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Environmental Noise Impact Assessment
Proposed 4.95 Megawatts Solar Farm

At:-

Lot 126 in DP 752299

Broughans Road

Finley, NSW 2713

Prepared for: -

BE Pro G Pty Ltd
C/- Habitat Planning Pty Ltd
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Attention: Mr David Hunter

Reference: 2011011E-R

Prepared by: -

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Habitat Planning Pty Ltd on behalf of BE Pro G Pty Ltd commissioned Harwood Acoustics to carry out an Environmental Noise Impact Assessment for a 4.95 Megawatts Solar Farm proposed to be constructed on a portion of Lot 126 in DP752299, Broughans Road, Finley, NSW.

Accordingly, Harwood Acoustics has prepared this report for the exclusive use of the Client identified on the title page. The report is prepared in accordance with the brief and scope of works agreed between the Client and Harwood Acoustics and may not be suitable for use beyond that scope.

Harwood Acoustics undertakes no duty nor accepts any responsibility to any third party who may rely upon this report.

Advice and recommendations provided in this report are in relation to acoustical issues only. No claims of expertise are made, and no liability is accepted, in relation to issues falling outside the field of acoustical consulting. These may include, but are not limited to, structural and waterproofing considerations, fire rating or thermal rating. Relevant authorities and / or experts should be consulted regarding areas other than acoustics.

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1. INTRODUCTION AND SUMMARY

Habitat Planning Pty Ltd on behalf of BE Pro G Pty Ltd commissioned Harwood Acoustics to carry out an Environmental Noise Impact Assessment for a 4.95 Megawatts Solar Farm proposed to be constructed on a portion of land within Lot 126 in DP752299, Broughans Road, Finley, NSW (the Site).

The Site is a large rural property located on the northern side of Broughans Road, approximately 4.5 kilometres south west of the town of Finley, NSW. The overall property is approximately 190 hectares in size however only a portion will be occupied by the proposed Solar Farm, being approximately 17 hectares at the eastern extent of the land.

The surrounding area is rural farm land and agricultural land, and the nearest rural residential receptors are approximately 250 metres south east of the proposed Solar Farm. Other residences are located further toward the south west, west, north and east as shown in Figure 2 of this Report.

It is proposed to establish a 4.95 Megawatts Solar Farm (referred to henceforth as the Facility) on the Site with access via Broughans Road. The Facility will comprise the installation of 16,500 solar photovoltaic panels (PV Panels) to be mounted in arrays on single axis trackers with cabling from the solar arrays to panel inverters and a substation, with connection into the local electricity network. The substation will be on the western side of the of the development area as shown in Figure 3 in this Report and the two inverters will be located amongst the PV Panels to the north east of the substation. The Facility will also include construction of unsealed perimeter and internal access tracks, parking and laydown areas as well as perimeter fencing. The Facility will generate power during daylight hours with all infrastructure being operational at all times.

The facility is expected to take approximately 6 months to complete construction. It will operate for a period of up to 30 years, after which it will be subject to further operation or decommissioning and removal of all components.

It is a requirement of Berrigan Shire Council that an Environmental Noise Impact Assessment be prepared to address the potential for noise impact arising from the operational phase of the project as well as during the construction phase.

The main sources of noise associated with the operational phase of the project are the inverters and the transformer within the substation.

Project noise trigger levels (noise design goals) for the operational phase have been derived from the NSW EPA's *Noise Policy for Industry* 2017 at each receptor. These are 35 dBA $L_{eq,\ 15\ minute}$ during the day time period and 30 dBA $L_{eq,\ 15\ minute}$ during the evening time and night periods.

Noise modelling has been undertaken based on noise data established for the inverters and the transformer. Noise data for each of the inverters has been provided by the manufacturer of SMA central inverter model SC2475. Noise data for the transformer has been established from noise measurements of similar transformers carried out by the author over the past 19 years.

Noise modelling and calculations show that the level of noise emission from the operational phase of the development is well below the EPA's project noise trigger levels at all receptor locations without the need for noise controls. This includes an additional 5 dB penalty for modifying factor adjustments applied to the transformer for potential tonal characteristics which is unlikely to be the case in practice, given the distances to each receptor.

The construction phase of the project will take approximately 6 months and include the following main components:-

- Site establishment, and
- Solar infrastructure construction works.

A summary of the details of the processes and equipment involved for each component are provided in Section 2.2 of this Report and full details can be seen in the *Statement of Environmental Effects* prepared by Habitat Planning, reference 02595, dated July 2020.

An assessment of the potential noise impacts associated with the construction phase is provided in Section 6.1 of this Report and this has been carried out in accordance with the NSW EPA's *Interim Construction Noise Guideline* 2009 and the Australian Standard AS2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*.

There is potential for minor exceedances of the construction noise management level of 45 dBA ($L_{eq,\ 15\ minute}$) at the closest receptor to the site whilst works are undertaken in the south eastern extent of the land. Once works progress toward the north, construction noise levels will be within the noise management level at all receptors.

Recommendations are made in Section 6.2 of this Report to minimise the impacts of construction noise and vibration in accordance with the Guideline and Australian Standard. Proper to the commencement of works following the issue a Construction Certificate, a Construction Noise and Vibration Management Plan may be prepared and submitted for approval by Council.

The NSW EPA's *Road Noise Policy* 2011 acceptable noise criteria for on-road traffic will also be met for this Facility at the nearest residence to Broughans Road for heavy and vehicle movements during the construction phase in the day time.

2. SITE AND DEVELOPMENT DESCRIPTION

2.1 Site Description

The Site is a large rural property located on the northern side of Broughans Road, approximately 4.5 kilometres south west of the town of Finley, NSW. The overall property is approximately 190 hectares in size however only apportion will be occupied by the proposed Solar Farm, being approximately 17 hectares at the eastern extent of the land as shown in Figure 1.

Figure 1. Ariel View – Lot 126 in DP752299, Broughans Road, Finley, NSW

(source: Habitat Planning Pty Ltd)

The surrounding area is rural farm land and agricultural land, and the nearest rural residential receptors are located toward the south east. Other residences are located toward the south west, west, north and east as shown in Figure 2.

The nearest receptors to the Site are shown in Figure 2 below:-

R1 – 167 Broughans Road (circa 250 metres)	R2 – 299 Broughans Road (circa 750 metres)
R3 – 285 Dales Road (circa 900 metres)	R4 – 194 Dales Road (circa 920 metres)
R5 – 231 Broockmanns Road (circa 990 metres)	R6 – 402 Canalla Road (circa 1980 metres)

Distances are approximate and based on the weighbridge to the assessment location at each receptor as a reference only. Individual noise sources, plant and equipment will be at varying distances from each receptor and this is taken into account in noise modelling.

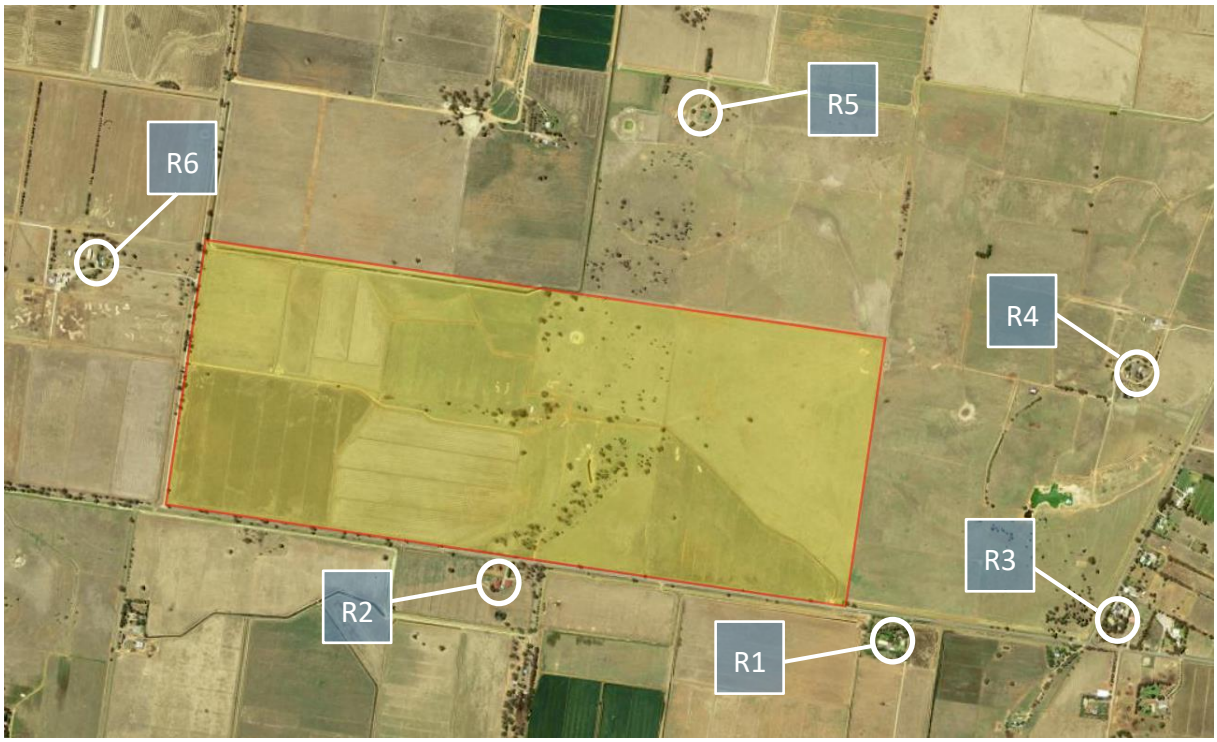

Figure 2. Location Plan – Lot 126 in DP752299, Broughans Road, Finley, NSW

(source: NSW Government Spatial Information Exchange ©)

2.2 Development Description

2.2.1 Operational Phase

The Solar Farm (Facility) will comprise the installation of 16,500 solar photovoltaic panels (PV Panels) to be mounted in arrays on single axis trackers with cabling from the solar arrays to panel inverters and a substation with connection into the local electricity network.

The substation will be on the western side of the development area as shown in Figure 3 and two inverters will be located amongst the PV Panels to the north east of the substation. The facility will also include construction of unsealed perimeter and internal access tracks, parking and laydown areas as well as perimeter fencing. The facility will generate power during daylight hours with all infrastructure being operational at all times.

The facility will operate for a period of up to 30 years, after which it will be subject to further operation or decommissioning and removal of all components.

The main sources of noise associated with the operational phase of the project are the inverters and to a lesser extent the transformer within the substation.

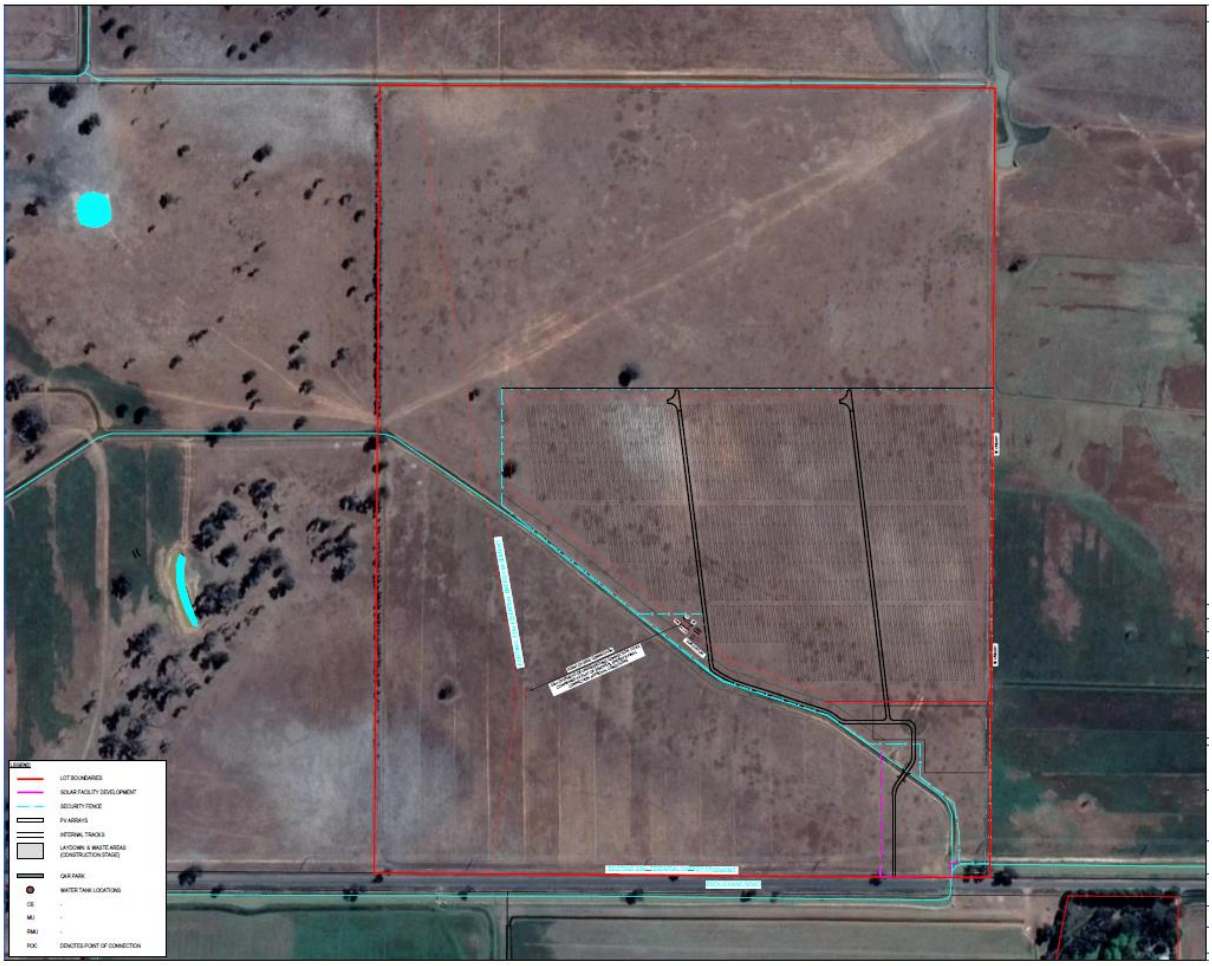

Figure 3. Solar Farm Layout

(source: Habitat Planning Pty Ltd)

2.2.2 Construction Phase

The proposed solar panels are to be mounted on a steel structure with mounting posts to be driven or screwed into the ground using a vibrating pile driver or screw pile (augur piling rig).

The internal site cabling will be installed by trenching up to 1 metre in depth, laying of electrical wiring and conduits and backfilling and compacted to natural ground level.

The inverters will be installed on pre-built skids that enable easy placement on the site.

During construction there is expected to be up to 50 to 100 personnel undertaking various construction processes that will vary throughout the total construction process.

The construction phase of the project will take approximately 6 months and include site establishment and the solar infrastructure construction works.

Noise producing plant and equipment that is likely to be used during the construction phase will include the following:-

- Auger Piling Rig
- Grader
- Trencher
- Water Cart
- Generators
- Bulldozer
- Vibrating Roller
- Crane
- Truck and Dog Combinations
- Power Tools

3. NOISE CRITERIA

This section outlines the noise guidelines applicable to this proposal and establishes the project specific noise trigger levels and noise design goals.

3.1 NSW EPA's Noise Policy for Industry 2017

3.1.1 Introduction

The NSW Environment Protection Authority (EPA) published the NSW *Noise Policy for Industry* in October 2017 (the Policy). This Policy has now replaced the *Industrial Noise Policy* (INP) 2000.

The Policy sets out the NSW Environment Protection Authority's (EPA's) requirements for the assessment and management of noise from industry in NSW. It aims to ensure that noise is kept to acceptable levels in balance with the social and economic value of industry in NSW.

The Policy is designed to assist industry and authorities to ensure that potential noise impacts associated with industrial projects are managed effectively.

The purpose of the policy is to ensure noise impacts associated with particular industrial developments are evaluated and managed in a consistent and transparent manner. It provides noise levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable noise mitigation measures.

The objectives of the policy are to:

- provide the noise levels that are used to assess both change in noise level and long-term noise levels;
- provide a clear and consistent framework for assessing environmental noise impacts from industrial premises and industrial development proposals;
- promote the use of best-practice noise mitigation measures that are feasible and reasonable where potential impacts have been identified;
- support a process to guide the determination of achievable noise limits for planning approvals and/or licences, taking into account the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

The policy is designed for large industrial and agricultural sources and specifies substantial monitoring and assessment procedures that may not always be applicable to the types of sources councils need to address.

However, local government may find the policy helpful in assessing noise from premises it regulates and in the carrying-out of its land-use planning responsibilities.

3.1.2 Project Noise Trigger Level

Section 2 of the *Noise Policy for Industry* 2017 sets out the procedure to determine the **project noise trigger levels** relevant to a particular industrial development.

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

The project noise trigger level, feasible and reasonable mitigation, and consideration of residual noise impacts are used together to assess noise impact and manage the noise from a

proposal or site. It is the combination of these elements that is designed to ensure that acceptable noise outcomes are determined by decision makers.

The **project noise trigger level** is defined as the lower (that is, the more stringent) value of the project **intrusiveness noise level** and project **amenity noise level**.

3.1.3 Project Intrusiveness Noise Level

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the **L_{Aeq} descriptor**), measured over a 15-minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold. This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment.

The intrusiveness noise level is determined as follows:

$L_{Aeq, 15\ minute}$ = rating background noise level (RBL) + 5 dB

Where:

$L_{Aeq, 15\ minute}$	*Represents the equivalent continuous energy average A-weighted sound pressure level of the source over 15 minutes.*

And:

Rating background noise level	*Represents the background level to be used for assessment purposes, as determined by the method outlined in Fact Sheets A and B.*

Intrusiveness noise levels are not used directly as regulatory limits. They are used in combination with the amenity noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options and subsequently determine achievable noise requirements.

Minimum assumed Rating Background Levels (RBLs) are applied in the Policy and these result in minimum intrusiveness noise levels. These are shown in Table 2.1 in the Policy and are replicated in Table 1 below.

Table 1 Minimum Assumed RBLs and Project Intrusiveness Noise Levels (Derived from EPA Table 2.1)

Time of Day	Minimum Assumed Rating Background Level dBA	Minimum Project Intrusive Noise Level ($L_{eq, 15\ minute}$, dBA)
Day (7 am to 6 pm)	**35**	**40**
Evening (6 pm to 10 pm)	**30**	**35**
Night (10 pm to 7 am)	**30**	**35**

3.1.4 Amenity Noise Levels and Project Amenity Noise Levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise levels within an area from **all** industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. (EPA Table 2.2 is replicated in Table 2 below).

The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

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.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a **project amenity noise level** applies for each new source of industrial noise as follows:

Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options, and subsequently determine achievable noise requirements.

Table 2 Amenity Noise Levels (EPA Table 2.2)

Receiver	Noise Amenity Area	Time of Day	L_{Aeq}, dBA
(see Table 2.3 to determine which residential receiver category applies)			**Recommended amenity noise level**
Residential	Rural	Day Evening Night	50 45 40
	Suburban	Day Evening Night	55 45 40
	Urban	Day Evening Night	60 50 45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks *	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom – internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward internal external	All	 Noisiest 1-hour Noisiest 1-hour	 35 50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Relevant Notes:

Time of day is defined as follows:

- day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays
- evening – the period from 6 pm to 10 pm
- night – the remaining periods.

3.1.5 Assessment Locations

For a **residence**, the project noise trigger levels are to be assessed at the reasonably most-affected point on or within the residential property boundary or, if that is more than 30 metres from the residence, at the reasonably most-affected point within 30 metres of the residence, but not closer than 3 metres to a reflective surface and at a height of between 1.2–1.5 metres above ground level. This should not be read to infer that the project noise trigger level (or a limit in a statutory document) applies only at the reasonably most-affected location.

3.2 Background Noise Levels

In order to establish the project intrusive noise levels, it is necessary to determine the background noise levels in the vicinity of all potentially affected residential receptors.

The background noise level is defined by the EPA as 'the underlying level of noise present in ambient noise when all unusual extraneous noise is removed' and is considered to be represented by the $L_{A90,\ 15\ minute}$ descriptor. This is a statistical measure of the sound pressure level that is exceeded for 90 % of the time. The Rating Background Level is the single-figure background noise level derived from monitoring $L_{A90,\ 15\ minutes}$ over a representative period of time. The Rating Background Level is established for the day, evening and night time periods and is used for assessment purposes.

Background noise measurements were taken at the Site on Monday 14 December 2020 by Mr Ray Walsh of Ray Walsh Acoustics, Noise and Sound. Short-term attended background noise measurements were taken between approximately 10 am and 11.30 am. During the noise survey the weather was warm with temperatures between 26 and 28 degrees with clear skies and sunshine with no rain. There was a north easterly breeze up to 5 m/s at the microphone height. Background noise levels ranged between 27 dBA and 31 dBA $L_{90,\ 15\ minute}$ during the survey.

The background noise levels in the area will be at or below the EPA's minimum Rating Background Noise Levels at least on some occasions, during the day, evening and night time periods. The minimum Rating Background Noise Levels shown in Table 1 above are therefore used in this assessment to establish project noise trigger levels in this assessment.

3.3 Sleep Disturbance Criteria

3.3.1 Noise Policy for Industry 2017

Section 2.5 'Maximum noise level event assessment' states: -

"The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

Where the subject development/premises night-time noise levels at a residential location exceed:

- *$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*

• L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy."

3.3.2 EPA's Road Noise Policy 2011 (Sleep disturbance)

Section 5.4 of the NSW EPA's *Road Noise Policy* states: -

"Further studies by the enHealth Council (2004) and the guidelines published by the World Health Organisation (1999) were reviewed and analysed in terms of the guidance on noise exposure and sleep disturbance. The enHealth report states that:

'as a rule for planning for short-term or transient noise events, for good sleep over 8 hours the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45 dB(A) L_{Max} more than 10 or 15 times per night'."

3.3.3 Environmental Criteria for Road Traffic Noise 2009

Appendix B5 of the NSW EPA's Environmental Criteria for Road Traffic Noise (ECRTN) reviews the current level of knowledge and concludes that maximum internal noise levels below 50–55 dBA are unlikely to cause awakening reactions, and that one or two noise events per night with maximum internal noise levels of 65–70 dBA are not likely to affect health and wellbeing significantly.

3.4 Construction Noise Criteria

The NSW EPA published the *Interim Construction Noise Guideline* in July 2009. While some noise from construction sites is inevitable, the aim of the Guideline is to protect the majority of residences and other sensitive land uses from noise pollution most of the time.

The Guideline presents two ways of assessing construction noise impacts; the quantitative method and the qualitative method.

The quantitative method is generally suited to longer term construction projects and involves predicting noise levels from the construction phase and comparing them with noise management levels given in the guideline.

The qualitative method for assessing construction noise is a simplified way to identify the cause of potential noise impacts and may be used for short-term works, such as repair and maintenance projects of short duration.

In this instance the entire construction phase may take approximately 6 months and involve some significant noise producing activities, such as piling. Consequently, a quantitative assessment of construction noise is undertaken in Section 6 of this report.

Table 2 in Section 4 of the Guideline sets out noise management levels at affected residences and how they are to be applied during normal construction hours. The noise management level is derived from the rating background level (RBL) plus 10 dB in accordance with the Guideline. This level is considered to be the 'noise affected level' which represents the point above which there may be some community reaction to noise.

Table 3 below shows the construction noise management levels at the nearest receptor locations used in this assessment.

Table 3 L_{eq} Noise Management Levels from Construction Activities

Receptor Location	Noise Management Level	How to Apply
All receptors	**45 dBA** (35 + 10)	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15\ min)}$ noise level is greater than the noise affected level, the proponent should apply all feasible and reasonable* work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. ▪ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

* Section 6, *work practices* of The *Interim Construction Noise Guideline*, states:-

"there are no prescribed noise controls for construction works. Instead, all feasible and reasonable work practices should be implemented to minimise noise impacts.

This approach gives construction site managers and construction workers the greatest flexibility to manage noise".

Definitions of the terms feasible and reasonable are given in Section 1.4 of the Guideline.

The 'highly noise affected' level of 75 dBA represents the point above which there may be strong community reaction to noise. This level is provided in the Guideline and is not based on the RBL.

3.5 On-Road Traffic Noise Criteria – *Road Noise Policy* 2011

The NSW EPA published the *NSW Road Noise Policy* in March 2011 (RNP) and the RNP replaced the *Environmental Criteria for Road Traffic Noise* in July 2011.

The Policy contains strategies to address the issue of road traffic noise from, among other things, traffic generating developments.

Section 2.3.1 of the Policy *'Noise assessment criteria – residential land uses'* sets out the assessment criteria for residences to be applied to particular types of project, road category and land use.

The relevant parts of the EPA's Table 3 are replicated in Table 4 below.

Table 4 Road Traffic Noise Assessment Criteria (EPA RNP, Table 3)

Road Category	Type of Project / Land Use	Assessment Criteria, dBA	
		Day (7 am – 10 pm)	**Night (10 pm – 7 am)**
Freeway / arterial / sub arterial	3. Existing residences affected by **additional traffic** on existing freeway / arterial / sub arterial roads generated by land use developments	$L_{Aeq\ (15\ hour)}$ 60 (external)	$L_{Aeq\ (9\ hour)}$ 55 (external)
Local Roads	6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq\ (1\ hour)}$ 55 (external)	$L_{Aeq\ (1\ hour)}$ 50 (external)

3.6 Environmental Noise Goals

The most relevant noise design goals are as follows: -

Operational Noise Goals

- (35 + 5 =) **40 dBA** $L_{eq,\ 15\ minute}$ during the day time period,
- (30 + 5 =) **35 dBA** $L_{eq,\ 15\ minute}$ during the evening and night time periods and shoulder period between 6 am and 7 am,
- (30 + 15 =) **48 dBA** L_{max} or $L_{1,\ 1\ minute}$ as an initial assessment for sleep disturbance,
- **45 dBA** to **55 dBA** L_{max} or $L_{1,\ 1\ minute}$ inside residential dwellings for further potential sleep disturbance assessment

Construction Phase Noise Management Levels

- **45 dBA** ($L_{eq,\ 15\ minute}$) ideal design goal at all receptors,
- **<75 dBA** ($L_{eq,\ 15\ minute}$) level above which strong community reaction is likely.

On-Road Traffic Noise Goals

- **55 dBA** $L_{eq,\ 1\ hour}$ from on-road traffic during the day, and
- **50 dBA** $L_{eq,\ 1\ hour}$ from on-road traffic at night.

4. MODIFYING FACTOR ADJUSTMENTS

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level. On the other hand, some sources may cause less annoyance where only a single event occurs for a limited duration.

Fact Sheet C of the *Noise Policy for Industry* 2017 outlines the correction factors to be applied to the source noise level at the receiver before comparison with the project noise trigger levels, to account for the additional annoyance caused by these modifying factors.

The modifying factor corrections should be applied having regard to:

- the contribution noise level from the premises when assessed/measured at a receiver location, and
- the nature of the noise source and its characteristics (as set out in this fact sheet).

The NPI Table C1 sets out the corrections to be applied. The corrections specified for tonal, intermittent and low-frequency noise are to be added to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. The adjustments for duration are to be applied to the criterion. Table C1 of the NPI Fact Sheet C is replicated in the attached Appendix A.

Consideration is given to the potential for tonal noise characteristics to be associated with the transformer in noise modelling in Section 5 of this Report.

5. OPERATIONAL NOISE EMISSION

5.1 Operational Source Noise Level Predictions

The main sources of noise associated with the proposed Solar Farm will be as follows: -

- 2 x SMA SC2475 Inverters systems, and
- Transformer at solar substation.

Noise data has been supplied by the manufacturer of the inverters and the measured sound pressure levels have been used to establish the 'A' frequency weighted sound power levels, in decibels re: 1 pW, shown in Table 5 below. Table 5 also shows the sound power level of the transformer which is derived from our database of carrying out noise assessments of similar items of plant and equipment over the past 19 years.

Table 5 $L_{eq,\ 15\ minute}$ Sound Power Levels – Mechanical Plant & Equipment

Equipment Description	Individual Sound Power Level $L_{eq,\ 15\ minute}$ (dBA)
SMA SC 2475 Inverter	**96**
Transformer	**80**

A noise model has been developed using *SoundPLAN* Essential version 5.1.

Table 6 below provides details on the specific parameters used to develop the noise model.

Table 6 Computer Noise Model Parameters

Parameter	Details
Noise Sources	Inverters • Assumes that inverters operate a nominal power with 100% fan sped at any given time*, • Manufacturer's stated height of 2.3 metres is given to the noise source in the model • * This is a worst-case scenario as the units may operate at lesser capacity during the night time period. Transformer • Operating at full sound power of 80 dBA ($L_{eq,\ 15\ minute}$) at any given time, • Source height of 2.5 metres, • A 5 dB penalty is applied to the predicted noise levels at all receptors for the potential for tonal noise characteristics** • ** It is unlikely that the level of noise emission from the transformer will be audible at the receptor locations or display tonal characterises if measurable at the distances in question. However, transformers typically display tonal at closer distances and modifying factor correction is applied as a worst-case scenario.
Algorithm & Meteorological conditions	Noise sources are modelled in accordance with the International Standard ISO 9613-2 (1996(E)) *'Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*. The method described in the Standard is general in the sense that it may be applied to a wide variety of noise sources, and covers the major mechanism of attenuation. The method allows for downwind propagation conditions namely:- • wind direction within an angle of ± 45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and • wind speed between approximately 1 m/s and 5 m/s measured at a height of 3 m to 11 m above the ground, The equations for calculating downwind sound pressure level, including the equations for attenuation… are the average for meteorological conditions within these limits. These equations also hold, equivalently, for average propagation under well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights.

Table 7 below shows the predicted noise levels at each receptor for the ongoing operation of the facility.

Table 7 Predicted $L_{eq,\ 15\ minute}$ Noise Levels at Receptor Locations

Description	Predicted Noise Level $L_{eq,\ 15\ minute}$ (dBA) at Receptor Location					
	R1	R2	R3	R4	R5	R6
Project Trigger Level - Day	**40**	**40**	**40**	**40**	**40**	**40**
Project Trigger Level – Evening & Night	**35**	**35**	**35**	**35**	**35**	**35**
Predicted noise level	30	24	23	22	20	14
Complies	Yes	Yes	Yes	Yes	Yes	Yes

Predictions in Table 7 assume the following:-

- Distance loss to each receptor,
- Sound power levels for each item of plant and equipment shown in Table 5,
- A 5 dB penalty applied to the predicted noise levels for the transformer for tonal noise characteristics.

A diagrammatical representation of the predicted noise levels from the *SoundPLAN* model is provided in the attached Appendix B.

The predicted L_{eq} noise levels for the operational phase of the facility are well below the EPA's project noise trigger levels at all receptor locations without the need for nose controls.

There is no specific noise data available for maximum or $L_{1,\ 1\ minute}$ noise levels for the inverters. Both the inverters and the transformer are steady state or quasi steady noise sources and the maximum noise levels produced are not significantly higher than the energy average (L_{eq}) noise levels. Based on several previous measurements of a number of transformer substations, the $L_{1,\ 1\ minute}$ noise level is approximately 5 to 7 dB higher than the L_{eq} noise level and often less than this during ongoing steady operation.

We have applied the difference of 7 dB to the $L_{eq,\ 15\ minute}$ nose levels to predict the level of $L_{1,\ 1\ minute}$ noise emission for assessment against the sleep disturbance criterion at night. The predicted night time noise levels are shown in Table 8 below.

Table 8 Predicted $L_{1,\ 1\ minute}$ Noise Levels at Receptor Locations

Description	Predicted Noise Level $L_{1,\ 1\ minute}$ (dBA) at Receptor Location					
	R1	R2	R3	R4	R5	R6
Sleep Disturbance Assessment Trigger Level	**45**	**45**	**45**	**45**	**45**	**45**
Predicted noise level	37	31	30	29	27	21
Below the trigger level	Yes	Yes	Yes	Yes	Yes	Yes

6. CONSTRUCTION NOISE

6.1 Construction Noise Level Predictions

Construction works will include site preparation and the installation of the solar farm infrastructure.

Site establishment will include the following works:-

- Removal of existing internal fences and gates
- Construct a new culvert
- Establish new parking, loading and delivery areas
- Establish temporary signage and sediment control,
- Establish new property access on Broughans Road
- Internal grading for access tracks
- Establish temporary site office
- Construct new internal fencing

Solar farm infrastructure will include the following works:-

- Direct pile driving using vibrating pile for installation of mounting poles
- Grading and compaction of areas for installation of inverters on skids
- Establish new parking, loading and delivery areas
- Site grading and placement of gravel for internal tracks between panel arrays and the substation,
- Open trenching excavation for underground cabling
- Grading and compaction and installation of concrete slab for substation
- Establish temporary site office
- Grading and placement of materials for establishment of permitter access tracks.

Table 9 below shows a schedule of sound power levels for typical construction equipment.

Table 9 Typical Construction Equipment – L_{eq} Sound Power Levels

Description	L_{eq} Sound Power Level (dBA)
Piling Rig	118
Auger Piling (CFA Rig)	113
D9 Dozer	110
Grader	110
Single Drum Roller	104
Trencher	110
Mobile Crane (Diesel)	110
Water Cart	107
Truck & Dog	110
Power Tools	100 - 110

The predicted levels of noise emission from construction activities are shown Tables 10 to 12 below, where:-

- Table 10 shows the predicted level of noise emission from construction activities when occurring at the closest typical location that each item of plant or equipment may operate relative to each of the receptors respectively,
- Table 11 shows the predicted level of noise emission from construction activities when occurring at approximately the central most location that each item of plant or equipment may operate relative to each of the receptors respectively.
- Table 12 shows the predicted level of noise emission from construction activities when occurring at the furthest typical location that each item of plant or equipment may operate relative to each of the receptors respectively

Table 10 Predicted $L_{eq,\ 15\ minute}$ Noise Levels at Receptor Locations – Closest Location

Description	Predicted Noise Level $L_{eq,\ 15\ minute}$ (dBA) at Receptor Location					
	R1	R2	R3	R4	R5	R6
Construction Noise Management Level	**45**	**45**	**45**	**45**	**45**	**45**
Piling Rig	52	46	44	44	43	35
Auger Piling (CFA Rig)	47	41	39	39	38	30
D9 Dozer	50	39	38	36	35	28
Grader	50	39	38	36	35	28
Single Drum Roller	43	32	31	29	28	21
Trencher	50	39	38	36	35	28
Mobile Crane (Diesel)	50	39	38	36	35	28
Water Cart	47	36	35	33	32	25
Truck & Dog	50	39	38	36	35	28
Power Tools	< 50	<39	<38	<36	<35	<28
Combined	57	47	46	44	43	36
Complies	No	No	Yes	Yes	Yes	Yes

Table 11 Predicted $L_{eq,\ 15\ minute}$ Noise Levels at Receptor Locations – Central Location

Description	Predicted Noise Level $L_{eq,\ 15\ minute}$ (dBA) at Receptor Location					
	R1	R2	R3	R4	R5	R6
Construction Noise Management Level	**45**	**45**	**45**	**45**	**45**	**45**
Piling Rig	47	43	40	41	41	34
Auger Piling (CFA Rig)	42	38	35	36	36	29
D9 Dozer	41	35	33	34	33	26
Grader	41	35	33	34	33	26
Single Drum Roller	34	28	26	27	26	19
Trencher	41	35	33	34	33	26
Mobile Crane (Diesel)	41	35	33	34	33	26
Water Cart	38	32	30	31	30	23
Truck & Dog	41	35	33	34	34	26
Power Tools	< 41	<35	<33	<34	<34	<26
Combined	49	43	41	42	41	34
Complies	No	Yes	Yes	Yes	Yes	Yes

Table 12 Predicted $L_{eq,\ 15\ minute}$ Noise Levels at Receptor Locations – Furthest Location

Description	Predicted Noise Level $L_{eq,\ 15\ minute}$ (dBA) at Receptor Location					
	R1	R2	R3	R4	R5	R6
Construction Noise Management Level	**45**	**45**	**45**	**45**	**45**	**45**
Piling Rig	44	40	37	38	38	32
Auger Piling (CFA Rig)	39	35	32	33	33	27
D9 Dozer	36	33	30	31	31	25
Grader	36	33	30	31	31	25
Single Drum Roller	29	26	23	24	24	18
Trencher	36	33	30	31	31	25
Mobile Crane (Diesel)	36	33	30	31	31	25
Water Cart	33	30	27	28	28	22
Truck & Dog	36	33	30	31	31	25
Power Tools	< 36	<33	<30	<31	<31	<25
Combined	44	41	38	39	39	33
Complies	Yes	Yes	Yes	Yes	Yes	Yes

Predictions in each o f the Tables above assume the following:-

- Distance loss to each receptor,
- Combined noise levels consider all items of plant and equipment (other than piling) operating simultaneously in close proximity of one another at an given time for a minimum of 15 minute.

Discussion

It can be seen from Tables 10 and 11 that there is potential for noise design goal of 45 dBA $L_{eq,\ 15\ minute}$ to be exceeded at receptors R1 and R2 on occasion. The predicted noise levels from construction activities are well below the highly affected noise level of 75 dBA at all receptors, at all times.

It is unlikely in practice that the combined noise levels will be realised as not all items of plant will operate simultaneously at full sound power for a minimum period of 15 minutes at similar distances to each receptor. There is however potential for individual items of plant to exceed the noise design goal of 45 dBA, particularly at receptor R1 when initial works commence in the south eastern corner of the Site.

Section 6.2 below provides a typical Construction Noise and Vibration Management Plan that may be implemented at the Site and finalised for approval by Council prior to the issue of a Construction Certificate.

6.2 Construction Noise Management Recommendations

The following recommendations are made to minimise the noise impacts during the construction phase and are in accordance with and derived from the Australian Standard AS 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* and the EPA's *Interim Construction Noise Guideline* 2009.

Allowable Hours

Construction hours should be as follows:-

- Monday to Friday 7 am to 6 pm,
- Saturday 8 am to 1 pm,
- No work on Sundays or Public Holidays.

Low Noise Plant and Equipment and Practices

Piling Activities

If practicable, screw piles should be used for the installation of the mounting poles rather than driven piles.

All other plant and machinery should be selected with consideration to low noise options where available.

For example, a wheeled dozer or loader is preferable to a tracked dozer or excavator if it is practicable.

Work Practices

Workers and contractors should be trained in work practices to minimise noise emission such as the following:-

- Employ the use of broadband audible reversing alarms on all mobile plant – no tonal alarms should be used on this Site where practicable, if the contractor is able to retro

fit broadband reversing alarms to mobile plant this should be done prior to the commencement of work to reduce tonal noise impacts,

- Avoid dropping materials from a height,
- Avoid shouting and talking loudly outdoors,
- Avoid the use of radios outdoors that can be heard at the boundary of residences,
- Turn off equipment when not being used,
- Carry out work only within the recommended hours of operation,
- No vehicles including staff vehicles or delivery trucks should arrive at the Site prior to the operating hours.

Heavy Vehicles and Staff Vehicles

- Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling),
- Establish the site office and staff parking area as far from the residences as possible,
- Optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads,

Community Relations

- A Community Liaison Officer is to be appointed by the contractor prior to the commencement of any works,
- The officer will approach all potentially affected residents prior to the commencement of any works as an initial introduction and provide his or her contact details,
- The officer will explain the project, duration of works, potentially noisy periods as well as determine any particularly sensitive receivers or sensitive time periods and schedule works accordingly, as far as reasonably practical,
- A contact number will be provided for any residents to call with complaints or queries.

Once works commence, communication with the community should be maintained by the officer. Communication should be maintained via a range of media including, for example, continued individual contact, letter box drops or a clearly visible notice board at the entrance to the site.

Consultation and cooperation between the contractor and the neighbours and the removal of uncertainty and rumour can help to reduce adverse reaction to noise.

Managing a Noise Complaint

The Liaison Officer should receive and manage noise complaints.

All complaints should be treated promptly and with courtesy.

Should a justified noise complaint not be resolved, noise monitoring may be carried out at the affected receptor location and appropriate measures be taken to reduce the noise emission as far as reasonably practicable.

Where it is not practicable to stop the noise, or reduce the noise, a full explanation of the event taking place, the reason for the noise and times when it will stop should be given to the complainant.

The following guidelines are recommended in Section 6 of the '*Interim Construction Noise Guideline*' to manage a noise complaint:

- Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line,
- Give complaints a fair hearing,
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow,
- Call back as soon as possible to keep people informed of action to be taken to address noise problems,
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information,
- Implement all feasible and reasonable measures to address the source of complaint,
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area (for larger projects), time of verbal response and timeframe for written response where appropriate.

7. ON-ROAD TRAFFIC NOISE

There will be an average of eight (8) light vehicles and eight (8) heavy vehicle movements per day, during the busier phases of the construction period in accordance with the Statement of Environmental Effects.

Vehicles will include a combination of semi-trailer, rigid trucks and truck and dog combinations.

The main route for construction vehicles to the site will be via Broughans Road from the Newell Highway to the east. The closest dwelling to the road along this route is 3290 Broughans Road, Finley at a distance of approximately 16 metres.

Formulae are given in the *Calculation of Road Traffic Noise* (CoRTN) from the UK Department of Transport and Welsh Office (1988) for the calculation of on-road vehicle noise. However, the calculation procedure given in CoRTN is untested for small traffic flows (under 200) and typically yields lower levels than occur in practice.

Therefore, a calculation based on the sound exposure level for various vehicles has been carried out. The sound exposure level (L_{Ae}) is a summation of the sound energy produced during a single event (i.e. a motor vehicle pass-by, train pass-by, etc).

The author has measured the level of noise emission from heavy vehicles, including semi-trailers, truck and trailer and truck and dog combination, as well as cars, four-wheel drives, etc.

The average maximum measured sound exposure levels of a range vehicles, normalised to a distance of 15 metres is as follows:-

- Truck – 84 dBA,
- Car – 67 dBA, and
- Ute / 4WD – 70 dBA.

Once established, a sound exposure level (L_{Ae}) can be used to calculate an energy average, sound pressure level ($L_{eq, time}$) using the following formula:-

$$L_{eq, 1\ hour} = L_{ae} - 10\ log_{10}(T) + 10\ log_{10}(N)$$

Where T is time in seconds and N is the number of vehicle trips. The calculated level can then be adjusted to various distances from the 15 metre assessment location.

For the purpose of predicting road traffic noise levels for this proposal we have assumed that in the busiest worst-case hour there may four (4) truck movements and four (4) light vehicle movements passing any given house.

The predicted noise level from on road vehicle movements during peak flows is shown in Table 13 below.

Table 13 Predicted $L_{1, 1\ minute}$ Noise Levels – Passing Heavy & Light Vehicles

Description	Predicted Noise Level $L_{eq, 1\ hour}$ (dBA) at Nearest Receptor Locations 3290 Broughans Road
Day Time Road Traffic Noise Limit	**55**
4 truck and 4 light vehicle movements in one hour	54

A movement is one pass-by, so the four movements used in calculations assumes two trucks in and out, passing the same dwelling in any gviven hour. No consideration is given to night time road traffic due to the prescribed hours of construction being the day time only.

It can therefore be seen from Table 13 that the EPA's acceptable road traffic noise level will be met for this development.

It is worth noting that the noise criteria used n this assessment as detailed in Section 3.5 and shown in Table 13 is the criterion applicable to traffic generated from new land use developments as it impacts residences on existing local roads as a conservatively stringent noise criterion. Broughans Road may be considered a sub-arterial road in which case the noise criterion becomes 60 dBA $L_{eq, 15\ hour}$ during the day time period. The predicted level of traffic noise for this development is well below the acceptable limit for sub-asterial roads and is also therefore acceptable.

8. CONCLUSION

An assessment of the potential noise emission arising from the operational and construction phases of a 4.95 Megawatts Solar Farm proposed t be established at Lot 126 in DP752299, Broughans Road, Finley, NSW ahs been undertaken.

Calculations show that the level of noise emission from the ongoing operation of the facility will be well below the NSW EPA's *Noise Policy for Industry* 2017 project noise trigger levels at all receptor locations without the need for noise controls.

The level of noise emission from the construction phase of the development has been assessed in accordance with the NSW EPA's *Interim Construction Noise Guideline* 2009 and *Australian Standard AS2436* – 2010.

There is potential for minor exceedances of the construction noise management level of 45 dBA ($L_{eq,\ 15\ minute}$) at the closest receptor to the site whilst works are undertaken in the south east extent of the land. Once works progress toward the north, the predicted construction noise levels will be within the noise management level at all receptors.

Recommendations are made in Section 6.1 of this Report to minimise the impacts of construction noise and vibration in accordance with the Guideline and Australian Standard. Proper to the commencement of works following the issue a Construction Certificate, a Construction Noise and Vibration Management Plan may be prepared and submitted for approval by Council.

The NSW EPA's *Road Noise Policy* 2011 road traffic noise criteria will also be met for this proposal from light and heavy vehicles accessing the site during day time hours.

Matthew Harwood, MAAS

Principal Acoustical Consultant

Attachments: -
Important note
Appendix A – NSW EPA's Noise Policy for Industry Fact Sheet C, Modifying Factor Adjustments,
Appendix A – *SoundPLAN* noise model depicting operational phase of the facility

Important Note

All products and materials suggested by Harwood Acoustics are selected for their acoustical properties only.

Recommendations made in this report are intended to resolve acoustical problems only, therefore all other properties such as aesthetics, air flows, chemical, corrosion, combustion, construction details, decomposition, expansion, fire rating, fumes, grout or tile cracking, loading, shrinkage, smoke, ventilation etc. are outside Harwood Acoustic's fields of expertise and ***must*** *be checked with the supplier or suitably qualified specialist before purchase.*

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Modifying Factor Corrections (EPA 2017)	Appendix A

Table C1Modifying Factor Corrections (from Table C.1 of the NSW Noise Policy for Industry 2017)

Factor	Assessment/ Measurement	When to Apply	Correction	Comments
Tonal Noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method (*ISO1996.2-2007 – Annex D*).	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz • 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz • 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.	5 dB	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. **Note:** Narrow-band analysis using the reference method in *ISO1996-2:2007, Annex C* may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.
Low Frequency Noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10–160 Hz	Measure/assess source contribution C- and A-weighted Leq,T levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and: • where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2 dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period • where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2-dB(A) positive adjustment applies for the daytime period.	2 or 5 dB	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.

Table C1Modifying Factor Corrections (from Table C.1 of the NSW Noise Policy for Industry 2017) *Cont…*

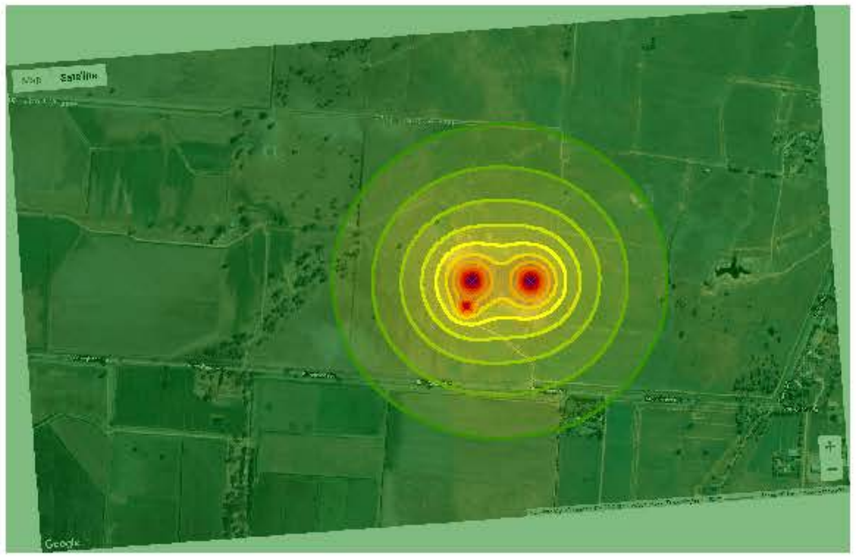
Factor	Assessment/ Measurement	When to Apply	Correction	Comments
Intermittent Noise	Subjectively Assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible.	5 dB	Adjustment to be applied for **night-time only**.
Duration	Single-event noise duration may range from 1.5 m to 2.5 h	One event in any 24-hour period	0 to -20dBA	The acceptable noise trigger level may be increased by an adjustment depending on duration of noise (see Table C.3)
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10 dBA[2] (excluding duration correction)	

Notes:

1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.

2. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.

3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard.



Finley Solar Farm
Operational Noise Emission
Substation and Inverters
Leq, 15 minute

Signs and symbols

× Transformer and Inverters

Levels in dB(A)

< 30
30 - 33
33 - 36
36 - 39
39 - 42
42 - 45
45 - 48
48 - 51
51 - 54
54 - 57
57 - 60
60 - 63
63 - 66
66 - 69
69 - 72
>= 72

1 : 30412

0 0.150.3 0.6 0.9 1.2 km

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