MARSHALL DAY Acoustics

MEADOW CREEK SOLAR FARM
NOISE ASSESSMENT

Rp 001 20230477 | 5 June 2024

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Project: **MEADOW CREEK SOLAR FARM**

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SUMMARY

Marshall Day Acoustics Pty Ltd (MDA) has been engaged to prepare an environmental noise and vibration assessment of the proposed Meadow Creek Solar Farm (the Project), located in regional Victoria. The Project is proposed to also include a battery energy storage system (BESS).

MDA has been provided with inputs for the assessment by Meadow Creek Solar Farm Pty Ltd (the Proponent), as far as they are available at this stage of the development process. Where relevant noise data or input information could not be provided, MDA has developed this information from previous project experience, relevant standards, and typical noise assessment assumptions. The developed data has been reviewed by the Proponent and approved as being representative of the types and specification of equipment items likely to be used for the Project. The Proponent remains responsible for the accuracy and reliability of noise modelling inputs.

MDA have considered potential noise impacts relating to:

- Operational noise from the Project; and
- Noise and vibration during the construction of the Project.

Operational noise from the Project is predicted to meet relevant noise criteria at all receivers, provided appropriate noise controls are implemented, including:

- Scheduling controls for equipment (i.e. solar farm equipment operates during the day and evening periods only, maintenance activities and construction activities to occur during the day period/normal working hours only)
- Maximum sound power level for inverters across the project limited to 88 dB Lw. At this stage we anticipate this being achieved by implementing silencers on all inverters.
- Inverters being located as far from residential land uses as practicable, with a specific minimum separating distance of 500 m to the nearest receiver at the northwest of the site
- Solar tracking motors being located at the southern extent of solar panel strings, or as far as practicable from receivers
- BESS battery units oriented with loud sides facing south (i.e. away from receivers), or alternatively, screening of 4 – 6 m height being provided around the BESS
- Nomination of specific approved driving routes for vehicles undertaking maintenance activities (two examples have been provided in this assessment)

Construction noise levels have been estimated under typical worst-case scenarios (i.e. with equipment working closest to receivers) to inform best practice noise controls that should be incorporated into a Construction Noise and Vibration management plan at the detailed design phase of the project.

Peak vibration levels due to construction plant are expected to be well below the most stringent peak vibration criteria.

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1.0 INTRODUCTION

Meadow Creek Solar Farm Pty Ltd (the Proponent) proposes to develop the Meadow Creek Solar Farm (the Project) on land located at 1033 Oxley-Meadow Creek Road, Meadow Creek. Urbis is assisting the Proponent with the planning application for the Project. We understand that a noise and vibration assessment is required as part of the project impact assessment and planning approvals process. The project seeks a Planning Permit, and the Minister for Planning is the Responsible Authority.

Marshall Day Acoustics Pty Ltd (MDA) has been engaged to undertake an environmental noise and vibration assessment suitable for inclusion in the planning application. This assessment represents a 'proof of concept' based on the specific site layout and nominal equipment selections available at this stage. Changes to the design that may occur at detailed design stage of the project would require re-assessment.

This assessment considers noise from the operation of the Project as well as noise and vibration associated with the construction of the Project.

This assessment is based on assessing the various aspects of noise against relevant state noise policy and guidelines, namely:

- Environment Protection Act 2017 [Victoria]
- Environment Protection Regulations 2021
- EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industry and trade premises and entertainment venues*

A risk assessment approach has been taken for construction stage vibration.

A glossary of acoustic terminology used throughout this report is provided in Appendix A.

2.0 PROJECT OVERVIEW

2.1 Project description

The Project site is 566 hectares and is located approximately 20 km south of Wangaratta in Victoria.

The Project incorporates a solar farm, battery energy storage system (BESS), substation and terminal station, including a transmission line that passes through a separate property before connecting to the Dederang-Glenrowan transmission line.

Based on information provided by the Proponent, the majority of operational related activities associated with the Project site would occur during the day and evening, with only the BESS and associated equipment operating during the night to generate reactive power.

Sheep kept at the Project site would keep grass down on a regular basis but occasionally there will be a requirement for maintenance vehicles on site to repair damaged equipment, clean solar panels, or spray grass/weeds. These maintenance activities would take place during the day period.

2.2 Project layout

Appendix B presents the solar farm, BESS, and substation Project layout plan and Figure 2 presents the whole Project (including terminal station) footprint shown with the nearby noise receiver locations, confirmed by Urbis.

A more detailed plan is provided in Appendix B.

Figure 1: Meadow Creek solar farm & BESS layout (Source: Urbis)

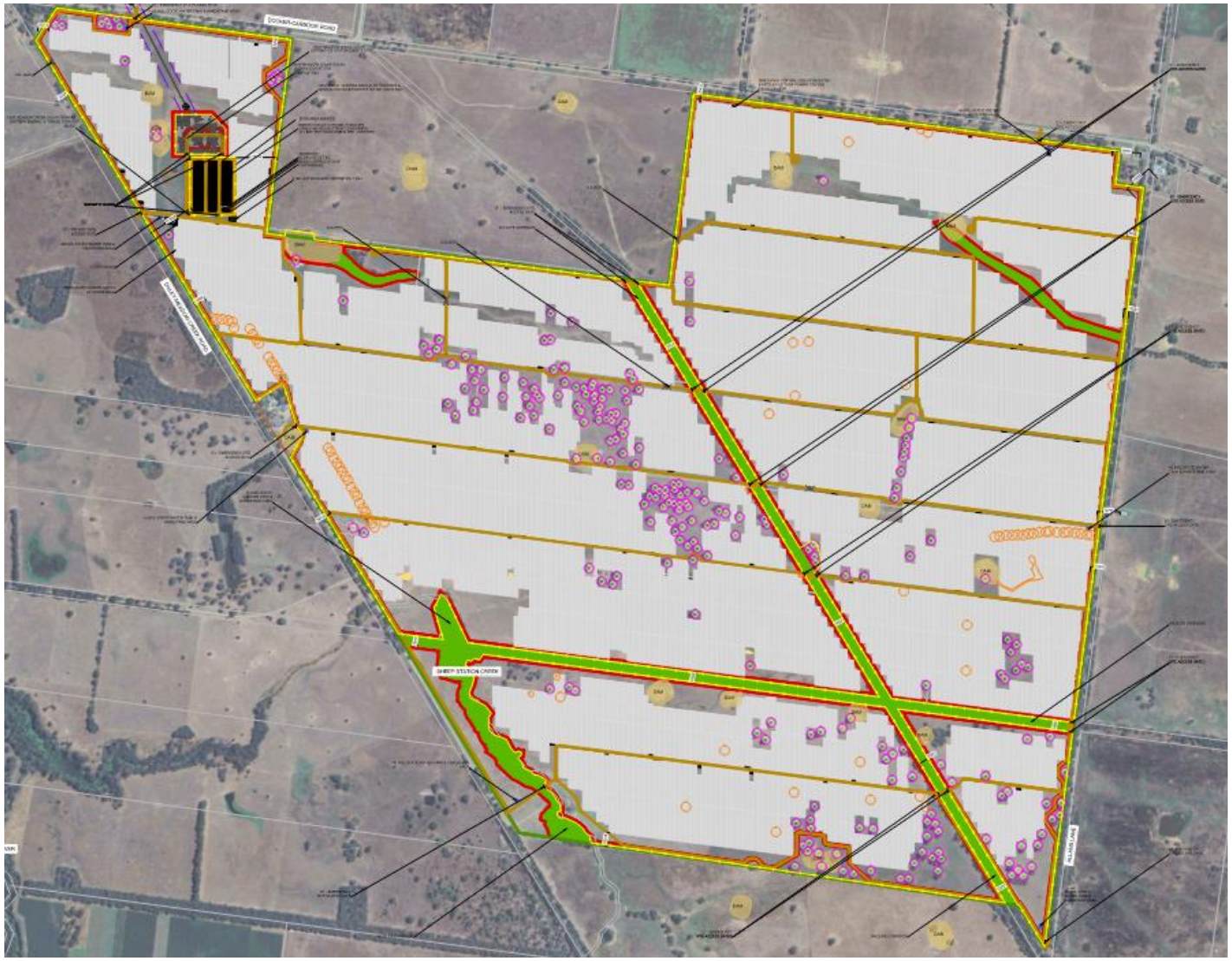
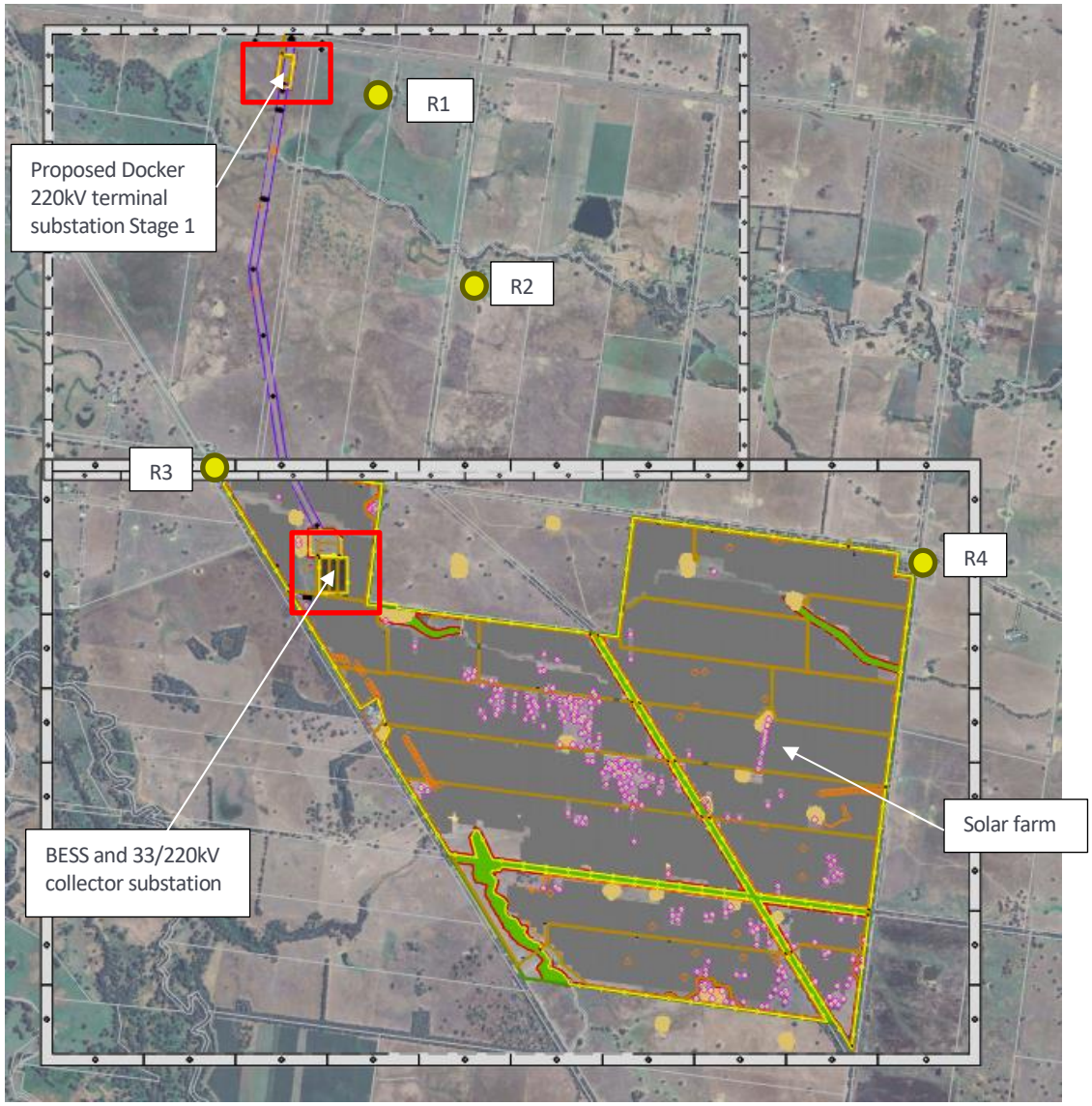


Figure 2: Whole site layout, including terminal station and receivers



2.3 Noise sensitive areas

The nearest noise sensitive areas to the Project comprise dwellings that were identified by MDA and confirmed by Urbis. The dwellings are shown in Figure 2 and detailed in Table 1. For the purposes of this report, the dwellings are referred to as "receivers".

This assessment focusses on the closest receivers to the subject site as these will generally be most affected by noise from the Project. Compliance at these receivers will indicate compliance at other receivers, further away.

Table 1: Noise sensitive receivers

Reference	Address	Description
R1	216 Whorouly-Bobinawarrah Rd Milawa	Single storey dwelling
R2	875 Milawa-Bobinawarrah Rd Milawa	Single storey dwelling
R3	883 Oxley-Meadow Creek Rd Meadow Creek	Single storey dwelling
R4	626 Docker-Carboor Rd, Bobinawarrah	Single storey dwelling

3.0 LEGISLATION AND GUIDELINES

3.1 Summary of applicable documents

A summary of the relevant Victorian legislation and guidelines is provided in Table 2. Refer to Appendix C for further details.

Table 2: Noise legislation and guidelines

Document	Overview
Environment Protection Act 2017 (EP Act)	The EP Act provides the overarching legislative framework for the protection of the environment in Victoria. The EP Act does not specify noise limit values but prohibits the emission of unreasonable or aggravated noise from non-residential premises. The EP Act provides general definitions of unreasonable and aggravated noise; definitions that are specific to commercial, industrial and trade premises are provided in supporting publications (see below). Part 3.2 of the EP Act outlines the general environmental duty (GED), which requires anyone engaging in an activity posing a risk of harm to human health and/or the environment from pollution to minimise those risks to prevent harm as far as reasonably practicable. Section 93 of the EP Act provides for the creation of an environmental reference standard to be used to assess and report on environmental conditions in the whole or any part of Victoria (see below).
Environment Protection Regulations 2021 (EP Regulations)	The objectives of the EP Regulations are to further the purposes of, and give effect to, the EP Act. The Regulations also define outdoor sensitive areas, commercial, industrial and trade premises. Part 5.3 of the EP Regulations sets out requirements that are specific to environmental noise. Division 1 states that the prediction, measurement, assessment, or analysis of noise within a noise sensitive area for the purposes of the EP Act or the EP Regulations must be conducted in accordance with the Noise Protocol (see below). Division 3 stipulates requirements that are specific to commercial, industrial and trade premises. In particular, noise from these types of premises is prescribed as unreasonable if it exceeds a noise limit or alternative criterion determined in accordance with the Noise Protocol (see below). Additional matters addressed in Divisions 3 and 4 include assessment time periods, minimum noise limit values, management of cumulative noise from multiple premises, noise sensitive areas where assessment requirements apply, definition of frequency spectrum as a prescribed factor, and a definition for aggravated noise.
EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues*, dated May 2021 (Noise Protocol)	The Noise Protocol defines the method for setting the noise limits for new and existing commercial, industrial and trade premises and entertainment venues in Victoria. It also outlines the steps that must be followed to undertake an assessment (measurement or prediction) of the effective noise level within a noise sensitive area or at an alternative assessment location. A comparison between the effective noise level and the relevant noise limit or the relevant alternative assessment criterion will determine whether the noise that is emitted from the premises is unreasonable under the Regulations. The noise limits for commercial, industrial and trade premises are determined on the basis of land zoning and background noise levels, and are separately designated for day, evening, and night periods.

Document	Overview
Environment Reference Standard dated 25 May 2021 (ERS)	The ERS is made under Section 93 of the EP Act. The ERS sets out environmental values for ambient sound that are sought to be achieved and maintained in Victoria and standards to support those values. The indicators and objectives within the standard provide a benchmark for comparing desired outcomes to the actual state of the environment and a basis for assessing actual and potential risks to the environmental values. The ERS is not a compliance standard, and the values listed within the ERS for different land uses are explicitly not noise limits nor design criteria. The primary function of the ERS is to provide assessment and reporting benchmarks for environmental values. EPA Publication 1992 *Guide to the Environment Reference Standard* states: *Indicators and objectives within the ERS are generally not relevant considerations where they relate to an aspect of the environment that is the subject of prescriptive regulation.* Therefore, we expect that compliance with the objective noise limits determined in accordance with the Noise Protocol would satisfy the environmental noise obligations of the current proposal.
EPA Publication 1834.1 *Civil construction, building and demolition guide* (EPA Publication 1834.1)	EPA Publication 1834.1 describes measures for managing noise and vibration from construction and decommissioning of a project. The guidance relates to: • Normal working hours, including scheduling works during normal hours, consultation with affected people and managing noise; • Justified unavoidable works that need to be conducted outside of normal working hours; and • Managing noise and vibration that cannot be eliminated or minimised by source control.
ISO 2631-2:2003 *Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration - Part 2: Vibration in buildings (1 Hz to 80 Hz)*	Provides guidelines for structural vibration for different building usage ranging from critical working areas such as laboratories and operating theatres to residences and workshops
ISO 10137 Annex C Second edition 2007 *Bases for design of structures – Serviceability of buildings and walkways against vibrations*	Provides structural vibration criteria for different building usage based on guidelines consistent with ISO 2631-2
German Standard DIN 4150-3	Assessment of vibration on structures with respect to the probability of building damage

A central element of the environmental management framework in Victoria is the general environmental duty (GED) under the EP Act. The GED requires all reasonably practicable measures to be implemented to reduce the risk of harm to human health and/or the environment from pollution, including risks associated with potential annoyance from noise. The GED applies wherever there is a risk of harm, regardless of whether the noise emitted has caused complaints or caused harm to people or the environment.

The GED requires the subject site operators to continue to review and eliminate or reduce the risk of harm from any emission of noise as far as reasonably practicable, even if they are compliant with the Noise Protocol.

The GED is applied first to eliminate or reduce the risk of harm to human health and the environment from noise so far as reasonably practicable. Any residual noise remaining after actions are taken to meet the GED is then managed as per the unreasonable noise definitions in Section 166 of the EP Act (i.e., complying with the Noise Protocol). Accordingly, risks of harm to human health and the environment must be considered for the Project.

Noise related risks of harm to human health and the environment are expected to be limited to possible impacts on amenity (such as annoyance), rather than significant health or physical hearing damage, based on the significant distances between the Project and the nearest dwellings, and typical noise levels from site equipment.

Noise associated with the Project is expected to be steady-state in nature and would therefore not be expected to generate significant maximum noise level events that may lead to awakening events at the nearest noise-sensitive areas during the night period. Accordingly, the risk of harm due to sleep disturbance is considered to be low.

3.2 Project noise criteria

3.2.1 Operational noise

Noise Protocol noise limits are determined on the basis of the zoning of land at the Project site and receivers. At the time of this study, land zoning for both the subject site and all receivers is Farming Zone, as shown on the planning map at Appendix D. The limits apply within 10 m of the outside of receivers and are shown in Table 3. Noise limits are defined for day, evening, and night periods, defined in Section C2.3. In this case no adjustments to the zone levels were warranted; the zone levels are therefore the noise limits.

The derivation of noise limits is provided in Figure 5, Appendix C2.3.

Table 3: Noise Protocol noise limits, dB ENL

	Time period		
Receiver	**Day**	**Evening**	**Night**
All receivers	46	41	36

3.2.2 Emergency equipment

The Noise Protocol states where the noise source under consideration is equipment used solely in relation to emergencies, the relevant noise limit applying to the testing or maintenance of such equipment is increased by 10 dB for a day period and by 5 dB for all other periods.

Items considered to be emergency equipment at the subject site include:

- Standby generators (located at the substation and terminal station)
- Dead tank circuit breakers (located at the substation and terminal station)
- Fire services pumps (located at the terminal station).

Accordingly, noise limits for the testing and maintenance of emergency equipment are as follows.

Table 4: Emergency equipment testing & maintenance noise limits, dB ENL

	Time period		
Receiver	**Day**	**Evening**	**Night**
All receivers	56	46	41

3.2.3 Construction noise

EPA Publication 1834.1 states that noise and vibration is to be minimised at all times, and that project developers should aim to constrain works to normal working hours. Where necessary, and subject to the approval of the relevant authority, construction activities outside normal working hours may occur for:

- Low-noise impact works: inherently quiet or unobtrusive activities that do not have intrusive noise characteristics;
- Managed-impact works: activities where the noise emissions are managed through actions specified in a noise and vibration management plan, and which do not have intrusive noise characteristics; and
- Unavoidable works: activities that need to occur outside of normal working hours due to risks to life or property, potential traffic hazards (e.g. oversized deliveries), or certain types of construction work that cannot be stopped midway through the process (concrete pours and tunnelling works are cited as examples).

The EPA Publication 1834.1 time periods that must be accounted for when scheduling construction activities for large industry projects which are summarised in Table 5. The summary includes the noise requirements specified in Table 4.3 of EPA Publication 1834.1. The following aspects of the noise requirements for evenings, weekends and night periods are noted:

- The noise requirements are only intended to be applied to construction activities that that are justified to occur outside of hours. Importantly, the noise requirements are not intended as the basis for determining whether works outside of normal working hours is justified.
- The background noise levels used for defining the noise requirements should represent the background sound environment at the time of impact
- The noise levels of construction are to be assessed using the A-weighted equivalent noise level, dB L_{Aeq}, plus character adjustments when tonality or impulsiveness is present (+ 2 dB each for just perceptible tonality and impulsiveness / +5 dB each for prominently audible tonality and readily detectible impulsiveness).

Table 5: EPA Publication 1834.1 time period designations

Period	Days	Hours	Note
Normal working hours	Monday to Friday Saturday	0700 – 1800 hrs 0700 – 1300 hrs	All construction activity should occur during these hours unless the activity is justified as 'low-noise impact works', 'managed impact works' or 'unavoidable works'. Noise control requirements for this period are defined in terms of mitigation and management measures; noise limits are not defined for this period.
Evenings and weekend	Monday to Friday Saturdays Sunday & public holidays	1800 – 2200 hrs 1300 – 2200 hrs 0700 – 2200 hrs	Construction noise is not to exceed the background noise by: • 10 dB or more for up to 18 months after project commencement • 5 dB or more after 18 months.
Night	Any day	2200 – 0700 hrs	Noise must be inaudible within a habitable room of any residential premises (referenced in relation to 'low-noise impact works' and 'managed impact works').

This assessment assumes that the identified construction activities take place during normal working hours only. Construction outside of normal working hours would only be conducted for unavoidable works which meet the definitions and requirements of EPA Publication 1834.1 (i.e. it would need to be demonstrated that the works cannot be reasonably moved to normal work hours). Justified unavoidable works would require additional consideration of potential noise and vibration generating activities, and controls to minimise noise and vibration.

3.3 Project vibration criteria

In general, empirical limits relating to vibration from commerce or industry generally distinguish between the effects on humans and the effects on buildings. For example, effects on humans depend on whether the vibration is continuous or intermittent. For buildings, the effect depends on whether the vibration is short term or long term. Also, human perception of vibration is evident at a level well below that which would be considered significant for establishing structural effects on a building and thus the assessment parameters commonly differ. The criteria in Section 3.3.1 and Section 3.3.2 present recognised vibration limits to assess vibration impact.

3.3.1 Human response to vibration

There are a number of reference documents available that provide criteria on the effects of vibration with respect to human comfort, summarised as follows:

- ISO 2631-2[1] provides guidelines for structural vibration for different building usage ranging from critical working areas such as laboratories and operating theatres to workshops

[1] International Standard ISO 2631-2 (2003) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 2: Vibration in buildings (1Hz – 80Hz)

- ISO 10137[2] provides structural vibration criteria for different building usage based on guidelines consistent with ISO 2631-2
- Additional guidance is also often provided by the ASHRAE 2015 Handbook[3]. The ASHRAE Handbook provides structural vibration criteria for different building usage and is derived from ISO 2631-2 with additional scope for assessing highly vibration sensitive facilities, e.g. theatres and hospitals.

The above standards and reference document share a common set of vibration curves which are defined as Vibration Criteria (VCs) commonly applied for assessing human comfort. The VCs are expressed as multiples of a base curve for various building usage, where the base curve VC-1 (0.1 mm/s RMS for Operating Theatres) approximates the threshold of human perception of vibration. The VC's are specified in Root Mean Square (RMS) vibration in 1/3 octave frequencies up to 80 Hz.

3.3.2 Vibration damage to buildings and structures

Apart from the now superseded standard AS 2187.2 1983[4], there are no current Australian Standards that present vibration criteria for building damage. A major and accepted international standard for the assessment of building vibration is the German Standard DIN 4150-3[5]. The structural damage criteria specified by DIN 4150-3 over the range 1–100 Hz are presented in Table 6. DIN 4150-3 specifies Peak Particle Velocity (PPV) as the assessable vibration parameter.

Table 6: Vibration limits according to DIN 4150-3

Type of building	Guideline values for velocity, v_i, in mm/s (peak)				
	Short term vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies	
	1-10 Hz	10-50 Hz	50-100 Hz*	Short term	Long term
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20-40	40-50	40	10
Dwellings and buildings of similar design and/or occupancy	5	5-15	15-20	15	5
Structures that because of their particular sensitivity to vibration, cannot be classified under lines 1 & 2 and are of great intrinsic value (e.g. listed buildings under a preservation order)	3	3-8	8-10	8	2.5

*At frequencies above 100 Hz, the values given in this column may be used as minima

Guidelines prepared by the Australian and New Zealand Environment Council (ANZEC 1990) recommend 2 mm/s PPV as the long-term regulatory goal for control of ground vibration.

[2] International Standard ISO 13172 (2007) Bases for design of structures – Serviceability of buildings and walkways against vibrations

[3] ASHRAE Handbook – HVAC Applications (SI) (2015)

[4] Australian Standard AS2187-2 (1983) [superseded] Exposives – Storage, transport and use, Part 2: Use of explosives

[5] German Standard DIN 4150-3 (2016) Vibrations in buildings – Part 3: Effects on structures

4.0 NOISE SOURCES

4.1 Operational noise

Noise sources for noise-producing equipment related to the Project have been identified by the Proponent and are listed in Table 7. Noise source data has been provided by the Proponent or sourced from the appropriate standards or MDA's database for similar items of equipment.

Detailed information is provided in Appendix E.

Table 7: Meadow Creek Solar Farm noise sources

Item	Quantity	Duty	Sound power level L_{wA} dB
BESS			
BVault DC Platform battery unit	196	3 – 32 kVA	See Appendix E
Inverter	98	3600 kVA	93
SMA Medium voltage transformer	98	3620 kVA	74
Collector substation			
High voltage transformer	2	300 MVA	93
Auxiliary transformer 'dry type'	1	500 kVA	69
AC outdoor unit	5	6 kW	64
Solar farm			
Nextracker tracking motors	7172	24 V	78
Inverter	68	4200 kVA	93
SMA Medium voltage transformer	68	4400 kVA	66
Docker terminal substation			
Single phase power transformer	6	50 kVA	56
AC outdoor unit	5	6 kW	64
Maintenance equipment – Solar farm			
Tractor	1	-	108
Truck	1	-	108
Pump	1	-	93

4.2 Emergency equipment

Item	Quantity	Duty	Sound power level L_{wA} dB
Docker terminal substation			
Dead tank circuit breaker	5	245 kV	122
Diesel generator	1	250 kVA	83
Fire service pumps	1	800 kPA	101
Collector substation			
Dead tank circuit breaker	2	245 kV	122
Diesel generator	1	250 kVA	83

Detailed information is provided in Appendix E.

5.0 OPERATIONAL NOISE ASSESSMENT

5.1 Noise prediction method

The method selected to predict noise levels is International Standard ISO 9613-2: 1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613).

Additional technical details related to the adopted method are provided in Appendix F.

5.2 Assessment scenarios

Four key operational scenarios were identified to form the basis of the noise assessment:

- Day period (operation of all equipment with and without maintenance activities)
- Evening period (operation of all equipment, no maintenance activities)
- Night period (operation of BESS, substation and terminal station equipment only)
- Emergency equipment testing and maintenance

5.3 Inherent noise controls

In accordance with the GED under the EP Act, the risks of harm as a result of operational noise from the Project must be minimised as far as reasonably practicable. The GED is an enduring requirement which applies throughout the planning, design, and operation of the Project.

Risk controls have been designed for this assessment in the form of noise control measures, as a result of discussions with the Project team and iterative noise modelling to determine effectiveness of controls. All noise modelling and assessment presented in this section is based on all the risk controls being implemented. The inherent risk controls for noise associated with on-site activities comprise:

- Operation of solar farm inverters/transformers/solar trackers limited to the day and evening periods only; no operation between 2200 hrs – 0700 hrs on any day
- Maintenance activities to occur only during the day period, with specific approved vehicle routes (examples provided at this stage as shown in Figure 3, alternatives to be developed during detailed design if required)
- Testing and maintenance of emergency plant to occur only during the day period
- Inverter silencers; all inverters for the subject site (located in the solar farm and BESS) are to incorporate silencers that reduce operational noise levels to an overall maximum sound power level of 88 dB and spectral data equivalent to that contained in Appendix E for silenced inverters.
- Inverter locations; inverters must be located a minimum of 500 m from receivers in the north-west of the Project, as shown on the current site plans
- Solar tracker motors must be located at the southern end of solar panel strings, and/or as far as practicable from noise-sensitive receivers (whichever is further)
- Battery units must be oriented with openings/louvres facing south, away from receivers (this recommendation is based on the specific equipment selection nominated in this assessment and would need to be reviewed in the event alternative equipment is selected). Should the battery units not be able to be faced southwards, or located in a different configuration to that shown on the site plans, noise barriers would need to be located around the BESS to provide a similar level of noise control to receivers. The extent and heights of the required barriers is shown in Figure 4.

Figure 3: Possible maintenance vehicle routes over 30-minute periods

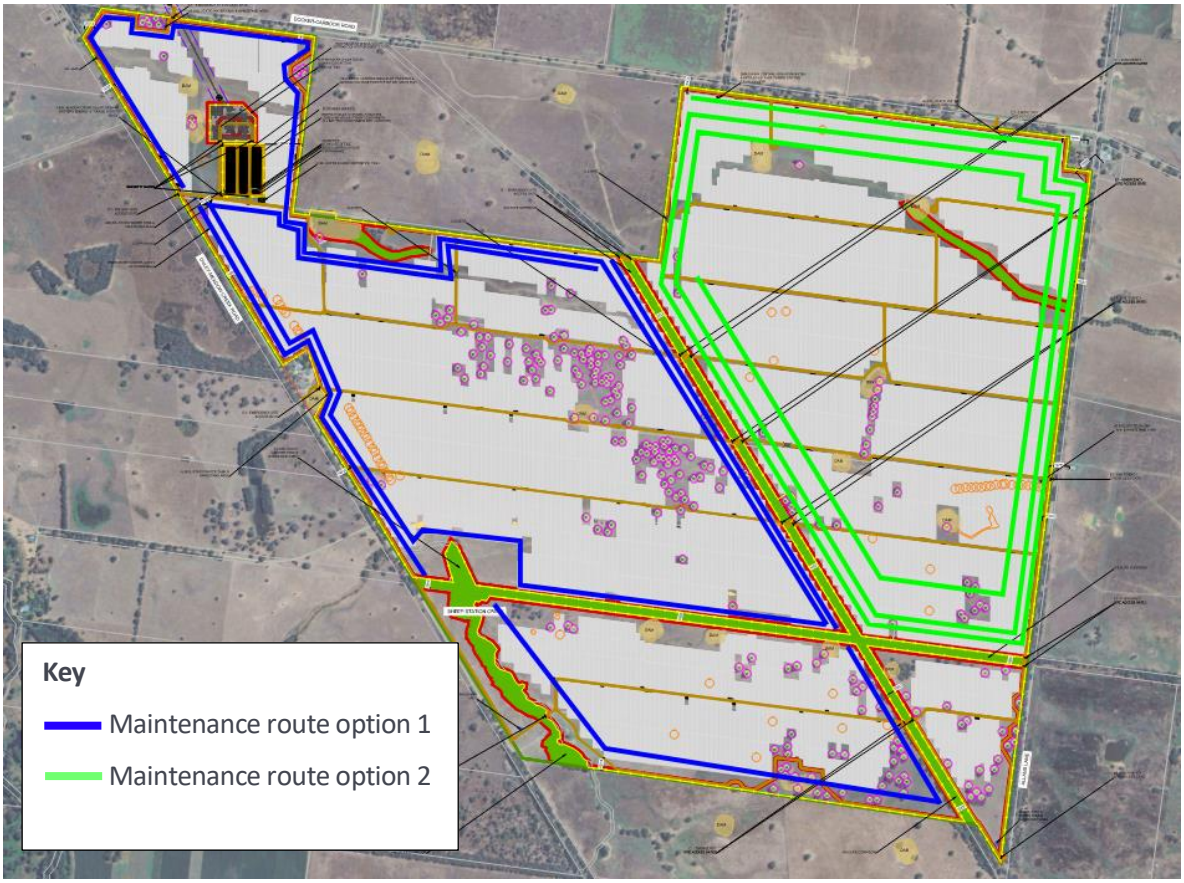


Figure 4: Indicative alternative screening required if batteries cannot be faced south

5.4 Character and other adjustments to predicted noise levels

5.4.1 Tonality

The inverter noise data provided by the client for review exhibits tonal character at source. In practice, tonality is assessed at the receiver location and can be based on a subjective or objective method of identification.

It is difficult to predict whether tonal noise will be present at receivers due to a number of factors, including:

- The ambient noise environment that may or may not provide masking of tonal noise at receiver locations
- Limitations of the predictive ISO 9613 noise method which is based on octave band propagation, with third-octave band propagation being extrapolated

A risk-screening approach was thereby undertaken to review the relative predicted contributions of noise from inverters, and for those receivers that had a significant component of noise due to inverters, review the predicted spectral data to identify potential tonal components.

Based on this approach, an adjustment of 2 – 5 dB was applied to predicted noise levels at receivers.

As a best practice approach, we recommend that non-tonal equipment is selected where possible.

5.4.2 Time adjustments

It is assumed that most equipment, plant and activities would operate continuously over any 30-minute assessment period, however time adjustments have been made for the following equipment items.

Tracking motors

Noise levels for the tracking motors have been based on the assumption that they would be operating for 10 seconds every 3 minutes (i.e. 100 seconds per 30-minute assessment period).

Dead tank circuit breakers

Noise levels for the dead tank circuit breakers have been based on the assumption that during testing, there would be five loud 'bangs' during any 30-minute period.

Noise from the dead tank circuit breakers may be impulsive in nature. The noise model accounts for each 'bang' occurring over 10 seconds duration in accordance with the Noise Protocol for impulsive sound, and a 5 dB character adjustment for impulsive sound has been applied to the predicted noise level at receivers.

5.5 Predicted noise levels

Noise levels have been predicted at the nearest receivers based on the method detailed in Appendix F1 and noise level data contained in Appendix E.

The following sections present the operational noise level results for the four operational model scenarios.

5.5.1 Predicted operational noise levels – day period

For the majority of the time, operational noise will be due to the fixed equipment related to the Project including the solar panel tracking motors, inverters, and the transformer at the substation.

An adjustment for tonality has been included as per the discussion presented in Section 5.4.1.

The predicted day period operational noise levels including maintenance activities are presented in Table 8. Other receivers are predicted to be subject to noise levels of lower magnitude.

Table 8: Predicted noise levels compared with day assessment targets, dB ENL

Receiver	Predicted noise level including maintenance	Tonality adjustment	Total ENL	Day noise limit ENL	Achieves noise limit
R1	24	2	26	46	✓
R2	29	2	31	46	✓
R3	43	2	45	46	✓
R4	41	5	46	46	✓

5.5.2 Predicted operational noise levels – evening period

The evening period scenario accounts for operational noise during summer months when it is possible that solar energy will still be generated after 1800 hrs. Maintenance activities are excluded. An adjustment for tonality has been included as per the discussion presented in Section 5.4.1.

Predicted noise levels for the evening period are presented in Table 9.

Table 9: Predicted noise levels compared with evening assessment targets, dB ENL

Receiver	Predicted noise level	Tonality adjustment	Total ENL	Evening noise limit ENL	Achieves noise limit
R1	23	2	25	41	✓
R2	27	2	29	41	✓
R3	35	2	37	41	✓
R4	33	5	38	41	✓

5.5.3 Predicted operational noise levels – night period

The night period scenario accounts for operational noise from the BESS, substation and terminal station. Noise from the solar farm and maintenance activities are excluded on the basis they will not be operating. An adjustment for tonality has been included as per the discussion presented in Section 5.4.1.

Predicted levels for the night period are presented in Table 10.

Table 10: Predicted noise levels compared with night assessment targets, dB ENL

Receiver	Predicted noise level	Tonality adjustment	Total ENL	Night noise limit ENL	Achieves noise limit
R1	23	2	25	36	✓
R2	27	2	29	36	✓
R3	34	2	36	36	✓
R4	24	2	26	36	✓

5.5.4 Predicted noise levels – emergency equipment

Maintenance and testing of emergency equipment would only be undertaken during the day period.

An adjustment for impulsive sound has been included as per the discussion in Section 5.4.

Predicted levels for emergency plant period, along with other day period operations (including maintenance) are contained in Table 11.

Table 11: Predicted noise levels compared with day emergency assessment targets, dB ENL

Receiver	Predicted noise level including maintenance	Impulsive adjustment	Total ENL	Day noise limit (emergency equipment), ENL	Achieves noise limit
R1	35	5	40	56	✓
R2	30	5	35	56	✓
R3	43	5	48	56	✓
R4	41	5	46	56	✓

While the predicted noise levels due to emergency equipment testing comply with the applicable day period emergency equipment noise limit, it is recommended to schedule emergency plant maintenance at a different time to general site maintenance to reduce the noise level at receivers.

5.6 Operational noise discussion and recommendations

Predicted noise levels associated with the operation of the Project during the day, evening and night period have been demonstrated to comply with the applicable noise limits, provided all of the noise controls detailed in Section 5.3 are implemented, and assuming the noise data and equipment selections nominated in this assessment. The predicted noise levels include consideration of tonality at the relevant receiver locations. Where the Project design changes or alternative equipment is selected during tender stages it is recommended that additional noise modelling of a finalised Project design and equipment selections is conducted to verify continued compliance with the noise limits.

6.0 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

6.1 Overview

On-site works include a range of activities such as construction of access tracks, connection of infrastructure and construction of solar panels and framing.

In accordance with the GED and EPA Guideline 1834, construction of the solar farm will require the adoption of reasonably practicable management measures and working practices. These measures are normally documented and agreed in a Construction Noise and Vibration Management Plan (CNVMP) for inclusion in a broader Environmental Management Plan (EMP), which is typically prepared for review and approval by the responsible authority prior to commencing any construction works.

The following sections provide general information regarding the types of activities that are expected to be associated with the construction of the solar farm, and reference data that should be considered as part of the preparation of a future CNVMP for the Project once a main contractor is appointed and specific equipment and work processes are known. Indicative noise levels due to various construction activities are provided to inform the types and scales of reasonably practicable noise controls.

6.2 Construction activities

The following construction activities are anticipated to be required:

- Site clearing works;
- Access road construction;
- Civil construction works;
- Construction of fencing, site offices and buildings, concrete foundations, piling, solar panel and tracking systems, installation of solar farm, BESS, substation and terminal station equipment; and
- Cable trench digging.

Specific details of the construction program and the number, type, and duty of the construction plant to be used would be determined during the advanced stages of the project when a construction contractor has been selected.

The types of equipment associated at different stages of construction typically include excavation plant, pneumatic equipment and lifting equipment.

A conservative construction noise assessment has been undertaken to inform the planning stage of the proposed solar farm of the potential worst-case impacts.

Four primary scenarios have been considered as detailed in Table 12. The assessment assumes that all construction activity described in the various scenarios occurs within an area closest to the nearest receiver and occurs simultaneously, presenting a highly conservative approach that is unlikely to occur in practice.

Table 12: Construction scenarios and equipment

Construction task	Plant/Equipment	Total scenario sound power level, dB L_{wA}
Site preparation – site clearing, access road construction and civil construction	3 x Bulldozer, 2 x Delivery Trucks, 2 x Dump truck, 6 x Excavator (100 to 200 kW), 1 x Front end loader, 1 x Grader, 1 x Rock crusher, 3 x Roller, 1 x Tractor, 1 x Wood Chipper, 1 x Bobcat	125
Solar farm installation – construction and installation of solar panels, tracking motors and inverters	2 x Bulldozer, 1 x Concrete pump, 3 x Concrete truck, 2 x Crane (200 t), 6 x Delivery Trucks, 1 x Dump truck, 4 x Excavator (100 to 200 kW), 1 x Front end loader, 1 x Grader, 1 x Tracked loader, 6 x Tractor, 3 x Forklift, 2 x Bobcat, 2 x Ute + Trailer, 7 x Telehandler, 1 x Piling Rig, 1 x Trencher, 1 x EWP, 1 x Drill Rig, 1 x Backhoe, 2 x Sand Cart	125
Transformer installation – construction and installation of the transformer at the substation location	2 x Bulldozer, 1 x Concrete pump, 3 x Concrete truck, 2 x Crane (200 t), 6 x Delivery Trucks, 1 x Dump truck, 4 x Excavator (100 to 200 kW), 1 x Front end loader, 1 x Grader, 1 x Tracked loader, 6 x Tractor, 3 x Forklift, 2 x Bobcat, 2 x Ute + Trailer, 7 x Telehandler, 1 x Piling Rig, 1 x Trencher, 1 x EWP, 1 x Drill Rig, 1 x Backhoe, 2 x Sand Cart	125
Deliveries and waste collection – on-site vehicle movements	1 x Crane (200 t), 4 x Delivery Trucks, 1 x Front end loader	116

6.3 Construction noise assessment

Noise levels associated with each of the main construction tasks have been predicted at the nearest receiver to provide an indication of the upper range of noise levels.

Given that the precise equipment selections and methods of working would be determined during the future development of a CNVMP, 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.

Table 13 details the predicted noise level ranges for each of the main construction tasks at the nearest receivers. The predicted level range accounts for variable equipment locations within the area considered in the assessment.

Table 13: Indicative range of construction noise predictions, dB L_{Aeq}

Construction task	Nearest receiver	Predicted level range
Site preparation	R3	55-65
Solar farm installation	R3	60-70
Transformer installation	R3	50-55
Deliveries and waste collection	R3	40-45

It is recommended that construction activities take place during normal working hours only. Construction outside of normal working hours would only be conducted for unavoidable works which meet the definitions and requirements of EPA Publication 1834.1 (i.e. it would need to be demonstrated that the works cannot be reasonably moved to normal work hours). Justified unavoidable works would require additional consideration of potential noise and vibration generating activities, and controls to minimise noise and vibration. Further discussion is provided in Section 6.6.

6.4 Construction vibration assessment

The prediction of vibration propagation through the ground is considered 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.

Construction activities with the potential to generate ground vibration during the construction phase include heavy machinery use.

The document *RTA Environmental Noise Management Manual*, produced by the NSW Roads and Traffic Authority, dated 2001 (superseded), contains typical vibration levels of the type of plant items proposed for construction and operational phases of the Project. The typical vibration levels are provided in Table 14 for reference.

Table 14: Typical vibration levels of plant items, PPV at 10 m, mm/s

Item	PPV at 10 m
Loader	6 – 8
Backhoe	1
Dozer	2.5 - 4
Roller	7 – 8

Typical vibration levels for a compactor shown in Table 14 have been calculated at a distance of 100 m using the vibration propagation algorithms defined for dynamic compaction in British Standard BS 5228-2:2009 Code of Practice for noise and vibration control on construction and open sites – Part 2: Vibration (BS5228-2). The propagation algorithm is valid only to a distance of 100 m however it is anticipated that works may occur at 50 m from the nearest receivers. The results are contained in Table 15.

Table 15: Typical vibration levels of plant items, PPV at 10 m, mm/s

Item	PPV at 10 m	PPV at 50 m
Loader/Roller	5 – 7	0.52

The predicted PPV vibration levels from heavy machinery such as compactors is predicted by the methodology in BS 5228-2 to be approximately 0.52 mm/s at a distance of 50 m from the plant operation. These levels are well below the recommended long-term regulatory goal value of 2 mm/s PPV stated in the ANZEC guideline, which is the most stringent peak vibration criteria. At noise-sensitive receivers located further from plant operations, vibration levels from heavy machinery are predicted to be lower than shown in Table 14.

6.5 Decommissioning

Similar construction activities to those detailed in Section 6.2 are expected to be required during the decommissioning of the Project and as such, the same outcomes should be considered in preparation of the CNVMP.

6.6 Construction noise and vibration recommendations

At this early stage, only a preliminary 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 should be prepared.

Any future CNVMP should include site and process specific noise management work practices designed to mitigate the impact of construction noise activities.

EPA Guideline 1834.1 provides extensive details and guidance with respect to noise mitigation including:

- All construction works to be undertaken during normal working hours where possible
- Scheduling work to minimise noise impacts, for example; scheduling work when neighbours/residents are not present, scheduling noisy works together to reduce the overall duration of exposure, scheduling noisy activities for less-sensitive times, for example during the later morning or afternoon
- Notify community to keep them informed of upcoming construction works, including the anticipated duration of works, type of noise and contact details for information or in the event they want to make a noise complaint
- Undertake preparatory work offsite where there is low potential for impacting people (e.g., formwork, cutting or prefabrication of materials offsite prior to transporting to the construction site)
- Connect to the electricity grid as early as possible to avoid the use of diesel generators
- Restrict areas where mobile plant can operate so that it is away from people who could be affected by noise
- Locate site vehicle access and waiting areas away from people who could be affected by noise
- Plan vehicle movements to avoid manoeuvres and idling at location nearest to nearby people
- Use quieter equipment or methods
- Use low noise saw blades
- Use electrical equipment rather than equipment driven by a diesel generator
- Use low noise emitting generators
- Use effective alternatives to ‘beeper’ alarms (e.g., broadband alarms, proximity sensors)
- Avoid using reversing alarms by designing site layout to avoid reversing (e.g., drive-through for parking and deliveries)
- Maintain equipment and vehicles Limit noise caused by people on-site
- Implement substitute methods taking into consideration:
    - alternatives to rock-breaking work methods, such as hydraulic splitters for rock and concrete, hydraulic jaw crushers, chemical rock and concrete splitting, and controlled blasting such as penetrating cone fractures. The suitability of alternative methods should be considered on a case by case basis, including what potential risks they involve

- alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electrical generator located away from nearby people.

Controls to limit vibration as described in EPA Guideline 1834.1 include:

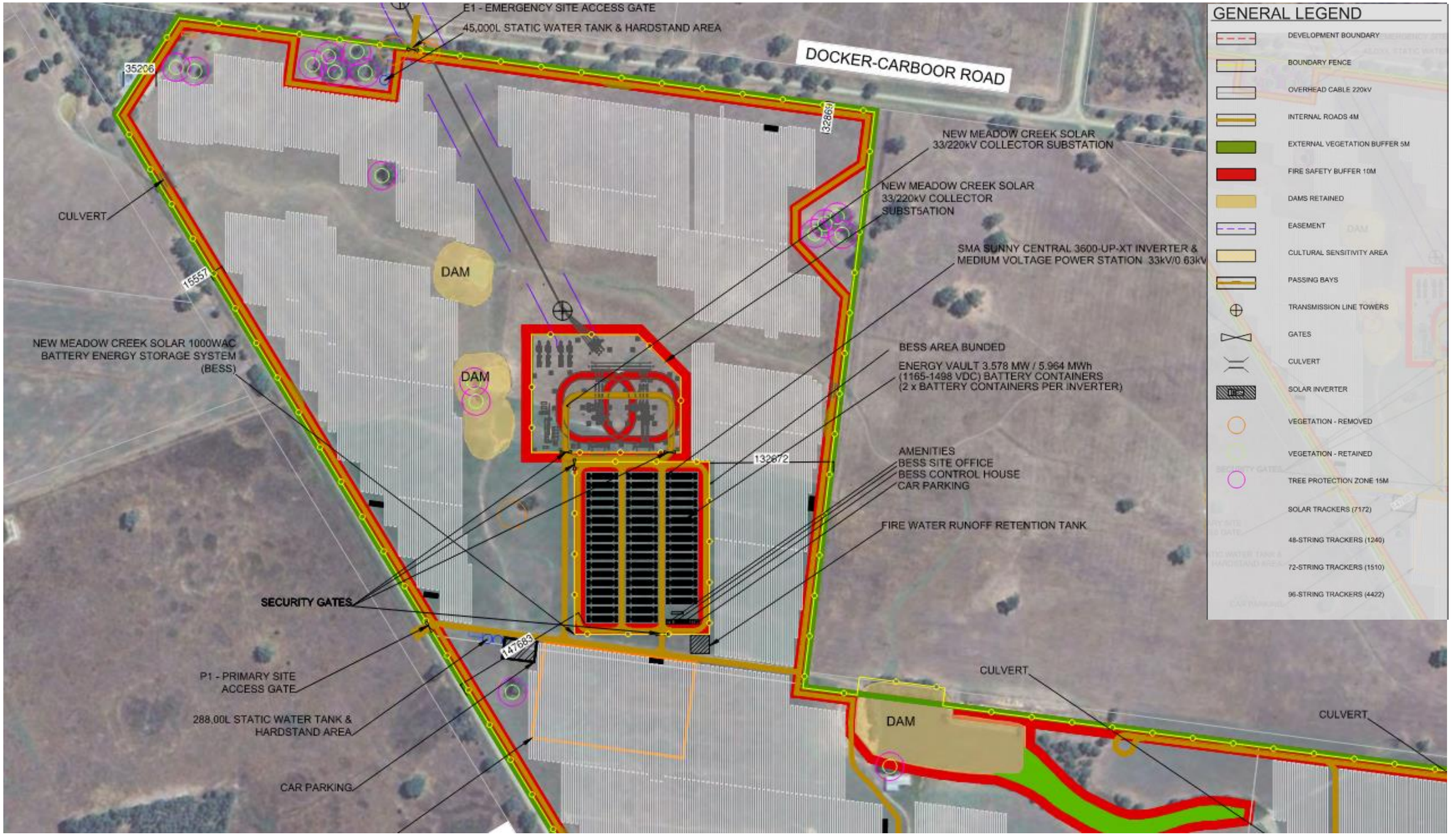
- Use alternative lower-impact equipment or methods (e.g., substitute impact piling with bored piling, grip jacking or the use of hammer cushion when driving steel piles that minimise the vibration)
- Use non-explosive demolition agents and/or chemical agents to facilitate concrete/rock breaking activities to reduce the noise generated
- Substitute demolition methods not involving impact where feasible (e.g., use hydraulic rock splitters rather than rock breakers)
- Schedule the use of vibration-causing equipment such as jackhammers, demolition, earthmoving and ground-impacting operations at the least sensitive time of day
- Routing, operating or locating high vibration sources as far away from people who could be affected by noise
- Sequencing operations so that vibration-causing activities do not occur simultaneously
- Isolate equipment causing vibration on resilient mounts
- Isolate activities from adjoining structures
- Maintain equipment in accordance with manufacturer's specifications.

All of the above items should be considered as part of the future CNVMP.

APPENDIX A GLOSSARY OF TERMINOLOGY

Frequency	The number of pressure fluctuation cycles per second of a sound wave. Measured in units of Hertz (Hz).
Hertz (Hz)	Hertz is the unit of frequency. One hertz is one cycle per second. One thousand hertz is a kilohertz (kHz).
Octave Band	A range of frequencies where the highest frequency included is twice the lowest frequency. 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.
Noise	A sound that is unwanted by, or distracting to, the receiver.
Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
SPL or L_p	Sound Pressure Level A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 µPa RMS) and expressed in decibels.
SWL or L_w	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10-12 watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
dB	Decibel The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr = 20 µPa i.e., dB = 20 x log(P/Pr)
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
L_{Aeq}	The A-weighted equivalent continuous (time-averaged) sound level. This is commonly referred to as the average noise level.
L_{A90}	The A-weighted noise level equalled or exceeded for 90 % of the measurement period. This is commonly referred to as the background noise level.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

APPENDIX B SITE LAYOUT – BESS



APPENDIX C NOISE LEGISLATION AND GUIDELINES

C1 Environmental Protection Regulations 2021

The *Environment Protection Act 2017* (EP Act) does not specify noise limit values or technical aspects of environmental noise but sets out legal requirements to comply with the described below. Clause 166 of the EP Act essentially places the onus of achieving compliance with noise limits on the commercial premises.

The *Environmental Protection Regulations 2021* (EP Regulations) are made under Section 465 of the EP Act and impose obligations in relation to environmental protection, including noise. The EP Regulations state that a person who conducts a prediction, measurement, assessment, or analysis of noise within a noise sensitive area must do so in accordance with the Noise Protocol. In particular, noise from industrial, commercial and trade premises or entertainment venues or events is prescribed as unreasonable if it exceeds a noise limit or alternative criterion determined in accordance with the Noise Protocol.

Key matters addressed in the EP Regulations include:

- Definition of commercial, industrial and trade premises, which is essentially any premises that is not a residential premises, a road, or a railway. It is noted that noise from common building services equipment (such as shared condensing units and kitchen exhaust fans) is assessable;
- Definition of an indoor music entertainment venue;
- Definition of noise sensitive areas where the noise limits are assessed, which broadly include:
  - a residential building
  - temporary accommodation
  - hospital corrective institution
  - retirement or residential village
  - A room for learning in a child care centre, kindergarten or school
  - A tourist establishment, campground, or caravan park;
- Assessment time periods;
- Noise sources that must not be taken into account;
- Minimum noise limit values; and
- Management of cumulative noise from multiple premises.

Error! Reference source not found. presents a summary of the relevant Divisions and EP Regulations from Part 5.3 – *Noise*.

Table 16: Summary of Part 5.3 - *Noise*

Section	Description
Division 1, Regulation 113	States that *a person who conducts a prediction, measurement, assessment or analysis of noise within a noise sensitive area for the purposes of the Act or these Regulations, must conduct the prediction, measurement, assessment or analysis in accordance with the Noise Protocol.*
Division 3	Applies to noise from commercial, industrial and trade premises
Regulation 116	Defines the day, evening and night period as follows: • Day: 0700 to 1800 hrs, Monday – Saturday • Evening: 1800 to 2200 hrs, Monday – Saturday 0700 to 2200 hrs, Sunday and Public Holidays • Night: 2200 to 0700 hrs the next day, Monday – Sunday.
Regulation 117	In this Division, when the level of noise emitted from commercial, industrial and trade premises is assessed, the following sources of noise that could be expected at the proposed facility must not be taken into account: • Voices; • Construction or demolition activity on building sites; • Intruder, emergency or safety alarms or sirens; • Equipment used in relation to an emergency; and • Non-commercial vehicles (except for maintenance activities).
Regulation 118	Defines noise as being unreasonable if it exceeds the Noise Protocol limits or the alternative assessment criteria that apply at an alternative assessment location. Defines the lowest base noise limits as follows: Major urban area: Day: 45 dB L_{eff} Evening: 40 dB L_{eff} Night: 35 dB L_{eff} Rural area: Day: 45 dB L_{eff} Evening: 37 dB L_{eff} Night: 32 dB L_{eff} The noise limit for commercial, industrial and trade premises for the night period must not exceed 55 dB $L_{eff.}$
Regulation 119	If multiple existing or proposed premises emit noise that contributes to the effective noise level at a noise sensitive receiver, all reasonable steps must be taken by the premises' management to ensure the combined noise level does not exceed the noise limit.
Regulation 120	This regulation essentially identifies that tonal aspects of noise must be considered when considering unreasonable noise for Section 3(1)(a)(v) of the EP Act. The Noise Protocol provides a method of assessing tonal characteristics of noise from commercial, industrial and trade premises, with additional guidance on low frequency noise available in EPA Publication 1996 *Noise guideline – assessing low frequency noise.*
Regulation 121	Noise emitted from commercial, industrial and trade premises is prescribed to be aggravated noise if it exceeds the noise limits by more than 15 dB, or the following if lower: • 75 dB L_{eff} during the day; • 70 dB L_{eff} during the evening; or • 65 dB L_{eff} during the night.

C2 Noise Protocol

C2.1 Application

EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues*, dated May 2021 (Noise Protocol) sets noise limits that apply to commercial, industrial and trade premises and entertainment venues within Victoria. Compliance with the noise limits is mandatory under the EP Act.

The EP Act defines a 'commercial, industrial and trade premises' as:

Any premises except the following –

> *(a) residential premises (other than common plant under the control of an owners corporation);*
>
> *(b) a street or road, including every carriageway, footpath, reservation and traffic island on any street or road;*
>
> *(c) a railway track used by rolling stock in connection with the provision of a freight service or passenger service—*
>
> > *(i) while travelling on a railway track or tramway track; or*
> >
> > *(ii) while entering or exiting a siding, yard, depot or workshop;*
>
> *(d) a railway track used by rolling stock in connection with the provision of a passenger service, while in a siding, yard, depot or workshop and is—*
>
> > *(i) powering up to commence to be used in connection with the provision of a passenger service; or*
> >
> > *(ii) shutting down after being used in connection with the provision of a passenger service;*
>
> *(e) the premises situated at Lower Esplanade, St Kilda and known as "Luna Park" and being the whole of the land more particularly described in Certificate of Title Volume 1204 Folio 109;*

The EP Act defines an 'entertainment venue' as

Any premises or place where music is performed or played but does not include residential premises or a place of worship

C2.2 Assessment method

The Noise Protocol prescribes the method and measurement procedure used to determine applicable noise limits and assessment of compliance.

The EP Act requires that proposed commercial premises be designed to comply with Noise Protocol noise limits and that premises have an ongoing obligation to meet the noise limits.

A 'noise sensitive area' is defined in the EP Regulations as:

> *(a) that part of the land within the boundary of a parcel of land that is—*
>
> > *(i) within 10 metres of the outside of the external walls of any of the following buildings—*
> >
> > > *(A) a dwelling (including a residential care facility but not including a caretaker's house);*
> > >
> > > *(B) a residential building;*

(C) a noise sensitive residential use; or

(ii) within 10 metres of the outside of the external walls of any dormitory, ward, bedroom or living room of one or more of the following buildings—

(A) a caretaker's house;

(B) a hospital;

(C) a hotel;

(D) a residential hotel;

(E) a motel;

(F) a specialist disability accommodation;

(G) a corrective institution;

(H) a tourist establishment;

(I) a retirement village;

(J) a residential village; or

(iii) within 10 metres of the outside of the external walls of a classroom or any room in which learning occurs in the following buildings (during their operating hours)—

(A) a child care centre;

(B) a kindergarten;

(C) a primary school;

(D) a secondary school; or

(b) subject to paragraph (c), in the case of a rural area only, that part of the land within the boundary of—

(i) a tourist establishment; or

(ii) a campground; or

(iii) a caravan park; or

(c) despite paragraph (b), in the case of a rural area only, where an outdoor entertainment event or outdoor entertainment venue is being operated, that part of the land within the boundary of the following are not noise sensitive areas for the purposes of that event or venue—

(i) a tourist establishment;

(ii) a campground;

(iii) a caravan park;

The assessment of non-music noise from the subject site under the Noise Protocol is based on the calculation of a noise limit at a receiver position, taking into account a zoning noise level derived from the land zoning types in the surrounding area and the background noise level.

Once a noise limit is established, the noise level (L_{Aeq}) due to the commercial premises is measured or predicted. If necessary, the L_{Aeq} noise level is adjusted for noise character and duration to give the effective noise level (ENL). If the ENL exceeds the noise limit, then remedial action is required.

C2.3 Calculation of noise limits for commercial, industrial and trade premises

The Noise Protocol provides two methods for deriving the relevant noise limits, the urban area method, and the rural area method. The rural area method is applicable to the current study.

Using the rural area method, noise limits are determined on the basis of land zoning at the noise generating and receiving zones, with adjustments applicable for high background noise, distance between the receiving zone and the noise generating zone, and for extractive type industries.

The noise limits are separately defined for the day, evening, and night periods. The time periods are defined in the EP Regulations and shown below.

Table 17: Noise Protocol time periods

Period	Day of week	Start time	End time
Day	Monday-Saturday	0700 hrs	1800 hrs
Evening	Monday-Saturday	1800 hrs	2200 hrs
	Sunday, Public holidays	0700 hrs	2200 hrs
Night	Monday-Sunday	2200 hrs	0700 hrs

The relevant noise limits applicable to this development are shown with their derivation in Figure 5**Error! Reference source not found.**.

Figure 5: Noise protocol zoning levels – Rural method

Table B.1: Zone levels (dB(A)) for rural area method for commercial, industrial and trade premises

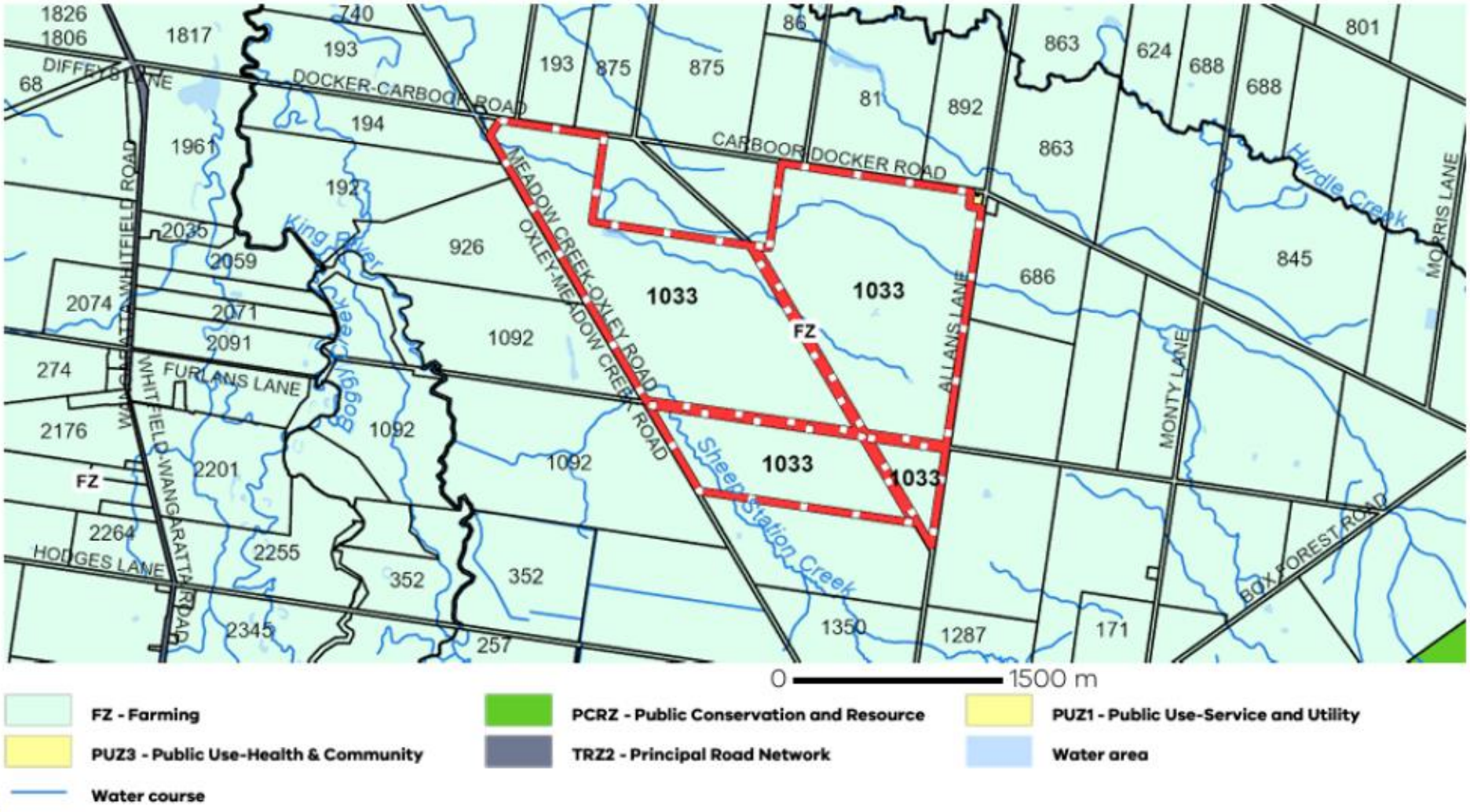
Generating Zone ↓ / Receiving zone →	Green Wedge A GWAZ, Rural Conservation RCZ, Rural Living RLZ Group E CDZ, SUZ & UGZ (*)	Low Density Residential LDRZ Public Conservation and Resource PCRZ Public Park and Conservation PPCZ Public Use 2 & 5 PUZ2 & PUZ5 Urban Floodway UFZ	Farming Zone FZ Green Wedge GW General Residential Zone GRZ Neighbour Residential Zone NRZ Residential Growth Zone RGZ, Rural Activity Zone RAZ, Township Zone TZ Urban Growth Zone before an incorporated precinct structure plan UGZ Group B CDZ, SUZ & UGZ (*)	Commercial 1 Zone C1Z B1Z B2Z B5Z Commercial 3 Zone C3Z Mixed use Zone MUZ Activity Centre Zone ACZ Public Use Zone 1,3,4,6&7 PUZ1 PUZ3 PUZ4 PUZ6 & PUZ7 Road RDZ1 RDZ2 Group A CDZ, SUZ & UGZ (*)	Industrial 3 IN3Z Group C CDZ, SUZ & UGZ (*)	Commercial 2 Zone C2Z B3Z B4Z	Industrial 2 Zone IN2Z Industrial 1 Zone IN1Z Group D CDZ, SUZ, UGZ (*)
Low Density Residential LDRZ Public Conservation and Resource PCRZ Public Park and Conservation PPCZ Public Use 2,5 PUZ2 & PUZ5 Urban Floodway UFZ Group E CDZ, SUZ & UGZ (*)	Day 45 Evening 37 Night 32	Day 45 Evening 39 Night 34	Day 45 Evening 40 Night 35	Day 47 Evening 42 Night 37	Day 48 Evening 43 Night 38	Day 50 Evening 45 Night 40	Day 53 Evening 48 Day 43
Farming FZ (*) Green Wedge GWZ, Green Wedge A GWAZ Public Use 2 & 5 PUZ2, PUZ5 Rural Activity RAZ Rural Conservation RCZ Rural Living RLZ Urban Growth Zone before an incorporated precinct structure plan (UGZ) Group B CDZ, SUZ & UGZ (*)	Day 45 Evening 38 Night 33	Day 45 Evening 40 Night 35	Day 46 Evening 41 Night 36	Day 48 Evening 43 Night 38	Day 50 Evening 45 Night 40	Day 52 Evening 47 Night 42	Day 54 Evening 49 Night 44
Commercial 1 CZ1 B1Z B2Z BZ5 Mixed Use MUZ Activity Centre Zone ACZ Public Use 1,2,3,4,6 & 7 PUZ1 PUZ3 PUZ4 PUZ6 PUZ7 Group A CDZ, SUZ & UGZ (*)	Day 45 Evening 40 Night 35	Day 47 Evening 42 Night 37	Day 48 Evening 43 Night 38	Day 50 Evening 45 Night 40	Day 52 Evening 47 Night 42	Day 53 Evening 48 Night 43	Day 55 Evening 50 Night 45
Industrial 3 IN3Z Group C CDZ, SUZ & UGZ (*)	Day 46 Evening 41 Night 36	Day 49 Evening 44 Night 39	Day 50 Evening 45 Night 40	Day 52 Evening 47 Night 42	Day 53 Evening 48 Night 43	Day 55 Evening 50 Night 45	Day 56 Evening 51 Night 46
Commercial 2 C2Z, B3Z, B4Z Commercial 3 C3Z	Day 48 Evening 43 Day 38	Day 50 Evening 45 Night 40	Day 52 Evening 47 Night 42	Day 54 Evening 49 Night 44	Day 55 Evening 50 Night 45	Day 56 Evening 51 Night 46	Day 57 Evening 52 Night 47
Industrial 1, 2 IN1Z IN2Z Group D CDZ, SUZ & UGZ (*)	Day 50 Evening 45 Night 40	Day 52 Evening 47 Night 42	Day 53 Evening 48 Night 43	Day 55 Evening 50 Night 45	Day 56 Evening 51 Night 46	Day 57 Evening 52 Night 47	Day 58 Evening 53 Night 48

(*) For Comprehensive Development Zone (CDZ), Special Use Zone (SUZ) and Urban Growth Zone (UGZ) refer to Table B.2.

APPENDIX D PLANNING MAP

FARMING ZONE (FZ)

SCHEDULE TO THE FARMING ZONE (FZ)



APPENDIX E NOISE DATA

Table 18: One-third octave band sound power data (data as provided by client; note that spectrums are A-weighted)

	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1kHz	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	A
Inverter																												
Inverter 4600kVA*	38	48	49	55	61	64	65	74	70	75	78	82	80	78	78	81	79	79	79	77	81	89	72	72	81	70	67	93
Silenced Inverter*	36	42	46	54	57	59	64	61	61	65	68	73	66	66	68	66	66	63	62	61	78	86	63	67	77	66	67	88
BVault DC Platform Battery Unit (level per area unit)																												
Long facade 1*	48	53	63	67	77	71	75	78	79	81	79	81	79	78	78	79	76	75	74	75	76	73	66	63	48	53	63	90
Long facade 2*	40	41	49	53	61	56	60	62	64	66	62	65	57	55	58	57	52	51	48	46	44	40	34	30	40	41	49	72
Short facade 1*	37	38	48	52	61	55	58	62	63	64	63	67	61	61	60	59	57	55	53	53	52	49	42	40	37	38	48	73
Short facade 2*	36	37	49	53	63	57	60	64	65	68	65	65	64	63	62	62	59	57	56	57	57	54	46	42	36	37	49	75
Top facade (estimate)*	38	39	48	52	62	56	59	63	64	66	64	66	62	61	60	60	57	55	54	54	54	50	43	40	38	39	48	74

* Denotes A-weighted spectrum as provided by client via manufacturer

Table 19: Octave band sound power data - operations

			Octave Band Centre Frequency (Hz)							
Source	**Location**	**Data source**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**A**
SMA Medium voltage transformer 3620kVA[1]	BESS	AS60076-10:2009 (overall level)/MDA noise source database (spectrum)	60	72	69	65	58	48	42	66
High voltage transformer[1]	Collector substation	AS60076-10:2009 (overall level)/MDA database (spectrum)	90	101	98	89	80	71	64	93
Auxiliary transformer 'dry type'[2]	Collector substation	AS60076-10:2009 (overall level)/MDA database (spectrum)	66	73	72	68	62	55	49	69
AC outdoor unit	Collector substation/ Docker terminal substation	Client - manufacturer data	67	72	65	58	57	55	53	64
Nextracker tracking motors	Solar farm	MDA noise source database	72	72	72	72	72	72	72	78
SMA Medium voltage transformer 4400kVA[1]	Solar farm	AS60076-10:2009 (overall level)/MDA database (spectrum)	61	73	70	67	59	49	43	67
Single phase power transformer[2]	Docker terminal substation	AS60076-10:2009 (overall level)/MDA database (spectrum)	53	60	59	55	49	42	36	56
Tractor	Maintenance equipment – Solar farm	MDA noise source database	107	99	106	103	106	98	89	108
Utility vehicle	Maintenance equipment – Solar farm	MDA noise source database	101	106	106	106	102	101	96	108
Pump	Maintenance equipment – Solar farm	MDA noise source database	101	96	90	90	89	84	81	93
220 kVA dead tank circuit breakers	Docker terminal substation and Collector substation	MDA noise source database	-	-	-	-	-	-	-	122

			Octave Band Centre Frequency (Hz)							
Source	**Location**	**Data source**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**A**
250kVA Diesel generator	Docker terminal substation and Collector substation	MDA noise source database	93	91	85	79	77	74	67	83
Fire services pumps	Docker terminal substation	MDA noise source database	105	98	96	96	97	95	88	101

1 Based on 'reduced maximum' data

2 Based on 'standard maximum' data

Table 20: Octave band sound power data - construction

		Octave Band Centre Frequency (Hz)							
Source	**Data source**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**A**
Backhoe	British Standard BS5228-1:2009	100	91	95	95	91	90	84	97
Bobcat	MDA noise source database	97	97	97	97	97	97	97	103
Bulldozer	MDA noise source database	112	112	106	104	103	101	95	108
Concrete pump	MDA noise source database	100	99	105	104	104	101	94	108
Concrete truck	British Standard BS5228-1:2009	111	102	95	101	100	105	96	108
Crane	British Standard BS5228-1:2009	102	105	102	96	100	100	89	105
Delivery truck	MDA noise source database	110	112	107	102	100	99	98	107
Drill rig	DEFRA database	106	106	106	106	106	106	106	112
Dump truck	MDA noise source database	124	124	116	113	111	108	102	117
Excavator 100 – 200W	MDA noise source database	110	112	105	104	101	99	95	107
Forklift	DEFRA database	88	88	88	88	88	88	88	94
Front end loader	MDA noise source database	122	118	115	108	107	106	100	113
Grader	MDA noise source database	112	111	107	103	108	102	98	110
Rock crusher	MDA noise source database	110	118	120	115	115	112	107	120
Roller	British Standard BS5228-1:2009	108	103	105	100	95	90	82	102
Sand cart	DEFRA database	101	101	101	101	101	101	101	107
Telehandler	British Standard BS5228-1:2009	113	107	97	95	92	90	84	99
Tracked loader	MDA noise source database	124	120	117	110	109	108	102	115
Tractor	British Standard BS5228-1:2009	107	99	106	103	106	98	89	108

		Octave Band Centre Frequency (Hz)							
Source	**Data source**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**A**
Trencher	DEFRA database	90	90	90	90	90	90	90	96
Ute & trailer	DEFRA database	99	99	99	99	99	99	99	105

APPENDIX F NOISE PREDICTION METHOD

F1 Operational noise

Operational noise levels associated with the Project (typical operation of panels, related infrastructure, and maintenance) are predicted using:

- noise emission data for all noise sources on site
- a 3D digital model of the Project and the surrounding environment using proprietary noise modelling software SoundPLANnoise 9.0; and
- international standards used for the calculation of environmental sound propagation.

The method selected to predict noise levels is International Standard ISO 9613-2: 1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613).

The implementation of ISO 9613 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 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.

Geometry data for the model has been sourced from public aerial photography and typical equipment dimensions. 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.

Terrain data for the Project site and surrounds has been sourced from publicly available terrain data[6]. 2 m elevation contours were available and are considered appropriate resolution for noise modelling purposes.

Several assumptions were required to undertake the noise modelling, including:

- A ground factor of G = 0.1 has been adopted for the extents of the BESS, reflecting hard/gravel ground conditions. Elsewhere on the site and surrounds, a ground factor of G = 0.5 has been adopted reflecting mixed ground conditions i.e. 50 % hard ground and 50 % soft ground; and
- The various equipment items exhibit noise levels as presented in Section 4.1 and Appendix E.

A revised version of the standard, ISO 9613-2:2024, was published earlier in 2024 based on broadly equivalent procedures to ISO 9613-2:1996, subject to refinements, clarifications, and supplementary advice for different types of sources.

At the date of preparing this report, the revised standard has not yet been implemented in commonly used proprietary noise modelling software options. However, the core elements of the two versions are similar.

On this basis ISO 9613-2:1996 continues to be used and referenced in Australia and has been chosen as the most appropriate method to calculate the level of A-weighted noise expected to occur at surrounding receivers.

[6] Sourced from NSW Government – Spatial Services via Elvis – Elevation and Depth – Foundation Spatial Data - https://elevation.fsdf.org.au/

F2 Construction noise

Predicted noise levels have been calculated in general accordance with the method detailed in Australian Standard 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* (AS 2436). 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 British Standard 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites: Noise* (BS 5228, referenced in AS 2436), and provides a margin of caution with respect to ground conditions for the typical magnitude of separating distances between construction activities and neighbouring sensitive receivers.