Noise Assessment

Avonlie Solar Farm
Narrandera NSW

Prepared for: NGH Environmental Pty Ltd
April 2018

MAC
Muller Acoustic Consulting

Document Information

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Avonlie Solar Farm, Narrandera NSW.

Prepared for: NGH Environmental Pty Ltd
Suite 1, 39 Fitzmaurice Street
Wagga Wagga NSW 2650

Prepared by: Muller Acoustic Consulting Pty Ltd
PO Box 262, Newcastle NSW 2300
ABN: 36 602 225 132
P: +61 2 4920 1833
www.mulleracoustic.com

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MAC180605RP1	Draft	30 April 2018	Rod Linnett		Oliver Muller	

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by NGH Environmental Pty Ltd (NGH) on behalf of RES Australia Pty Limited (RES) to complete a Noise Assessment (NA) for the proposed Avonlie Solar Farm near Narrandera, NSW (the 'project'). This report presents the methodology and findings of the NA for the construction and operation of the project.

1.1 Purpose and Objectives

A NA is required as part of the Environmental Impact Statement (EIS) for the project. The NSW Department of Planning and Environment (DPE) issued the Secretary's Environmental Assessment Requirements (SEARs) 9th February 2019. The SEARs in relation to noise assessment require the EIS to address specific issues and states:

> *including an assessment of the construction noise impacts of the development in accordance with the Interim Construction Noise Guideline (ICNG) and operational noise impacts in accordance with the NSW Noise Policy for Industry 2017 and a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria.*

The purpose of the NA is to quantify potential environmental noise levels associated with the construction and operation of the project.

Where impacts are identified, the assessment includes recommendations for potential noise mitigation and management measures.

1.2 Scope of the Assessment

The NA includes the following key tasks:

- review construction and operating activities to identify noise generating plant, equipment, machinery or activities proposed to be undertaken as part of the project;
- identify the closest and/or potentially most affected receptors situated within the area of influence to the project;
- establish existing noise levels to determine project-specific construction Noise Management Levels (NMLs), and operational noise criteria;

- undertake 3D noise modelling to predict levels that may occur as a result of the construction and operation of the project at the closest and/or potentially most affected receptors;
- provide a comparison of predicted noise levels against relevant construction NMLs and operational criteria;
- assess the potential noise impacts associated with construction and operational aspects of the project; and
- provide feasible and reasonable noise mitigation and management measures, and monitoring options, where NMLs or operational criteria may be exceeded.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A.**

2 Project Description

2.1 Background

RES proposes to construct and operate a 200 Megawatt (MW) solar farm using photovoltaic (PV) technology at a 500 hectare site at Avonlie, NSW.

The project is located within the Narrandera Local Government Area (LGA) and is approximately 20km south east of Narrandera town centre. The project site consists of approximately 633 hectares which is currently used for agriculture, specifically grazing. The solar farm will occupy up to 530 hectares of the project site.

2.2 Description of Proposed Construction Works

The project includes installation of groups of north facing PV modules (approximately 2m x 1m) on mounting structures up to approximately 4m in height. An estimated 700,000 PV panels will be installed using fixed panels or tracking panels, or a combination or both. The PV mounting structure would comprise steel posts driven up to approximately 2.5m below ground using a small pile driver. Additional support structures would be attached to the piles, which would then support the PV panels.

Earthworks will primarily involve trenching which is required for cabling of each PV array/module to inverters and a substation. Other minor earthworks would be completed for the preparation of the site and in most cases a concrete slab would be required to support the ancillary infrastructure. Most of the infrastructure would be pre-fabricated off-site, delivered and assembled on-site.

It is anticipated that the solar farm would be constructed in one-hectare stages, with up to 10 stages in construction at any one time over a 12 to 18 month period during standard construction hours.

All vehicles would access the project from Muntz Road, via Sandigo Road, a sealed two-way road which joins the Sturt Highway (A20) 1.5km east of the project during construction and operational phases.

During construction, traffic generated by the project would include employee and delivery vehicles. During the peak construction period, the daily traffic volume is expected to be up to 80 heavy vehicles (mostly semi-trailers) and 50 light commercial vehicles or equivalent mini buses for worker transport.

There are no noise sensitive receivers along the proposed transport route, and hence off site road traffic noise has not been included in this assessment.

2.3 Description of Proposed Operation

PV infrastructure on site will comprise of groups of PV panels located up to 4m above ground with a 10m-15m set back from the site boundaries. The PV infrastructure will be mounted on support structures attached to the driven galvanized steel posts. Electrical cabling would be attached beneath the modules and would connect the individual PV modules to each other. Inverters will be located centrally to groups of PV panels and connected to each other by underground cables. The PV modules will be on a single axis tracker system which will follow the sun and move in an east to west direction.

The project will be contained solely within the site, including areas required for stockpiling and materials laydown during construction as shown in Figure 1.

The project would operate 24 hours a day, 7 days a week, with three to four permanent staff on site. During operation, the PV panels would generate electricity which would be fed into the power grid via the substation. Alternatively, energy would be stored in the batteries on site and delivered to the grid on demand. Key noise emissions from the operation of the project are associated with the inverter and transformer components of the substation. It is noted that emissions from these sources are anticipated to be acoustically insignificant compared to ambient background noise levels at assessed receptors.

When required, maintenance activities will occur during standard working hours (except for emergencies) and are expected to include:

- panel cleaning;
- repairs or replacement of infrastructure, as required; and
- land management including mowing to control vegetation as required.

Typical noise sources associated with maintenance activities would include light vehicle movements on site and maintenance of equipment.

2.4 Potentially Sensitive Receptors

Using aerial photography and other project information, MAC has identified the following potentially sensitive receptors that may be affected by noise from operation or construction activities and related road traffic. **Table 1** presents a summary of receiver identification (MAC & NGH), address and coordinates. These are reproduced graphically in **Figure 1.**

Table 1 Noise Sensitive Receptors

MAC ID	NGH ID	Description Address	Coordinates (MGA 55)	
			Easting	Northing
R1	1245	218 Muntz Road (Project related, derelict)	464296	6135243
R2	1246	303 Muntz Road (Derelict)	463936	6134726
R3	1247	2025 Sandigo Road (Project Related)	465895	6134145
R4	1256	1895 Sandigo Road	465456	6132877
R5	1257	1777 Sandigo Road	465589	6131715
R6	1250	441 Birrego Road	463199	6132410
R7	1259	838 Birrego Road	461002	6131227
R8	1261	2358 Strontian Road	458731	6133006
R9	1248	2794 Strontian Road	459586	6136946
R10	1249	456 Quilters Road	460858	6139277
R11	1242	204 Quilters Road	463373	6138728
R12	1243	7781 Sturt Highway	465166	6137623
R13	1244	7715 Sturt Highway	465484	6137285
R14	1252	7662 Sturt Highway	466237	6136908
R15	1254	7481 Sturt Highway	467564	6135674
R16	1253	Settlers Road	468073	6136294
R17	1255	7259 Sturt Highway	468608	6134096
R18	1258	838 Birrego Road	461574	6130508
R19	1260	2195 Strontian Road	457347	6131514

R1 is an unoccupied project related derelict dwelling; R2 is an unoccupied non project related derelict dwelling. Receivers R3, R10, R11, R12, R13 and R14 are project related, and hence have not been included in the assessment.

2.5 Potential Impacts

Potential noise impacts associated with the project relate to construction and operational noise. Road traffic noise associated with the transportation of equipment to site during construction is not expected to be significant as there are no receivers on the transport route from the site to the Sturt Highway.

Additionally, estimated construction related road traffic would be less than 10% of current traffic flow on the Sturt Highway, and would result in a negligible increase in road traffic noise levels.

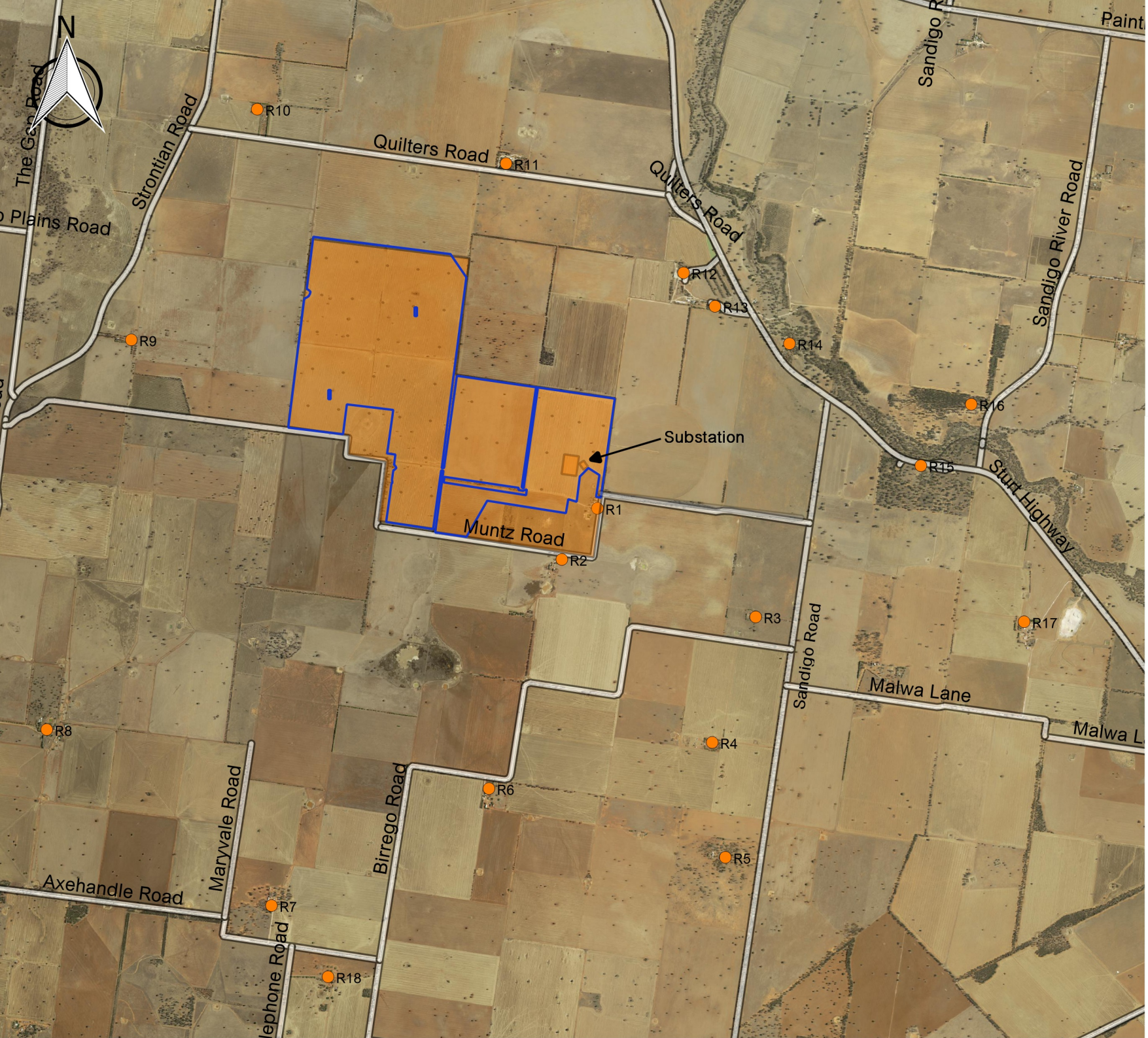

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FIGURE 1

PROJECT LAYOUT

REF: MAC180605

Legend

- Receiver
- Project Boundary
- PV Panels
- Roads

0 700 1400 2100 2800 m

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3 Noise Policy and Guidelines

This Noise Assessment has been conducted in accordance with the following key policy and guidelines:

- NSW Department of Environment and Climate Change, NSW Interim Construction Noise Guideline (ICNG), 2009;
- Environment Protection Authority's (EPA's), Noise Policy for Industry (NPI), 2017; and
- NSW Department of Environment, Climate Change and Water (DECCW), NSW Road Noise Policy (RNP), 2011.

The assessment has also considered and applied the following additional policy, guidelines and standards where relevant:

- Standards Australia AS 2436–2010 (R2016) (AS 2436) – Guide to Noise and Vibration Control on Construction, Demolition and Maintenance sites;
- Standards Australia AS 1055–1997 (AS 1055) – Description and Measurement of Environmental Noise;
- Standards Australia AS IEC 61672.1–2004 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;
- Standards Australia AS 1259.2-1990 (AS 1259) – Acoustics – Sound Level Meters – Integrating/Averaging as appropriate to the device; and
- Standards Australia AS IEC 60942-2004 (AS 60942) – Electroacoustics – Sound Calibrators.

3.1 Interim Construction Noise Guideline

The assessment and management of noise from construction work is completed with reference to the Interim Construction Noise Guideline (ICNG). The ICNG is specifically aimed at managing noise from construction work regulated by the EPA and is used to assist in setting statutory conditions in licences or other regulatory instruments. The types of construction regulated by the EPA under the POEO Act (1997), include construction, maintenance and renewal activities carried out by a public authority, such as road upgrades as described in Schedule 1 of the POEO Act.

The ICNG sets out procedures to identify and address the impact of construction noise on residences and other sensitive land uses. This section provides a summary of noise objectives that are applicable to the assessment.

The ICNG provides two methodologies for the assessment of construction noise emissions:

- Quantitative, which is suited to major construction projects with typical durations of more than three weeks; or
- Qualitative, which is suited to short term infrastructure maintenance (for projects with a typical duration of less than three weeks).

The methodology for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the nearest relevant receptors. The qualitative assessment methodology is a more simplified approach that relies more on noise management strategies. This study has adopted a quantitative assessment approach.

The quantitative approach includes identification of potentially affected receptors, description of activities involved in the project, derivation of the construction noise management levels, quantification of potential noise impact at receptors and, provides management and mitigation recommendations. **Table 2** summarises the ICNG recommended standard hours for construction.

Table 2 Recommended Standard Hours for Construction

Period	Preferred Construction Hours
Day (Standard construction hours)	Monday to Friday - 7am to 6pm Saturdays - 8am to 1pm Sundays or Public Holidays - No construction

The recommended hours do not apply in the event of direction from police, or other relevant authorities, for safety reasons or where required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm. Work conducted outside of standard hours are considered out of hours work (OOH). OOH periods are divided into two categories representing evening and night periods and cover the hours listed below:

Period 1 (evening/low risk period): Monday to Friday – 6pm to 10pm, Saturdays – 1pm to 6pm, Sundays 8am to 6pm.

Period 2 (night/medium to high risk period): Monday to Friday – 10pm to 7am, Saturdays/Sundays – 6pm to 7am (8am on Sunday mornings).

There are no out of hours work proposed for this project.

3.1.1 Construction Noise Management Levels

Section 4 of the ICNG details the quantitative assessment method involving predicting noise levels and comparing them with the Noise Management Level (NML) and are important indicators of the potential level of construction noise impact. **Table 3** provides the ICNG recommended $LA_{eq,15min}$ NMLs and how they are to be applied.

Table 3 Noise Management Levels		
Time of Day	Management Level $LA_{eq,15min}$[1]	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB.	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $LA_{eq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of work to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA.	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account times identified by the community when they are less sensitive to noise (such as before and after school for work near schools, or mid-morning or mid-afternoon for work near residences; and 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 + 5dB.	A strong justification would typically be required for work outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction noise management levels for noise assessment purposes and is the median of the ABL's.

3.1.2 Construction Sleep Disturbance

Section 4.3 of the ICNG (DECC, 2009) states that a sleep disturbance assessment is required where construction activities are planned to occur for more than two consecutive nights.

Given that construction activities are anticipated to occur during standard construction hours, sleep disturbance has not been considered in this assessment.

3.2 Noise Policy for Industry

The EPA released the Noise Policy for Industry (NPI) in October 2017 which provides a process for establishing operational noise criteria for development consents and/or licenses where the EPA regulate noise emissions from scheduled premises under the Protection of the Environment Operations Act 1997. The objectives of the NPI are to:

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

The policy sets out a process for industrial noise management during operation, including:

1. Determine the Project Noise Trigger Levels (PNTLs) (ie criteria) for a development. These are the levels, above which noise management measures are required to be considered. They are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment; and maintaining the noise amenity of an area.
2. Predict or measure the noise levels produced by the development with regard to the presence of annoying noise characteristics and meteorological effects such as temperature inversions and wind.
3. Compare the predicted or measured noise level with the PNTLs, assessing impacts and the need for noise mitigation and management measures.
4. Consider residual noise impacts, where noise levels exceed the PNTLs after the application of feasible and reasonable noise mitigation measures. This may involve balancing economic, social and environmental costs and benefits from the proposed development against the noise impacts, including consultation with the affected community where impacts are expected to be significant.

5. Set statutory compliance levels that reflect the best achievable and agreed noise limits for the development.

6. Monitor and report environmental noise levels from the development.

3.2.1 Project Noise Trigger Levels

The policy sets out the procedure to determine the PNTLs for an industrial development. The PNTL is the lower (ie, the more stringent) value of the **Project Intrusiveness Noise Level** (PINL) and **Project Amenity Noise Level** (PANL) determined in accordance with Section 2.3 and Section 2.4 of the NPI.

3.2.2 Project Intrusiveness Noise Level

The PINL ($LA_{eq,15min}$) is the RBL + 5dB and seeks to limit the degree of change a new noise source introduces to an existing environment. When assessing intrusiveness, background noise levels needs to be measured, from which RBLs are determined.

3.2.3 Project Amenity Noise Level

PANL is relevant to a specific land use or locality. To limit continuing increases in intrusiveness levels, the ambient noise level within an area from all combined industrial sources should remain below the recommended amenity noise levels specified in Table 2.2 (of the NPI) and are reproduced in **Table 4**. The NPI defines two categories of amenity noise levels:

- **Amenity Noise Levels (ANL)** – are determined considering all current and future industrial noise within a receiver area.
- **Project Amenity Noise Levels (PANL)** – is the recommended levels for a receiver area, specifically focusing the project being assessed.

Additionally, Section 2.4 of the NPI states: "*to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise levels applies for each new source of industrial noise as follows*":

- areas with high traffic noise levels;
- proposed developments in major industrial clusters;
- existing industrial noise and cumulative industrial noise effects; and
- greenfield sites.

Notwithstanding, where the PANL is applicable and can be satisfied, the assessment of cumulative industrial noise is not required.

Table 4 Amenity Criteria

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

Notes: The recommended amenity noise levels refer only to noise from industrial noise sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as rural residential; suburban residential; urban residential; industrial interface; commercial; industrial – see Table 2.3 and Section 2.7.

Time of day is defined as follows: (These periods may be varied where appropriate, for example, see A3 in Fact Sheet A.)

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

In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable LAeq noise level may be increased to 40dB LAeq(1hr).

3.2.4 Maximum Noise Level Assessment

The potential for sleep disturbance from maximum noise level events from a project during the night-time period needs to be considered. The NPI considers sleep disturbance to be both awakenings and disturbance to sleep stages.

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

- $L_{Aeq,15min}$ 40dBA or the prevailing RBL plus 5dB, whichever is the greater, and/or
- L_{Amax} 52dBA or the prevailing RBL plus 15dB, whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.

A detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Other factors that may be important in assessing the impacts on sleep disturbance include:

- how often the events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the development;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current understanding of effects of maximum noise level events at night.

4 Assessment Criteria

Background noise monitoring has not been conducted for this project and hence, the minimum applicable Rating Background Levels of 35dBA for the daytime and 30dBA for the evening and night time periods have been adopted as per NPI methodology.

4.1 Construction Noise Management Levels

Noise Management Levels (NMLs) for construction activities at all residential receivers are 45dB $L_{Aeq,15min}$ (RBL +10dB). Construction activities are planned for standard hours, however the relevant NML standard construction hours and out of hours periods are summarised in **Table 5**.

Table 5 Construction Noise Management Levels

Location	Assessment Period	RBL, dBA	NML dB $L_{Aeq,15min}$
All Residential Receivers	Day (Standard Hours)	35	45 (RBL+10dBA)
	Evening (OOH Period 1)	30	35 (RBL+5dBA)
	Night (OOH Period 2)	30	35 (RBL+5dBA)

4.2 Operational Noise Criteria

4.2.1 Project Intrusiveness Noise Levels

The PINLs for the project are presented in **Table 6** and have been determined based on the RBLs +5dBA.

Table 6 Project Intrusiveness Noise Levels

Receiver	Period[1]	Adopted RBL dB LA_{90}	PINL dB $L_{Aeq,15min}$
All Residential Receivers	Day	35	40
	Evening	30	35
	Night	30	35

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2.2 Project Amenity Noise Levels

The PANLs for residential receivers potentially affected by the project are presented in **Table 7.**

Table 7 Project Amenity Noise Levels

Receiver Type	Noise Amenity Area	Assessment Period[1]	Recommended ANL dB $L_{Aeq,period}$[2]	PANL dB $L_{Aeq,period}$[3]	PANL dB $L_{Aeq,15min}$[4]
Residential	Rural	Day	50	50	53
		Evening	45	45	48
		Night	40	40	43

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Recommended amenity noise levels as per Table 2.2 of the NPI.

Note 3: Project Amenity Noise Level equals the amenity noise level as there is no other industry in the area.

Note 4: Includes a +3dB adjustment to the amenity period level to convert to a fifteen-minute assessment period as per Section 2.2 of the NPI.

4.2.3 Project Noise Trigger Levels

The PNTLs are the lower of either the PINLs or the PANLs. **Table 8** presents the derivation of the PNTL's in accordance with the methodologies outlined in the NPI. For this assessment the night time PNTL of 35dB $L_{Aeq,15min}$ is the limiting criteria.

Table 8 Project Noise Trigger Levels

Catchment	Assessment Period[1]	Intrusiveness Noise Level dB $L_{Aeq,15min}$	PANL dB $L_{Aeq,15min}$	PNTL dB $L_{Aeq,15min}$
Residential Receivers (Rural)	Day	40	53	40
	Evening	35	48	35
	Night	35	43	35

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2.4 Maximum Noise Level Screening Criterion

The maximum noise level screening criterion shown in **Table 9** is based on night time RBLs and trigger values as per Section 2.5 of the NPI.

Table 9 Maximum Noise Assessment Trigger Levels

Residential Receivers			
LAeq,15min		LAmax	
40dB $LA_{eq,15min}$ or RBL + 5dB		52dB LA_{max} or RBL + 15dB	
Trigger	40	Trigger	52
RBL +5dB	35	RBL +5dB	45
Highest	**40**	**Highest**	**52**

Note 1: As per Section 2.5 of the NPI, the highest of the two criteria are adopted as the screening criteria.

Note: For road noise assessments, the day period is from 7am to 10pm (ie there is no evening assessment period as there is with operational noise). Night is from 10pm to 7am.

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5 Modelling Methodology

A computer model was developed to quantify project noise emissions to neighbouring receivers for typical construction activities and operations. Brüel and Kjær Predictor Type 7810 (Version 11.10) noise modelling software was used to assess potential noise impacts associated with the project. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. Additionally, the model uses relevant noise source data, ground type, shielding such as barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers. Plant and equipment were modelled at various locations and heights, representative of realistic construction and operational conditions for assessed scenarios.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation'.

5.1 Construction Assessment Methodology

Construction activities are proposed to be progressive (trenching, piling and assembly) and will occur at several locations simultaneously. Noise emissions were modelled for the following four scenarios:

- Earthworks for internal road and compound construction including the stripping of topsoil and unsuitable soil and the placement and compaction of road base;
- earthworks involving trenching for cabling;
- piling of panel supports; and
- assembly of the panels and general construction of other buildings and structures.

It is envisaged that all four construction scenarios have the potential to occur simultaneously at up to 10 locations across the site. Noise emission data and assumptions used in this assessment are summarised in Table 10. All significant noise generating construction activities will be limited to standard construction hours. Where low intensity construction activities are required to be undertaken outside standard construction hours, such as cabling, minor assembly, use of hand tools etc, they will be managed such that they are not audible at any residential receivers.

Table 10 Construction Equipment Sound Power Levels, Lw dBA re 10^{-12} W				
Noise Source/Item	Utilisation %	Quantity	Lw/ Item	Total Lw
Trenching & Earthworks (per work area)				
Backhoe	100	1	104	104
Light vehicle	50	2	76	76
Total – Trenching & Earthworks				**104**
Piling (per work area)				
Piling Rig (hydraulic)	100	1	113	113
Tele-handler	80	1	106	105
Light vehicle	50	1	76	73
Total – Piling				**114**
Assembly (per work area)				
Mobile Crane/HIAB	100	1	104	104
Tele-handler	100	1	106	106
Light vehicle	50	2	76	76
Hand tools/Power tools	25	1	102	96
Welder	25	1	105	99
Total – Assembly				**109**
Transport (on site)				
Heavy vehicle	100	1	104	104
Tele-handler	100	1	106	106
Total – Transport				**108**

5.2 Operational Assessment Methodology

5.2.1 Operational Noise Modelling Scenarios

For this assessment, noise predictions were modelled for a typical worst case operational scenario over a 15-minute assessment period based on the assumptions and sound power levels in **Table 11.** The configuration of the inverter and transformer consists of a twin skid Process Control Unit (PCU), with two inverters and one transformer per skid, with a total of 90 skids. There will be 16 Heating Ventilation Air Conditioning (HVAC) plant enclosures to provide cooling and ventilation to the battery storage facility and associated buildings. Each enclosure will contain nine HVAC units. Plant noise emission data used in modelling for this assessment were obtained from manufacturers data or the MAC database. Where relevant, modifying factors in accordance with Section 3.3 and Fact Sheet D of the NPI have been applied to calculations.

Table 11 Operational Equipment Sound Power Levels, Lw dBA re 10^{-12} W				
Noise Source/Item	Activity	Quantity	Lw/Item	Total Lw
PV Panel Tracking Motor[1,2]	All tracking motors in operation 1 minute per 15-minute period	9525	78	101
Inverter[2,3]	Constant	96	81	101
Transformer[2,3]	Constant	48	77	97
HVAC unit	Constant	144	89	101
Substation	Constant	1	90	90
Light Vehicle	2 vehicles arrive and depart from site (5 minutes duration)	2	76	79

Note 1: Tracking motor is situated underneath the PV panel, -5dB attenuation applied to account for shielding provided by the panel.

Note 2: Modifying factor penalty of +5dB added for low frequency and +5dB added for tonality.

Note 3: -10dB applied to account for enclosure containing inverters and transformers

5.2.2 Meteorological Analysis

Noise emissions from industry can be significantly influenced by prevailing weather conditions. Wind has the potential to increase noise at a receiver when it is at low velocities and travels from the direction of the noise source.

Meteorological conditions that enhance received noise levels include source to receiver winds and the presence of temperature inversions. To account for the potential for enhancements, the NPI specifies that the source to the receiver wind component speeds up to 3m/s for 30% or more of the time in any seasonal period (i.e. day, evening or night), is a significant meteorological feature and predictions must incorporate these conditions.

To determine the prevailing conditions for the project, weather data during the period January 2015 to November 2017 was obtained from the nearest Bureau of Meteorology's (BOM) weather station at Narrandera Airport located approximately 26km north west of the project site. The data was analysed using the EPA's Noise Enhancement Wind Analysis (NEWA) program to determine the frequency of occurrence of winds speeds up to 3m/s in each seasonal period.

Table 12 summarises the results of the wind analysis and includes the dominant wind direction and percentage occurrence during each season for each assessment period. The results of the detailed analysis of meteorological data is presented in Appendix B.

Table 12 Seasonal Frequency of Occurrence Wind Speed Intervals			
Season	Period	Wind Direction ±(45°)	% Wind Speeds 0.5m/s to 3m/s
Summer	Evening	SSW (202.5°) SW (225°)	20
Autumn	Night	ESE (112.5°)	24
Winter	Night	ESE (112.5°) SE (135°)	17
Spring	Evening	SW (225°)	17

Based on the results of this analysis, prevailing winds are not a feature of the area and default calm meteorological conditions have been adopted for noise modelling. The relevant meteorological conditions adopted in the noise modelling assessment are summarised in **Table 13**.

Table 13 Modelled Site Specific Meteorological Parameters				
Assessment Condition[1]	Temperature	Wind Speed / Direction	Relative Humidity	Stability Class
Day - Calm	20°C	n/a	60%	n/a
Evening - Calm	10°C	n/a	60%	n/a
Night - Calm	10°C	n/a	60%	n/a

Note 1: Day 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening 6pm to 10pm; Night - the remaining periods.

6 Results

6.1 Construction Noise Results

Noise levels were predicted to each assessed receptor assuming receiver heights of 1.5m above ground level for typical construction activities. **Table 14** summarises the maximum predicted noise level from each of the construction scenarios (trenching, piling and assembly) at identified residential receptors.

Table 14 Predicted Construction Noise Levels

Receiver ID	Address	Highest Predicted Noise Level dB $LA_{eq,15min}$	NML Standard Hours dB $LA_{eq,15min}$	Compliance
R4	1895 Sandigo Road	<30	45	Yes
R5	1777 Sandigo Road	<30	45	Yes
R6	441 Birrego Road	30	45	Yes
R7	838 Birrego Road	<30	45	Yes
R8	2358 Strontian Road	<30	45	Yes
R9	2794 Strontian Road	36	45	Yes
R15	7481 Sturt Highway	<30	45	Yes
R16	Settlers Road	<30	45	Yes
R17	7259 Sturt Highway	<30	45	Yes
R18	838 Birrego Road	<30	45	Yes
R19	2195 Strontian Road	<30	45	Yes

6.2 Operational Noise Results

Noise levels were predicted at each assessed receptor assuming receiver heights of 1.5m above ground level. Table 15 summarises the predicted operational noise levels which are demonstrated to comply with the PNTLs at all residential receptors.

Table 15 Predicted Operational Noise Levels

Receiver ID	Address	Predicted Noise Level dB $LA_{eq,15min}$	Limiting Night PNTL dB $LA_{eq,15min}$	Comply
R4	1895 Sandigo Road	<20	35	Yes
R5	1777 Sandigo Road	<20	35	Yes
R6	441 Birrego Road	<20	35	Yes
R7	838 Birrego Road	<20	35	Yes
R8	2358 Strontian Road	<20	35	Yes
R9	2794 Strontian Road	<20	35	Yes
R15	7481 Sturt Highway	<20	35	Yes
R16	Settlers Road	<20	35	Yes
R17	7259 Sturt Highway	<20	35	Yes
R18	838 Birrego Road	<20	35	Yes
R19	2195 Strontian Road	<20	35	Yes

6.3 Maximum Noise Level Assessment - Operations

A detailed maximum noise level assessment is not required as predicted noise levels for night time operations do not exceed the maximum noise level screening criterion of 40dB $LA_{eq,15min}$ and/or 52dB LA_{max}.

7 Recommendations

7.1 Construction Noise Recommendations

It is noted that construction noise emissions are anticipated to satisfy relevant NMLs, however, the project is committed to managing noise emissions within the community and will adopt the following procedures where feasible. Recommendations for consideration during construction activities to reduce emissions to the surrounding community for this project may include:

- a construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community;
- where possible use localised mobile screens or construction hoarding around plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (eg unloading and laydown areas);
- operating plant in a conservative manner (no over-revving), shutdown when not in use, and be parked/started at farthest point from relevant assessment locations;
- selection of the quietest suitable machinery available for each activity;
- avoidance of noisy plant/machinery working simultaneously where practicable;
- minimise impact noise wherever possible;
- utilise a broadband reverse alarm in lieu of the traditional high frequency type reverse alarm;
- provide toolbox meetings, training and education to drivers and contractors visiting the site during construction so they are aware of the location of noise sensitive receivers and to be cognisant of any noise generating activities;
- signage is to be placed at the front entrance advising truck drivers of their requirement to minimise noise both on and off-site; and
- utilise project related community consultation forums to notify residences within close proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure.

7.2 Operational Noise Recommendations

Operational noise predictions identify that relevant noise criteria would be satisfied at all receivers. Notwithstanding, it is recommended that the proponent actively minimise potential noise emissions from the project. To assist in noise management for the project the following is recommended that a one-off noise validation monitoring assessment to quantify emissions from site and to confirm emissions meet relevant criteria.

8 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by NGH Environmental on behalf of RES Australia Pty Limited (RES) to complete a Noise Assessment (NA) for the construction and operation of a Solar Farm at Avonlie, near Narrandera, NSW. The assessment has quantified potential noise emissions associated with the construction and operation of the project.

The results of the NA demonstrate that construction noise levels satisfy relevant construction NMLs and operational noise levels satisfy the NPI PNTLs for assessed receivers. However, recommendations to ensure noise levels are minimised and verified have been provided in this report.

Based on the NA results, there are no noise related issues which would prevent the approval of the project. The results of the assessment shows compliance with the relevant construction, operational and road noise criteria. Accordingly, no ameliorative measures will be required.

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Appendix A – Glossary of Terms

A number of technical terms have been used in this report and are explained in Table A1.

Table A1 Glossary of Terms

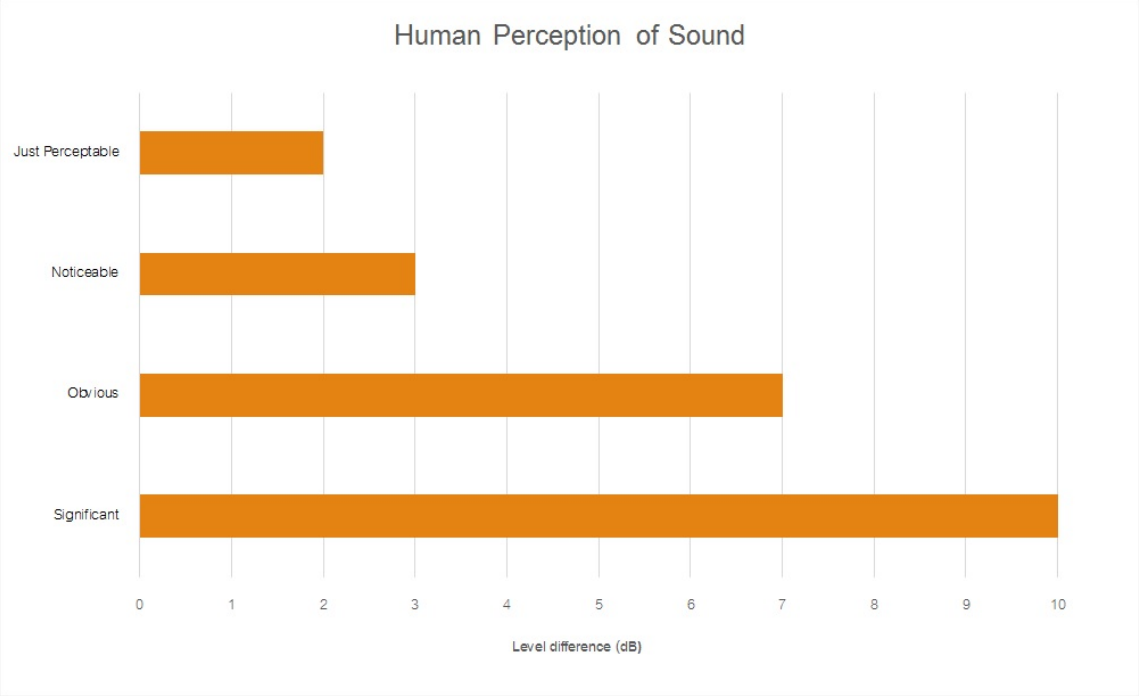
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by : = 10.log10 (W/Wo) Where : W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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Appendix B – NEWA Analysed Meteorology

Table B1 NEWA Analysed Meteorological Conditions, Narrandera Airport NSW									
Direction ± 45°	Season	Day	Evening	Night	Direction	Season	Day	Evening	Night
		Percentage Occurrence %					Percentage Occurrence %		
0	Summer	5	4	5	180	Summer	8	16	13
0	Autumn	8	4	4	180	Autumn	9	12	10
0	Winter	8	9	8	180	Winter	13	8	8
0	Spring	5	6	5	180	Spring	5	11	9
22.5	Summer	5	5	5	202.5	Summer	10	20	12
22.5	Autumn	9	6	5	202.5	Autumn	11	15	8
22.5	Winter	8	8	6	202.5	Winter	14	8	5
22.5	Spring	6	7	5	202.5	Spring	7	14	10
45	Summer	6	5	8	225	Summer	12	20	11
45	Autumn	10	9	10	225	Autumn	13	13	9
45	Winter	8	7	7	225	Winter	15	10	7
45	Spring	6	6	8	225	Spring	9	17	11
67.5	Summer	6	7	11	247.5	Summer	12	19	10
67.5	Autumn	10	12	17	247.5	Autumn	13	12	8
67.5	Winter	10	9	9	247.5	Winter	15	9	8
67.5	Spring	6	8	10	247.5	Spring	9	16	11
90	Summer	6	8	13	270	Summer	10	16	7
90	Autumn	10	13	20	270	Autumn	12	11	8
90	Winter	11	11	14	270	Winter	13	10	10
90	Spring	6	9	14	270	Spring	8	12	9
112.5	Summer	6	10	15	292.5	Summer	9	11	7
112.5	Autumn	10	14	24	292.5	Autumn	11	7	7
112.5	Winter	12	11	17	292.5	Winter	12	13	14
112.5	Spring	6	10	16	292.5	Spring	7	10	8
135	Summer	5	12	15	315	Summer	7	7	6
135	Autumn	9	15	22	315	Autumn	10	5	6
135	Winter	12	11	17	315	Winter	11	12	12
135	Spring	5	10	14	315	Spring	6	7	7
157.5	Summer	4	10	10	337.5	Summer	5	4	5
157.5	Autumn	6	10	13	337.5	Autumn	8	4	5
157.5	Winter	8	8	12	337.5	Winter	8	10	11
157.5	Spring	3	7	9	337.5	Spring	6	6	5