predicted noise levels

Noise levels resulting from the operation of the Project have been predicted at all receivers referenced in Appendix D and are shown in Table 11.

Only receivers at which the predicted noise level is greater than 25 dB $L_{Aeq, 15 \text{ min}}$ are included.

Predicted noise contours have also been provided in Figure 3.

Table 11: Predicted noise levels at receivers greater than 25 dB, dB $L_{Aeq, 15 \text{ min}}$

Receiver	BESS	Substation	Total ^a
1	33	18	34
2	31	16	31
3	27	12	27
5	25	11	25
11	27	12	27
12	28	13	28
13	26	11	26
40	34	21	34
167	25	12	25

a Predicted noise level from all Project related operational noise sources combined

As shown in Table 11, the predicted noise levels at all receivers are below the most stringent project noise trigger level of 35 dB $L_{Aeq, 15 \text{ min}}$, applicable during the evening and night periods, by a minimum margin of 1 dB.

6.6 Tonality

Noise associated with the operation of inverters and HV transformers has the potential to be tonal in nature, as these equipment items can exhibit tonal characteristics at source.

Table C1 of Fact Sheet C of the NPfI sets out assessment procedures and modifying factor corrections for annoying noise characteristics, including tonality, that must be applied where the characteristics are evident at receiver locations.

The procedure for tonality assessment is based on analysing measured third octave band sound pressure levels from the subject noise source at receivers, using the objective method for assessing the audibility of tones in noise set out in Annex D of ISO 1996.2-2017.¹⁶

It is evident that direct evaluation of tonality, via measurement at noise sensitive receivers is not feasible for a development that is yet to be constructed.

There is no documented or recognised method for the prediction of tonality, pre-construction. In order to provide the best, feasible approach, and evaluate risk associated with potential tonality, noise predictions at receivers have been repeated using third octave band sound power level data for noise sources. The resultant third octave band predictions at receivers have then been treated as effective measurements, with analysis for tonality then conducted per Fact Sheet D.

Validation of the ISO 9613-2 method is limited to octave band data, therefore when using one-third octave band noise data the modelling software assumes the same attenuation factors for the adjacent two bands. This is a limitation of the method and may result in a minor variation in the results where one-third octave band data is used.

Based on evaluation of the predicted third octave band noise levels at receivers for inverters and battery units, a modifying factor correction for tonality has not been found to be applicable.

At this stage of the Project third octave band sound power levels for the HV transformers are not available, and an objective assessment similar to the above is not feasible. However, given the magnitude of predicted HV transformer noise levels at receivers ($< 21 \text{ dB } L_{Aeq, 15 \text{ min}}$) it is unlikely that tonal character associated with HV transformer operation (if present) would be emergent from the background and ambient noise levels at receivers, given additional noise contributions from other Project equipment items.

On this basis it is not expected that tonality is a risk for the Project likely to warrant penalties post-construction. Modifying factor corrections for tonality are therefore not included in the noise modelling results. Tonality factors will continue to be reviewed as the Project progresses and will be a core consideration during tender and procurement.

¹⁶ International Organisation for Standardisation, ISO 1996-2:2017 *Acoustics - Description, measurement and assessment of environmental noise – Determination of environmental noise levels* dated July 2017 (ISO 1996-2:2017)

Figure 3: Predicted noise contours



6.7 Discussion

The results shown in Table 11 demonstrate that predicted noise levels are below the 35 dB $L_{Aeq, 15 \text{ min}}$ evening and night-time project noise trigger level at all receivers, by a minimum margin of 1 dB.

Operational noise from the Project is therefore predicted to be below the most stringent project noise trigger level applicable under the NPfl at all assessed receivers.

It should be noted that the operational noise assessment is inherently conservative, particularly with respect to the adoption of worst-case operation of all cooling systems during the evening and majority of the night period.

Cooling system operation for all equipment will be controlled by facility load and operation but also ambient temperature. In the evening and night periods when ambient temperatures are lower cooling system operation will be reduced. Noise levels during reduced cooling system operation will be lower than predicted by this assessment.

7.0 CUMULATIVE OPERATIONAL NOISE ASSESSMENT

The key issues related to noise identified in the Project SEARs include:

an assessment of cumulative noise impacts (considering other developments in the area)

There are a number of other existing and proposed developments in the area surrounding the Project. The following subsections provide a high-level summary of each development and any related information relevant to noise.

A review of receiver locations in relation to the subject developments indicates that receiver 40 is most at-risk of cumulative noise impacts. On this basis the cumulative operational noise assessment documented herein is focused on receiver 40. Given the larger separating distances between the subject developments and other assessment receivers, it is expected that compliance at receiver 40 would also mean compliance at receivers further away.

The location of each of the other developments in relation to the Project can be seen in Figure 4.

7.1 Existing premises

7.1.1 Griffith Solar Farm

Griffith Solar Farm (GSF) is a 36 MW solar farm located approximately 0.6 km to the north-east of the Project. Planning approval for GSF was received in June 2016, with construction starting in January 2017 and completed in April 2018. It has been operational since construction was completed.

A predictive noise assessment for GSF is documented in the GSF Noise Report, submitted in support of the GSF EIS.¹⁷

The predicted worst-case operational noise level set out in the GSF Noise Report for receiver 40 (referred to as M1 within the GSF Noise Report) is 35 dB $L_{Aeq, 15 \text{ min}}$ for all assessment time periods

7.1.2 Transgrid Griffith 132 kV Substation

The Transgrid Griffith 132 kV Substation (TGS) is a 132/33 kV Transgrid Transmission Substation located approximately 0.3 km to the north of the Project. The TGS includes 3 HV transformers and provides the grid connection point for the Project.

Publicly available information regarding either the noise emissions or the specifications of the HV transformers located at the TGS were not able to be sourced as part of the preparation of this report. It is also noted that the GSF Noise Report does not include an assessment of cumulative noise related to the TGS. Background noise monitoring was, however, undertaken at receiver 40/M1. The survey was carried out in November 2015, during which time the TGS is understood to have been operational.

On the basis that transformers typically exhibit steady state noise emissions, the conservative assumption that the total L_{A90} sound energy measured at receiver 40 is attributable to the TGS can be made. Based on this assumption, the contribution from the TGS transformers at receiver 40 is expected to be in the order of 30 dB $L_{Aeq, 15 \text{ min}}$.

¹⁷ Renzo Tonin & Associates, *Griffith Solar Farm – Construction & Operational Noise & Vibration Assessment*, dated 24 February 2016 (GSF Noise Report)

7.2 Proposed premises

7.2.1 Yoogali Solar Farm

Yoogali Solar Farm (YSF) is an approved but yet to be constructed solar farm development with a capacity of 15 MW AC. The Project and YSF share a development lot, with YSF currently in the process of pursuing a modification to the approved design to accommodate the footprint of the Project.

The YSF Noise Assessment, submitted in support of the YSF development application, indicates predicted worst-case operational noise level at receiver 40 (identified as 'Hamilton Rd' within the YSF Noise Assessment) of 29 dB $L_{Aeq, 15 \text{ min}}$.¹⁸

7.2.2 Riverina Solar Farm

Riverina Solar Farm (RSF) is an approved solar farm development with a capacity of 30 MW AC and is located approximately 0.4 km to the north/north-west of the Project.

The RSF was approved in 2016, and the development is currently considered to be under construction. However, based on information provided by Cogency, it is understood that construction is stalled, and the development is not likely to proceed.

Publicly available information relating to the noise emissions of the RSF is limited to a construction noise management plan submitted in support of the RSF EIS. No information is included within the EIS submission related to operational noise emissions or predicted noise levels at receiver 40.

It is also noted that the RSF Assessment Report specifically notes that '*there would be negligible noise during operation*'.¹⁹

Based on the above, at this stage it is understood that the RSF is not a material concern for the assessment of cumulative operational noise associated with the Project. Should the development status or intended use of the site change, the cumulative noise assessment should be revisited at a later date as part of any future design development or pre-construction noise assessment.

7.2.3 Hawkins Road Solar Farm & BESS

Hawkins Road Solar Farm & BESS (HRSFB) is a 5 MW hybrid solar farm & BESS located approximately 1.2 km to the south of the Project.

Given the relatively small size/capacity and correspondingly lower noise generation profile, together with the significant distance to the relevant receiver, HRSFB is not expected to have a material contribution to the cumulative noise levels. On this basis it has not been considered further within this assessment.

¹⁸ Wilkinson Murray, *Yoogali Solar Farm – Noise Assessment*, dated September 2018 (YSF Noise Assessment)

¹⁹ Department of Planning & Environment, *State Significant Development Assessment – Riverina Solar Farm (SSD 7482)*, dated June 2016 (RSF Assessment Report)

7.3 Discussion

Cumulative noise is addressed within the NPfl through the amenity noise levels, which are a component of the derivation of noise limits. With regards to the recommended amenity noise levels, the NPfl states:

The recommended amenity noise level from Table 2.2 represents the total industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.

The NPfl project amenity noise level is designed ‘to protect against cumulative noise impacts from industry’. Modifications are made to the recommended amenity noise level to account for noise contributions for existing industry, as described in Section 3.1 and Appendix E.

Further, the NPfl states:

The recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

Based on the classification of nearby receivers under the NPfl as ‘Rural Residential’, the most stringent recommended amenity noise level is 40 dB L_{Aeq} , applicable during the night period.

In order to provide an assessment of cumulative operational noise, reference can be made to the noise levels documented within the relevant planning reports and summarised in the previous subsections. These are reproduced in Table 12

Table 12: Predicted cumulative noise levels, dB $L_{Aeq, 15 \text{ min}}$

Receiver	Project	GSF	YSF	TGS	Total
40	34	35	29	30	39

As shown in Table 12, the total cumulative noise level is below the 40 dB L_{Aeq} recommended amenity noise level.

It is noted that this represents a conservative assessment, as cumulative noise has been considered as the total worst-case noise levels from all developments, occurring during the night period when the recommended amenity noise level is most stringent.

Worst-case noise emissions for the identified solar farm developments are most likely to occur during the day or evening periods, during which the applicable recommended amenity noise levels would be higher.

The recommended amenity noise level during the day is 50 dB $L_{Aeq, 15 \text{ min}}$ and the recommended amenity noise level during the evening is 45 dB $L_{Aeq, 15 \text{ min}}$ for rural residential receivers.

Where the solar farm infrastructure is not operating, as would be the case for a majority of the night period, cumulative noise levels would be driven by the Project and TGS only, resulting in cumulative noise levels in the order of 35 dB $L_{Aeq, 15 \text{ min}}$.

Based on the above, it is expected that the intent of the NPfl with respect to cumulative industrial noise is satisfied and the risk of cumulative noise impact is not significant.

Figure 4: Other developments in the vicinity of the Project



8.0 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

8.1 Overview

The construction of the Project will generate noise and vibration as a result of activities occurring both inside and outside of the Project Site.

As per the Project SEARs construction noise is to be assessed in accordance with the ICNG (see Section 3.1.2). Whilst not formally required by the Project SEARs, construction vibration is also addressed considering the AVTG (see Section 3.3).

General construction works associated with the Project are only expected to occur during standard working hours. On this basis a detailed assessment of out of hours construction activity is not included in this report.

While not currently planned or scheduled, unavoidable works outside of standard hours could conceptually comprise the delivery of over-size/over-mass (OSOM) components at times selected to minimise traffic disruption associated with intersection closures and unloading or installation of oversize equipment, such as HV transformers.

Should out of hours works be required, a detailed out of hours construction noise and vibration assessment should be conducted during the detailed design stage. However, the potential for traffic noise impacts associated with OSOM vehicle movements is considered as part of the traffic noise assessment in Section 9.0, to provide an early evaluation of risks at later stages of project development.

As per the ICNG, noise associated with the construction of the Project may require the adoption of reasonable and feasible general management measures and considerate working practices. These measures will be documented and agreed in a Construction Noise and Vibration Management Plan (CNVMP). This document is typically prepared for review and approval by the responsible authority prior to commencing any construction works.

At this stage a detailed construction strategy is not known but would be developed during the detailed design phase of the Project, once a main contractor is appointed. Therefore, the following sections provide general information regarding the types of activities that are expected to be associated with the construction of the Project, and reference data that should be considered as part of the preparation of a future CNVMP for the Project.

8.2 On-site construction activities

Based on information provided by the Proponent, the primary construction tasks associated with the Project include:

- Site Mobilisation
- Combined Earthworks and Drainage
- BESS - Construction
- Electrical Works
- Substation Construction
- Roads
- 132kV HV Cable Works

Specific details of the construction program and the number, type, and duty of the construction plant to be used would be determined during the detailed design phase of the Project when a construction contractor has been selected.

The types of equipment associated with each of the construction tasks include excavation plant, pneumatic equipment, piling processes and lifting equipment.

Appendix G provides a construction site layout denoting key work areas.

Appendix H details typical major equipment items associated with the above construction tasks, alongside noise levels developed on the basis of reference data from AS 2436 and previous project experience. Correlations between the above primary construction tasks, and the Project construction work areas are also provided.

The assessed construction tasks, plant/equipment items, and construction work areas are conceptual assumptions provided by the Proponent and provide an approximation of potential construction equipment and processes. Project specific equipment and processes will be determined once a main contractor is appointed. Typical construction plant sound power levels range from approximately 99 to 117 dB L_{WA} per equipment item.

Based on the groupings of major plant items during key construction tasks, the total aggregated noise emissions for the proposed works stages typically ranges from 120 to 125 dB L_{WA} . These predictions assume that each item of plant associated with a task operates simultaneously for the entire duration of an assessment period thus providing a conservative approach that is unlikely to occur in practice.

8.3 On-site construction noise assessment

Noise levels associated with each of the main construction tasks have been predicted at the nearest noise sensitive receivers to provide an indication of the upper range of noise levels that may occur during construction.

Given that the precise equipment selections and methods of working would be determined once a main contractor is appointed, and that the noise associated with construction plant and activity varies significantly, the predicted noise levels are provided in the following sections as an indicative range of levels which may occur in practice.

The following assumptions are included within the construction noise assessment:

- Construction works have been assumed to be occurring at the nearest point from the relevant work area to the receivers.
- All equipment and plant items are assumed to be operating for 100% of the subject 15-minute period.
- All equipment and plant items are assumed to be operating at the same location.

The assumptions outlined above provide a generally conservative assessment. This is on the basis that plant items will typically be distributed throughout the work area, and not all plant and equipment items identified for each construction task will be operating concurrently.

The predicted noise level ranges for each of the main construction tasks are provided in Table 13.

Table 13: Indicative range of construction noise predictions at receivers, dB L_{Aeq, 15 min}

Construction phase	Nearest receiver (distance, m)	Predicted level range	Noise affected management level	Exceedance	Highly noise affected management level	Exceedance
132kV HV Cable Works	40 (305)	50-60	45	Up to 15	75	-
BESS - Construction	40 (305)	55-65	45	Up to 20	75	-
Combined Earthworks and Drainage	40 (455)	55-65	45	Up to 20	75	-
Electrical Works	40 (455)	50-60	45	Up to 15	75	-
Site Mobilisation	40 (455)	50-60	45	Up to 15	75	-
Substation	40 (260)	55-65	45	Up to 20	75	-
132kV HV Cable Works	40 (305)	50-60	45	Up to 15	75	-

The following can be seen from the construction noise predictions shown in Table 13.

- Construction noise levels are predicted to be below the highly noise affected management level for all receivers during all assessed construction stages
- Construction noise levels are predicted to be up to 15-20 dB above the noise affected management level at the nearest affected receiver during all assessed construction stages.

8.3.1 Discussion

The ICNG provides the following context for proponents when assessing construction noise:

The noise affected level represents the point above which there may be some community reaction to noise.

- *Where the predicted or measured $L_{Aeq(15min)}$ 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.*

As the noise affected management levels are predicted to be exceeded during the construction of the Project, work practices and mitigation measures should be considered and included in the future CNVMP. Further discussion, including conceptual mitigation strategies, is provided in Section 8.7.

It is noted, however, that exceedances above the noise affected management levels are not unique to this project, and are characteristic of many construction noise assessments due to the high at source noise levels of construction equipment. Based on previous project experience, the predicted noise levels are typical of the range expected for a medium size infrastructure project in a rural setting.

8.4 On-site construction noise assessment – TGS

Following discussions with Cogency, it is also understood that additional works may be required at the TGS to facilitate the Project grid connection. This may include the installation of a new switch bay and associated high-voltage equipment. Although the specific requirement for these works has not yet been established, a conceptual risk assessment of associated construction noise has been included at the request of Cogency. It is expected that further assessment may be necessary should the works be required.

The details of the modelling method and assumptions summarised in Section 8.3 are also relevant to the TGS assessment, however, the specific work processes and equipment requirements for the TGS works are not currently known. The assessment has therefore been conducted based on a representative cumulative sound power level of 125 dB L_{WA} , being typical of the range of noise levels referred to in similar assessments of construction noise.

The results of the TGS assessment are presented in Table 14.

Table 14: Indicative range of construction noise predictions at receiver 40 – TGS switchbay & bench extension, dB $L_{Aeq, 15min}$

Nearest receiver (distance, m)	Predicted level range	Noise affected management level	Exceedance	Highly noise affected management level	Exceedance
40 (160)	65-75	45	Up to 30	75	-

Based on the results shown in Table 14, it can be seen that the predicted construction noise levels at receiver 40 are just below the highly noise affected management level. It is noted, however, that the separating distance between the TGS work area and the nearest receiver (40) is reduced when compared to the other work areas and tasks assessed in Table 13. This means that works occurring within the TGS work area have an increased likelihood of exceedances of the noise affected management level when assessed at receiver 40.

On this basis it is expected that, should these works be required, further investigation into construction work processes and potential mitigation measures will be necessary. This is expected to include the application of all feasible and reasonable work practices in order to minimise noise and meet the noise affected management level, in accordance with the requirements of ICNG.

8.5 Construction vibration assessment

The prediction of vibration propagation through the ground is convoluted and complex, and depends on several factors including damping, reflection, and impedance in-ground conditions. A detailed vibration propagation assessment is considered to be a site-specific assessment and often requires a combination of baseline vibration assessment, empirical measurement of equipment and analytical methods. Assessment of this nature is outside of the scope of a planning stage vibration risk assessment.

The AVTG provides guidance with respect to the assessment of human comfort due to vibration from construction works. This guideline distinguishes intermittent, impulsive, and continuous vibration sources, which can be generated by construction activities. For the purposes of this planning risk assessment only residential receivers are considered.

8.5.1 Intermittent vibration

The AVTG indicates that intermittent vibration should be assessed in terms of the vibration dose value (VDV). Representative VDV values for construction works are calculated considering the magnitude and duration of vibration events and are highly specific to site conditions, equipment selections and operational durations. As such, calculation of VDV levels is not typical or practical at the planning stage but will need to be considered as part of a later detailed vibration assessment.

The AVTG recommends that best management practices in all cases should be to reduce values as far as practicable, and a comprehensive community consultation program should be developed.

8.5.2 Continuous vibration

Vibration due to some construction operations can be considered continuous depending on the duration and nature of the works. Since the guide values for continuous vibration are independent of exposure duration, indicative safe working distances can be developed. Section 7.1 of the CNVG sets out minimum working distances from sensitive receivers for typical items of vibration intensive plant.²⁰ The minimum distances, reproduced in Table 15 are quoted for effects relating to human comfort.

²⁰ Transport for NSW, *Construction Noise & Vibration Guideline – Public Transport Infrastructure*, September 2023 (CNVG)

Table 15: Recommended minimum working distances for human response limits for vibration intensive plant

Plant item	Rating/description	Minimum working distance, m
Vibratory roller	< 50 kN (typically 1-2 tonnes)	15 to 20
	< 100 kN (typically 2-4 tonnes)	20
	< 200 kN (typically 4-6 tonnes)	40
	< 300 kN (typically 7-13 tonnes)	100
	> 300 kN (typically 13-18 tonnes)	100
	> 300 kN (> 18 tonnes)	100
Small hydraulic hammer	300 kg – 5 to 12 t excavator	7
Medium hydraulic hammer	900 kg – 12 to 18 t excavator	23
Large hydraulic hammer	1600 kg – 18 to 34 t excavator	73
Vibratory pile driver	Sheet piles	20
Pile boring	≤ 800 mm	4
Jackhammer	Handheld	2

Note: Reproduced from Table 2 of Section 7.1 of the CNVG

The CNVG notes that the minimum working distances for human comfort relate to continuous vibration and are indicative. In practice, appropriate minimum working distances will vary depending on the particular item of plant and local geotechnical conditions. The CNVG further notes that for most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, likely equating to greater minimum working distances.

8.6 Decommissioning

Similar construction activities to those detailed in Section 8.2 are expected to be required during the decommissioning of the Project. Decommissioning activities are likely to be less intensive than during construction and occur over a shorter duration. On this basis no further assessment has been conducted.

8.7 Construction noise and vibration recommendations

At this stage of the Project, only a preliminary, conceptual assessment of construction noise and vibration impact risk is feasible. Once a more detailed schedule of equipment and plant items, construction method and work areas are known, a detailed CNVMP will be prepared.

The preliminary assessment of construction noise, adopting conservative assumptions, indicates that noise may be above the noise affected management level for all construction stages. This would trigger a need to establish site and process specific noise management work practices to mitigate the impact of construction noise activities.

An updated construction noise assessment should be conducted once a main construction contractor is appointed, and specific details of the construction program and the number, type, and duty of the construction plant to be used are known.

This would provide an updated evaluation of construction noise impact, removing excess conservatism that is likely present in the current assessment.

Where noise impact is still indicated, by way of noise levels above the noise affected management level, project specific noise controls and management processes should be detailed in a project specific CNVMP.

The ICNG provides extensive details and guidance with respect to noise mitigation and management processes that may be included in a CNVMP, including:

- universal work practices
- consultation and notification
- plant and equipment, e.g. utilising bored piling in lieu or impact or vibratory piling
- on-site controls
- work scheduling
- transmission path and at-receiver considerations.

Where feasible, restricting works to normal construction hours, i.e. the ICNG recommended standard construction hours detailed in Section 3.1.2, will assist in limiting noisy activities to times of the day when intrusive impacts or adverse reactions may be less likely.

In some cases, construction works may be required to occur outside of these hours. Such activities are typically related to public infrastructure i.e. timing oversized deliveries to avoid hazardous traffic conditions or weather windows.

Where out of hours works are proposed, the ICNG advises:

- *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(A) above the noise affected level, the proponent should negotiate with the community.*

With reasonable and feasible work practices implemented it is expected that noise associated with the construction and decommissioning of the Project can be acceptably managed.

9.0 TRAFFIC NOISE ASSESSMENT

Noise criteria for the assessment of traffic associated with the construction and operation of the Project are detailed in Section 3.3.

Traffic generation during the operation of the Project is expected to be limited, with construction stage traffic likely to comprise the significant majority of traffic movements associated with the Project. On this basis, operational traffic on public roads is not considered further in this report as it is likely to be very low and have negligible noise impacts.

Based on information provided by Cogency and the engaged traffic consultant One Mile Grid Pty Ltd (OneMileGrid), noise impacts associated with construction traffic have been assessed along Irrigation Way, Bob Irvin Road and Hanwood Avenue. This assessment also extends to consider cumulative traffic from other nearby developments, being YSF and HRSFB, with corresponding traffic data also provided by OneMileGrid.

It is understood that the Project will target the use of existing major roads and designated heavy vehicle routes, with existing traffic flows expected to be greater than any increase arising from construction of the Project. On this basis traffic noise along the broader transport route has not been considered further in this report - increases in traffic noise levels experienced by receivers near these major roads are likely to be negligible.

The base traffic flows and estimated construction traffic flows along the roads considered within this assessment have been provided by OneMileGrid in correspondence dated 10 September 2025. The traffic data is reproduced in Table 16.

It is noted that day-time peak traffic flows for Hanwood Avenue are associated with the period 15:00 to 16:00, while for Bob Irvin Road these are between 16:00 and 17:00. Night-time peak traffic flows for both Hanwood Avenue and Bob Irvin Road are associated with the period 06:00 to 07:00.

Based on the definitions in the RNP, Irrigation Way is considered to be a freeway/arterial/sub-arterial road, while Bob Irvin Road and Hanwood Avenue are local roads. The assessment has been based on the relevant RNP criteria for each road category.

Table 16: Construction traffic and base traffic flows on public roads – vehicles (% heavy vehicles)

Road category	Existing traffic		Future: existing + Project construction traffic		Future: existing + Project construction traffic + YSF traffic + HRSFB traffic	
	Day ^a	Night ^a	Day ^a	Night ^a	Day ^a	Night ^a
Freeway/arterial/sub-arterial roads^{b,c}						
Irrigation Way	2,301 (15%)	214 (13%)	2,416 (16%)	214 (13%)	2,500 (16%)	229 (12%)
Local roads^d						
Bob Irvin Road	15 (7%)	2 (0%)	94 (5%)	81 (5%)	135 (4%)	122 (4%)
Hanwood Avenue	43 (10%)	17 (8%)	47 (13%)	96 (5%)	48 (13%)	137 (4%)

a Day is 07:00 – 22:00; Night is 22:00 – 07:00

b Night: Total 9 hr AADT/% heavy vehicles

c Day: Total 15 hr AADT/% heavy vehicles

d Day & Night: Peak 1 hr AADT (annual average daily traffic)/% heavy vehicles

9.1 Screening assessment

In considering feasible and reasonable mitigation measures, the RNP states that an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. On this basis, to assess noise impacts from construction traffic, an initial screening test is undertaken in the following section to evaluate whether existing road traffic noise levels would increase beyond this threshold.

Where the predicted traffic noise increase is 2 dB or less, no further assessment is conducted, as impacts will be barely perceptible. However, where the road traffic noise levels are predicted to increase by more than 2 dB as a result of additional traffic, consideration is given to the actual noise levels associated with the construction traffic and whether or not these levels comply with the road traffic noise criteria detailed in Table 2 of Section 3.3.

A 2 dB increase in relative traffic noise level is approximately equal to a 60% increase in traffic flow.

The relative traffic flow increases that are estimated to occur on the roads included within this assessment during the construction of the Project are shown in Table 17.

Table 17: Relative increase to traffic flow on public roads

Road category	Relative increase – Project		Relative increase – Project + YSF + HRSFB	
	Day	Night	Day	Night
Freeway/arterial/sub-arterial roads				
Irrigation Way	5%	0%	9%	7%
Local roads				
Bob Irvin Road	527%	3,950%	800%	6,000%
Hanwood Avenue	9%	465%	12%	706%

Based on the data in Table 17, the relative traffic noise level increase due to the proposed construction activities is predicted to be:

- Below the 2 dB threshold on all freeway/arterial/sub-arterial roads considered within the assessment, when considering both Project only and cumulative cases.
- Below the 2 dB threshold on Hanwood Avenue during day period, when considering both Project only and cumulative cases.
- Above the 2 dB threshold on Hanwood Avenue during night period, when considering both Project only and cumulative cases.
- Above the 2 dB threshold on Bob Irvin Road during both day and night periods, when considering both Project only and cumulative cases.

On this basis, the detailed assessment documented herein has only considered construction traffic noise along Bob Irvin Road for day and night periods, and Hanwood Avenue for night period.

The location of each of the assessed road sections in relation to the Project is shown in Figure 5.

Figure 5: Assessed road sections in relation to the Project



9.2 Construction traffic predictions

Based on the information provided in Table 16, it is noted that both the existing traffic volumes and those associated with the construction of the Project are generally low in absolute levels, particularly when considering traffic flows on local roads. The CoRTN prediction method, preferred by Transport for NSW (TfNSW) and the EPA, is not typically applied where traffic flows are less than 50 vehicles per hour.²¹ A correction factor for low traffic volumes, applicable when considering traffic flows lower than 200 vehicles per hour, has been applied where relevant, in accordance with CoRTN.

From the traffic data in Table 16, traffic noise levels have been predicted in the vicinity of the assessed roads using the following method and assumptions:

- Traffic speed set to 100 km/h.
- Roads assessed as a local road as defined in the RNP.
- Predicted noise levels include an additional +2.5 dB correction for facade reflection as required by the RNP.
- $L_{Aeq, 1h}$ levels are calculated as CoRTN $L_{A10(1hr)}$ - 3 dB, per RMS practice (noting that this research was conducted by the RMS which has now been absorbed into TfNSW).
- Grass or cultivated fields assumed between the road and receivers.

Modifying corrections for Australian conditions or for road surface conditions have not been applied as applicable data for the road surfaces in question is not available.

Table 18 and shows a summary of the minimum setback distances from the assessed roads, beyond which compliance with the RNP criteria is predicted to be achieved during the day and night periods.

Table 18: Minimum setback distance for RNP compliance per traffic flows associated with the Project only

Road	Minimum setback distance, m		Identified receivers within setback zone	
	Day	Night	Day	Night
Local roads				
Bob Irvin Road	40	80	3	1, 2, 3, 4, 69
Hanwood Avenue	-	90	-	-

Table 19: Minimum setback distance for RNP compliance per traffic flows associated with the Project, YSF and HRSFB

Road	Minimum setback distance, m		Identified receivers within setback zone	
	Day	Night	Day	Night
Local roads				
Bob Irvin Road	50	105	3	1, 2, 3, 4, 69
Hanwood Avenue	-	110	-	-

²¹ UK Department of Transport, The Calculation of Road Traffic Noise (CoRTN)

As shown in Table 18 and Table 19, there is one receiver located within the predicted day setback zones, and 5 receivers located within the predicted night setback zones. These receivers are shown geographically in Figure 6 and Figure 7 for Project only and cumulative traffic assessments respectively, and should be included in the CNVMP, where relevant.

Notwithstanding the prediction results, the increase in traffic noise from the already low existing volumes may result in a noticeable increase in noise during some periods of construction. Noise mitigation options are generally limited for local roads, with community consultation and regular communication being the most effective and practical means of minimising adverse impacts.

It is recommended that residents residing nearby to Bob Irvin Road and Hanwood Avenue be included in consultation prior to, and during, construction.

Alternative practical methods for minimising noise impact may include limiting construction traffic speed for the affected road sections. Reducing construction traffic speeds would reduce the minimum setback distances and the potential for noise impact to these receivers.

9.3 Sleep disturbance due to construction traffic

The majority of construction traffic movements will occur during the day period, as construction works associated with the Project are only expected to occur during standard working hours.

Out of hours work is not specifically scheduled in the current conceptual construction works information provided by Cogency. However, a maximum of 5 oversize/over mass vehicles (OSOM) movements over the Project construction period are included in OSOM journey counts provided by OneMileGrid.

The RNP sleep disturbance criteria established in Section 3.3, provides context to external noise levels that may give rise to awakening impacts. Based on this an external noise level screening threshold of 65 dB L_{Amax} has been adopted to assess the potential for sleep disturbance due to construction traffic during the periods of OSOM delivery. Typical OSOM vehicle noise data, taken from MDA's library, indicates a maximum external noise level of 65 dB L_{Amax} or higher, is feasible within 40 m of an OSOM vehicle movement.

OSOM route information provided by OneMileGrid shows that OSOM vehicle movements could occur along Bob Irvin Road and Hanwood Avenue, or an alternative proposed route along Murray Road and Wincey Road. At this stage, the preference for routes is unknown, and hence both the designated and alternative routes have been included in this assessment for completeness.

Based on the receiver dataset provided by Cogency, only receiver 3 on Bob Irvin Road is within the 40 m setback zone for the designated route, while receivers 21, 24, 26, 27 and 28 on Murray Road are within the 40 m setback zone for the alternative route.

It should be noted that, as shown in Figure 8, receivers 23 and 29 on Murray Road are marginally outside the 40 m setback zone and should also be proactively considered.

It is recommended that these receivers be included in any community consultation and communications regarding the scheduling of OSOM deliveries, given the potential for noise impacts associated with both OSOM vehicle movements and general construction traffic associated with the Project.

Where OSOM deliveries must be carried out during night periods, reasonable and feasible noise mitigations should be considered. Potential mitigation could include:

- Reducing the maximum number of movements to once or twice each night.
- Scheduling for times when adverse impact is less likely, e.g. the very start of the night period and the very end of the night period, to reduce the potential for sleep disturbance.

Figure 6: Receivers within minimum setback distances adjacent to assessed roads – Project only



Figure 7: Receivers within minimum setback distances adjacent to assessed roads – Project & YSF & HRSFB



Figure 8: Receivers within minimum setback distances for OSOM vehicle movements



APPENDIX A GLOSSARY OF TERMINOLOGY

Term	Definition	Abbreviation
A-weighting	A method of adjusting sound levels to reflect the human ear's varied sensitivity to different frequencies of sound.	See discussion below this table.
A-weighted 90 th centile	The A-weighted pressure level that is exceeded for 90 % of a defined measurement period. It is used to describe the underlying background sound level in the absence of a source of sound that is being investigated, as well as the sound level of steady, or semi steady, sound sources.	L _{A90}
A-weighted average noise level	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.	L _{Aeq(t)}
A-weighted maximum noise level	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.	L _{Amax}
C-weighting	The process by which noise levels are corrected to account for non-linear frequency response of the human ear at high noise levels (typically greater than 100 decibels).	See discussion below this table
Decibel	The unit of sound level.	dB
Hertz	The unit for describing the frequency of a sound in terms of the number of cycles per second.	Hz
Octave Band	A range of frequencies. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.	-
Peak Particle Velocity	The measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment	PPV
Sound power level	A measure of the total sound energy emitted by a source, expressed in decibels.	L _w
Sound pressure level	A measure of the level of sound expressed in decibels.	L _p
Special Audible Characterises	A term used to define a set group of Sound characteristics that increase the likelihood of adverse reaction to the sound. The characteristics comprise tonality, impulsiveness and amplitude modulation.	SAC
Tonality	A characteristic to describe sounds which are composed of distinct and narrow groups of audible sound frequencies (e.g. whistling or humming sounds).	-

The basic quantities used within this document to describe noise adopt the conventions outlined in ISO 1996-1:2016.²² Accordingly, all frequency weighted sound pressure levels are expressed as decibels (dB) in this report. For example, sound pressure levels measured using an "A" frequency weighting are expressed as dB L_A.

Alternative ways of expressing A-weighted decibels such as dBA or dB(A) are therefore not used within this report, unless included in a direct quote of external documentation.

²² ISO 1996-1:2016 *Acoustics - Description measurement and assessment of environmental noise – Basic quantities and assessment procedures* (ISO 1996-1:2016)

APPENDIX B DESCRIPTION OF SOUND

Sound is an important feature of the environment in which we live; it provides information about our surroundings and influences our overall perception of amenity and environmental quality.

While sound is a familiar concept, its description can be complex. A glossary of terms and abbreviations is provided in Appendix A.

This appendix provides general information about the definition of sound and the ways that different sound characteristics are described.

B1 Definition of sound

Sound is a term used to describe very small and rapid changes in the pressure of the atmosphere. Importantly, for pressure fluctuations to be considered sound, the rise and fall in pressure needs to be repeated at rates ranging from tens to thousands of times per second.

These small and repetitive fluctuations in pressure can be caused by many things such as a vibrating surface in contact with the air (e.g. the cone of a speaker) or turbulent air movement patterns. The common feature is a surface or region of disturbance that displaces the adjacent air, causing a very small and localised compression of the air, followed by a small expansion of the air.

These repeated compressions and expansions then spread into the surrounding air as waves of pressure changes. Upon reaching the ear of an observer, these waves of changing pressure cause structures within the ear to vibrate; these vibrations then generate signals which can be perceived as sounds.

The waves of pressure changes usually occur as complex patterns, comprising varied rates and magnitudes of pressure changes. The pattern of these changes will determine how a sound spreads through the air and how the sound is ultimately perceived when it reaches the ear of an observer.

B2 Physical description of sound

There are many situations where it can be useful to objectively describe sound, such as the writing or recording of music, hearing testing, measuring the sound environment in an area or evaluating new man-made sources of sound.

Sound is usually composed of complex and varied patterns of pressure changes. As a result, several attributes are used to describe sound. Two of the most fundamental sound attributes are:

- sound pressure
- sound frequency.

Each of these attributes is explained in the following sections, followed by a discussion about how each of these attributes varies.

B2.1 Sound pressure

The compression and expansion of the air that is associated with the passage of a sound wave results in changes in atmospheric pressure. The pressure changes associated with sound represent very small and repetitive variations that occur amidst much greater pressures associated with the atmosphere.

The magnitude of these pressure changes influences how quiet or loud a sound will be; the smaller the pressure change, the quieter the sound, and vice versa. The perception of loudness is complex though, and different sounds can seem quieter or louder for reasons other than differences in pressure changes.

To provide some context, Table 20 lists example values of pressure associated with the atmosphere and different sounds. The key point from these example values is that even an extremely loud sound equates to a change in pressure that is thousands of times smaller than the typical pressure of the atmosphere.

Table 20: Atmospheric pressure versus sound pressure – example values of pressure

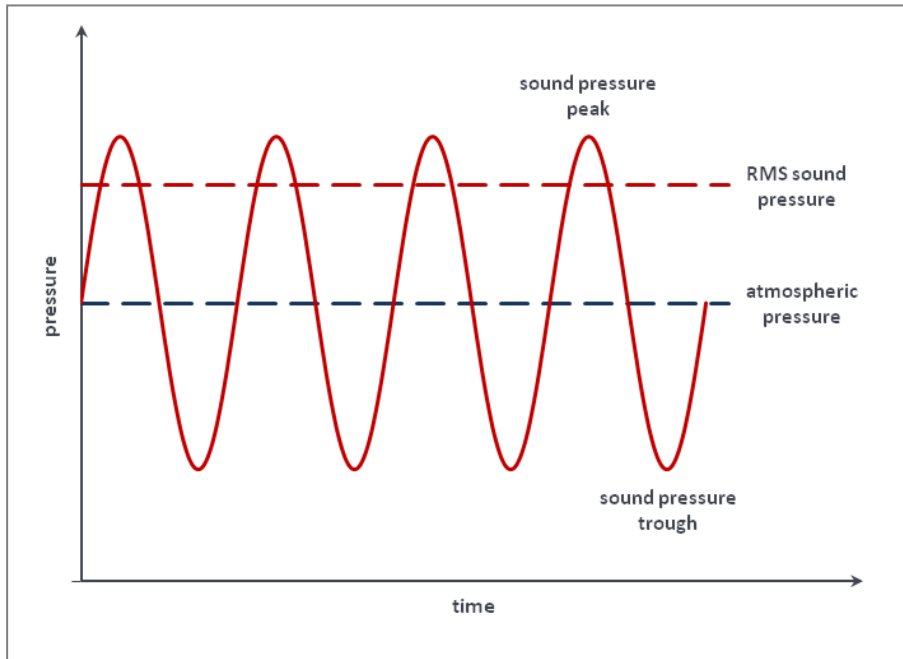
Example	Pascals	Bars	Pounds per Square Inch (PSI)
Atmospheric pressure	100,000	1	14.5
Pressure change due to weather front	10,000	0.1	1.5
Pressure change associated with sound at the threshold of pain	20	0.0002	0.003
Pressure change associated with sound at the threshold of hearing	0.00002	0.000000002	0.000000003

The pressure values in Table 20 also show that the range of pressure changes associated with quiet and loud sounds span over a very large range, albeit still very small changes compared to atmospheric pressure. To make the description of pressure changes more practical, sound pressure is expressed in decibels or dB.

To illustrate the pressure variation associated with sound, Figure 9 shows the repetitive rise and fall in pressure of a very simple and steady sound. This figure illustrates the peaks and troughs of pressure changes relative to the underlying pressure of the atmosphere in the absence of sound. The magnitude of the change in pressure caused by the sound is then described as the sound pressure level. Since the magnitude of the change is constantly varying, the sound pressure may be defined in terms of either:

- Peak sound pressure levels: the maximum change in pressure relative to atmospheric pressure i.e. the amplitude as defined by the maximum depth or height of the peaks and troughs respectively
- Root Mean Square (RMS) sound pressure levels: the average of the amplitude of pressure changes, accounting for positive changes above atmospheric pressure, and negative pressure changes below atmospheric pressure.

Figure 9: Pressure changes relative to atmospheric pressure associated with sound



B2.2 Frequency

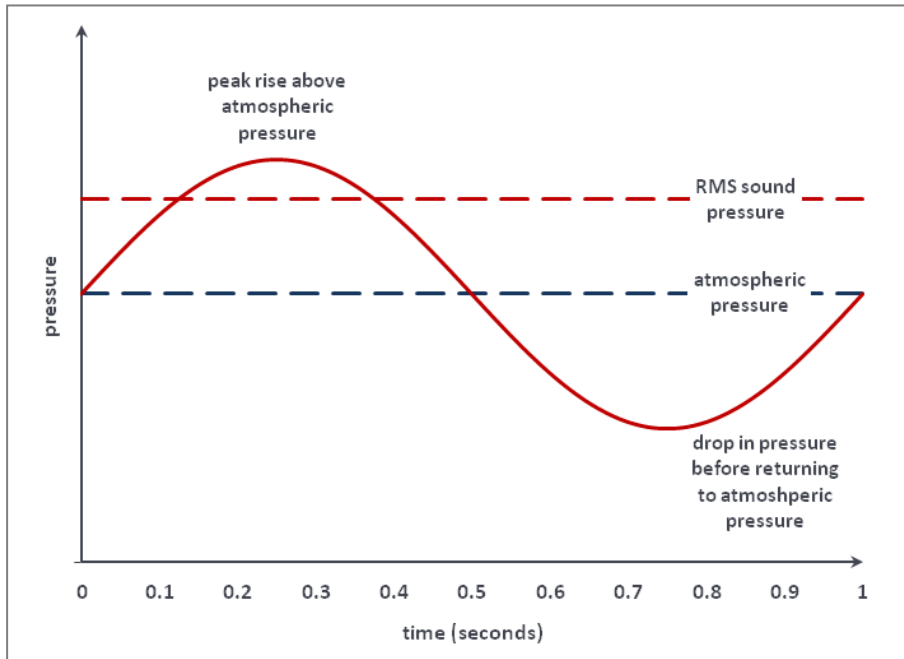
Frequency is a term used to describe the number of times a sound causes the pressure to rise and fall in a given period. The rate of change in pressure is an important feature that determines whether it can be perceived as a sound by the human ear.

Repetitive changes in pressure can occur as a result of a range of factors with widely varying rates of fluctuation. However, only a portion of these fluctuations can be perceived as sound. In many cases, the rate of fluctuation will either be too slow or too fast for the human ear to detect the pressure change as a sound. For example, local fluctuations in atmospheric pressure can be created by someone waving their hands back and forth through the air; the reason this cannot be perceived as a sound is the rate of fluctuation is too slow.

At the rates of fluctuation that can be detected as sound, the rate will influence the character of the sound that is perceived. For example, slow rates of pressure change correspond to rumbling sounds, while fast rates correspond to whistling sounds.

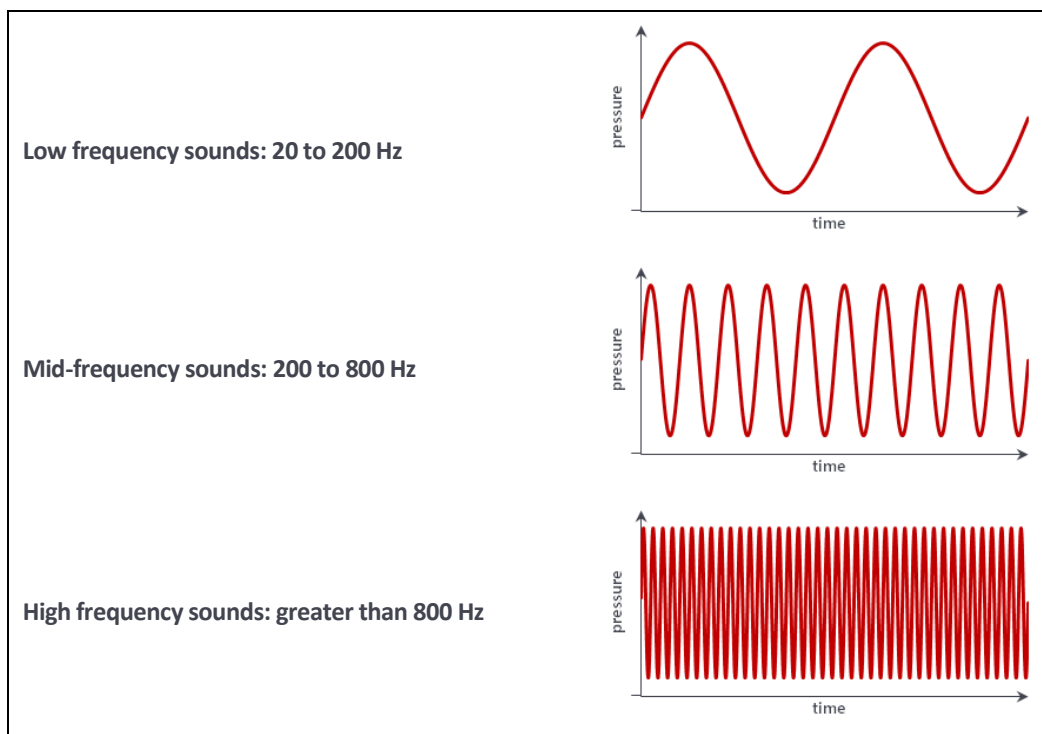
The rate of fluctuation is numerically described in terms of the number of pressure fluctuations that occur in a single second. Specifically, it is the number of cycles per second of the pressure rising above, falling below, and then returning to atmospheric pressure. The number of these cycles per second is expressed in Hertz (Hz). This concept of cycles per second is illustrated in Figure 10, which illustrates a 1 Hz pressure fluctuation. The figure provides a simple illustration of a single cycle of pressure rise and fall occurring in a period of a single second.

Figure 10: Illustration of a pressure fluctuation with a frequency of 1 Hz



The rate that sound pressure rises and falls will vary depending on the source of the sound. For example, the surface of a tuning fork vibrates at a specific rate, in turn causing the pressure of the adjacent air to fluctuate at the same rate. Recalling the idea of pressure fluctuations from someone waving their hands, the pressure would fluctuate at the same rate as the hands move back and forth; a few times a second translating to a very low frequency below our hearing range (termed an infrasonic frequency). Examples of low and high frequency sound are easily recognisable, such as the low frequency sound of thunder, and the high frequency sound of crashing cymbals. To demonstrate the differences in the patterns of different frequencies of sound, Figure 11 illustrates the relative rates of pressure change for low, mid and high frequency sounds. Note that in each case the amplitude of the pressure changes remains the same; the only change is the number of fluctuations in pressure that occur over time.

Figure 11: Examples of the rate of change in pressure fluctuations for low, mid and high frequencies



B2.3 Sound pressure and frequency variations

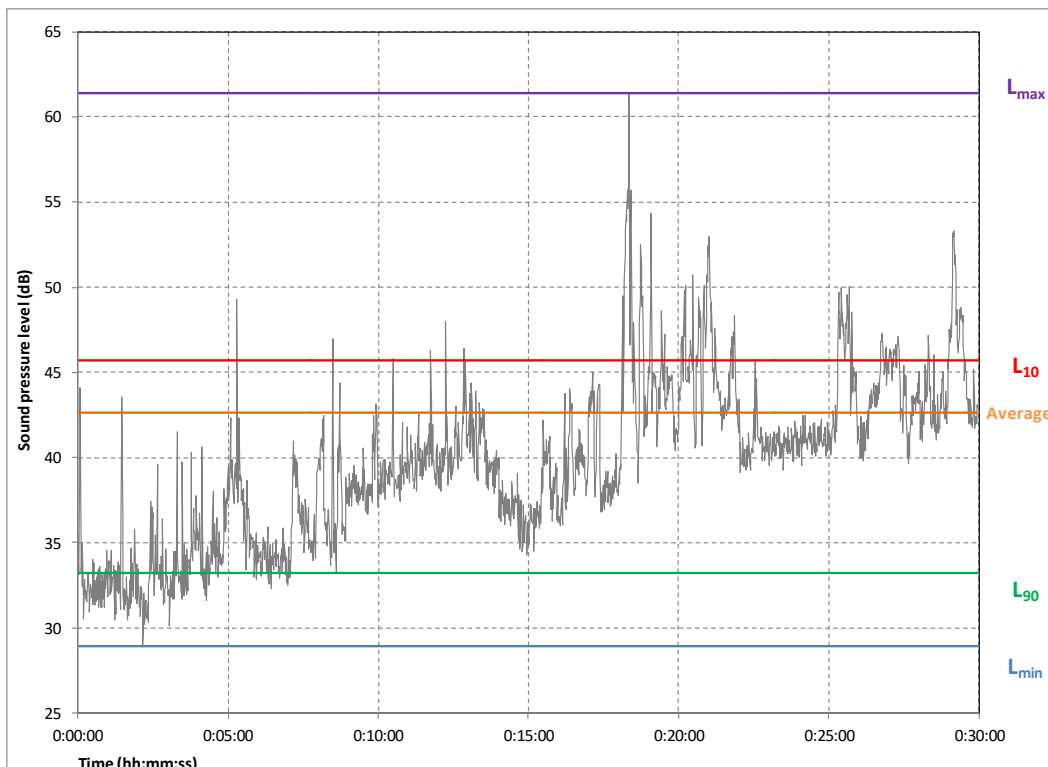
The preceding sections describe important aspects of the nature of sound, the changes in pressure and the changes in the rate of pressure fluctuations.

The simplest type of sound comprises a single constant sound pressure level and a single constant frequency. However, most sounds are made up of many frequencies, and may include low, mid and high frequencies. Sounds that are made up of a relatively even mix of frequencies across a broad range of frequencies are referred to as being ‘*broad band*’. Common examples of broad band sounds include flowing water, the rustling of leaves, ventilation fans and traffic noise.

Further, sound quite often changes from moment to moment, in terms of both pressure levels and frequencies. The time varying characteristics of sound are important to how we perceive sound. For example, rapid changes in sound level produced by voices provide the component of sound that we interpret as intelligible speech. Variations in sound pressure levels and frequencies are also features which can draw our attention to a new source of sound in the environment.

To demonstrate this, Figure 12 illustrates an example time-trace of total sound pressure levels which varies with time. This variation presents challenges when attempting to describe sound pressure levels. As a result, multiple metrics are generally needed to describe sound pressure, such as the average, minimum or maximum noise levels. Other ways of describing sound include statistics for describing how often a defined sound pressure level is exceeded; for example, typical upper sound levels are often described as an L_{10} which refers to the sound pressure exceeded for 10 % of the time, or typical lower levels or lulls which are often described as an L_{90} which refers to the sound exceeded for 90% of the time.

Figure 12: Example of noise metrics that may be used to measure a time-varying sound level



This example illustrates variations in terms of just total sound pressure levels, but the variations can also relate to the frequency of the sound, and frequently the number of sources affecting the sound.

These types of variations are an inherent feature of most sound fields and are an important point of context in any attempt to describe sound.

B3 Hearing and perception of sound

This section provides a discussion of:

- The use of the decibel to practically describe sound levels in a way that corresponds to the pressure levels the human ear can detect as sounds.
- The relationship between sound frequency and human hearing.

The section concludes with a discussion of some of the complicating non-acoustic factors that influence our perception of sound.

B3.1 Sound pressure and the decibel

Previous sections discussed the wide range of small pressure fluctuations that the ear can detect as sound. Owing to the wide range of these fluctuations, the way we hear sound is more practically described using the decibel (dB). The decibel system serves two key purposes:

- Compressing the numerical range of the quietest and loudest sounds commonly experienced.
As an indication of this benefit, the pressure of the loudest sound that might be encountered is around a million times greater than the quietest sound that can be detected. In contrast, the decibel system reduces this to a range of approximately 0-120 dB.
- Consistently representing sound pressure level changes in a way that correlate more closely with how we perceive sound pressure level changes.

For example, a 10 dB change from 20-30 dB will generally be subjectively like a 10 dB change from 40-50 dB. However, expressed in units of pressure as Pascals, the 40-50 dB change is ten times greater than the 20-30 dB change. For this reason, sound pressure changes cannot be meaningfully communicated in terms of units of pressure such as Pascals.

Sound pressure levels in most environments are highly variable, so it can be misleading to describe what different ranges of sound pressure levels correspond to. However, as a broad indication, Table 21 provides some example ranges of sound pressure levels, expressed in both dB and units of pressure.

Table 21: Example sound pressure levels that might be experienced in different environments

Environment	Example sound pressure level	
Outside in an urban area with traffic noise	50-70 dB	0.006-0.06 Pa
Outside in a rural area with distant sounds or moderate wind rustling leaves	30-50 dB	0.0006-0.006 Pa
Outside in a quiet rural environment in calm conditions	20-30 dB	0.0002-0.0006 Pa
Inside a quiet bedroom at night	<20 dB	0.0002 Pa

The impression of how much louder or quieter a sound is, will be influenced by the magnitude of the change in sound pressure. Other important factors will also influence this, such as the frequency of the sound which is discussed in the following section. However, to provide a broad indication, Table 22 provides some examples of how changes in sound pressure levels, for a sound with the same character, can be perceived.

Table 22: Perceived changes in sound pressure levels

Sound pressure level change	Indicative change in perceived sound
1 dB	Unlikely to be noticeable
2-3 dB	Likely to be just noticeable
4-5 dB	Clearly noticeable change
10 dB	Distinct change - often subjectively described as halving or doubling the loudness

The example sound pressure level changes in Table 22 are based on side by side comparison of a steady sample of sound heard at different levels. In practice, changes in sound pressure levels may be more difficult to perceive for a range of reasons, including the presence of other sources of sound, or gradual changes which occur over a longer period.

B3.2 Sound frequency and loudness

Although sound pressure level and the sensation of loudness are related, the sound pressure level is not a direct measure of how loud a sound appears to humans. Human perception of sound varies and depends on a number of physical attributes, including frequency, level and duration.

An example of the relationship between the sensation of loudness and frequency is demonstrated in Figure 13. The chart presents equal loudness curves for sounds of different frequencies expressed in ‘*phons*’.

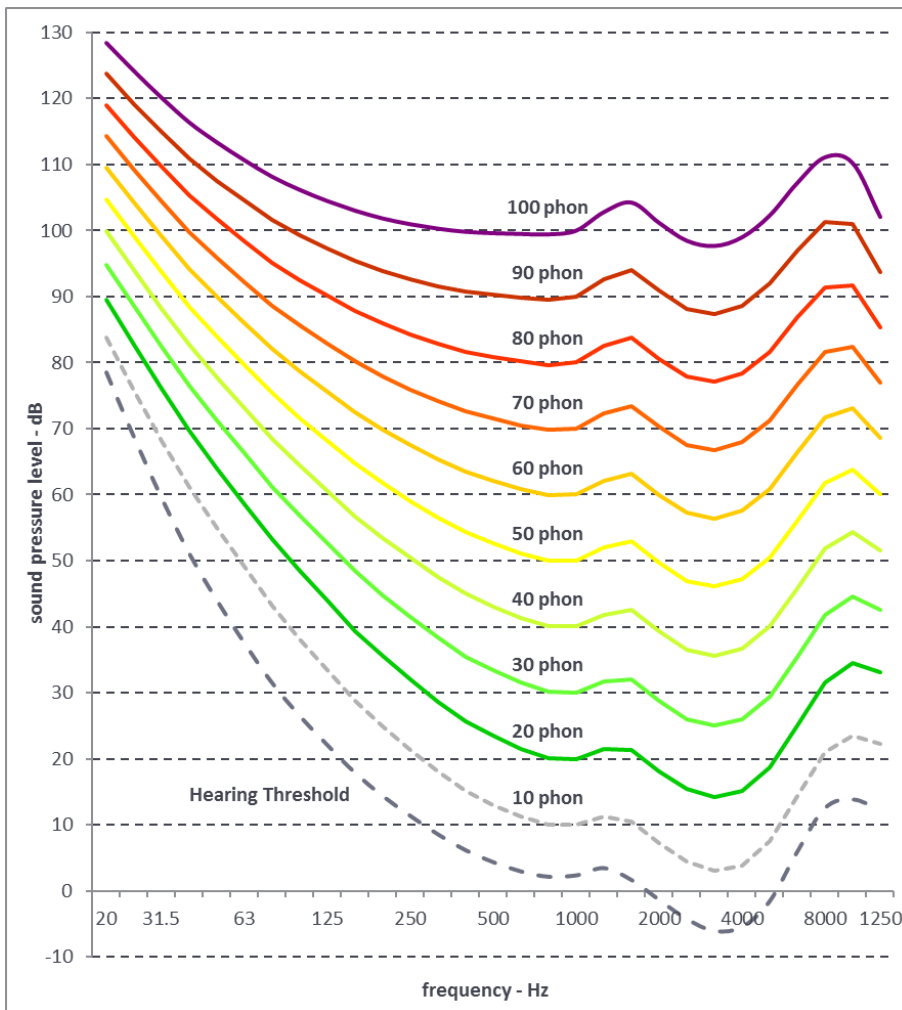
Each point on the phon curves represents a sound of equal loudness. For example, the 40 phon curve shows that a sound level of 100 dB at 20 Hz (a very low frequency sound) would be of equal loudness to a level of 40 dB at 1,000 Hz (a whistling sound) or approximately 50 dB at just under 8,000 Hz (a very high pitch sound).

The information presented is based on an international standard that defines equal loudness levels for sounds comprising individual frequencies.²³ In practice, sound is usually composed of many different frequencies, so this type of data can only be used as an indication of how different frequencies of sound may be perceived.

An individual’s perceptions of sound can also vary significantly. For example, the lower dashed line in Figure 13 shows the threshold of hearing, which represents the sounds an average listener could correctly identify at least 50% of the time. However, these thresholds represent the average of the population. In practice, an individual’s hearing threshold can vary significantly from these values, particularly at the low frequencies.

²³ ISO 226:2003 *Acoustics - Normal equal-loudness-level contours*, 2003

Figure 13: Equal loudness contours for pure tone sounds



The noise curves in Figure 13 demonstrate that human hearing is most sensitive at frequencies from 500 to 4,000 Hz, which usefully corresponds to the main frequencies of human speech. The contours also demonstrate that sounds at low frequencies must be at much higher sound pressure levels to be judged equally loud as sounds at mid to high frequencies.

To account for the sensitivity of the ear to different frequencies, a set of adjustments were developed to enable sound levels to be measured in a way that more closely aligns with human hearing. Sound levels adjusted in this way are referred to as A-weighted sound levels.

B3.3 Interpretation of sound and noise

Human interpretation of sound is influenced by many factors other than its physical characteristics, such as how often the sound occurs, the time of day it occurs and a person's attitude towards the source of the sound.

For example, the sound of music can cause very different reactions, from relaxation and pleasure through to annoyance and stress, depending on individual preferences, the type of music and the circumstances in which the music is heard. This example illustrates how sound can sometimes be considered noise; a term broadly used to describe unwanted sounds or sounds that have the potential to cause negative reactions.

The effects of excess environmental sound are varied and complicated and may be perceived in various ways including sensations of loudness, interference with speech communication, interference with working concentration or studying, disruption of resting/leisure periods, and disturbance of sleep. These effects can give rise to behavioural changes such as avoiding the use of exposed external spaces, keeping windows closed, or timing restful activities to avoid the most intense periods of disruption. Prolonged annoyance or interference with normal patterns can lead to possible effects on mental and physical health. In this respect, the World Health Organization (preamble to the *Constitution of the World Health Organization, 1946*) defines health in the following broad terms:

A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity

The World Health Organization Guidelines for Community Noise (Berglund, Lindvall, & Schwela, 1999) documents a relationship between the definition of health and the effects of community noise exposure by noting that:

This broad definition of health embraces the concept of well-being, and thereby, renders noise impacts such as population annoyance, interference with communication, and impaired task performance as 'health' issues.

The reaction that a community has to sound is highly subjective and depends on a range of factors including:

- The hearing threshold of individuals across the audible frequency range. These thresholds vary widely across the population, particularly at the lower and upper ends of the audible frequency range. For example, at low frequencies the distribution of hearing thresholds varies above and below the mean threshold by more than 10 dB.
- The attitudes and sensitivities of individuals to sound, and their expectations of what is considered an acceptable level of sound or intrusion. This in turn depends on a range of factors such as general health and the perceived importance of sound amongst other factors relevant to overall amenity perception.
- The absolute sound pressure level of the sound in question. The threshold for the onset of community annoyance varies according to the type of sound; above such thresholds, the percentage of the population annoyed generally increases with increasing sound pressure level.
- The sound pressure level of the noise relative to background noise conditions in the area, and the extent to which general background noise may offer beneficial masking effects.
- The characteristics of the sound in question such as whether the sound is constant, continually varies, or contains distinctive audible features such as tones, low frequency components or impulsive sound which may draw attention to the noise.
- The site location and the compatibility of the source in question with other surrounding land uses. For example, whether the source is in an industrial or residential area.

- The attitudes of the community to the source of the sound. This may be influenced by factors such as the extent to which those responsible for the sound are perceived to be adopting reasonable and practicable measures to reduce their emissions, whether the activity is of local or national significance and whether the noise producer actively consults and/or liaises with the community.
- The times when the sound is present, the duration of exposure to increased sound levels, and the extent of respite periods when the sound is reduced or absent (for example, whether the sound ceases at weekends).

The combined influence of the above considerations means that physical sound levels are only one factor influencing community reaction to sound. Importantly, this means that individual reactions and attitudes to the same type and level of sound will vary within a community.

APPENDIX D RECEIVER COORDINATES

Table 23 sets out the 48 receivers identified by Cogency that are located within 2 km of the BESS Area and have therefore been considered within the noise assessment.

Data has been supplied by Cogency on 15 October 2025.

Table 23: Receivers within 2 km of Project infrastructure– GDA2020 MGA zone 55

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Approximate distance to BESS Area, m
1	417,619	6,201,641	127	520
2	417,554	6,201,528	127	650
3	417,335	6,201,257	127	995
4	416,973	6,200,935	127	1,470
5	416,895	6,201,608	127	1,085
6	416,556	6,201,954	126	1,315
7	416,555	6,201,850	127	1,330
8	416,400	6,202,113	126	1,460
9	416,390	6,202,305	127	1,485
10	416,318	6,202,007	126	1,545
11	416,951	6,202,261	126	925
12	417,015	6,202,432	127	905
13	416,846	6,202,507	127	1,090
14	416,599	6,202,714	127	1,400
15	416,483	6,202,464	126	1,425
16	416,617	6,202,494	127	1,305
17	416,954	6,203,017	127	1,270
18	416,409	6,202,814	126	1,615
19	416,582	6,203,149	127	1,645
20	416,106	6,202,244	126	1,760
21	416,057	6,202,477	126	1,840
22	416,167	6,202,533	126	1,745
23	416,138	6,202,725	127	1,830
24	416,256	6,202,764	127	1,735
25	416,242	6,202,968	127	1,835
26	416,351	6,203,021	126	1,765
27	416,407	6,203,094	126	1,760
28	416,436	6,203,130	126	1,755

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Approximate distance to BESS Area, m
29	416,550	6,203,324	126	1,775
40	418,319	6,202,523	127	445
41	417,124	6,203,153	127	1,240
42	416,871	6,203,311	126	1,530
47	417,123	6,203,699	127	1,690
48	417,524	6,203,987	127	1,820
49	417,414	6,203,946	127	1,810
55	418,792	6,203,044	127	1,145
56	417,752	6,203,720	127	1,515
57	417,706	6,203,883	127	1,685
58	417,707	6,203,847	127	1,645
60	419,308	6,203,174	127	1,610
67	417,479	6,200,598	126	1,470
68	417,994	6,200,237	127	1,675
69	416,861	6,200,510	126	1,880
71	416,720	6,200,706	126	1,805
83	416,082	6,201,572	126	1,855
159	416,542	6,201,037	126	1,695
165	416,071	6,202,264	126	1,795
167	418,083	6,203,283	127	1,075

APPENDIX E NOISE POLICY FOR INDUSTRY DERIVATION

In NSW, the Environmental Protection Authority's NPfl is the guideline for assessing noise emissions from industrial facilities and other developments with noise sources that may be considered industrial in nature. The NPfl sets out a procedure where an industrial facility can be assessed against a series of noise levels. Project specific noise levels are derived from an analysis of background noise levels, ambient noise environment and zoning information.

An NPfl assessment requires the derivation of two project noise trigger levels - one from an intrusiveness assessment and another from an amenity assessment.

E1 Project intrusiveness noise level

The intrusiveness noise assessment is applicable to residential receivers and is based on knowledge of the RBL (background noise level) at the receiver location. In the absence of measured RBLs, minimum assumed RBLs are provided in Table 2.1 of the NPfl. The project intrusiveness noise level is taken to be the RBL plus 5 dB. Therefore, the noise emissions from the noise source are considered to be intrusive if the A-weighted source noise level ($L_{Aeq, 15min}$) is greater than the RBL (L_{A90}) plus 5 dB.

Assessment time periods are set out in Table 5 of Section 5.2.

The minimum project intrusiveness noise levels set out in Table 2.1 of the NPfl are reproduced in Table 24.

Table 24: Minimum assumed RBLs and minimum project intrusiveness noise levels, dB $L_{Aeq, 15 min}$

Time of day	Minimum assumed RBL	Minimum project intrusiveness noise level
Day	35	40
Evening	30	35
Night	30	35

E2 Project amenity noise level

Project amenity noise levels are designed to prevent industrial noise continually increasing above an acceptable level over time with the expansion of infrastructure and development.

Based on guidance provided in Table 2.3 of the NPfl all receivers relevant for assessment have been determined to be '*Rural Residential*', being a residential receiver type in a rural noise amenity area.

Table 2.2 of the NPfl sets out recommended amenity noise levels for each receiver category. Modification of the recommended amenity noise level is required in accordance with Section 2.4 of the NPfl, to account for the potential existing contribution or future contribution of industrial noise from other nearby developments on receivers.

A further modification is made to standardise the amenity assessment time period to align with the intrusiveness assessment. This adjustment assumes that the $L_{Aeq, 15 min}$ will be taken to be equal to the $L_{Aeq, period} + 3$ dB. The resultant project amenity noise levels are shown in Table 25.

Table 25: Project amenity noise level, dB

Receiver	Time of day	Recommended amenity noise level, dB $L_{Aeq, period}$	Project amenity noise level, dB $L_{Aeq, 15min}$
Rural Residential	Day	50	48
	Evening	45	43
	Night	40	38

E3 Project noise trigger levels

The final process in determining the operational noise limits for the Project is to derive the project noise trigger levels. The project noise trigger levels are levels that, if exceeded, would indicate a potential noise impact on the community, and so 'trigger' a management response; for example, further investigation of noise mitigation measures.

The project noise trigger levels are derived by selecting the more stringent of either the project intrusiveness noise level or project amenity noise level. The project noise trigger levels applicable to receivers relevant for assessment of the Project are shown in Table 26.

Table 26: Project noise trigger levels, dB $L_{Aeq, 15min}$

Receiver	Time of day	Project noise trigger level
Rural Residential	Day	40
	Evening	35
	Night	35

APPENDIX F NOISE PREDICTION MODEL

F1 Noise prediction method

A computer model was created in the environmental noise modelling program SoundPLANnoise v9.1 to predict noise levels from the Project to relevant noise-affected receivers in the vicinity of the Project Site. The noise model has been used to calculate noise levels at the nearest noise-affected premises in accordance with ISO 9613-2:2024, which enables the calculation of noise levels over a wide area, and accounts for key considerations including site arrangement, terrain, and atmospheric conditions.

The ISO 9613-2:2024 standard specifies an engineering method for calculating noise at a known distance from a variety of sources under meteorological conditions that are favourable to sound propagation. The standard defines favourable conditions as downwind propagation where the source blows from the source to the receiver within an angle of +/-45 degrees from a line connecting the source to the receiver, at wind speeds between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground. Equivalently, the method accounts for average propagation under a well-developed moderate ground based thermal inversion.

Accordingly, predictions based on ISO 9613-2:2024 account for the instances when local atmospheric conditions at the site favour the propagation of sound to surrounding receptor locations. Under alternative atmospheric conditions, such as when the wind is blowing from a receiver location to the development site, the noise levels would be lower than calculated.

To calculate far-field noise levels according to the ISO 9613-2:2024, the noise levels of each source are firstly characterised in the form of octave band frequency levels. A series of octave band attenuation factors are then calculated for a range of effects including:

- geometric divergence
- air absorption
- reflecting obstacles
- screening
- ground reflections.

The octave band attenuation factors are then applied to the noise data to determine the corresponding octave band and total calculated noise level at relevant receiver locations.

In some cases, third octave band noise data is used to provide a preliminary assessment of potential tonality.

The geometries in the model are simplified representations of the built environment that have been configured to a level of detail that is appropriate for noise calculation purposes.

F2 Noise model configuration

The parameters detailed in Table 27 were utilised to develop the noise model.

Table 27: Noise model configuration

Feature	Description
Terrain data	Digital elevation model with a cell size of 1 m taken from the public national portal, ELVIS
Environmental ground conditions	<p>Ground conditions on the Project site were assigned a ground factor (G) of G = 0 representing <i>'hard ground'</i>.</p> <p>The surrounding area has been assigned a ground factor of G = 1 to reflect ground <i>'suitable for growth of vegetation'</i>.</p> <p>This aligns with guidance set out in Section 7.3.1 of ISO 9613-2:2024.</p>
Atmospheric conditions	<p>Temperature 10°C and relative humidity 70%.</p> <p>These represent conditions which result in relatively low levels of atmospheric sound absorption, resulting in slightly higher predicted noise levels.</p>
Site layout	Spatial data provided to MDA by the Proponent via email dated 10 April 2025
Receiver heights	1.5 m above ground.
Noise calculation method	Noise model calculated according to ISO 9613-2:2024.
Noise data for all equipment	<p>As detailed in Section 6.3</p> <p>Noise data has been derived based on:</p> <ul style="list-style-type: none"> • candidate manufacturer data provided by the Proponent • empirical standards • noise data from MDA's library.
Operating duration	All equipment has been conservatively modelled considering worst-case operational duty during all time periods.

APPENDIX G CONSTRUCTION WORK AREA LAYOUT



APPENDIX H CONSTRUCTION EQUIPMENT, WORK STAGES AND ACOUSTIC DATA

Sound power levels for the types of equipment used to construct the Project have been determined from guidance and data sources including AS 2436, and noise level data from previous projects of a similar nature.

Table 28 summarises the noise emissions used to represent key items of plant associated with construction.

Table 28: Construction noise sources sound power level data, dB L_{WA}

Noise source	Sound power level
Dump truck	117
Scraper	116
Concrete vibratory screed	115
Compactor	113
Front end loader	113
Piling (bored)	111
Grader	110
Concrete agitator truck	109
Bulldozer	108
Concrete pump truck	108
Roller (vibratory)	108
Delivery truck	107
Excavator	107
Excavator (100 to 200 kW)	107
Truck (> 20 t)	107
Truck (water cart)	107
Backhoe with auger	106
Forklift	106
Vehicle (light commercial e.g. 4WD)	106
Cherry picker	105
Crane (200 t)	105
Backhoe	104
Crane (mobile)	104
Concrete pencil vibrator	103
Hand tools (electric)	102
Generator	99

Overall aggregated total sound power levels for key construction tasks have been determined on the basis of a typical schedule of equipment associated with each task. The actual equipment choices and equipment numbers for each task are not presently defined in detail, and therefore the schedule of equipment listed here does not represent a final or definitive list of plant. The equipment schedule is therefore presented solely as an indication of typical construction noise levels.

The overall total aggregated sound power levels for each of the key construction tasks are detailed in Table 29. These have been developed based on the assumption that each item of plant associated with a task operates simultaneously for the entire duration of an assessment period. The work areas (as per the construction work area layout in Appendix G) that correspond with each task are also included in Table 29.

Table 29: Approximate aggregate sound power levels of key construction tasks, dB L_{WA}

Construction task	Work areas	Plant/Equipment	Approx. aggregate level, L _{WA}
132kV HV Cable Works	Cable installation	1 x Backhoe, 1 x Cherry picker, 1 x Delivery truck, 2 x Excavator (100 to 200 kW), 1 x Forklift, 1 x Generator, 10 x Hand tools (electric), 1 x Truck (> 20 t), 1 x Truck (water cart), 10 x Vehicle (light commercial e.g. 4WD)	120
BESS - Construction	All other works	1 x Backhoe, 1 x Compactor, 4 x Concrete agitator truck, 4 x Concrete pencil vibrator, 1 x Concrete pump truck, 1 x Concrete vibratory screed, 1 x Crane (mobile), 6 x Delivery truck, 1 x Dump truck, 1 x Excavator, 2 x Excavator (100 to 200 kW), 1 x Forklift, 1 x Generator, 1 x Grader, 15 x Hand tools (electric), 2 x Piling (bored), 2 x Roller (vibratory), 1 x Truck (water cart), 10 x Vehicle (light commercial e.g. 4WD)	125

Construction task	Work areas	Plant/Equipment	Approx. aggregate level, L _{WA}
Combined Earthworks and Drainage	Site mobilisation	1 x Backhoe, 2 x Bulldozer, 2 x Compactor, 1 x Concrete agitator truck, 2 x Concrete pencil vibrator, 1 x Concrete pump truck, 4 x Dump truck, 3 x Excavator, 2 x Excavator (100 to 200 kW), 1 x Forklift, 1 x Front end loader, 1 x Generator, 2 x Grader, 10 x Hand tools (electric), 2 x Roller (vibratory), 1 x Scraper, 1 x Truck (water cart), 10 x Vehicle (light commercial e.g. 4WD)	125
Electrical Works	All other works	1 x Backhoe, 2 x Cherry picker, 1 x Compactor, 1 x Crane (200 t), 1 x Crane (mobile), 4 x Delivery truck, 2 x Excavator (100 to 200 kW), 1 x Forklift, 1 x Generator, 20 x Hand tools (electric), 1 x Truck (water cart), 10 x Vehicle (light commercial e.g. 4WD)	120
Roads	Site mobilisation	1 x Backhoe, 1 x Compactor, 2 x Dump truck, 2 x Excavator (100 to 200 kW), 1 x Forklift, 2 x Front end loader, 1 x Generator, 2 x Grader, 1 x Roller (vibratory), 1 x Truck (water cart), 10 x Vehicle (light commercial e.g. 4WD)	125

Construction task	Work areas	Plant/Equipment	Approx. aggregate level, L _{WA}
Site Mobilisation	Site mobilisation	1 x Backhoe, 1 x Backhoe with auger, 1 x Bulldozer, 1 x Concrete agitator truck, 1 x Concrete pencil vibrator, 1 x Concrete pump truck, 1 x Crane (mobile), 2 x Delivery truck, 1 x Excavator, 1 x Excavator (100 to 200 kW), 1 x Forklift, 1 x Generator, 1 x Grader, 4 x Hand tools (electric), 1 x Roller (vibratory), 1 x Truck (water cart), 10 x Vehicle (light commercial e.g. 4WD)	120
Substation	All other works	1 x Backhoe, 1 x Compactor, 2 x Concrete agitator truck, 2 x Concrete pencil vibrator, 1 x Concrete pump truck, 1 x Crane (mobile), 2 x Delivery truck, 2 x Excavator (100 to 200 kW), 1 x Forklift, 1 x Generator, 20 x Hand tools (electric), 1 x Roller (vibratory), 1 x Truck (water cart), 10 x Vehicle (light commercial e.g. 4WD)	120
TGS – Switchbay + benching	TGS – Switchbay + benching	N/A ^a	125

a Plant/equipment specifications for this task are not currently known. The assessment has therefore been based on the higher aggregate sound power level to adopt a conservative approach.