

Appendix E

NOISE IMPACT ASSESSMENT



**GOONUMBLA SOLAR FARM – NOISE & VIBRATION IMPACT
ASSESSMENT – SEPTEMBER 2016**

RENEWABLE ENERGY DEVELOPMENTS PTY LTD

Project ID. 10531

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1 INTRODUCTION

1.1 Scope of Assessment

The Assured Monitoring Group was appointed by Renewable Energy Developments Pty Ltd to undertake a noise assessment for the proposed Goonumbra Solar Farm project. The project involves construction and operation of a 70 MW solar farm across five land parcels (Lots 1 and 2 on DP602329, Lot 409 on DP750152, Lot 5 of DP854193 and Lot 1 on DP877903).

The noise study has been undertaken to assess the potential impacts of the construction and operation of the proposed solar farm on nearby sensitive receptors in accordance with the following NSW policies and guidelines:

- NSW Environmental Protection Authority Industrial Noise Policy (EPA, 2000)
- NSW Assessing Vibration: a technical guideline (DEC, 2006);
- NSW Road Noise Policy (DECCW, 2011); and
- Interim Construction Noise Guideline (DECCW, 2009)

In accordance with the requirements of the above guidelines, computational modelling and first principle calculations have been undertaken to support the assessment of the potential for adverse amenity impacts as a result of the development.

1.2 This Report

This report summarises the methodology, results and conclusions of the noise and vibration impact assessment. A glossary of terms is presented in Appendix A to assist the reader.

2 PROPOSED DEVELOPMENT SITE

2.1 Development Site

The proposed development site is located approximately 10 km west of Parkes in the Central West Slopes and Plains of New South Wales. Specifically, the proposed solar farm is to be constructed within the boundaries of five adjoining land parcels including:

- Lot 1 DP602329
- Lot 2 DP602329
- Lot 409 DP750152
- Lot 5 DP854193
- Lot 1 DP877903

The area surrounding the proposed development includes a range of agricultural and rural uses. Adjoining the proposed development site to the south is the proposed Parkes Solar Farm development which has recently received development approval by the NSW Department of Planning and Environment.

Figure 1 presents the location of the site.

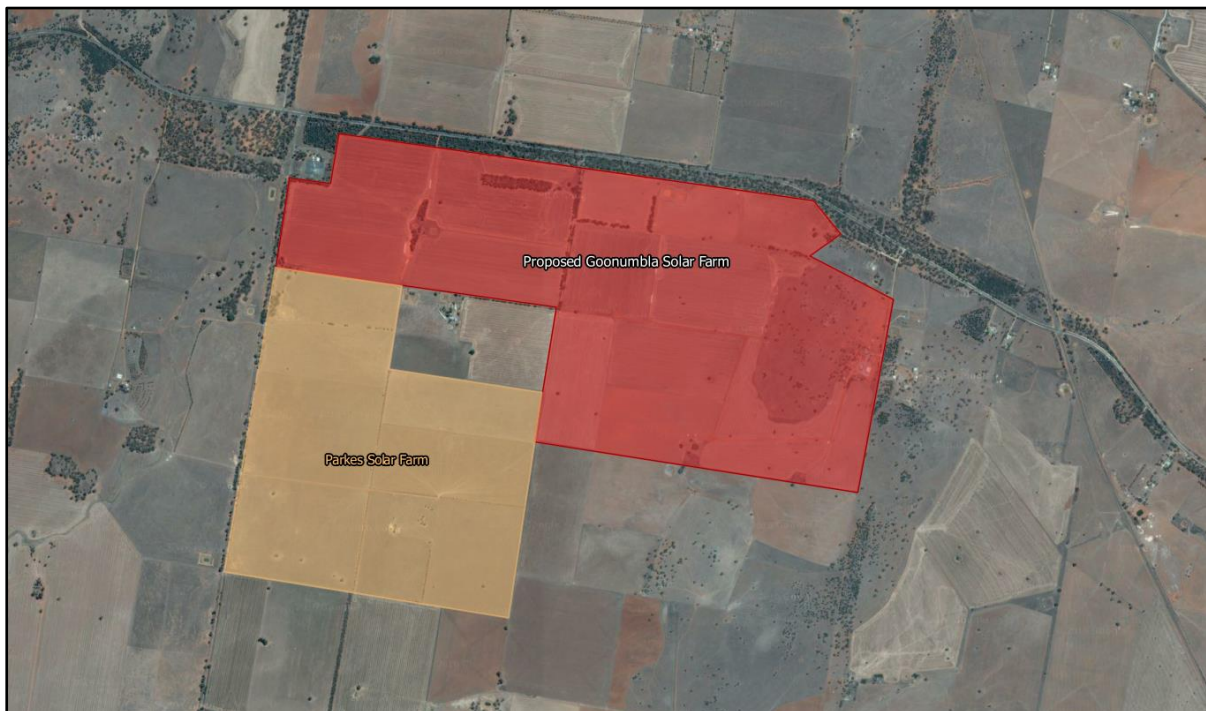


Figure 1: Site Location and Surrounding Landuses

2.2 Nearby Sensitive Receptors

The site is located predominantly on cleared land used for agricultural purposes, such as cropping and grazing. There are some small areas of native vegetation remaining within the site, and a hill (known as Millers Lookout) at the eastern extent of the site that is not cultivated due to outcropping rock. Currently there is a single residential dwelling within the site, located on the eastern side of Millers Lookout.

The nearest off-site residential receptors include approximately 8 single dwellings located within 1 km to the east and north-east of the proposed Solar Farm. Beyond this, there are a further 10 residential dwellings that have been identified in the area between 1 km and 2 km from the site boundary.

Table 3 and Figure 2 below provide a summary of the nearest sensitive uses to the proposed Goonumbra Solar Farm development.

Table 3: Nearby Sensitive Receptors

Receptor ID	Description	Distance to Proposed Development Site
R1	1129 Condobolin Road	1200 m
R2	Velvedere	70 m
R3	Existing dwelling on Goonumbra site	200 m
R4	43 Millers Lookout Road	750 m
R5	65 Millers Lookout Road	570 m
R6	8 Millers Lookout Road	500 m
R7	629 Henry Parkes Way	670 m
R8	1071 Back Trundle Road	1050 m
R9	1195 Back Trundle Road	1600 m



Figure 2: Surrounding Landuses and Nearby Sensitive Receptors

3 CONSTRUCTION NOISE ASSESSMENT

3.1 Duration of Construction Works

The construction of the Goonumbla Solar Farm is expected to take approximately 12 months with a number of different activities undertaken over that time. Table 4 below presents an overview of each of the construction tasks along with their expected duration. It is noted that some of these tasks are likely to occur concurrently (e.g. site preparation and construction of the substation is likely to be undertaken at the same time as installation of the solar PV modules and cabling).

For all phases of the project, construction works are expected to be undertaken during normal construction hours only. That is, for construction, works are to be undertaken between 7am and 6pm Monday to Friday and 8am to 1pm Saturday.

Table 4: Construction Phases and Expected Duration

Construction Phase	Duration
Site preparation and construction of site substation	18- 26 weeks
Installation of solar PV modules & inverter assemblies	16 – 26 weeks
Installation of cabling	12 – 16 weeks
Commissioning	6 – 8 weeks
Construction restoration and completion	2 weeks

3.2 Interim Construction Noise Guideline

Guidance on the assessment and management of construction noise in NSW is provided in the Interim Construction Noise Guideline 2009 (ICNG) published by the EPA.

The main objectives of the Guideline are to:

- promote a clear understanding of ways to identify and minimise noise from construction works;
- focus on applying all ‘feasible’ and ‘reasonable’ work practices to minimise construction noise impacts;
- encourage construction to be undertaken only during the recommended standard hours, unless approval is given for works that cannot be undertaken during these hours;
- streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage;
- provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts; and
- provide guidelines for assessing noise generated during the construction phase of developments.

In achieving these objectives, the guideline provides a framework for the qualitative and quantitative assessment of potential construction noise impacts noting that, for major projects, a quantitative assessment is the preferred approach. Table 5 presents construction noise criteria outlined in the guideline. Noise levels apply at the property boundary that is

most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Table 5: NSW EPA Construction Noise Criteria – Residential Receivers

Time of Day	Management Level (Free-field)	How to Apply
<p>Recommended standard hours:</p> <p>Monday to Friday, 7 am to 6 pm</p> <p>Saturday, 8 am to 1 pm</p>	Noise affected RBL + 10 dB	<p>The noise affected level represents the point above which there may be some community reaction to noise.</p> <p>Where the predicted or measured $L_{Aeq(15\text{ min})}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>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.</p>
No work on Sundays or public holidays	Highly noise affected 75 dB(A)	<p>The highly noise affected level represents the point above which there may be strong community reaction to noise.</p> <p>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:</p> <ul style="list-style-type: none"> 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) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	<p>A strong justification would typically be required for works outside the recommended standard hours.</p> <p>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.</p>

Where nearby sensitive uses are predicted to be noise affected, the proponent of the project is required to comply reasonable and feasible noise mitigation measures noting that a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

3.3 Construction Noise Sources

In terms of noise emissions, the site preparation activities and installation of the solar PV modules are expected to represent those with the most significant potential for adverse impacts. For the purposes of the assessment, the cumulative impacts of these two activities have been considered.

It is noted that construction works are expected to progress across the site such that plant and equipment would only be in a single area for a short period of time. Given this, the potential for adverse impacts at any one receptor is expected to only occur for a short period of time.

Table 6 below presents a summary of the plant and equipment likely to be required to complete the on-site construction works. The sound power levels presented have been sourced from published noise emission datasets and the library of source noise levels maintained by Assured Monitoring Group.

Table 6: Construction Phases and Expected Duration

Construction Phase	Plant Item	Sound Power Level, dB(A)	Acoustical Usage Factor, %
Site preparation and construction of site substation	Wheeled Loader	107	40
	Excavator	106	40
	Truck and Dog	108	40
Installation of solar PV modules & inverter assemblies	Piling Drill Rig	111	20
	Franna Crane	107	16
	Delivery Truck	105	40
	Powered Hand Tools	110	20

3.4 Assessment of Impacts

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 4.6) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. The noise modelling also allows investigation of possible noise management solutions, in the event that non-compliance with the assessment criterion is predicted.

For the construction phase of the proposed project, predictive noise modelling has considered the range of potential impacts likely noting that noise generating activities will progressively move across the site over a 26-week period. As such, the highest noise levels would not be expected to be experienced at a single receptor for more than one day while construction equipment (e.g. piling drill rig) is at the closest point to the receptor.

Table 7 below presents predicted receptor noise levels during the construction phase of the proposed solar farm.

Table 7: Predicted Receptor Noise Levels - Construction Phase, dB(A)

Receptor	Description	Predicted Construction Noise Levels, $L_{Aeq, 15min}$	Noise Management Level ¹⁾	Comply (Y/N)
R1	1129 Condobolin Road	15	40	Y
R2	Velvedere	24 - 45	40	Partial
R3	Existing dwelling on Goonumbla Solar Farm site	19 - 26	40	Y
R4	43 Millers Lookout Road	0 - 27	40	Y
R5	65 Millers Lookout Road	0 - 25	40	Y
R6	8 Millers Lookout Road	19 - 31	40	Y
R7	629 Henry Parkes Way	19 - 29	40	Y
R8	1071 Back Trundle Road	22 - 28	40	Y
R9	1195 Back Trundle Road	0 - 10	40	Y

Review of the predicted noise levels confirms that compliance with the noise management level provided in the ICNG is predicted to be achieved for all receptors with the exception of R2 (Velvedere). Given this, reasonable and feasible mitigation measures have been considered for this receptor.

3.5 Mitigation of Construction Noise Levels

Receptor R2 dwelling is located within approximately 70 m from the nearest potential construction activities. As noted previously, the construction works expected to generate the highest noise levels are not anticipated to be in close proximity to this receptor for an extended period. Given this, the construction of physical noise controls (e.g. temporary acoustic barriers) is not considered to be feasible.

Potential controls available to the construction contractor could include:

- consultation with R2 landholder throughout the construction process to inform him on the duration and timing of potentially noisy activities
- staging construction such that activity at the nearest point to this receptor is undertaken in isolation (with other noise generating construction works being undertaken at distances of more than 500 m from this receptor);
- using broad-band reversing alarms on all mobile plant and equipment;

- examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine;
- select quieter items of plant and equipment where feasible and reasonable.;
- operating plant in a quiet and efficient manner;
- reduce throttle setting and turn off equipment when not being used; and
- regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

Overall, given the short duration elevated noise levels could be expected at receptor R2, the implementation of the above controls is considered to represent the reasonable and feasible mitigation measures available to the project.

3.6 Potential Cumulative Impacts

As discussed previously, a recent approval has been granted for the construction of another solar farm on the site adjacent to the proposed Goonumbla development. Given this, there is potential for cumulative noise associated with emissions from the adjacent solar farms to impact on some residences in the area.

It is noted that the current schedule for the Parkes Solar Farm targets construction completion in September 2017. The Goonumbla Solar Farm construction is scheduled to commence no sooner than October 2017. Simultaneous construction is therefore not anticipated, however the potential does exist.

Despite this, the potential for cumulative impacts are only expected to be significant where construction activities for both solar farm projects are undertaken in close proximity to a receiver at the same time. Given this, the potential for cumulative impacts is expected to be able to be effectively managed by coordinating work across the two project sites such that noisy activities are only undertaken at the nearest point to Receptor R2 on one site at a time.

4 OPERATIONAL PHASE NOISE ASSESSMENT

4.1 Operational Noise Criteria

4.1.1 Overview

The acoustic assessment has been completed in accordance with the procedure identified in the NSW INP. The INP establishes two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses.

The derivation of the two sets of criteria are presented below. For residential dwellings, the noise criteria are assessed at the most-affected point (i.e. highest noise level) on or within the property boundary. Where the property boundary is more than 30 metres from the house, then the criteria applies at the most-affected point within 30 m of the house.

4.1.2 Intrusiveness Noise Criteria

According to the INP, intrusive noise refers to noise that exceeds background noise levels (as defined by the Rating Background Level) by more than 5 dB. For the purposes of the assessment reference was made to the baseline noise monitoring undertaken during preparation of the Noise Impact Assessment for the adjacent solar farm development^a. The results of this baseline noise monitoring confirms that existing noise levels in the area are below the minimum background noise levels provided for in the INP. Therefore, Table 8 presents the derivation of the intrusiveness criteria based on the minimum background noise level established by the INP.

Table 8: Derived Intrusiveness Noise Criteria

Receptor	Intrusiveness $L_{Aeq,15\text{-minute}}$ Criteria		
	Day	Evening	Night
All nearby residential receptors ^{a)}	35 ^{b)}	35 ^{b)}	35 ^{b)}
a) Receptor noise limit applied at a location 30 m from the dwelling façade. b) Minimum background noise level established by the INP (30 dB(A)) + 5 dB.			

4.1.3 Amenity Criteria

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels (ANL) specified in Section 2.2 of the INP. The ANL is dependent on the type of area being considered. Table 9 presents ANL values for residential receivers in Rural areas.

^a Renzo Tonin & Associates (2 March 2016) 'Parkes Solar Farm – Construction & Operational Noise & Vibration Assessment) prepared on behalf of NRG Environmental

Table 9: INP Acceptable Noise Levels for Residential Receivers

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dBA	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45

When the existing industrial noise levels approach the ANL, then the noise level from a new source must be controlled to preserve the amenity of the area. In the absence of the proposed solar farm, the only other industrial noise sources in the area are expected to be related to the operation of the solar farm on the adjacent site. Further, given the scale of the solar farms (encompassing a significant area), the on-going development of the area to incorporate additional industrial noise sources with the potential to impact on nearby sensitive receptors is considered unlikely.

In view of this, the amenity criteria are considered to be equivalent to the ANL for a rural residence being 50 dB(A) for day periods, 45 dB(A) for evening periods and 40 dB(A) during the night. The amenity criteria have been used in the assessment of the potential cumulative impacts of the two adjacent solar farms.

4.1.4 Sleep Disturbance

NSW EPA have identified the potential for noise emissions from developments to impact on the sleep of residents living in the area. To assist in the reducing the potential for these impacts, the EPA released a policy statement in relation to the assessment of the potential for sleep disturbance effects. The following presents an excerpt from this policy statement:

“Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development.”

For the operational phase of the project, loud impact noises associated with sleep disturbance are considered unlikely with all plant and equipment continuous or semi-continuous in its operations. Furthermore, the operation of plant and equipment on-site is expected to only occur during daylight hours where solar energy is available with peak operations.

Given the lack of short-term impact noise sources on site consideration of sleep disturbance impacts for the operational phase of this project is considered unnecessary. Rather, where compliance can be demonstrated with the intrusive noise criteria established for the development, compliance with the sleep disturbance provisions would also be expected.

4.2 Noise Sources

The Goonumbla Solar Farm is to consist of solar photovoltaic (PV) plant and associated infrastructure producing up to 70 Megawatts of electricity for supply into the grid. It is expected that, at completion, infrastructure installed on site will incorporate:

- a total of 214,000 solar panels;
- 28 solar inverters with integrated transformers; and
- a high-voltage step-up transformer.

The PV panels are expected to be mounted onto fixed support structures in one of two manners, these being:

- Single axis tracking panels which track the sun's movement across the day through the use of small motors which rotate the panel arc of the sun to maximise the solar effect;
- Fixed panels tilted to face either the north or east dependent on detailed design.

The selection of the panel mounting option to be adopted for the Goonumbla Solar Farm will be determined during detailed design. For the purposes of the noise impact assessment however, it has been assumed that single axis tracking panels will be installed. This represents a worst-case assumption with noise emissions from the tracking motors expected to occur for approximately one minute out of each 15-minute period (providing for up to five degrees rotation per hour) during day periods.

Based on the size of the Goonumbla Solar Farm (70 MW AC generation capacity) it is expected that approximately 2,800 NexTracker tracking motors would be required. For the purposes of the assessment it is assumed that these tracking motors would be evenly distributed across the development area.

Placement of the required inverters is also expected to be finalised during the detailed design phase of the project. For the purposes of the assessment, the 28 inverters expected to be required have been located at approximately even spacing across the site with all inverters located a minimum of 300 m from any sensitive receptor.

A single transformer is expected to be required for the proposed solar farm to allow connection of the solar farm to the power grid. At this stage the location of the transformer has not been confirmed however, it is considered likely that it would be located near to the existing Parkes substation to minimise the costs associated with cabling.

Table 10: Source Noise Levels

Source	Sound Power Level (dB(A))
NexTracker	58 (each)
Sunny SC2500 Inverter	92 (each)
Transformer	75
Light Vehicle	88
a) 1/3 rd octave band frequency data provided by the manufacturer indicates a tonal component presented at 3 kHz for this source. Therefore, in accordance with the INP, a +5 dB penalty has been applied to this source.	

The sound power levels for the plant and equipment presented in the above table are provided by the manufacturer or taken from information held in our library.

4.3 Noise Modelling Methodology

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 4.6) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. The noise modelling also allows investigation of possible noise management solutions, in the event that non-compliance with the assessment criterion is predicted.

4.4 Meteorology

The NSW Industrial Noise Policy (INP) presents guidelines for the consideration of meteorological effects on noise propagation. Specifically, temperature inversions and/or gradient winds should be modelled if each factor is a feature of the local environment. The following conditions for modelling temperature inversions or gradients winds are provided:

- temperature inversions:
 - use default parameters for temperature inversions and drainage-flow wind speed where inversions are present for at least 30 percent of the total night time during winter as specified; or
 - use parameters determined by direct measurement. Wind data should be collected at a 10 m height.
- gradient winds:
 - where there is 30 percent or more occurrence of wind speeds below 3 m/s (source-to-receiver component), then the highest wind speed (below 3 m/s) is used instead of the default.

- where there is less than 30 percent occurrence of wind speeds of up to 3 m/s (source-to-receiver component), wind is not included in the noise prediction calculation.

Given the location of the site, the presence of temperature inversions is considered possible for night-periods. Therefore, in accordance with the requirements of the INP, the following scenarios have been considered:

- Day Periods - Source to receptor wind at 3 m/s representing a worst-case assessment of potential impacts for day-periods; and
- Night Periods - Moderate temperature inversion with light source to receptor winds representing a worst-case assessment of potential impacts for night periods.

4.5 Predicted Noise Levels

Table 11 below presented predicted receptor noise levels during the operational phase of the proposed solar farm. Review of the predicted noise levels confirms that compliance with the intrusive noise criteria established in accordance with the INP can be achieved for all receptors for both day and night periods under worst-case meteorological conditions.

Table 11: Predicted Receptor Noise Levels - Operational Phase, dB(A)

Receptor	Description	Predicted Operational Noise Levels, $L_{Aeq, 15min}$		Intrusive Noise Criteria ^{a)}	Comply (Y/N)
		Day Periods	Night Periods		
R1	1129 Condobolin Road	17	17	35	Y
R2	Velvedere	35	35	35	Y
R3	Existing dwelling on Goonumbla Solar Farm site	20	20	35	Y
R4	43 Millers Lookout Road	20	20	35	Y
R5	65 Millers Lookout Road	19	19	35	Y
R6	8 Millers Lookout Road	23	23	35	Y
R7	629 Henry Parkes Way	21	21	35	Y
R8	1071 Back Trundle Road	22	22	35	Y
R9	1195 Back Trundle Road	10	10	35	Y

a) Intrusive noise criteria for day, evening and night periods

Given the predicted compliance with the noise limits derived in accordance with the INP, no further noise mitigation is considered necessary.

4.6 Potential Cumulative Impacts

As noted in Section 1.2, there is potential for cumulative noise impacts as a result of the combined noise emissions from the proposed Goonumbla Solar Farm and the previously approved Parkes Solar Farm. In order to determine the potential for cumulative impacts, the maximum predicted receptor noise levels provided in the noise impact assessment

presented in the EIS for the adjacent Parkes Solar Farm^b have been combined with the maximum predicted levels provided in Table 11 above.

It is noted that for both predicted noise datasets, the potential impacts assume source to receptor winds. As wind in a single direction is unlikely to represent a source to receptor wind for both solar farms concurrently, this is considered to represent a conservative assumption.

Table 12 below presents predicted cumulative receptor noise levels based on the worst-case assumptions detailed above. Review of the predicted cumulative noise levels confirms that, for all receptors, noise levels are expected to remain well below the amenity noise criteria for a rural area for day, evening and night periods.

Table 12: Predicted Cumulative Receptor Noise Levels - Operational Phase, dB(A)

Receptor	Predicted Operational Noise Levels, $L_{Aeq, 15min}$						Amenity Noise Criteria ^{a)}	Comply (Y/N)
	Goonumbra Solar Farm		Parkes Solar Farm		Cumulative Noise Level			
	Day	Night	Day	Night	Day	Night		
R1	17	17	30	30	30	30	Day: 50	Y
R2	35	35	35	35	38	38	Evening: 45	Y
R3	20	20	22	22	24	24	Night: 40	Y

^b Renzo Tonin and Associates (2 March 2016) 'Parkes Solar Farm – Construction & Operational Noise & Vibration Assessment' prepared on behalf of NGH Environmental

5 ROAD TRAFFIC NOISE ASSESSMENT

5.1 Introduction

Noise impacts associated with vehicle movements during the operational phase of the Goonumbla Solar Farm project are expected to be negligible given the small number of movements expected (maximum of 4 per day). During the construction phase of the project however, significantly higher traffic volumes are expected for the duration of the construction works.

Table 6 presents expected average and peak traffic volumes for the duration of the construction works.

Table : Construction Phase Traffic Generation

Vehicle Type	Peak Traffic Volume (Jan – June) [Vehicles per day]		Off-peak Traffic Volume (Jul – Sep) [Vehicles per day]	
	Average	Peak	Average	Peak
Light Vehicles	50	70	28	40
Utility Vehicles	14	20	8	12
Buses (12 seater)	12	12	6	6
HGV	28	40	8	40
Total	104	142	50	98

Given this, the assessment has considered the potential impacts associated with noise emissions from the maximum expected 142 vehicle movements from the site entry along Pat Meridith Drive and Condobolin Road. It is noted that traffic movements along Pat Meridith Drive are not expected to pass by any residences prior to entering Condobolin Road. As such, the assessment of potential traffic noise impacts considers only vehicle movements along Condobolin Road.

5.2 Assessment Criteria

The ICNG does not provide criteria for the assessment of construction road traffic during the project. Given this, reference is made to the noise criteria provided in the NSW Road Noise Policy (RNP). Based on the type of roadway, Table 13 below presents the applicable road traffic noise criteria for existing residences affected by traffic on existing roadways generated by land use developments.

Table 13: Applicable Road Traffic Noise Criteria

Road Category	Type of Project & Land Use	Assessment Criteria – Day Periods
Freeway / arterial / sub-arterial road	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,15\text{ hour}}$ 60 dB(A) (external)

5.3 Noise Modelling Methodology

For the purposes of predicting impacts associated with road traffic noise emissions was completed using the proprietary software Cadna (version 4.6) developed by DataKustik. The model incorporates the influence of terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with Calculation of Road Traffic Noise (CRTN) methodology developed by the UK Department of Transport. In accordance with the requirements of the RNP, the predictive noise modelling incorporated the following assumptions:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CRTN methodology using the approximation $L_{Aeq,1\text{ hour}} = L_{A10,1\text{ hour}} - 3$.
- Noise source heights were set at 0.5 m above road level for cars, 1.5 m for heavy vehicle engines and 3.6 m for heavily vehicle exhausts.
- Noise from heavy vehicle exhausts is 8 dB lower than the steady continuous engine noise; and
- Corrections established for Australian conditions applied through a negative correction to the CRTN predictions of -1.7 dB for façade-corrected levels (Samuels and Sauders, 1982).

Table 14 below presents predicted noise levels for the nearest potential receptor to Condobolin Road assuming a minimum setback distance of 20 m. It should be noted that this is considered to represent a conservative assumption with the majority of dwellings along Condobolin Road noted to be setback considerable further than this.

Review of the predicted noise level presented in Table 14 below confirms that compliance with the RNP is predicted by a considerable margin. Given this, adverse amenity impacts as a result of peak traffic levels generated by the proposed construction works is considered unlikely.

Table 14: Predicted $L_{Aeq,15\text{ hour}}$ Noise Levels - Road Traffic Noise

Setback from Roadway	Criteria	HGV Traffic Movements	Vehicle Speed	Predicted Noise Level	Comply (Y/N)
20 m	60 dB(A)	142 vehicles per day	100 km/hr	47 dB(A)	Y



6 VIBRATION ASSESSMENT

6.1 Introduction

A review of the proposal indicates there is potential for impacts as a result of vibration generated by plant and equipment during the construction phase. Given this, an assessment of the potential for vibration impacts has been undertaken. In particular, the assessment has considered the potential for impacts on both human comfort and structural damage for the nearest residence to the construction works.

6.2 Assessment Criteria

The vibration criteria presented in the Environmental Noise Management – Assessing Vibration: A Technical Guide (2006) published by the NSW Department of Environment Climate Change and Water (DECCW) have been adopted for the assessment. The technical guide provides vibration criteria associated with amenity impacts (human annoyance) for the three categories of vibration:

- Continuous vibration (e.g. road traffic, continuous construction activity);
- Impulsive vibration includes less than 3 distinct vibration events in an assessment period (e.g. occasional dropping of heavy equipment); and
- Intermittent vibration includes interrupted periods of continuous vibration (e.g. drilling), repeated periods of impulsive vibration (e.g. pile driving) or continuous vibration that varies significantly in amplitude.

Table 15 and Table 16 present the criteria for continuous and impulsive vibration and intermittent vibration, respectively.

Table 15: Continuous & Impulsive Vibration Criteria for Residences – Peak Velocity

Location	Vibration Type	Preferred Limit (mm/s)	Maximum Limit (mm/s)
Residences	Continuous	0.28	0.56
Residences	Impulsive	8.6	17

Table 16: Intermittent Vibration Criteria for Residences

Location	Assessment Period	Preferred Value (m/s ^{1.75})	Maximum Value (m/s ^{1.75})
Residences	Day-time	0.20	0.40

The above criteria are suitable for assessing human annoyance in response to vibration levels. In order to assess potential damage to buildings, reference has been made to British Standard BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration. Table 17 presents vibration criteria for assessing the potential for building damage.

Table 17: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Particle Velocity (mm/s)	
	4 Hz to 15 Hz	15 Hz and above
Unreinforced or light framed structures – residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

6.3 Potential Vibration Sources

Table 18 identifies the construction activities and associated equipment that are likely to be used for the construction of the proposed development. From the list of proposed equipment presented in Table 18, equipment with the greatest potential to contribute to vibration levels at nearby sensitive receptors include excavators, trucks and piling equipment. Table 19 presents vibration source levels for various construction equipment.

Table 18: Construction Activities and Equipment Used

Construction Activity	Potential Source of Vibration
Site Preparation	Excavator
	Truck
Panel Installation	Piling Rig
	Crane

Table 19: Vibration Source levels – Peak Particle Velocity

Equipment Item	PPV at 10 metres (mm/s)	Source
Piling	1 – 2	Rockhill, D.J. et. al. ^{b)}
Loaded trucks (rough surface)	5	USA DT ^{a)}
Loaded trucks (smooth surface)	1 – 2	USA DT ^{a)}
Excavator	2.5 – 4	DECCW
a) Transit Noise and Vibration Impact Assessment, US Department of Transportation, May 2006.		
b) Rockhill, D.J., Bolton, M.D. & White, D.J. (2003) 'Ground-borne vibrations due to press-in piling operations'		

6.4 Assessment of Potential Impacts

Based on the vibration source levels at 10 metres (presented in Table 19), peak particle velocities have been predicted at various separation distances. The NSW DECCW indicates that in predicting vibration levels, it can be assumed that the vibration level is inversely proportional to distance (with the relationship varying between $d^{-0.8}$ to $d^{-1.6}$ based on field data).

The US Department of Transportation's Transit Noise and Vibration Impact Assessment (May 2006) presents the following construction vibration propagation formula assuming an inverse relationship:

$$PPV@d_2 = PPV@d_1 \times (d_1/d_2)^{1.5}$$

where: d_1 = distance 1 (reference distance for source data) (m)

d_2 = distance 2 (separation distance for predicted PPV) (m)

PPV = peak particle velocity (mm/s)

The above formula has been considered for predicted PPVs at various distances from construction equipment. Based on the above information, Table 20 presents PPV predictions for the various construction equipment.

Table 20: Predicted Peak Particle Velocity at Sensitive Receptors (mm/s)

Distance from Source (m)	Predicted Peak Particle Velocity (mm/s)			
	Excavator	Piling	Loaded trucks (rough surfaces)	Loaded trucks (smooth surfaces)
10	4.00	0.35 - 0.71	5.00	1 - 2
20	1.41	0.19 - 0.38	1.77	0.35 - 0.71
30	0.77	0.13 - 0.25	0.96	0.19 - 0.38
40	0.50	0.09 - 0.18	0.63	0.13 - 0.25
50	0.36	0.07 - 0.14	0.45	0.09 - 0.18
60	0.27	0.05 - 0.11	0.34	0.07 - 0.14
70	0.22	0.04 - 0.09	0.27	0.06 - 0.11
80	0.18	0.04 - 0.07	0.22	0.05 - 0.09
90	0.15	0.03 - 0.06	0.19	0.04 - 0.07
100	0.13	0.02 - 0.03	0.16	0.03 - 0.06
150	0.07	0.35 - 0.71	0.09	0.02 - 0.03
Type	Continuous	Intermittent	Intermittent	Intermittent
Nuisance Criteria	0.28 (Preferred) 0.56 (Maximum)	0.2 (Preferred) 0.4 (Maximum)		
Building Criteria	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above			

The predicted vibration levels presented in Table 20 indicate compliance with the continuous preferred vibration nuisance criteria for locations at a separation distance of 50-60 metres. Compliance with the building damage criteria is predicted at 10 metres from construction for each source.

For intermittent vibration associated with haul vehicles and piling, it is difficult to provide an appropriate comparison with the relevant criteria (which is presented as a Vibration Dose Value (VDV) in $m/s^{1.75}$). The calculation of a VDV requires both the overall weighted RMS

(root mean square) acceleration (m/s^2) typically obtained from on-site measurements and the estimated time period for vibration events.

It is noted, however, that the piling PPV at distances of 70 m (the distance to the nearest sensitive receptor from potential piling) is predicted to be within the maximum continuous criteria of 0.56 mm/s. This comparison with the continuous criteria (as a conservative approach) indicates that vibration levels associated with piling are not considered to be significant (which is expected given the significant separation distances).

7 CONCLUSIONS AND RECOMMENDATIONS

Renewable Energy Developments Pty Ltd propose to construct a 70 MW solar farm (to be known as the Goonumbla Solar Farm) across five land parcels (Lots 1 and 2 on DP602329, Lot 409 on DP750152, Lot 5 of DP854193 and Lot 1 on DP877903) on a site located approximately 10 km west of Parkes, NSW.

The area surrounding the proposed development is sparsely populated with dominant activities including a range of agricultural and rural uses. Adjoining the proposed development site to the south is the proposed Parkes Solar Farm development which recently received development approval by the NSW Department of Planning and Environment.

The impact assessment has considered the potential for adverse impacts resulting from noise (construction, road traffic and operational) and vibration (construction) emissions on nearby residential uses.

For the construction phase, significant amenity impacts are considered unlikely where the following management measures are implemented during the construction phase of the project:

- staging construction such that activity at the nearest point to Receptor R2 (see Figure 2) is undertaken in isolation (with other noise generating construction works being undertaken at distances of more than 500 m from this receptor);
- using broad-band reversing alarms on all mobile plant and equipment;
- selection of quieter items of plant and equipment where feasible and reasonable.;
- operating plant in a quiet and efficient manner;
- reduce throttle setting and turn off equipment when not being used; and
- regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

For the operational phase of the project, adverse amenity impacts are considered unlikely providing the final site layout adopted for the development maintains a minimum separation distance of 300 m between any sensitive receptor and solar inverter plant items.

Overall, based on the results of the assessment, the risk of adverse impacts as a result of the proposed Goonumbla Solar Farm is considered to be low. Hence, from an acoustic perspective, the proposed development site is considered acceptable for the proposed use.

APPENDIX A: GLOSSARY OF TERMS

A-Weighting	A response provided by an electronic circuit which modifies sound in such a way that the resulting level is similar to that perceived by the human ear.
dB (decibel)	This is the scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure (0.00002 N/m ²).
dB(A) or dBA	This is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Free-field	Refers to a sound pressure level determined at a point away from reflective surfaces other than the ground with no significant contribution due to sound from other reflective surfaces; generally, as measured outside and away from buildings.
L _{Aeq}	This is the equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over the given period. Noise levels often fluctuate over a wide range with time. Therefore, when a noise varies over time, the L _{Aeq} is the equivalent continuous sound which would contain the same sound energy as the time varying sound. Many studies show that human reaction to level-varying sounds tends to relate closer to the L _{Aeq} noise level than any other descriptor.