

BOOKAAR SOLAR FARM

Acoustic Report

22 November 2022

Bookaar Renewables Pty Ltd

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Update r9 – 22 November 2022

Renzo Tonin & Associates (RT&A) was engaged by Bookaar Renewables Pty Ltd to undertake an acoustic assessment of the proposed 220MWac (282 MWdc) Solar Farm in Bookaar, Victoria (Corangamite Shire) (the Proposal).

This update (r9, 22 November 2022) has been prepared to respond to and fully address the following. On this basis there are no remaining planning acoustic considerations impeding commencement of this project.

Document	RT&A Comment
Site Plan P1017-01-001-01, received from Bookaar Renewables Pty Ltd in October 2022	Updated drawings reviewed: no material changed which would alter the outcome of the assessment.
Officers Assessment Report, entitled 'Bookaar Solar Farm, Planning Permit Application No: PA2000997 520 Meningoort Road, Bookaar', dated 1 December 2021:	
<p><i>Noise</i></p> <p><i>Although the proposal will result in increased noise impacts in the surrounds, these are within allowable limits, as outlined in the Acoustic Report by Renzo Tonin & Associated, dated 9 August 2021. This report provides an assessment of the proposal against the Noise from Industry in regional Victoria (NIRV) guidelines.</i></p> <p><i>It is noted that at the time of assessment that the NIRV Guidelines have been superseded by EPA Publication 1826.4 (May 2021) Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues. This publication, in relation to the circumstances of this proposal, has not altered the methodology used to calculate maximum allowable noise impacts of the proposal in a way that would affect the outcomes of such calculations. ...</i></p>	<p>This report (r9) has been updated to refer to EPA Pub. 1826.4 Noise Protocol, which superseded NIRV.</p> <p>There are no material changes as a result of this update</p>
<p><i>Compliance against the relevant noise criteria of the NIRV has been demonstrated in all instances by a fair margin. The modelling is at the worst affected locations; compliance at these locations would mean compliance with other sensitive receivers further afield. As such, it is concluded that the proposal's noise impacts are acceptable.</i></p>	Satisfactory; no additional comment
<p><i>However, conditions should be imposed on any permit issued requiring:</i></p> <p>i) <i>A pre-construction noise assessment to ensure that the final design of the facility, including selection of battery and inverter equipment, as shown on plans that will be required under Condition 1 of any permit issued, complies with the EPA's new Noise Standard</i></p> <p>ii) <i>a post-construction noise assessment to ensure that the use of the facility is compliant with the Environment Protection Regulations 2021 (as amended).</i></p>	These conditions are observed to be included in Corangamite Planning Permit PA2000997 for the Subject Land, dated 14 August 2022.
<p><i>Vibration</i></p> <p><i>Given the scale, nature and location of the proposal and its components, as well as its relationship to other sensitive receivers, it is not expected that there will be any significant or discernible vibration impacts. The submitted Acoustic Report did however make comment with regards to vibration during the construction phase of the development and recommended that construction during Saturday 1-5pm is limited to low noise works. As Corangamite Shire does not have local laws governing construction noise, permit conditions will require the Construction Management Plan to include this requirement.</i></p>	<p>Satisfactory; no additional comment.</p> <p>Condition observed to be included in Corangamite Planning Permit PA2000997 for the Subject Land, dated 14 August 2022.</p>

(continued overleaf)

Document	RT&A Comment
Corangamite Planning Permit PA2000997 for 520 Meningoort Road, Bookaar (Subject Land), dated 14 August 2022	
<i>Operational noise</i>	Addressed:
4) <i>The use of the land must at all times comply with the Environmental Protection Authority's EPA Publication 1826.4 Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues (the Noise Standard).</i>	Satisfactory; no additional comment. (this condition is set out to aid Council enforcement if required)
5) <i>Prior to the endorsement of plans in accordance with condition 1 of this permit, an updated predictive noise assessment report must be provided to the Minister for Planning and Corangamite Shire Council that:</i>	Addressed:
a) <i>is modelled using the final design layout and electrical components for the facility</i>	We are advised that the Site Plan provided in Oct 2022 is the final design layout (Condition addresses the Officers Assessment Report item i above).
b) <i>demonstrates the proposal will comply with the Noise Standard at all times without relying on limiting the operating capacity of any part of the facility</i>	This Report document demonstrates compliance with the Noise Standard (EPA Pub. 1826.4 Noise Protocol) at all times without relying on limiting the operating capacity of any part of the facility, on the basis of the assessed configuration.
c) <i>provides details of any noise attenuation measures that need to be implemented to achieve compliance with the Noise Standard.</i>	This Report documents that no additional measures are required with the assessed configuration.
<i>All measures relied on to achieve compliance with the Noise Standard must be shown on the endorsed plans under condition 1, and implemented to the satisfaction of the responsible authority.</i> <i>The Predictive Noise Assessment must be made available to the public.</i>	No additional comment. Action by others.
7) <i>Within 1 year of the commencement of the use, a Post-Construction Acoustic Assessment Report must be prepared by a suitably qualified acoustic engineer and must be submitted to the Minister for Planning and Corangamite Shire Council, demonstrating compliance with the Noise Standard at all times. The Acoustic Report must be made available to the public. The report must assess the compliance of the use with the Noise Standard and, where necessary, make recommendations to limit the noise impacts in accordance with the Noise Standard. If recommendations to limit the noise impacts are made, they must be implemented to the satisfaction of the Minister for Planning and Corangamite Shire Council.</i>	(Condition addresses the Officers Assessment Report item ii above). No additional comment. To action once constructed.
<i>Construction Environment Management Plan</i>	
20) <i>The Environment Management Plan must include ...</i>	

Document	RT&A Comment
<p>a) <i>Procedures to manage noise emissions and vibration generally in accordance with the requirements of the Noise Control Guidelines (EPA Publication 1254) and the Environmental Guidelines for major construction sites (EPA Publication 480), including that the requirement that only low noise works are undertaken during construction on Saturdays between 1pm and 5pm</i></p>	<p>(Condition addresses the Officers Assessment Report item under 'Vibration' heading above).</p> <p>Note that EPA 1254 and 480 are superseded, but the superseding EPA 1834 has materially the same recommendations. EPA 1254, 480 and 1834 addressed in this Report.</p>

Executive summary

Renzo Tonin & Associates was engaged by Bookaar Renewables Pty Ltd to undertake an acoustic assessment of the proposed 220MWac (282 MWdc) Solar Farm in Bookaar, Victoria (Corangamite Shire) (the Proposal). The assessment responds to the DELWP 'Solar Energy Facilities - Design and Development Guideline - August 2019' (the Guideline). The Guideline states:

The design response should also include one or more written reports and assessments including: ... an assessment of:

- *an assessment of potential noise impacts ... EPA Victoria's Noise from industry in regional Victoria ... (EPA Pub 1411 'NIRV')*
- *construction management plan... EPA Victoria's Environmental Guidelines for Major Construction Sites has best-practice guidelines for general construction. ... (EPA Pub 480)*

The assessment comprised:

- Review of the surroundings, the Subject Site and Proposal
- Determination of relevant noise criteria:
 - EPA 1826 Noise Protocol (and superseded NIRV) noise limits
 - Construction noise and vibration criteria
- Assessment of the operational noise from the Proposal
- Recommendations with respect to noise and vibration during the construction phase

On the basis of the assessed configuration, it considered that the Proposal is very low risk with respect to operational and construction noise and vibration, and can operate without unreasonable acoustic impact on residential amenity.

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1 Introduction

Renzo Tonin & Associates was engaged by Bookaar Renewables Pty Ltd (the Proponent) to undertake an acoustic assessment of the proposed 220MWac (282 MWdc) Solar Farm (the Proposal) encompassing part of 520 Meningoort Road, Lots 51 and 52 and Res 1 on LP4677 and adjacent parts of Meningoort Road, Bookaar (the 'Site') (Corangamite Shire). The assessment responds to the DELWP 'Solar Energy Facilities - Design and Development Guideline - August 2019' (the Guideline).

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Context

2.1 Application history

It is understood that the Proposal follows from an earlier design for a solar farm (the Previous Application) on the same site. The Previous Application was the subject of a 2019 Victorian Civil and Administrative Tribunal (VCAT) hearing (Bookaar Renewables Pty Ltd vs Corangamite SC[2019] VCAT 1244). The VCAT decision was not in favour of the Previous Application (noting the decision was not based on acoustic matters) and, therefore, revised plans have been prepared for a new application.

With regard to noise, the VCAT decision noted the following of the Previous Application:

- *"Clause 13.05 of the scheme addresses noise abatement. Clause 53.13-3 requires us to consider the effect of the proposal on the surrounding area in terms of, amongst other things, noise.*
- *We have not been persuaded that there are specific impacts in terms of noise that will affect amenity or neighbours. The proposal is well separated from dwellings in terms of the potential for any noise intrusions."*

As noted, this assessment considers the new plans (the Proposal), however its conclusions are in line with those reached by the Tribunal above. This is due to the Proposal being within the same footprint as the Previous Application, and remaining a proposal for a solar farm of the same scale, as described in Section 2.2 below.

2.2 The Proposal

Bookaar Renewables Pty Ltd is proposing to develop a 220MW solar energy facility (the 'Proposal'), located within the 'Farming Zone'.

Renzo Tonin & Associates has been provided with the following briefing with respect to the Proposal (refer to the 'Site Plan' accompanying the planning report for detail):

- 'Array Areas', containing Photovoltaic (PV) panels mounted on a single axis tracking system with a maximum height of 4 m above natural ground at maximum tilt. The tracking system would be supported by piles driven into the ground. Row spacing is either 12.75 m or 13 m (pile to pile);
- 82 inverters located centrally throughout the Site in pairs at 41 locations across the Site (inverter stations). Inverter stations are located at least 170 m from the Site boundary;
- Below ground cabling connecting the PV panels between trackers and inverters;
- Below ground cabling connecting the inverters to the substation;
- An internal track network of all-weather gravel tracks (4 m), including a perimeter track which forms part of a 10 m wide defendable Asset Protection Zone (APZ) that surrounds the Site;
- Four (4) gated main site access points via Meningoort Road;
- Four (4) gated emergency access points along the western boundary of the Site;
- Eight dedicated water tanks for firefighting (maximum of 3.6m high), located adjacent to each access point;
- A perimeter security fence 2.5 m high (chain mesh);
- Perimeter vegetation screens (15 m wide with 4 rows of trees and maintained to a height of at least 4 m), planted on the outside of the security fencing;
- Agricultural style fencing 1.2 m high, around the perimeter of the vegetation screens and the perimeter of the existing vegetation on the Site's western boundary;
- A SCADA system that will gather, monitor and analyse data generated through operating the Proposal;
- On-demand, downward facing lighting (restricted to 4m in height); and
- Sensor triggered CCTV security cameras located around the perimeter of the Site and adjacent to key infrastructure.

Substation Area (1.76 ha):

- Substation connecting the Proposal to the onsite 220KV transmission line, via two (2) new high voltage (HV) 220 kV transmission lines;
- A Control building (up to 5 m high);
- Substation Operations and Maintenance building (up to 5 m high);
- A security fence (chain mesh) up to 2.5 m high, enclosing the Substation;
- A 10 m wide defendable APZ around the perimeter of the Substation; and
- Parking for 5 vehicles.

Battery Area (0.91 ha):

- A series of separate containerised battery units, connected by underground cables to the Substation (approximately 2.5 m high);
- A separate transformer adjacent to each battery; and
- A 10m defendable APZ around the perimeter of the Battery Area.

Operations Buildings Area (0.96 ha):

- A Site office building including amenities with a height of 3.6 m;
- A maintenance building and workshop with a height of 5 m;
- 3 Storage sheds with a height of 4.1 m;
- Car parking for twelve (12) vehicles;
- A septic tank and potable water tank;
- A defendable APZ of 20 m, which allows the area to function as the nominated 'Shelter in Place' location (see Bushfire Risk Assessment and Mitigation Plan).

In addition to the key components outlined above, there will be a temporary construction compound (1.44 ha) to facilitate the construction phase of the Proposal. The construction compound would include:

- Temporary construction offices (up to 5 m high);
- Car and bus parking areas for construction vehicles (51 workers cars, 5 mini vans; and additional parking space provided for delivery vehicles and construction machinery);
- Staff amenity block including portable toilets, showers and a kitchen, designed for peak staff numbers during the construction period; and
- Laydown areas.

Once the Proposal is operational, the construction compound will be decommissioned and revegetated.

The Proposal would take approximately 12 months to construct and would be operational for approximately 28 years. Following the operational period, all above ground infrastructure would be removed from Site, which would take approximately 12 months.

3 Overview of site and surrounds

Renzo Tonin & Associates has based its assessment of the Proposal on the drawing set P1017-01 dated June 2021 by NG Electrical Pty. Ltd and the Proposal description provided in Section 2. The Proposal includes the following items relevant to acoustics:

- Approximately 640,000 panels supported by approximately 5724 x NEXTracker Gemini 2P tracker motors
- 82 x SMA Sunny Central 2750-EV inverters
- A substation area including up to 2 x 110 MVA transformers
- A battery area including:
 - Up to 88 x 1.2 MW inverters
 - Up to 88 x 2.5 MWH batteries
 - Up to 44 x transformers

The Proposal will have the capacity to generate electricity during day light hours. This will predominantly be during day and evening periods (7am-6pm and 6pm-10pm, respectively) throughout the year and potentially part of the night-time period (prior to 7am) during the summer months. Batteries could potentially operate at all times.

Nearby dwellings relevant for the assessment were identified using aerial maps and are presented in Table 1. As noise reduces with distance, assessment of noise levels at these dwellings also addresses noise impacts at more distant dwellings.

Table 1: Dwellings near the Proposal

ID	Address	Approximate distance to Site	Zone
N ¹	520 Meningoort Road, Bookaar 3260 – landowner property	800 m	Farm Zone 1 (FZ1)
B	391 Darlington Road, Bookaar 3260	1280 m	Farm Zone 1 (FZ1)
E ¹	599 Darlington Road, Bookaar 3260	450 m	Farm Zone 1 (FZ1)
G	699 Darlington Road, Bookaar 3260	1210 m	Farm Zone 1 (FZ1)
I ¹	745 Darlington Road, Bookaar 3260	890 m	Farm Zone 1 (FZ1)
K ^{1,2}	905 Darlington Road, Bookaar 3260	630 m	Farm Zone 1 (FZ1)
L ¹	924 Darlington Road, Bookaar 3260	840 m	Farm Zone 1 (FZ1)

Notes: As noise reduces with distance, assessment of noise levels at these dwellings also addresses noise impacts at more distant dwellings.

1. Dwelling is within 1km of the Subject Site boundary. Dwelling IDs match those used in the 'Amenity Report'
2. Dwelling is located approximately 50 m from proposed upgrade works to Meningoort Road (north)

Figure 1, overleaf, presents an overview of the Subject Site and surrounding land uses.

Figure 1: Overview of the Site and dwellings assessed



Note: Dwelling 'E' is the closest dwelling (approximately 450m from the Proposal).

4 Noise criteria

4.1 Planning scheme

As noted in Section 2, the VCAT decision for the Previous Application noted the following with respect to acoustics (para. 342 -343):

- *"Clause 13.05 of the scheme addresses noise abatement. Clause 53.13-3 requires us to consider the effect of the proposal on the surrounding area in terms of, amongst other things, noise.*
- *We have not been persuaded that there are specific impacts in terms of noise that will affect amenity or neighbours. The proposal is well separated from dwellings in terms of the potential for any noise intrusions."*

With respect to Corangamite Planning Scheme Clauses mentioned above:

- Clause 13.05-1S references the following acoustic criteria documents:
 - *State Environment Protection Policy (Control of Music Noise from Public Premises) No. N-2*
 - o Music noise policy – not applicable to the Proposal
 - *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 in metropolitan Melbourne*
 - o Applicable within the Melbourne Metropolitan boundaries, not Corangamite.
 - *Interim Guidelines for Control of Noise from Industry in Country Victoria (Environment Protection Authority, 1989)*
 - o Superseded by Noise from Industry in Regional Victoria (NIRV), which is addressed in this acoustic report
 - *A Guide to the Reduction of Traffic Noise (VicRoads 2003)*
 - o Not applicable to the Proposal
- Clause 53.13-3 sets out the following decision guidelines with respect to acoustics:
 - *"The effect of the proposal on the surrounding area in terms of noise, ..."*
 - o Addressed in this acoustic report.
 - *"Solar Energy Facilities Design and Development Guideline (Department of Environment, Land, Water and Planning, August 2019)"*
 - o Addressed in this acoustic report.

4.2 DELWP Solar Energy Facilities – Design and Development Guideline

The Department of Environment Land Water and Planning (DELWP) *Solar Energy Facilities – Design and Development Guideline, 2019* (the 'Guideline') provides an overview of the policy, legislative and statutory planning arrangements for solar energy facilities in Victoria. The Solar Facilities Guideline states the following in relation to acoustics:

- *"Noise*
A facility should keep its noise impacts at or below the levels in EPA Victoria's Noise from industry in regional Victoria guideline [see Section 4.3]. Noise attenuation measures could include:
 - *ensuring any components operate to relevant standards*
 - *acoustic housing or baffles at the noise source*
 - *conducting maintenance and other operational activity during the daytime*
 - *using landscaping or locating noisier components centrally within a site"*
- *"Construction noise and dust management*
To address impacts on nearby sensitive land uses, a proponent should reduce the potential noise from vehicles servicing the site, from fixed machinery onsite and from construction activities, for example by limiting times when noisy operations are allowed. It should also engage with stakeholders to address any potential impacts... The EMP should outline measures to address noise and the disturbance of dust and sediment during construction and operation of the facility.
EPA Victoria's Environmental Guidelines for Major Construction Sites has best-practice guidelines for general construction" [see Section 4.4]

4.3 EPA Publication 1826 industrial noise

From 1 July 2021, EPA Publication 1826 *'Noise Limit and Assessment Protocol for the Control of Noise from Commercial, Industrial and Trade Premises and Entertainment Venues'* (EPA Pub. 1826) superseded:

- State Environmental Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1), and
- EPA Publication 1411, *'Guidelines: Noise from Industry in Regional Victoria'* (NIRV)

For this assessment's application, EPA Publication 1826 (1826-P1) uses the same methods to assess noise impacts as the superseded noise policies, but with slight amendments to the durations of day, evening & night; differences immaterial for this assessment.

Since the Subject Site is not located in a Major Urban Area (ie. <7,000 population), applicable noise limits for commercial activity are set out in Part 1, Section 2 of EPA Publication 1826 *'Noise Limit and Assessment Protocol for the Control of Noise from Commercial, Industrial and Trade Premises and Entertainment Venues'* (1826-P1) following the 'rural area method'. The applicable noise criteria are presented in Table 2, which are applicable for mechanical services and on-site commercial activities.

Table 2: EPA 1826 Noise Protocol and NIRV commercial noise limits

Noise generating planning zone	Noise receiving planning zone	Period	Noise criteria, L_{eq} dB(A)
Farming Zone (FZ)	Farming Zone (FZ)	Day	46
		Evening	41
		Night	36
EPA 1826-P1 period definitions:	Day:	Monday-to-Saturday 7am-to-6pm;	Sundays NA
	Evening:	Monday-to-Saturday 6pm-to-10pm;	Sundays or Holidays 7am-to-10pm
	Night:	All days 10pm-to-7am	

EPA 1826-P1 night-time noise limits are more stringent than that of the day or evening periods. As such, compliance during the night-time period implies compliance during the day and evening periods, provided that emitted noise levels do not vary. For this assessment the applicable location of assessment is outside surrounding dwellings, assessed over a 30-minute period.

4.4 Construction noise and vibration

There are currently no objective legislative requirements to limit noise and vibration from construction in Victoria however there are Guidelines that set out best practice and are considered below.

We note that EPA Pub. 1834 '*Civil Construction, Building and Demolition Guide*' superseded:

- EPA Pub. 480 '*Environmental Guidelines for Major Construction Sites*'
- EPA Pub. 1254 '*Noise Control Guidelines*'

Since EPA 480 and 1254 are referenced in the permit conditions, we will document requirements set out in 1834, 480 and 1254.

4.4.1 EPA Civil construction, building and demolition guide, Publication 1834

From November 2020, EPA Publication 1834 '*Civil construction, building and demolition guide*' (EPA Pub. 1834) superseded:

- EPA Publication 480, '*Environmental Guidelines for Major Construction Sites*' (EPA Pub 480)
- Section 2 of EPA Publication 1254 *Noise Control Guidelines (October 2008)* (EPA Pub 1254)

The DELWP '*Solar Energy Facilities – Design and Development Guideline*' states that "...EPA Victoria's *Environmental Guidelines for Major Construction Sites* has best-practice guidelines for general construction"

The Civil construction, building and demolition guide (EPA Pub 1834) states:

"New environment protection laws mean that anyone engaging in an activity that poses risk of harm to human health and the environment, from pollution or waste, must eliminate or reduce that risk. The **general environmental duty** applies to all Victorians.

It is your responsibility to understand and assess your risks. This includes understanding how your activities can impact land, water and air quality, or cause harm from waste or excessive noise.

You also need to eliminate or reduce risk as far as reasonably practicable. You can do this by putting appropriate controls in place that are proportionate to the risk.



















Your approach to managing risk will depend on the complexity and scale of your activities or project, as well as the nature of the risks you need to manage."

Section 4.2 of EPA Pub. 1834 sets out the following key aspects to consider when planning a project:

- Identifying people and sensitive environments (sensitive receivers) that could be affected by your activities
- Carrying out appropriate engagement as early as possible
- Avoiding the generation of noise and vibration
- Facilitating construction during normal working hours, where possible
- Reducing noise and vibration by using the most appropriate equipment and work practices for your activities
- Choosing alternative equipment or methods that generate less noise or vibration
- Maintaining equipment and vehicles according to manufacturer's instructions
- Attenuating noise by obstructing the path between noise source and receiver

- *Mitigating offsite noise with measures such as respite offers and acoustic treatment*
- *Considering alternatives if noise and vibration cannot be reduced through avoidance, reduction or attenuation*

Section 4.3 of EPA Pub. 1834 provides (within Table 4.1) the working hours schedule for construction, building and demolition noise, reproduced below:

 Minimise noise and vibration as far as possible in any situation	
Normal working hours for all civil construction, building and demolition activities.	
 →  Monday to Friday, 7 am – 6 pm	
 →  Saturday, 7 am – 1 pm	 →  Saturday, 9 am – 1 pm
Normal working hours for: <ul style="list-style-type: none"> • works for commissioning or construction of major infrastructure projects • commercial and industrial construction and demolition sites • demolition works on an existing commercial or industrial site that is intended for residential redevelopment • construction works for large-scale residential developments in non-residential zones • commercial and industrial land subdivision. 	Normal working hours for: <ul style="list-style-type: none"> • residential construction and demolition sites • residential or mixed-use development in residential zones, including urban infill and redevelopments • land preparation on infill and smaller residential developments • land preparation for residential subdivision, not including works to construct or upgrade a road • residential construction in a large-scale fringe residential subdivision, once the road servicing the residential development is complete.
 Minimise noise and vibration as far as possible in any situation	
Outside normal working hours for all civil construction, building and demolition activities.	
 →  Monday to Friday, 6 pm – 10 pm	
 →  Saturday, 1 pm – 10 pm	 →  Saturday, 1 pm – 8 pm
 →  Sundays and public holidays, 7 am – 10 pm	 →  Sundays and public holidays, 9 am – 8 pm
Applies to: <ul style="list-style-type: none"> • works for commissioning or construction of major infrastructure projects • commercial and industrial construction and demolition sites • demolition works on an existing commercial or industrial site that is intended for residential redevelopment • construction works for large-scale residential developments in non-residential zones • commercial and industrial land subdivision. See section 4.4 for conditions to apply within these hours and for works outside these hours.	Working hours providing that the activities do not result in unreasonable noise for: <ul style="list-style-type: none"> • residential construction and demolition sites • residential or mixed-use development in residential zones, including urban infill and redevelopments • land preparation on infill and smaller residential developments • land preparation for residential subdivision • residential construction in a large-scale fringe residential subdivision. See section 4.4. No works to be conducted after 8 pm unless they are inaudible.

Section 4.3.3 of EPA Pub. 1834 sets out the following noise source controls to help achieve the objectives:

- *Undertake preparatory work offsite where there is low potential for impacting people (e.g., formwork, cutting or prefabrication of materials offsite prior to transporting to the construction site)*
- *Connect to the electricity grid as early as possible to avoid the use of diesel generators.*
- *Restrict areas where mobile plant can operate so that it is away from people who could be affected by noise.*
- *Locate site vehicle access and waiting areas away from people who could be affected by noise.*
- *Plan vehicle movements to avoid manoeuvres and idling at location nearest to nearby people.*
- *Use quieter equipment or methods. This may require considering*
 - *buying or leasing quieter equipment*
 - *avoiding metal-to-metal and metal-to-stone contact*
 - *installing mufflers*
 - *reducing throttle and turning off equipment when not in use*
 - *placing things down rather than throwing*
 - *educating drivers to use driving practices that minimise noise*
- *Use low noise saw blades*
- *Use electrical equipment rather than equipment driven by a diesel generator.*
- *Use low noise emitting generators*
- *Use effective alternatives to 'beeper' alarms (e.g., broadband alarms, proximity sensors).*
- *Avoid using reversing alarms by designing site layout to avoid reversing (e.g., drive-through for parking and deliveries).*
- *Maintain equipment by:*
 - *inspecting regularly and maintaining equipment to ensure good working order*
 - *checking machines with enclosures, including doors & door seals and that the door closes properly against seals*
 - *maintaining air lines on pneumatic equipment so they do not leak.*
- *Maintain vehicles by:*
 - *considering good working conditions of mufflers*
 - *securing loose parts that may rattle.*
- *Limit noise caused by people onsite. This may include procedures to:*
 - *avoid yelling and shouting onsite (note: if people onsite need to shout to hear each other over the site ambient noise, it is possible the noise level may be putting their hearing at risk)*
 - *minimising the use and volume of any electrical amplified sound-reproducing equipment, for example radios, stereos, televisions, or public address systems*
- *Plan transport and haulage routes to minimise the number of trucks/vehicles. Where there are large numbers of truck movements, consider truck route and truck waiting protocols (e.g., engines on/off and restart requirements).*
- *Implement substitute methods taking into consideration:*
 - *alternatives to rock-breaking work methods, such as hydraulic splitters for rock and concrete, hydraulic jaw crushers, chemical rock and concrete splitting, and controlled blasting such as penetrating cone fractures. The suitability of alternative methods should be considered on a case-by-case basis, including what potential risks they involve.*
 - *alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electrical generator located away from nearby people*

Section 4.3.4 of EPA Pub. 1834 sets out the following vibration and regenerated noise source controls to help achieve the objectives:

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

Section 4.3.5 of EPA Pub. 1834 sets out the following noise reduction between noise source and receiver controls to help achieve the objectives:

- *Plan to have as much distance as possible between plant, equipment or other noisy activities and people who could be affected by noise.*
- *Maximise shielding taking into consideration:*
 - *topography of the site (e.g., use of earth mounds as barriers)*
 - *existing structures, temporary buildings, and material stockpiles*
 - *early construction of permanent walls so they can be used as early as possible as noise barriers*
 - *avoiding placing noise-producing equipment in locations where reflected noise will increase noise exposure or reduce the effectiveness of mitigation measures.*
- *Prioritise construction of structures such as buildings and walls that can contribute to shielding noise from the construction site.*
- *Obstruct the transmission path of sound (e.g., using acoustical walls or barrier, flexible noise barriers such as noise curtain or blankets, acoustic sheds, or enclosures. See Figure 4.2 and Figure 4.3.*
- *Protect noise sensitive receivers (e.g., increasing window sound insulation by retrofitting acoustic glazing or suitable double glazing).*

Table 3: EPA Pub. 1834 - operation schedule and noise guidelines

Normal working hours	Weekend/evening work hours	Night period
Monday to Friday, 7am – 6pm Saturday, 7am – 1pm	Noise level from non-residential construction at any residential premises is not to exceed background noise by: <ul style="list-style-type: none"> • 10dB(A) or more for up to 18 months after project commencement • 5dB(A) or more after 18 months during the hours of: <ul style="list-style-type: none"> • 6pm – 10pm Monday to Friday • 1pm – 10pm Saturdays • 7am – 10pm Sundays and public holidays 	Noise inaudible (see definition below) within a habitable room of any residential premises during the hours of: <ul style="list-style-type: none"> • 10pm – 7am Monday to Friday • 10pm – 7am Saturdays, Sundays and public holidays

4.4.2 EPA Environmental Guidelines for Major Construction Sites, Publication 480

The DELWP *Solar Energy Facilities – Design and Development Guideline* states that “...EPA Victoria’s *Environmental Guidelines for Major Construction Sites* has best-practice guidelines for general construction”

The Environmental Guidelines for Major Construction Sites (EPA Pub. 480) states:

“While no specific statutory controls exist for noise from construction sites, all noise nuisance should be reduced wherever possible from vehicles, fixed machinery within the site, blasting, general construction activities, and from movements of vehicles servicing the site.”

EPA Pub. 480 sets out the following suggested measures, with the objective to “...ensure nuisance from noise and vibration does not occur”:

- *“Fit and maintain appropriate mufflers on earth-moving and other vehicles on the site*
- *Enclose noisy equipment*
- *Provide noise attenuation screens, where appropriate*
- *Where an activity is likely to cause a noise nuisance to nearby residents, restrict operation hours to between 7am and 6pm weekdays and 7am to 1pm Saturday, except where, for practical reasons, the activity is unavoidable*
- *Noise should not be above background levels inside any adjacent residents between 10pm and 7am*
- *Advise local residents when unavoidable out-of-hours work will occur*
- *Schedule deliveries to the site so that disruption to local amenity and traffic are minimised*
- *Conduct a study on the impact of ground vibration from construction activities, where these operations occur within 50 metres of a building and take appropriate action*
- *Minimise air vibrations”*

Per Section 5.5 of EPA Pub. 480:

- *“A British study has found that nuisance from ground vibration and building damage is unlikely to occur if the operation is conducted at distances greater than 50 metres.*
- *Complaints about air vibrations from blasting have been received from people 100 metres away from the activity.”*

It is understood that blasting is not proposed for the construction of the Proposal, therefore vibration and noise distance thresholds for typical construction activities are considered to be less onerous (ie. closer), than the 50 metres and 100 metres thresholds respectively.

4.4.3 EPA Noise Control Guidelines, Publication 1254

EPA Publication 1254 Noise Control Guidelines applies to:

- *“industrial and commercial premises*
- *large-scale residential premises under construction in non-residential zones, as defined in regulation 9 of the Environment Protection (Residential Noise) Regulations 2008.”*

As such EPA Pub. 1254 is understood not to be intended for application to major infrastructure projects such as the Subject Construction. However, EPA Pub. 1254 does present noise level targets, and non-prescriptive recommendations including, but not limited to:

- *“Inform potentially noise-affected neighbours about the nature of construction stages and noise reduction measures.*
- *Give notice as early as possible for periods of noisier works such as excavation. Describe the activities and how long they are expected to take. Keep affected neighbours informed of progress.*
- *Appoint a principal contact person for community queries.*
- *Provide 24-hour contact details through letters and site signage. Record complaints and follow a complaint response procedure suitable to the scale of works.*
- *Within normal working hours, where it is reasonable to do so:*
 - *Schedule noisy activities for less sensitive times, (for example, delay rock-breaking task to the later morning or afternoon)*
 - *Provide periods of respite from noisier works (for example, periodic breaks from jackhammer noise)*
- *The weekend/evening work hours in the schedule (including Saturday afternoon or Sunday) are more sensitive times and have noise requirements consistent with quieter work.*
- *The weekend/evening periods are important for community rest and recreation and provide respite when noisy work has been conducted throughout the week. Accordingly, work should not usually be scheduled during these times.*
- *Where work is conducted in a residential area or other noise-sensitive location, use the lowest noise work practices and equipment that meet the requirements of the job.*
- *Site building, access roads and plant should be positioned such that the minimum disturbance occurs to the locality. Barriers such as hoardings or temporary enclosures should be used. The site should be planned to minimise the need for reversing of vehicles.*
- *Site building, access roads and plant should be positioned such that the minimum disturbance occurs to the locality. Barriers such as hoardings or temporary enclosures should be used. The site should be planned to minimise the need for reversing of vehicles.*
- *All mechanical plant is to be silenced by the best practical means using current technology. Mechanical plant, including noise-suppression devices, should be maintained to the manufacturer's specifications. Internal combustion engines are to be fitted with a suitable muffler in good repair.*
- *Fit all pneumatic tools operated near a residential area with an effective silencer on their air exhaust port.*
- *Install less noisy movement/reversing warning systems for equipment and vehicles that will operate for extended periods, during sensitive times or in close proximity to sensitive sites. Occupational health and safety requirements for the use of warning systems must be followed.*
- *Turn off plant when not being used.*
- *All vehicular movements to and from the site to only occur during the scheduled normal working hours, unless approval has been granted by the relevant authority.*
- *Where possible, no truck associated with the work should be left standing with its engine operating in a street adjacent to a residential area.*
- *Special assessment of vibration risks may be needed, such as for pile-driving or works structurally connected to sensitive premises.”*

EPA Publication 1254 noise level targets are:

Table 4: EPA 1254 - operation schedule & noise guidelines

Normal working hours		Weekend/evening work hours	Night period
Mon-Fri	07:00-18:00 hours	Noise level at any residential premises is not to exceed background noise by 10dB(A) (for the first 18 months, 5dBA thereafter). During the hours of:	Noise inaudible within a habitable room of any residential premises during the hours of:
Sat	07:00-13:00 hours		
		Mon-Fri	18:00-22:00 hours
		Sat	13:00-22:00 hours
		Sun and Public Holidays	07:00-22:00 hours
			Mon-Sun 22:00-07:00 hours

4.4.4 Construction vibration

Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy, however, Australian Standard AS 2187.2 '*Explosives—Storage and use*', refers to British Standard BS 7385.2 '*Evaluation and measurement of vibration in buildings*' for prevention of minor or cosmetic damage occurring in structures from ground vibration.

Regarding application to heritage buildings, British Standard 7385.2 notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.*"

German Standard DIN 4150.3 '*Structural vibration in buildings - Effects on Structure*' also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative. Per DIN450.3 "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible. Exceeding the values in table 1 [provided in Table 7 below] does not necessarily lead to damage; should they be significantly exceeded; however, further investigations are necessary.*"

The tables overleaf present summaries of applicable BS 7385 and DIN 4150.3 criteria.

Table 5: BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	25 ⁽¹⁾	25 ⁽¹⁾	25 ⁽¹⁾
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	7.5 ⁽¹⁾ to 10 ⁽¹⁾	10 ⁽¹⁾ to 25 ⁽¹⁾	25 ⁽¹⁾

Note: 1. Presented noise levels are 50% lower than presented in BS 7385.2, as per BS 7385.2 Section 7.3.3 "*Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values ... may need to be reduced by up to 50%*"

Table 6: DIN 4150-3 structural damage criteria (recognised to be conservative)

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

Table 7: DIN 4150-3 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

Note: For gas and water supply pipes within 2 m of buildings, the levels given in Table 13 should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered. For long-term vibration the guideline levels presented should be halved.

Referring back to EPA Pub. 480 (See section 4.4.2 above):

- *"A British study has found that nuisance from ground vibration and building damage is unlikely to occur if the operation is conducted at distances greater than 50 metres.*
- *Complaints about air vibrations from blasting have been received from people 100 metres away from the activity."*

As it is understood that blasting is not proposed for the construction of the Proposal, vibration and noise distance thresholds for typical construction activities are considered to be much less onerous (ie. closer) than the 50 metres and 100 metres thresholds respectively.

5 Noise impact assessment

5.1 Noise propagation model

A CadnaA three-dimensional noise model, implementing ISO 9613 noise propagation algorithms was built, to calculate noise propagation from the Proposal to surrounding residential premises during the operational period. The built form of the Proposal and surrounding dwellings were integrated into the model. The following propagation effects were included in the predictive model:

- Mitigation of noise with distance, including geometrical spreading and air absorption (per ISO 9613)
- Reflections from buildings and environment (max. order 3 reflections)
- Barrier effects due to obstructions between noise sources and dwellings (predominantly due to topography)
- Ground absorption effects ($G=1.0$)
- Local topography (Topographic data for the Subject Site and surrounding area was in the form of 10-20m resolution contour lines from VicMaps.)

Appendix B presents a graphical overview of the noise model and noise model contours for reference.

5.2 Operational noise

Table 8 provides details of equipment and corresponding sound power levels which have been incorporated into this assessment. Equipment has been assumed to be distributed uniformly across the site except where equipment locations been indicated specifically in provided drawings.

Table 8: Equipment and associated sound power levels

Plant Item	Plant Description ¹	$L_{W,eq}$ Sound Power Levels, dB(A) re. 1pW
1	NEXTracker Gemini 2P tracker motors (5723 in total)	52 (each) ³
2	Inverter/power stations: SMA SC 2750-EV inverters (82 in total)	92 (each) ³
3	Substation area: 110 MVA transformers (2 in total)	96 (each) ^{2,4}
4	Battery area: 2.5 MWH battery storage units (88 in total)	87 (each) ²
5	Battery area: 1.2 MW inverters (88 in total)	88 (each) ²
6	Battery area: Transformers (44 in total)	83 (each) ^{2,4}

- Notes:
1. The above equipment and sound power levels are understood to be consistent with those proposed to be used
 2. Based on sound power level data from past projects and/or RT&A's acoustic database
 3. Based on sound power level data provided by the client or manufacturer
 4. +5dB correction applied to plant during assessment to account for tonality

Table 9 presents the predicted noise levels at the nearest dwellings. Since noise reduces with distance, assessment of noise levels at these dwellings also addresses noise impacts at more distant dwellings. As shown, noise levels conform with EPA 1826.4 Noise Protocol (and superseded NIRV) night time criteria and therefore also conform with day and evening criteria.

On the basis of the assessed configuration, without additional noise mitigation measures, it is considered that the Proposal can operate without adverse acoustic impact on residential amenity, and is

considered very low risk with respect to noise (and per Permit PA2000997 item 5b '*demonstrates the proposal will comply with the Noise Standard at all times without relying on limiting the operating capacity of any part of the facility*', on the basis of the assessed configuration). This is as a result of the significant intervening distances between the proposal and the nearest dwellings (approximately 450 metres to nearest dwelling), and location of noisier infrastructure away from boundaries with neighbouring properties.

Table 9: Predicted noise levels at dwellings from operation

Dwelling ID	Predicted noise levels, L_{eq} dB(A)	EPA 1826.4 Noise Protocol night time noise limits (most stringent), L_{eq} dB(A)	Complies?
N	32	36	✓
B	17	36	✓
E	28	36	✓
G	21	36	✓
I	27	36	✓
K	24	36	✓
L	22	36	✓

5.3 Construction noise and vibration

It is understood that the construction of the Proposal is to occur over 12 months, between the following hours:

- Mondays – Fridays: 7am – 6pm
- Saturdays: 7am – 5pm

During the standard building activity hours (Weekdays 7am-6pm; Saturdays 7am-1pm), there are no quantitative noise criteria and therefore noise monitoring is not mandatory during these hours.

Between 1pm and 5pm on Saturdays, EPA Pub. 1834 and 1254 recommends construction noise levels at dwellings be limited to:

- $L_{eq} \leq L_{90} + 10\text{dB(A)}$ for the first 18 months
- $L_{eq} \leq L_{90} + 5\text{dB(A)}$ after the first 18 months

It is therefore recommended that only low noise works occur during the Saturday 1pm-to-5pm period. Decommissioning is expected to occur over a similar 12 month period and the same recommendations would apply. In consideration of local stakeholders, it is understood that Heavy Goods Vehicles (HGV) and Meningoort Road/ Darlington Road upgrade works (to occur over only an 18 day period) will be managed to standard construction hours (Weekdays 7am-6pm; Saturdays 7am-1pm).

With consideration of the significant distance to dwellings, and with implementation of appropriate noise management strategies (see Section 4.4.1 and 4.4.2 for examples), construction of the Proposal and associated access upgrades, is considered very low risk with respect to noise and adverse acoustic impact on residential amenity.

Referring to EPA Pub. 480 (See section 4.4.2 above):

- *"A British study has found that nuisance from ground vibration and building damage is unlikely to occur if the operation is conducted at distances greater than 50 metres.*
- *Complaints about air vibrations from blasting have been received from people 100 metres away from the activity."*

As It is understood that blasting is not proposed for The Proposal, vibration and noise distance thresholds for typical construction activities are much less onerous than the 50 metres and 100 metres thresholds respectively.

The Proposal is considered very low risk with respect to construction noise and vibration impact on the basis of

- The Proposal commitment to construction noise and vibration management strategies consistent with EPA Pub 1834, 1254 and 480
- The significant intervening distance between the Proposal and nearest dwellings (approximately 450 metres to the nearest)
- The significant intervening distance between road upgrade works on Meningoort Road (north) and to the intersection of Meningoort Road and Darlington Camperdown Road and the nearest dwelling (approximately 50 metres at the minimum distance to 'Dwelling 'K').
- A Proposal commitment to limit HGV construction movements and roadworks to standard construction hours.

6 Conclusion

Renzo Tonin & Associates was engaged by Bookaar Renewables Pty Ltd to undertake an acoustic assessment of the proposed 220MWac (282 MWdc) Solar Farm in Bookaar, Victoria (Corangamite Shire) (the Proposal). The assessment responds to the DELWP 'Solar Energy Facilities - Design and Development Guideline - August 2019' (the Guideline). The Guideline states:

The design response should also include one or more written reports and assessments including: ... an assessment of:

- *an assessment of potential noise impacts ... EPA Victoria's Noise from industry in regional Victoria ... (EPA Pub 1411 'NIRV')*
- *construction management plan... EPA Victoria's Environmental Guidelines for Major Construction Sites has best-practice guidelines for general construction. ... (EPA Pub 480)*

The assessment comprised:

- Review of the surroundings, the Subject Site and Proposal
- Determination of relevant noise criteria:
 - EPA 1826 Noise Protocol (and superseded NIRV) noise limits
 - Construction noise and vibration criteria
- Assessment of the operational noise from the Proposal
- Recommendations with respect to noise and vibration during the construction phase

On the basis of the assessed configuration, it considered that the Proposal is very low risk with respect to operational and construction noise and vibration, and can operate without unreasonable acoustic impact on residential amenity.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.		
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level if measured as an overall level or an L90 noise level when measured in octave or third-octave bands.		
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our environment:		
	threshold of hearing	0 dB	The faintest sound we can hear, defined as 20 micro Pascal
		10 dB	Human breathing
	almost silent	20 dB	
		30 dB	Quiet bedroom or in a quiet national park location
	generally quiet	40 dB	Library
		50 dB	Typical office space or ambience in the city at night
	moderately loud	60 dB	CBD mall at lunch time
		70 dB	The sound of a car passing on the street
	loud	80 dB	Loud music played at home
		90 dB	The sound of a truck passing on the street
	very loud	100 dB	Indoor rock band concert
		110 dB	Operating a chainsaw or jackhammer
	extremely loud	120 dB	Jet plane take-off at 100m away
	threshold of pain	130 dB	
140 dB		Military jet take-off at 25m away	
dB(A)	A-weighted decibel. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the “A” filter. A sound level measured with this filter is denoted as dB(A). Practically all noise is measured using the A filter.		
Reflection	Sound wave reflected from a solid object obscuring its path.		
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.		
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 pico watt.		
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 micro Pascals.		
Tonal Noise	Sound containing a prominent frequency and characterised by a definite pitch.		

APPENDIX B Operational noise level contours

Figure 2: Noise level contours predicted from operation

