Noise Assessment

Suntop Solar Farm, Wellington, NSW.

Prepared for: Pitt&Sherry Operations Pty Ltd

May 2018

MAC

Muller Acoustic Consulting

Document Information

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Suntop Solar Farm, Wellington NSW.

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Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by pitt&sherry Operations Pty Ltd on behalf of Photon Energy (Photon) to complete a Noise Assessment (NA) for the proposed Suntop Solar Farm near Wellington, NSW. 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 report is required as part of the Environmental Impact Statement (EIS) for the project. 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.

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

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;
- quantify the existing noise environment by conducting unattended and operator attended noise measurements at locations representative of the closest and/or potentially most affected receptors;
- establish existing noise levels to determine project-specific construction Noise Management Levels (NMLs), and operational noise criteria;
- undertake 3D noise modelling to predict noise 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 noise 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 noise criteria may be exceeded.

2 Project Description

2.1 Background

Photon propose to construct and operate a 200 Megawatt (MW) Photovoltaic Solar (PV) Farm at a 517 - hectare site at Suntop, NSW (the 'project'). The project would be located adjacent to Suntop Road, Suntop, NSW, contained within Lot 1-2-3 DP 506925, Lot 122 DP 753238 and Lot 90 DP 657805 (the 'subject lands'). The project is located within the Dubbo Local Government Area (LGA) and is approximately 10km south-west from the Wellington town centre. The area was previously considered part of the Wellington LGA, which has recently amalgamated with Dubbo to form the Dubbo Regional Council. The Wellington Local Environmental Plan (LEP 2012) is still current and applies to the Site.

Total subject land is approximately 517 hectares in area and is currently used for agriculture including cropping (e.g. wheat and lucerne) and grazing. The solar farm would occupy 472 hectares (the "Site") out of the 517 hectares (equivalent to approximately 83%) with the remaining land retained as existing agricultural land.

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 approximately 3m in height. An estimated 900,000 PV panels will be installed tilted at a 25° north facing angle or using a single axis tracking system, tilted +/- 60° along the north-south axis. The PV mounting structure would comprise steel posts driven 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 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 nine to 12 month period during standard construction hours.

All vehicles would access the Site from Suntop Road, a sealed single-lane, two-way local road. Suntop Road joins Renshaw McGirr Way about 6.5km east of the Site. The Mitchell Highway (A32) joins Renshaw McGirr Way about 9km further east of the Site. A new access road would be constructed leading south into the Site from Suntop Road of the subject land.

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

2.3 Description of Proposed Operation

PV infrastructure on site will comprise of groups of PV panels located 3m above ground with a 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 that will be connected to each other by underground cables. The PV modules will either be in a fixed position facing north or 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 and would not involve the presence of staff on-site (aside from routine maintenance work) and would typically see minimal plant and equipment operating on site. During operation, the PV panels would generate electricity which would be fed into the power grid via the substation. Key noise emissions from the operation of the project are associated with the invertor 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.

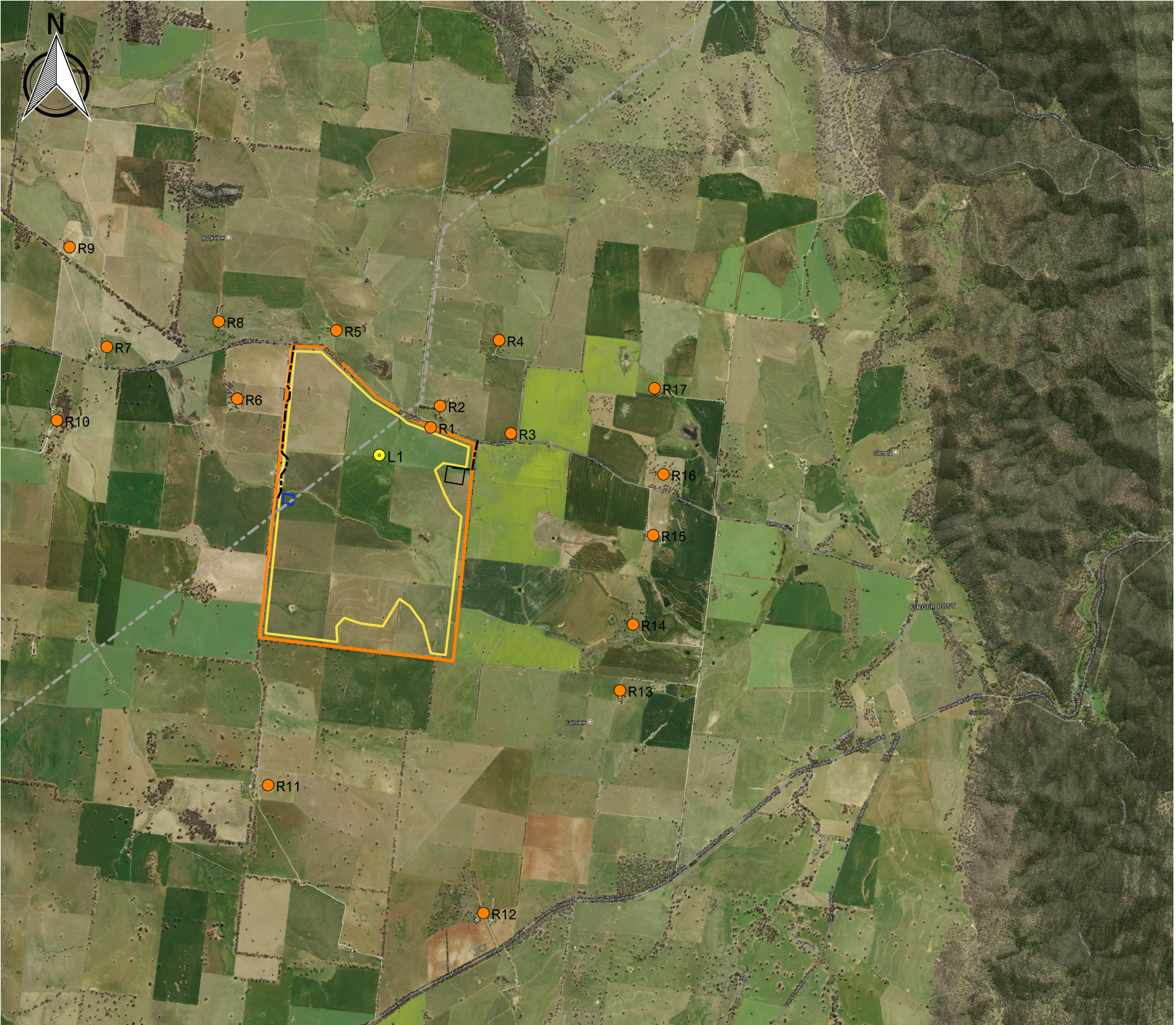
When required, maintenance activities will be undertaken during standard working hours (except for emergencies) and are expected to include:

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

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

FIGURE 1

PROJECT LAYOUT
REF: MAC170550



LEGEND

- Site Boundary
- Receivers
- Monitoring Location
- Access Road
- Construction Compound
- PV Panels
- Proposed Substation
- 132kV - Overhead

0 500 1000 1500 2000 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 (DECC), 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(2016) (AS2436) – Guide to Noise and Vibration Control on Construction, Demolition and Maintenance sites;
- Standards Australia AS1055–1997 (AS1055) – Description and Measurement of Environmental Noise;
- Standards Australia AS IEC 61672.1–2004 (AS61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring or Standards Australia AS1259.2-1990™ (AS1259) – Acoustics – Sound Level Meters – Integrating/Averaging as appropriate to the device; and
- Standards Australia AS/IEC 60942:2004/IEC 60942:2003 (IEC60942) – Australian Standard – 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. Error! Reference source not found. summarises the ICNG recommended standard hours for construction.

Table 1 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 is 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. Error! Reference source not found. provides the ICNG recommended $LA_{eq,15min}$ NMLs and how they are to be applied.

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 only expected to occur during standard construction hours, sleep disturbance has not been considered in this assessment.

Table 2 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 + 10 dB	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 75 dBA.	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 + 5 dB	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.

3.2 Noise Policy for Industry

The EPA released the Noise Policy for Industry (NPI) in October 2017 which provides a process for establishing noise criteria for consents and licenses enabling the EPA to 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 that is used 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, taking into account the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

The policy sets out a process for industrial noise management involving the following key steps:

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, that is, 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 relevant to 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 Project Intrusiveness Noise Level ($L_{Aeq,15min}$) is the RBL + 5dB and seeks to limit the degree of change a new noise source introduces to an existing environment. Hence, when assessing intrusiveness, background noise levels needs to be measured.

3.2.3 Project Amenity Noise Levels

Amenity noise levels are 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 **Error! Reference source not found.**. 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 under investigation.

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 3 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 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays;

• evening – the period from 6 pm to 10 pm;

• night – the remaining periods.

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.

3.3 Road Noise Policy

The road traffic noise criteria are provided in the Department of Environment, Climate Change and Water NSW (DECCW), Road Noise Policy (RNP), 2011. The policy sets out noise criteria applicable to different road classifications for the purpose of quantifying traffic noise impacts. Road noise criteria relevant to this assessment are presented in detail in **Section 6**.

4 Existing Environment

A key element in assessing environmental noise impacts is understanding the existing ambient and background noise levels at the closest and/or potentially most affected receptors to the project.

4.1 Potentially Sensitive Receptors

From observations on site, review of aerial photos and other project information, MAC has identified the following potentially sensitive receptors that may be affected by noise from operations, construction activities and related road traffic. **Table 4** presents a summary of receiver Identification, type, address and coordinates. These are reproduced graphically in **Figure 1.**

Table 4 Noise Sensitive Receptors

ID	Type	Description Address	Coordinates (MGA 56)	
			Easting	Northing
R01		675 Suntop Road	108862	6388151
R02		14 Bennetts Road	108960	6388371
R03		586 Suntop Road	109684	6388090
R04		582 Suntop Road	109563	6389044
R05		796 Suntop Road	107898	6389143
R06		1834 Arthurville Road	106884	6388444
R07		Lot 17 1094 Suntop Road	105549	6388976
R08		898 Suntop Road	106696	6389236
R09	Rural Residential	Lot 86 1094 Suntop Road	105168	6389997
R10		69 Frogleys Road	105038	6388224
R11		1570 Renshaw McGirr Way	107199	6384488
R12		1420 Renshaw McGirr Way	109403	6383178
R13		193 Bestwicks Lane	110800	6385458
R14		233 Bestwicks Lane	110935	6386134
R15		433 Suntop Road	111140	6387048
R16		440 Suntop Road	111245	6387671
R17		18 Ringwood Road	111154	6388552

4.2 Noise Monitoring Methodology

In accordance with NSW noise guidelines, background noise levels are measured in the absence of the site under assessment and are used to develop NMLs for residential receptors.

To quantify existing noise levels, long-term unattended noise measurements were performed on the subject land (Location L1) as it is representative of receptors located near the project (refer **Table 5**). Location L1 is situated on the subject land and is currently used for agriculture.

The unattended noise monitoring survey was conducted in general accordance with the procedures described in Australian Standard AS 1055-1997, "Acoustics - Description and Measurement of Environmental Noise" and the EPL. Noise measurements were carried out using a Svantek Type 1, 977 noise analyser from Wednesday 22 November 2017 to Thursday 30 November 2017. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672.1-2004- Electroacoustics - Sound level meters - Specifications. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Table 5 Noise Monitoring Locations

ID	Unattended Noise Monitoring Location	Site Description	Co-ordinates MGA56	
L1	Project Site	Off Suntop Road	672143m E	6394263m S

4.3 Noise Monitoring Results

From observations whilst on site, the noise environment at existing residential receptors is best described as 'rural' in accordance with the NPI. A rural area, as described in the NPI, is one that has an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. he results of the unattended noise measurements for the background monitoring location, including derived RBLs are summarised in **Table 6**. **Appendix B** presents the noise monitoring charts for the monitoring period.

Table 6 Unattended Noise Monitoring Results

Unattended Noise Monitoring Location	Period[1]	Measured Background Level RBL L_{A90}, dBA	Measured Ambient Noise Level L_{Aeq}, dBA
L1 Project Site	Day	26	66
	Evening	26	59
	Night	26	59

Note 1: Monday to Saturday: Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Day 8am to 6pm; Evening 6pm to 10pm; Night 10pm to 8am.

5 Assessment Criteria

5.1 Construction Noise Management Levels

Noise Management Levels (NMLs) for construction activities at all residential receivers are 45dB $L_{Aeq,15min}$ (RBL +10dB). Although construction activities are only planned for standard hours, the relevant NML standard construction hours and out of hours periods are summarised in **Table 7**.

Table 7 Construction Noise Management Levels

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

5.2 Operational Noise Criteria

5.2.1 Project Intrusiveness Noise Levels

The PINLs for the project are presented in **Table 8** and have been determined based on the RBLs +5dBA.

Table 8 Intrusiveness Noise Levels

Receiver	Period[1]	Measured RBL dB LA_{90}	Adopted RBL[2] dB LA_{90}	Intrusiveness Noise Level dB $LA_{eq,15min}$
All Residential Receivers	Day	26	35	40
	Evening	26	30	35
	Night	26	30	35

Note 1: Monday to Saturday: Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Day 8am to 6pm; Evening 6pm to 10pm; Night 10pm to 8am.

Note 2: Where the measured RBL is less than 35dBA for the day period, is set to 35dBA, and where the measured RBL is less than 30dBA for the evening and night, is set to 30dBA.

5.2.2 Project Amenity Noise Levels

The PANLs for residential receivers potentially affected by the project are presented in **Table 9.**

Table 9 Amenity Noise Levels and 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: Monday to Saturday: Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Day 8am to 6pm; Evening 6pm to 10pm; Night 10pm to 8am.

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.

5.2.3 Project Noise Trigger Levels

The PNTLs are the lower of either the PINL or the PANL. **Table 10** 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 10 Project Noise Trigger Levels

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

Note 1: Monday to Saturday: Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Day 8am to 6pm; Evening 6pm to 10pm; Night 10pm to 8am.

5.2.4 Maximum Noise Level Screening Criterion

The maximum noise level screening criterion shown in **Table 11** is based on night time RBLs and trigger values as per Section 2.5 of the NPI.

Table 11 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.

5.3 Road Traffic Noise Criteria

The road traffic noise criteria are provided in the RNP. For this assessment, the 'local road' category, as specified in the RNP, has been adopted for Suntop Road, and 'sub arterial road' category for Renshaw McGirr Way. It is acknowledged that the functional classification of Renshaw McGirr Way is a 'Collector Road' in accordance with the Roads and Maritime Noise Criteria Guideline (April 2015). However, the Road Noise Policy does not provide separate noise criteria for Collector Roads but applies the sub-arterial category to all roads that are not classified as local roads.

Road noise criteria relevant to this assessment are presented in **Table 12** for residential receivers.

Table 12 Road Traffic Noise Assessment Criteria for Residential Land Uses

Road category	Road Name	Type of Project/Development	Assessment Criteria - dBA	
			Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub-arterial road	Renshaw McGirr Way	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	60dBA LAeq,15hr external	55dBA LAeq,9hr external
Local Roads	Suntop Road	Existing residences affected by additional traffic on existing local roads generated by land use developments	55dBA LAeq,1hr external	50dBA LAeq,1hr external

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.

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dB, which is generally accepted as the threshold of perceptibility to a change in noise level.

5.3.1 Relative Increase Criteria

In addition to meeting the assessment criteria, any significant increase in total traffic noise at receivers must be considered. Receivers experiencing increases in total traffic noise levels above those presented in **Table 13** due to the addition of project vehicles on Renshaw McGirr Way should be considered for mitigation. Relative increase criteria is not applicable to local roads.

Table 13 Increase Criteria for Residential Land Uses

Road Category	Type of Project/Development	Total Traffic Noise Level Increase, dBA	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment or existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic LAeq,15hr +12dB (external)	Existing traffic LAeq9hr +12dB (external)

Note 1: Relative increase criteria is not applicable to local roads.

6 Modelling Methodology

A computer model was developed to determine the impact of 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 (measured on site at the project), 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'.

6.1 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 three scenarios:

- earthworks involving trenching for cabling;
- piling of panel supports; and
- assembly of the panels.

It is envisaged that all three scenarios have the potential to occur simultaneously at up to 10 locations across the site, together with substation construction, vehicle movements on the site and deliveries of material to site. Noise emission data and assumptions used in this assessment are summarised in **Table 14**. 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 14 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	2	104	107
Tele-handler	100	1	106	106
Total – Transport				**110**

6.2 Operational Assessment Methodology

6.2.1 Modelling Scenarios

For this assessment, operational noise predictions were modelled for a typical worst case operational scenario over a 15-minute assessment period based on the operational assumptions and sound power levels in **Table 15.** The exact design details regarding the number of transmission kiosk/inverter stations (40 x 4.92MW or 59 x 3.20MW) is yet to be confirmed, therefore the maximum potential number of sources has been adopted for the assessment. Plant noise emission data used in modelling for this assessment were obtained from manufacturer 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 15 Operational Equipment Sound Power Levels 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	12380	78	102
Transmission Kiosk/Inverter Stations – each consisting of the following				
Inverter	Constant	69	75	99
Transformer	Constant	69	70	94
Capacitor Battery	Constant	69	75	99
Transmission Kiosk - Total[2,3]	Constant	69	79	102
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: -5dB applied to account for power station/ kiosk vented enclosure.

6.2.2 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 Dubbo Airport located approximately 58km 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 16 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 C.

Table 16 Seasonal Frequency of Occurrence Wind Speed Intervals

Season	Period	Wind Direction ±(45°)	% Wind Speeds (m/s)
			0.5 to 3 m/s
Summer	Night	292.5	15
Autumn	Night	292.5	22
Winter	Night	292.5	23
Spring	Night	292.5	21

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 17.

Table 17 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, Evening 6pm to 10pm, Night 10pm to 7am.

6.3 Road Traffic Noise

The United States (US) Environmental Protection Agency's road traffic calculation method was used to predict the L_{Aeq} noise levels from construction vehicles travelling past receivers along public roads. This method is an internationally accepted theoretical traffic noise prediction model and is ideal for calculating road traffic noise where relatively small traffic flows are encountered.

Suntop Road is a local road managed by Dubbo Regional Council which runs along the northern border of the Site. The south, east and west boundaries of the project are adjoined by neighbouring agricultural lots with some sections of unnamed, unsealed rural roads and tree-lined fences.

7 Results

7.1 Construction Results

Noise levels were predicted to each assessed receptor assuming receiver heights of 1.5m above ground level for typical construction activities. **Table 18** summarises the maximum predicted noise level from each of the construction scenarios at identified residential receptors.

Table 18 Predicted Construction Noise Levels

Receiver ID	Description	Highest Predicted Noise Level dB $LA_{eq,15min}$	NML Standard Hours dB $LA_{eq,15min}$	Compliance
R01	675 Suntop Road	**56**	45	No
R02	14 Bennetts Road	**51**	45	No
R03	586 Suntop Road	**46**	45	No
R04	582 Suntop Road	42	45	Yes
R05	796 Suntop Road	**51**	45	No
R06	1834 Arthurville Road	**48**	45	No
R07	Lot 17 1094 Suntop Road	37	45	Yes
R08	898 Suntop Road	43	45	Yes
R09	Lot 86 1094 Suntop Road	29	45	Yes
R10	69 Frogleys Road	32	45	Yes
R11	1570 Renshaw McGirr Way	37	45	Yes
R12	1420 Renshaw McGirr Way	29	45	Yes
R13	193 Bestwicks Lane	34	45	Yes
R14	233 Bestwicks Lane	36	45	Yes
R15	433 Suntop Road	35	45	Yes
R16	440 Suntop Road	34	45	Yes
R17	18 Ringwood Road	32	45	Yes

The activities predicted to exceed the NMLs at receives along Suntop Road are (ranked order) are: piling, general assembly and trenching works. These levels would be experienced only when these construction activities occur simultaneously along the northern boundary. Scheduling of piling activities to minimise the number of work fronts along the northern boundary would reduce noise levels by approximately 3dB in most situations. The predicted maximum noise levels would be expected when construction work is occurring at the closest point to the receivers, although this is anticipated to be for a limited period.

7.2 Operational Noise Results

Noise levels were predicted at each assessed receptor assuming receiver heights of 1.5m above ground level. **Table 19** summarises the predicted operational noise levels which are demonstrated to comply with the PNTLs at all residential receptors.

Table 19 Predicted Operational Noise Levels

Receiver ID	Description	Predicted Noise Level dB $LA_{eq,15min}$	Limiting Night time PNTL dB $LA_{eq,15min}$	Compliance
R01	675 Suntop Road	32	35	Yes
R02	14 Bennetts Road	26	35	Yes
R03	586 Suntop Road	22	35	Yes
R04	582 Suntop Road	19	35	Yes
R05	796 Suntop Road	25	35	Yes
R06	1834 Arthurville Road	23	35	Yes
R07	Lot 17 1094 Suntop Road	15	35	Yes
R08	898 Suntop Road	19	35	Yes
R09	Lot 86 1094 Suntop Road	<15	35	Yes
R10	69 Frogleys Road	<15	35	Yes
R11	1570 Renshaw McGirr Way	<15	35	Yes
R12	1420 Renshaw McGirr Way	<15	35	Yes
R13	193 Bestwicks Lane	<15	35	Yes
R14	233 Bestwicks Lane	<15	35	Yes
R15	433 Suntop Road	<15	35	Yes
R16	440 Suntop Road	<15	35	Yes
R17	18 Ringwood Road	<15	35	Yes

7.3 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}.

7.4 Road Traffic Noise Assessment

As described in **Section 2.2**, the route via Suntop Road and Renshaw McGirr Way would be the major transport route for all vehicles. During construction, traffic generated by the project include employee/subcontractor and delivery vehicles. During construction, the traffic volume over a typical day for standard construction hours is expected to be 80 heavy vehicles (semi-trailers) and 50 light vehicles per day (including mini buses for employee transport). Road traffic noise calculations are based on the parameters adopted for average and peak flows presented in **Table 20**.

Table 20 Predicted Construction Road Traffic Noise Levels

Vehicle Type	Vehicles / day[1]	Average / hour	Maximum / hour[2]	Movements / hour	Speed km/h
B-double or Semi-trailer	80	7.2	14	28	80
Mini bus	5	<1	5	10	80
Light Vehicle	45	4.1	20	40	100

Note 1: Standard construction hours 7am to 6pm

Note 2: Assumes that all mini buses and 50% of light vehicles travel to and from site during AM peak and PM peak.

Predicted $LA_{eq,1hr}$ noise levels from project related construction traffic at the closest receptor on both roads on the route has been completed using the United States (US) Environment Protection Agency's road traffic calculation method is presented in **Table 21**.

Table 21 Predicted Construction Road Traffic Noise Levels

Road Name	Nearest Offset Distance to Receiver	Predicted Noise Level	RTN Criteria	Comply
Suntop Road site access[1]	23m	48dB $LA_{eq,1hr}$	55dB $LA_{eq,1hr}$	Yes
Suntop Road	65m	49dB $LA_{eq,1hr}$	55dB $LA_{eq,1hr}$	Yes
Renshaw McGirr Way	30m	54dB $LA_{eq,15hr}$	60dB $LA_{eq,15hr}$	Yes

Note 1: A pass by speed of 25km/h has been used for vehicles at this location

Results demonstrate that project construction traffic noise levels would comply with the relevant RNP criteria.

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8 Recommendations

8.1 Construction Noise Recommendations

It is noted that construction noise emissions are anticipated to satisfy relevant NMLs at most receivers. Noise levels are predicted to exceed the NMLs at those receivers along Suntop Road (R1, R2, R3, R5, R6), however, the project is committed to managing noise emissions within the community and will adopt the following procedures where feasible to minimise noise emissions. 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;
- limiting and scheduling the number of work areas along the northern boundary for piling, trenching and assembly activities to minimise noise levels at receptors along Suntop Road;
- 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), be 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 hi 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.

8.2 Operational Noise Recommendations

Operational noise predictions identify that relevant noise criteria would be satisfied at all receivers. Notwithstanding this, it is recommended that the proponent actively minimise potential noise emissions from the project. To assist in noise management for the project the following recommended:

- complete a one-off noise validation monitoring assessment to quantify emissions from site and to confirm emissions meet relevant criteria; and
- prepare an operational noise management protocol to minimise noise emissions and to respond to potential concerns from the community regarding project noise emissions.

9 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by pitt&sherry Operations Pty Ltd on behalf of Photon Energy (Photon) to complete a Noise Assessment (NA)for the construction and operation of a Solar Farm at Suntop, near Wellington, NSW. The assessment has quantified potential noise emissions associated with the construction and operation of the project including road traffic noise associated with the construction phase.

The results of the NA demonstrate that construction noise levels satisfy relevant NMLs; at all assessed receivers, with the exception of those situated along Suntop Road when noise intensive works are nearest. Mitigation measures such as localised barriers, scheduling and respite would minimise noise emissions. Impacts would be of short duration and of a temporary nature.

Operational noise levels are predicted to satisfy the NPI PNTLs at all assessed receivers. However, recommendations to ensure noise levels are minimised and verified have been provided in this report.

Additionally, the NA demonstrates that the road noise criteria as specified in the RNP will be satisfied at all receivers on the proposed transport route.

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. Additionally, the results of the operational assessment demonstrate compliance with the relative EPA and DECCW policies, once ameliorative measures have been adopted.

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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

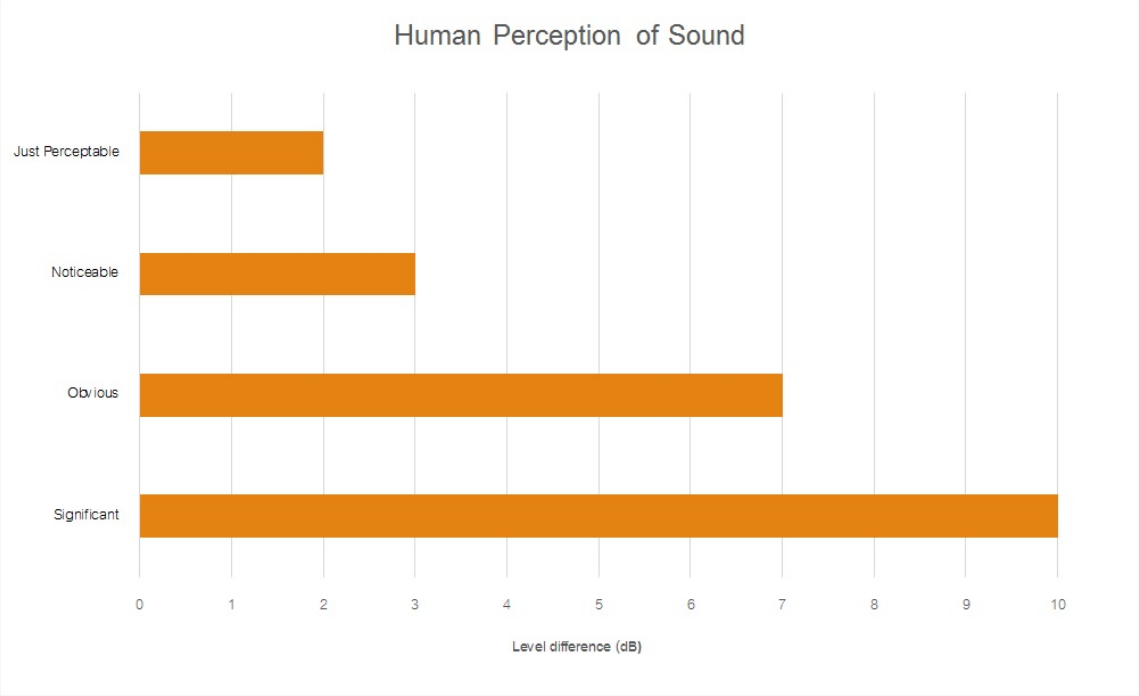
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for 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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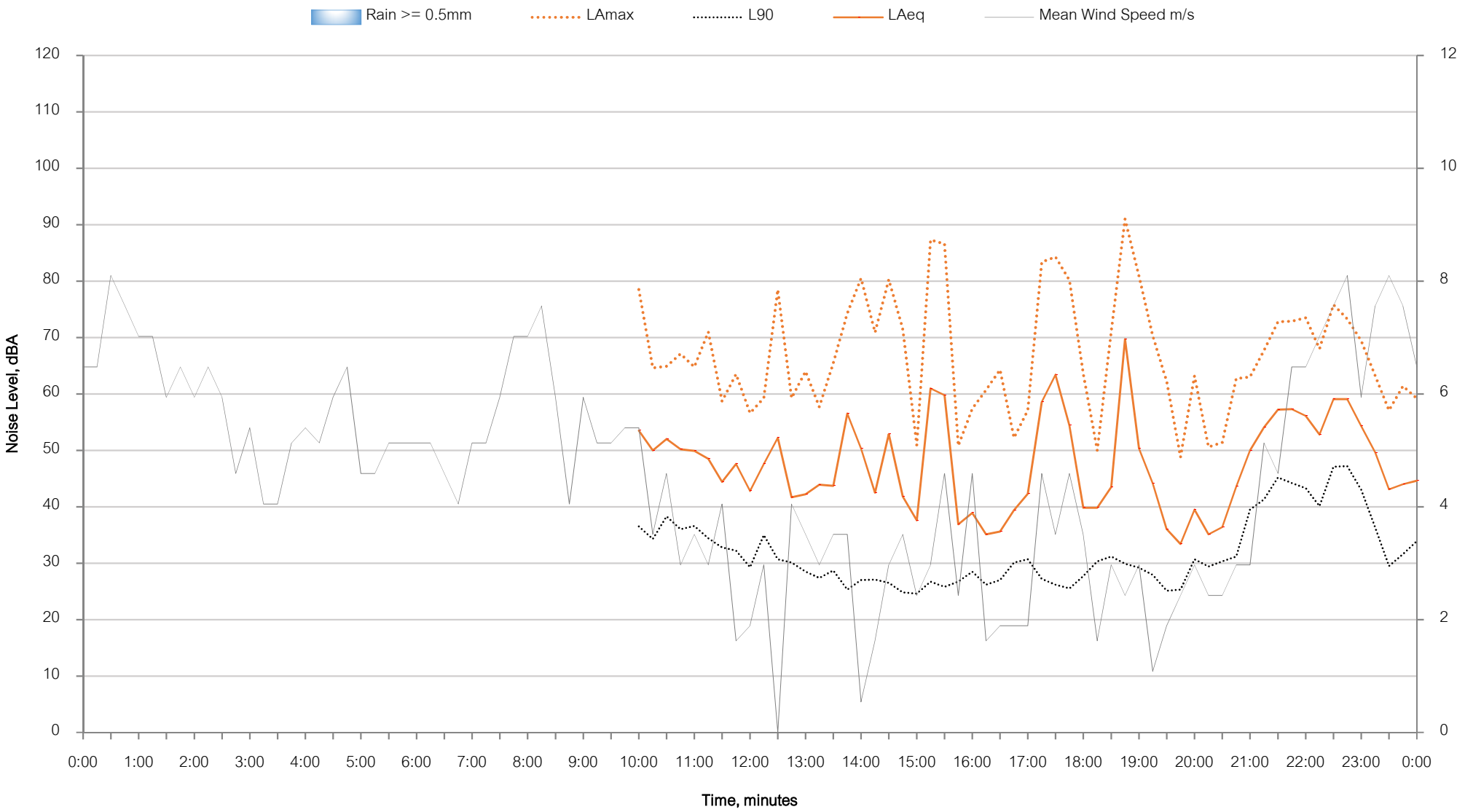
Appendix B – Noise Monitoring Charts

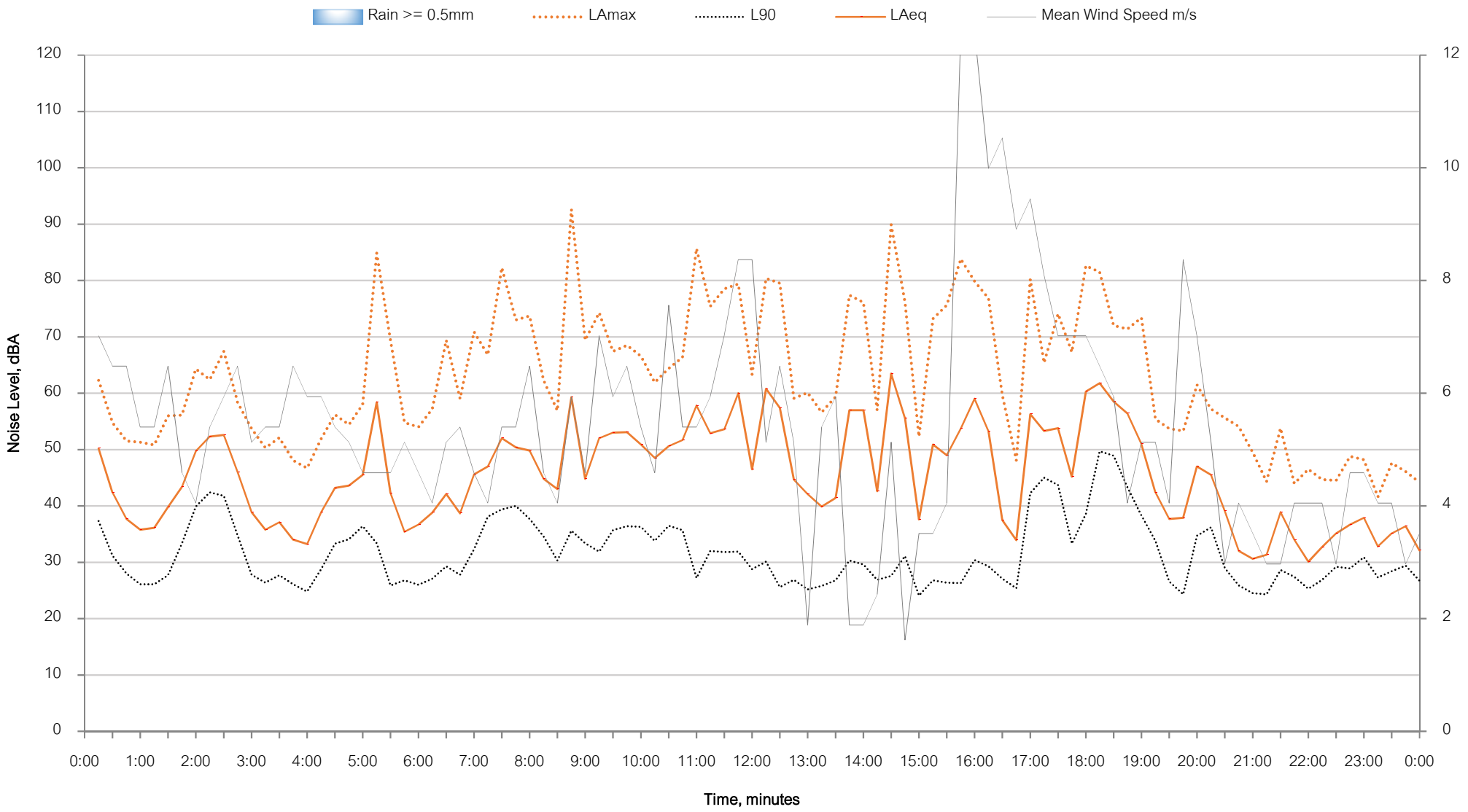
Background Noise Levels

Photon Suntop - Wednesday 22 November 2017



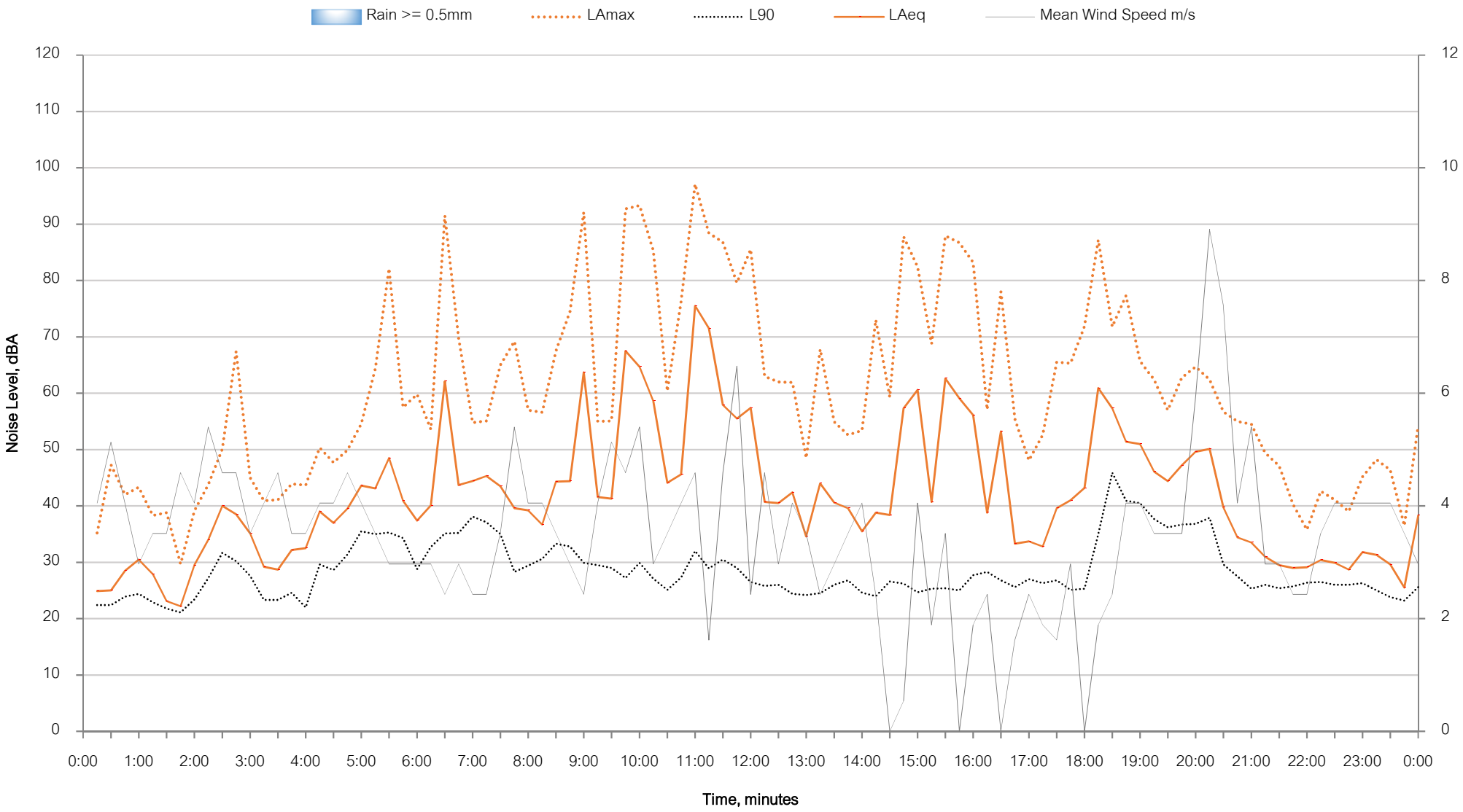
Background Noise Levels

Photon Suntop - Thursday 23 November 2017



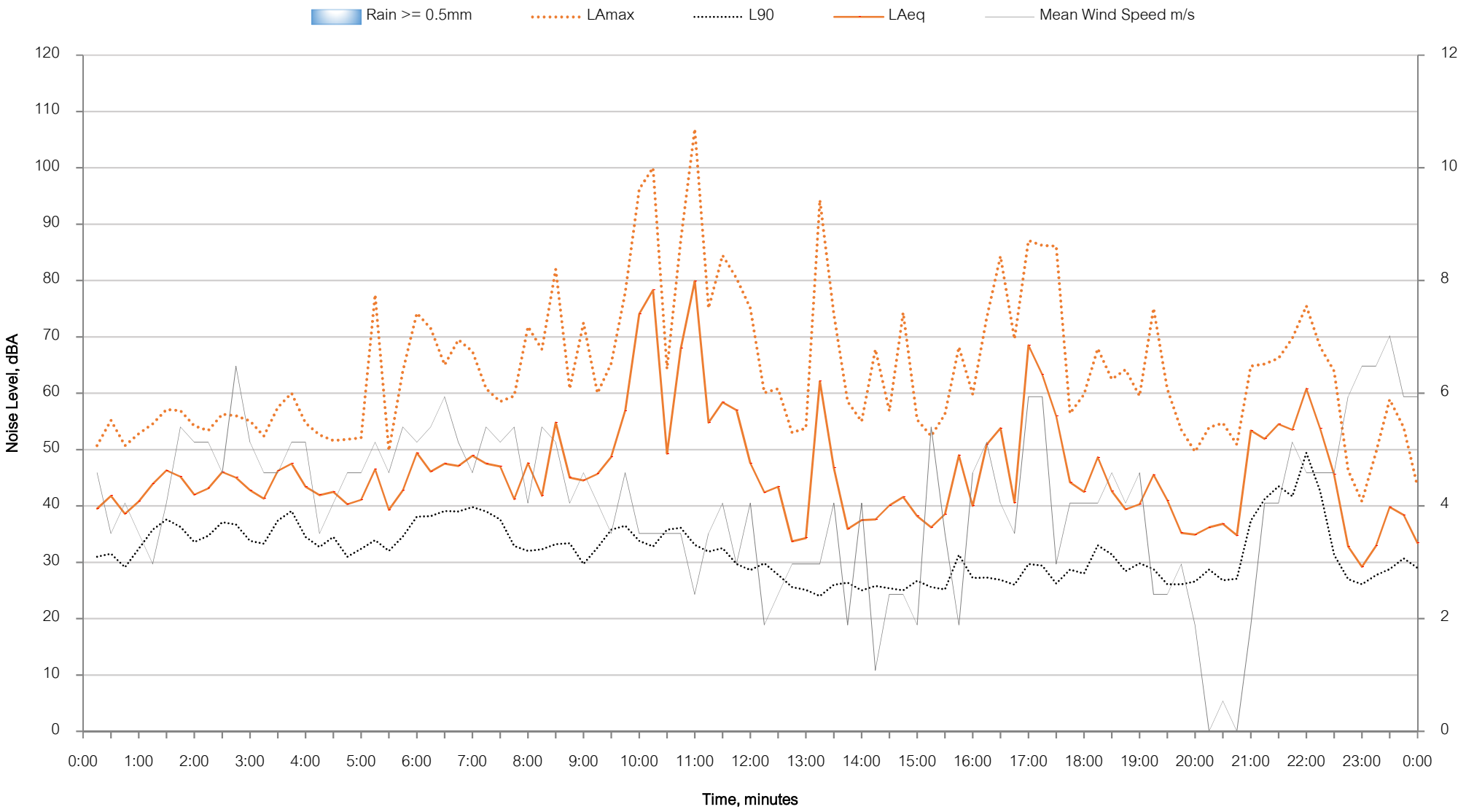
Background Noise Levels

Photon Suntop - Friday 24 November 2017



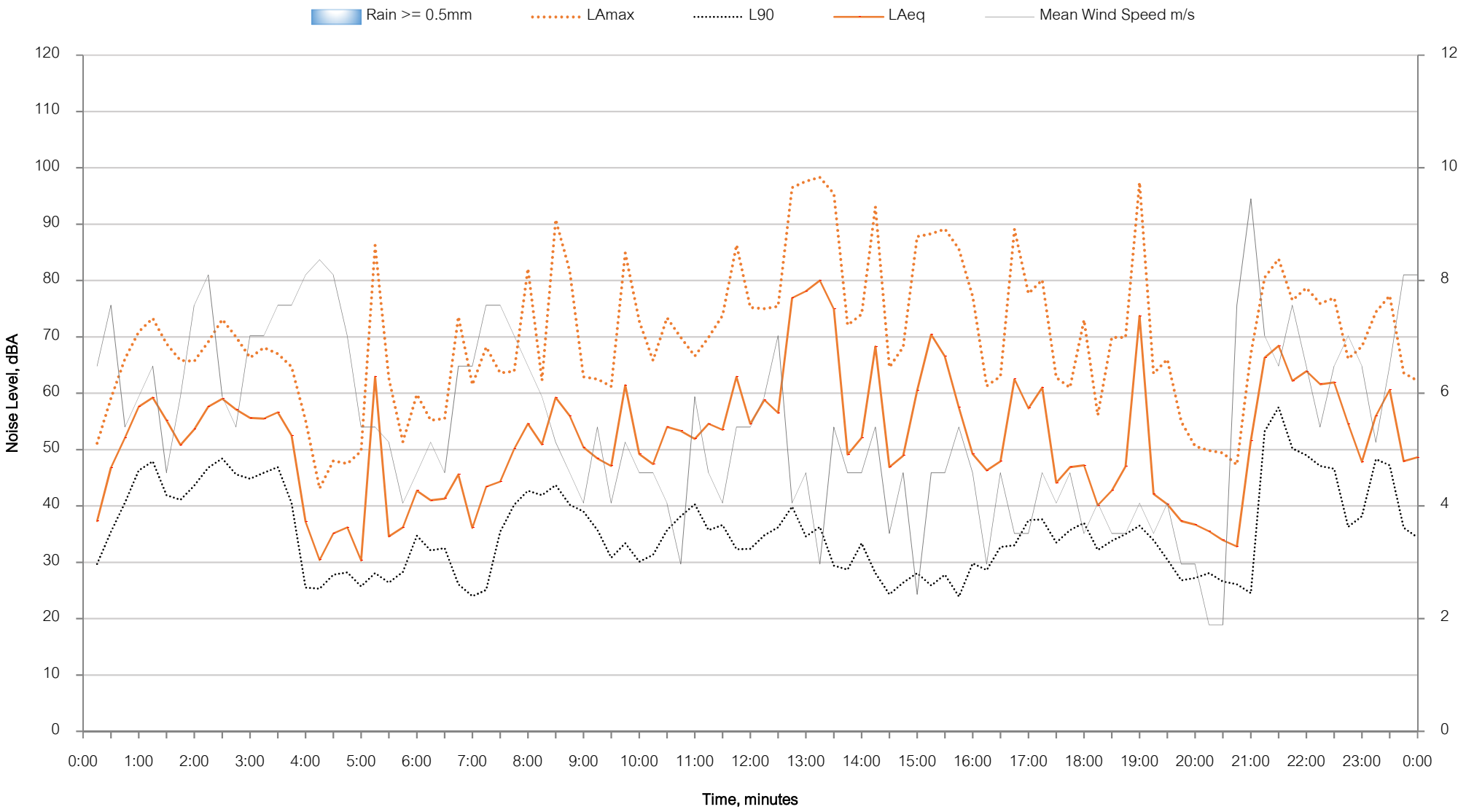
Background Noise Levels

Photon Suntop - Saturday 25 November 2017



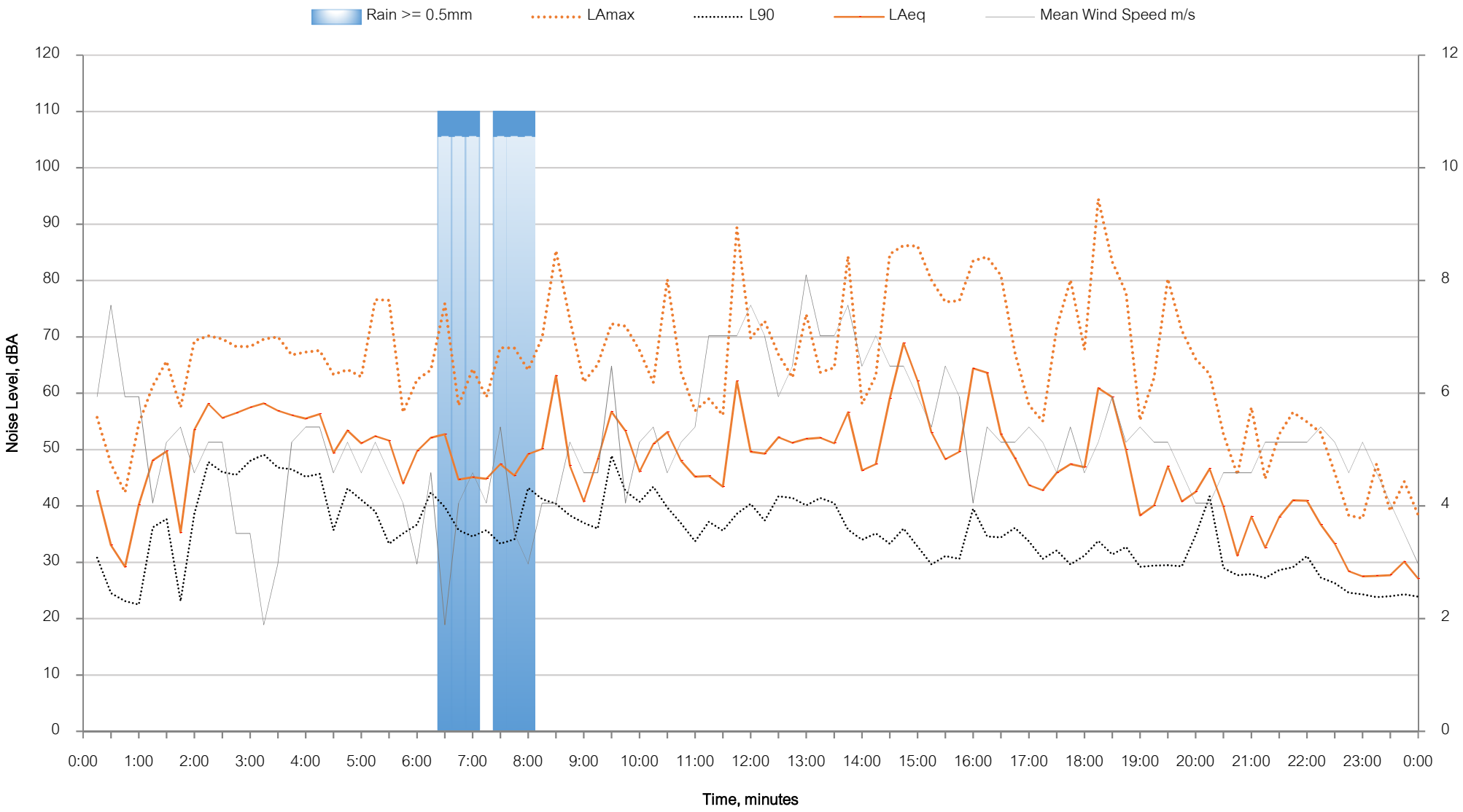
Background Noise Levels

Photon Suntop - Sunday 26 November 2017



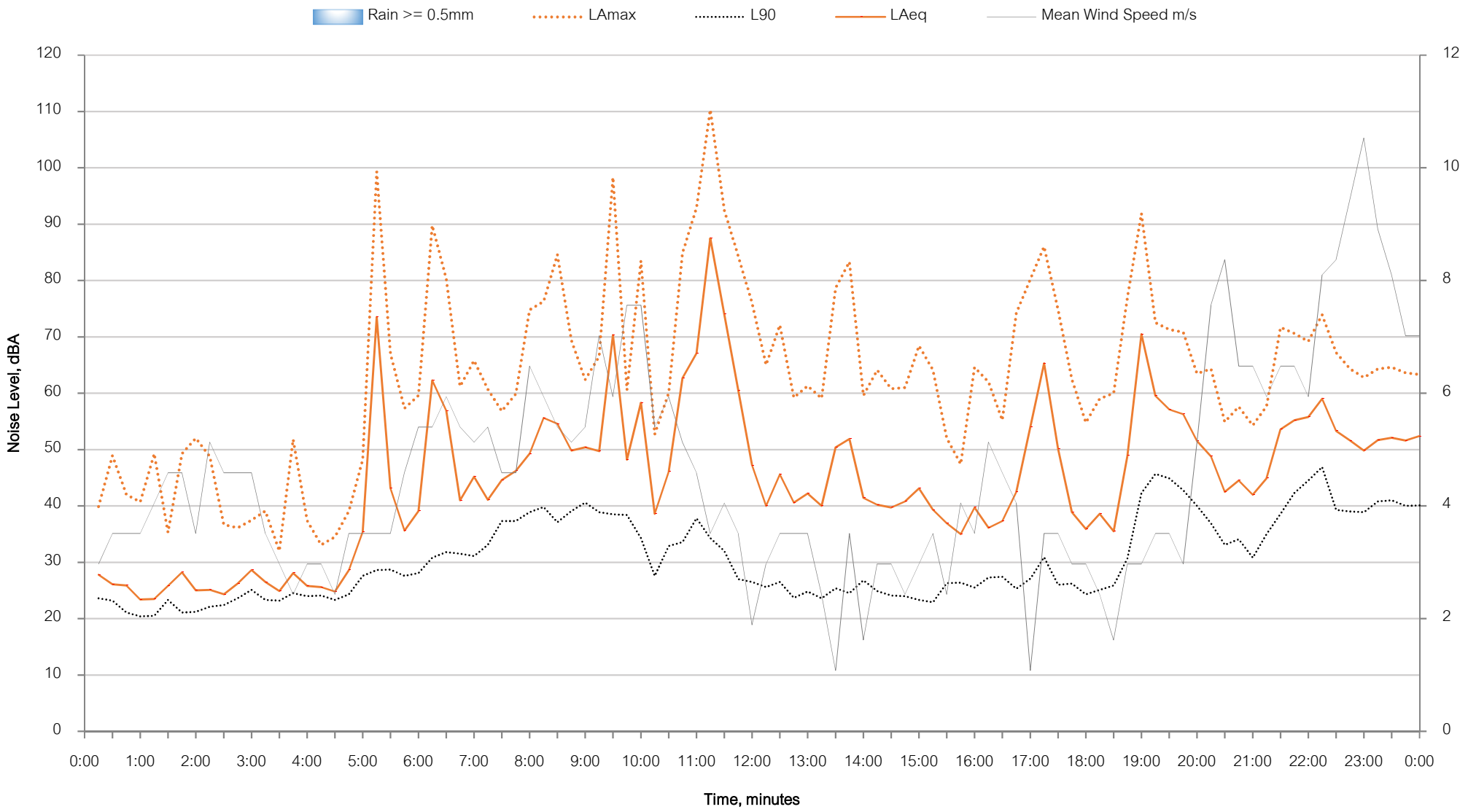
Background Noise Levels

Photon Suntop - Monday 27 November 2017



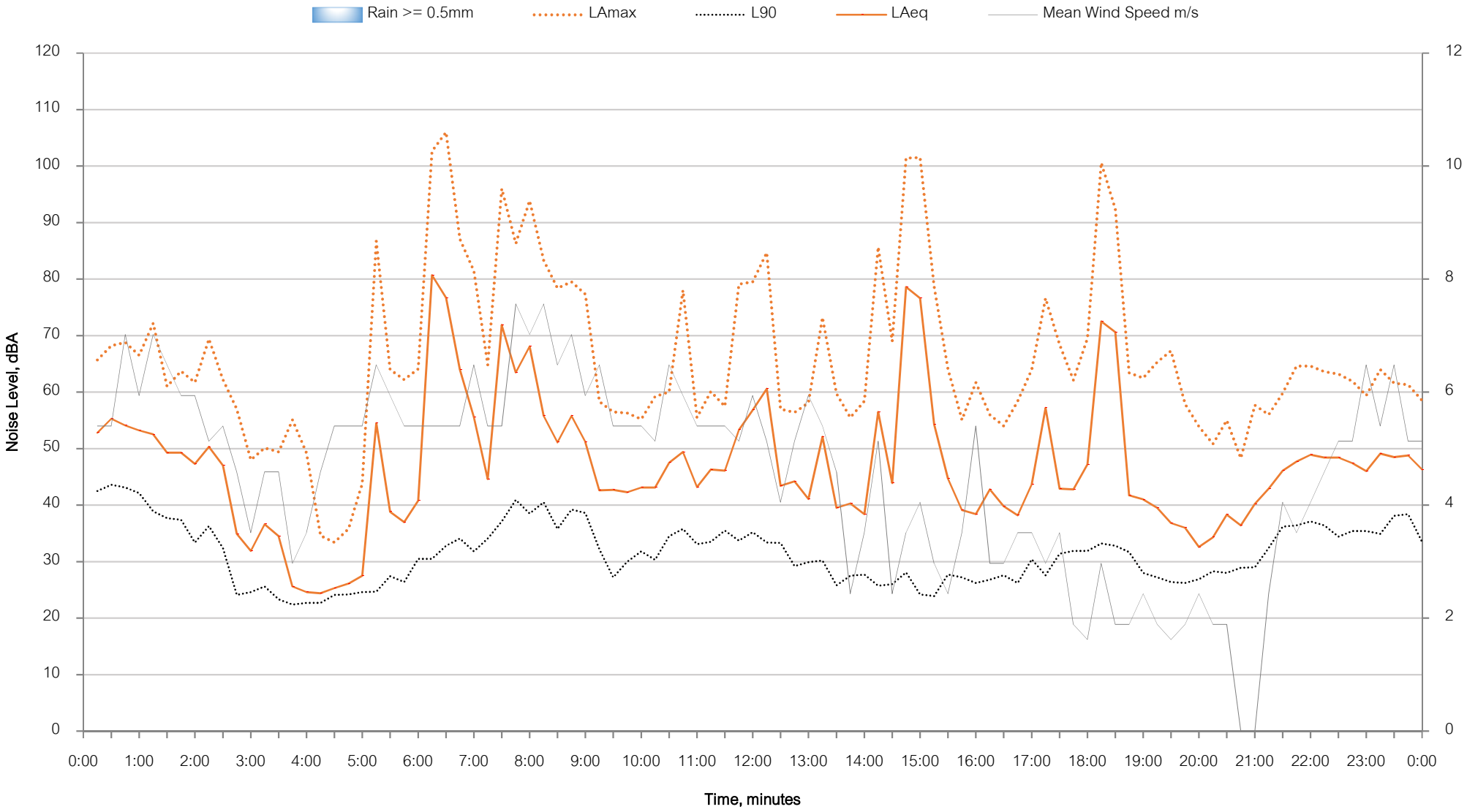
Background Noise Levels

Photon Suntop - Tuesday 28 November 2017



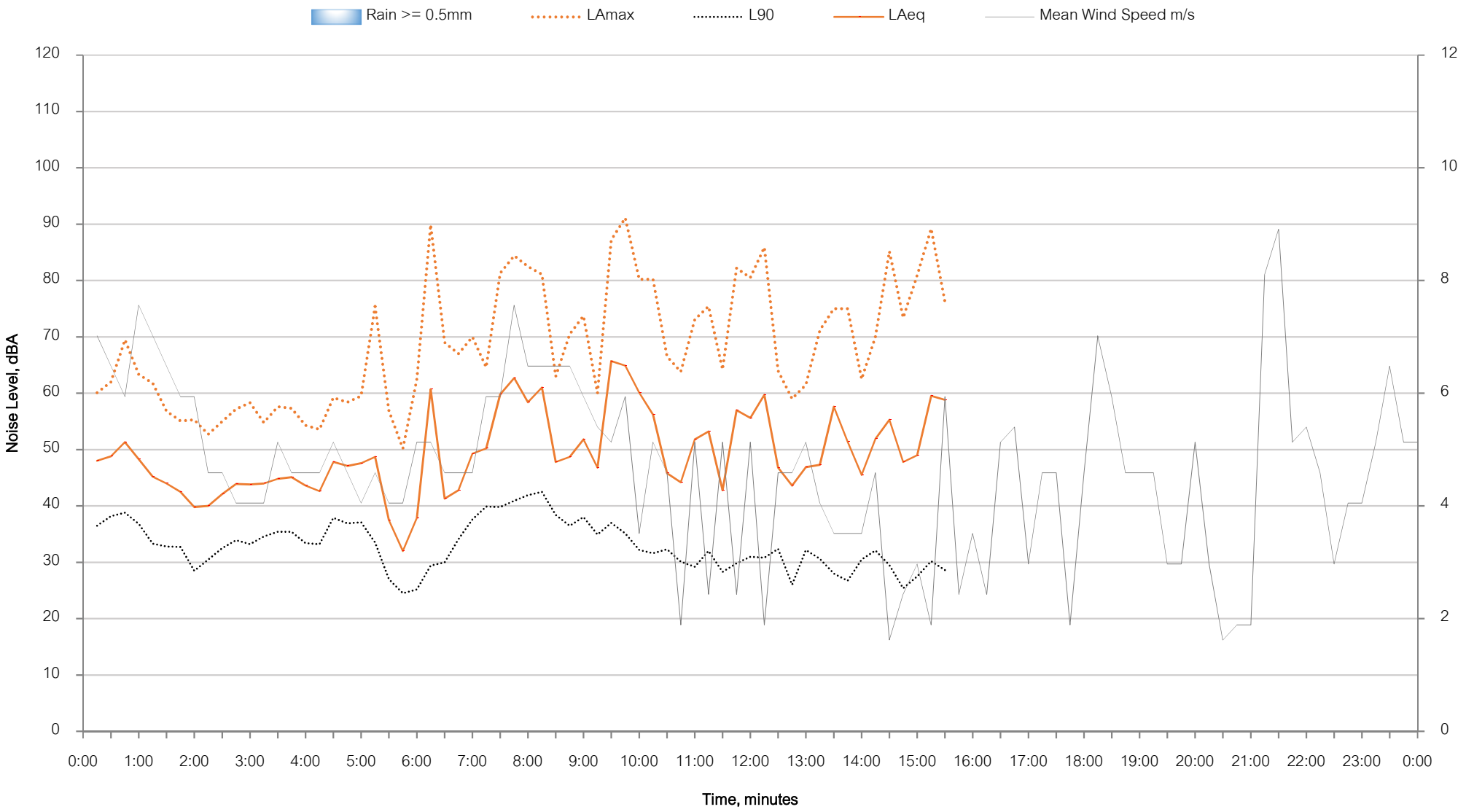
Background Noise Levels

Photon Suntop - Wednesday 29 November 2017



Background Noise Levels

Photon Suntop - Thursday 30 November 2017



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Appendix C – NEWA Analysed Meteorology

Table C1 NEWA Analysed Meteorological Conditions, Dubbo NSW									
Direction ± 45°	Season	Day	Evening	Night	Direction	Season	Day	Evening	Night
		Percentage Occurrence %					Percentage Occurrence %		
0	Summer	5	8	7	180	Summer	7	9	5
0	Autumn	9	13	11	180	Autumn	7	6	4
0	Winter	10	16	13	180	Winter	7	10	6
0	Spring	6	14	10	180	Spring	7	11	6
22.5	Summer	5	8	6	202.5	Summer	8	12	8
22.5	Autumn	7	14	8	202.5	Autumn	7	8	6
22.5	Winter	9	17	10	202.5	Winter	7	11	8
22.5	Spring	5	14	8	202.5	Spring	8	13	8
45	Summer	5	6	4	225	Summer	9	14	13
45	Autumn	7	12	6	225	Autumn	9	13	11
45	Winter	9	17	9	225	Winter	8	15	12
45	Spring	6	13	6	225	Spring	9	17	14
67.5	Summer	4	5	3	247.5	Summer	8	11	14
67.5	Autumn	7	10	6	247.5	Autumn	10	14	15
67.5	Winter	9	16	10	247.5	Winter	9	15	14
67.5	Spring	6	11	7	247.5	Spring	9	15	16
90	Summer	4	4	3	270	Summer	7	10	14
90	Autumn	6	8	5	270	Autumn	11	14	18
90	Winter	9	11	9	270	Winter	11	15	19
90	Spring	6	8	7	270	Spring	9	13	19
112.5	Summer	5	4	2	292.5	Summer	8	10	15
112.5	Autumn	7	6	4	292.5	Autumn	13	14	22
112.5	Winter	10	9	9	292.5	Winter	14	15	23
112.5	Spring	7	6	6	292.5	Spring	9	13	21
135	Summer	6	5	2	315	Summer	7	9	13
135	Autumn	7	5	3	315	Autumn	13	15	20
135	Winter	10	8	7	315	Winter	14	14	20
135	Spring	7	4	5	315	Spring	8	12	19
157.5	Summer	7	10	4	337.5	Summer	4	5	7
157.5	Autumn	7	6	3	337.5	Autumn	8	10	14
157.5	Winter	9	9	6	337.5	Winter	10	10	15
157.5	Spring	8	8	5	337.5	Spring	5	9	13

Construction Noise Management Plan

Suntop Solar Farm,
Wellington, NSW.

Prepared for: pitt&sherry Operations Pty Ltd
May 2018
MAC170550RP2

Muller Acoustic Consulting

Document Information

Construction Noise Management Plan

Suntop Solar Farm, Wellington NSW

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MAC170550RP2	Draft	10 May 2018	Rod Linnett		Oliver Muller	

CONTENTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by pitt&sherry Operations Pty Ltd on behalf of Photon Energy (Photon) to prepare a Construction Noise Management Plan (CNMP) for the proposed Suntop Solar Farm near Wellington, NSW (the 'project').

1.1 Purpose and Objectives

The Noise Assessment (NA) completed for the project Environmental Impact Statement (EIS) identified potential noise impacts during its construction phases. This CNMP summarises the construction noise and vibration related findings of the NA completed for the Environmental Impact Statement and noise mitigation and management measures that may be implemented to effectively manage construction noise emissions at off-site receivers.

The objectives of the CNMP are as follows:

- identify the closest and/or potentially most affected receivers situated within the area of influence to the project;
- review construction and operating activities to identify noise generating plant, equipment, machinery or activities proposed to be undertaken that have the potential to exceed construction Noise Management Levels (NMLs) during standard construction hours and out of hours periods;
- utilise 3D noise modelling to predict noise 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 the project construction NMLs;
- assess the potential noise impacts associated with construction aspects of the project; and
- provide feasible and reasonable noise mitigation and management measures, and monitoring options, where NMLs may be exceeded.

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

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2 Project Description

Photon propose to construct and operate a 200 Megawatt (MW) Photovoltaic Solar (PV) Farm at a 517 hectare site at Suntop, NSW (the 'project'). The project would be located adjacent to Suntop Road, Suntop, NSW, contained within Lot 1-2-3 DP 506925, Lot 122 DP 753238 and Lot 90 DP 657805 (the 'subject lands'). The project is located within the Dubbo Local Government Area (LGA) and is approximately 10km south-west from the Wellington town centre. The area was previously considered part of the Wellington LGA, which has recently amalgamated with Dubbo to form the Dubbo Regional Council. The Wellington Local Environmental Plan (LEP 2012) is still current and applies to the site.

2.1 Description of Proposed Construction Works

The project includes the installation of approximately 550,000 PV modules in one hectare groups on mounting structures approximately 3m in height. The PV mounting structure would comprise of steel posts driven 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 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.

2.2 Project Duration

It is anticipated that the project would be constructed in one-hectare stages, with up to 10 stages in construction at any one time over a nine to twelve month period. Most construction work will be conducted during standard construction hours, however, there will be periods where works will be required after outside standard construction hours to undertake minor works or low intensity activities. This may be required to catch up on program schedule, to meet delivery deadlines or other unforeseeable program restrictions.

2.3 Receiver Review

From observations on site, review of aerial photos and other project information during the EIS, MAC has identified the following potentially sensitive receivers that may be affected by noise from construction activities and related road traffic. **Table 1** presents a summary of receiver Identification, type, address and coordinates. These are reproduced graphically in **Figure 1.**

Table 1 Noise Sensitive Receivers

ID	Type	Description Address	Coordinates (MGA 56)	
			Easting	Northing
R01		675 Suntop Road	108862	6388151
R02		14 Bennetts Road	108960	6388371
R03		586 Suntop Road	109684	6388090
R04		582 Suntop Road	109563	6389044
R05		796 Suntop Road	107898	6389143
R06		1834 Arthurville Road	106884	6388444
R07		Lot 17 1094 Suntop Road	105549	6388976
R08		898 Suntop Road	106696	6389236
R09	Rural Residential	Lot 86 1094 Suntop Road	105168	6389997
R10		69 Frogleys Road	105038	6388224
R11		1570 Renshaw McGirr Way	107199	6384488
R12		1420 Renshaw McGirr Way	109403	6383178
R13		193 Bestwicks Lane	110800	6385458
R14		233 Bestwicks Lane	110935	6386134
R15		433 Suntop Road	111140	6387048
R16		440 Suntop Road	111245	6387671
R17		18 Ringwood Road	111154	6388552

2.4 Vibration Impacts

A qualitative assessment of potential vibration impacts has been completed. Due to the nature of the works proposed and distances to receivers, vibration impacts from the project would be negligible.

The Construction Noise Strategy (Transport for NSW, 2012) sets out safe working distances to achieve the human response criteria for vibration. The key vibrating source proposed to be used on the project is a vibratory pile driver. For a small hydraulic hammer, similar to the type of vibration generated by pile driving works, the Construction Noise Strategy sets a safe working distance of 7m to achieve the residential human response criteria for continuous vibration. Therefore, as the nearest receivers to the project site are greater than 20m, human exposure to vibration is anticipated to be minimal. Furthermore, where the human response criteria are satisfied, the structural or cosmetic criteria for sensitive receivers will be achieved. Therefore, vibration impacts are not considered to be a significant issue to the project and has not been considered further in this assessment.

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3 Noise Policy and Guidelines

This CNMP has been prepared in consideration of the following relevant policies and standards, providing a framework for monitoring, communication, management, reporting and auditing.

- Environment Protection Authority (EPA) 2017, NSW Noise Policy for Industry (NPI);
- Department of Environment and Climate Change (DECC) 2009, Interim Construction Noise Guideline (ICNG);
- Australian Standard AS 2436-2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites;
- Australian Standard AS 1055.1:1997 - Acoustics - Description and measurement of environmental noise - General Procedures; and

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

- Australian Standard AS IEC 61672.1–2004 (AS61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring or Standards Australia AS1259.2-1990 (AS1259) – Acoustics – Sound Level Meters – Integrating/Averaging as appropriate to the device; and
- Australian Standard AS/IEC 60942:2004/IEC 60942:2003 (IEC60942) – Australian Standard – Electroacoustics – Sound Calibrators.

3.1 Construction Noise

The ICNG sets out procedures to identify and address the impacts 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; and
- Qualitative, which is suited to short term infrastructure maintenance (< three weeks).

The methodology for a quantitative assessment requires a more complex approach, involving noise predictions from construction activities to the nearest relevant assessment locations.

The qualitative assessment methodology is a more simplified approach that relies on noise management strategies. This study has adopted a quantitative assessment approach. Steps of the quantitative approach are summarised in **Figure 1.**

The quantitative approach includes identification of potentially affected receivers, description of activities involved in the proposal, derivation of the construction noise management levels, quantification of potential noise impact at receivers and, provides management and mitigation recommendations.

Figure 1 Quantitative Assessment Processes for Assessing and Managing Construction Noise

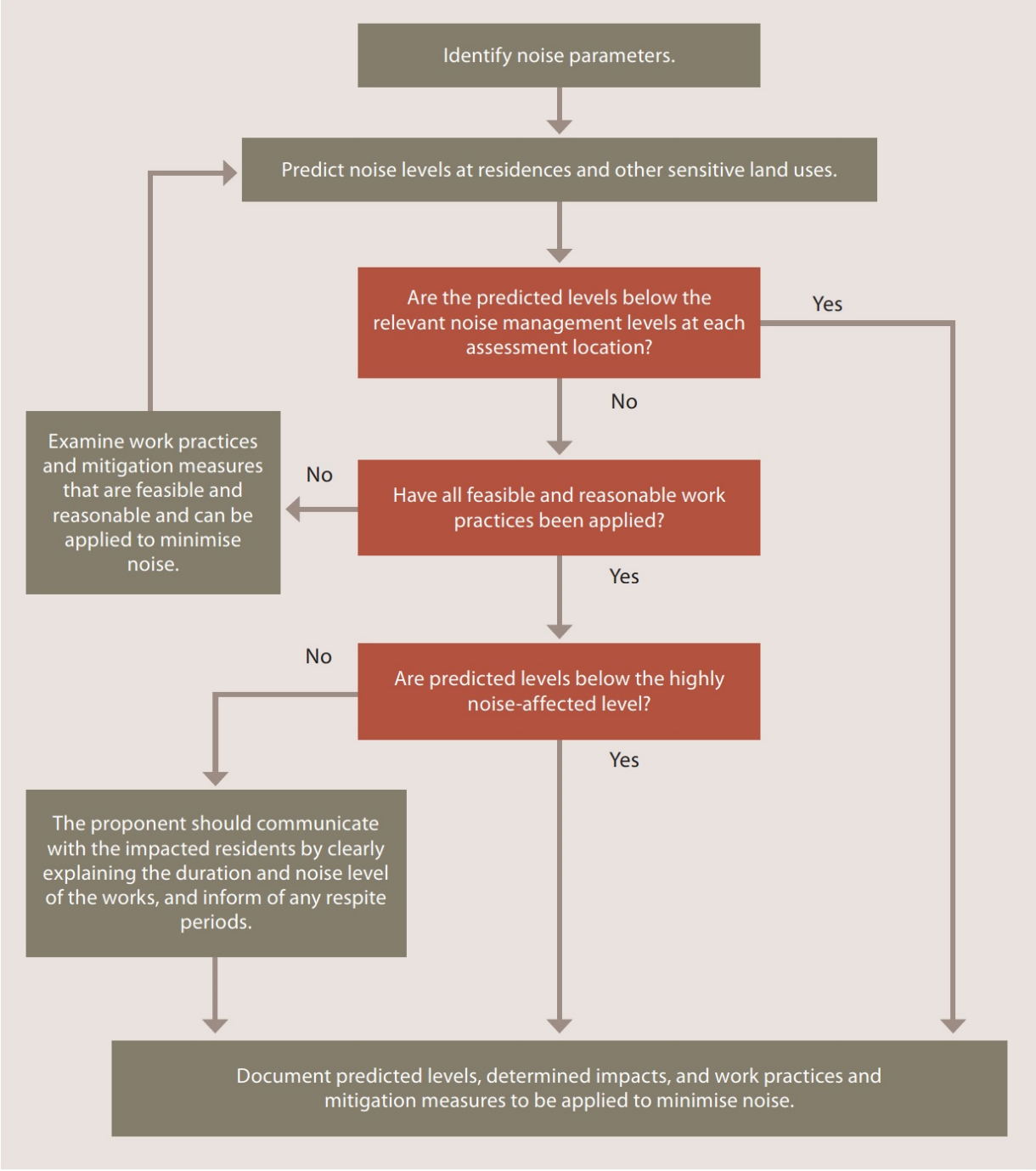

Table 2 summaries the recommended standard and out of hours periods for construction. Note, although are not mandatory, strong justification is required to work outside of normal construction hours.

Table 2 Recommended Hours for Construction

Period	Preferred Construction Hours
Normal construction	Monday to Friday - 7am to 6pm Saturdays - 8am to 1pm Sundays or Public Holidays - No construction
Out of Hours Period 1	Monday to Friday - 6pm to 10pm Saturdays - 7am to 8am and 1pm to 10pm Sundays or Public Holidays - 8am to 6pm
Out of Hours Period 2	Monday to Friday - 10pm to 7am Saturdays - 10pm to 8am Sundays or Public Holidays - 6pm to 7am

These 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 (OOH) work periods. 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).

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 + 10 dB	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 75 dBA.	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 + 5 dB	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 not expected to occur during Period 2, sleep disturbance has not been considered.

4 Existing Environment

4.1 Noise Monitoring Methodology

In accordance with NSW noise guidelines, background noise levels were measured for the EIS (MAC170550RP1) and are used to develop NMLs for residential receivers.

To quantify existing noise levels, long-term unattended noise measurements were performed on the project site (Location L1) as it is currently used for agriculture and representative of receivers located near the project (refer **Table 4**).

Table 4 Noise Monitoring Locations

ID	Unattended Noise Monitoring Location	Site Description	Co-ordinates MGA56	
L1	Project Site	Off Suntop Road	672143m E	6394263m S

4.2 Noise Monitoring Results

From observations whilst on site, the noise environment at existing residential receivers is best described as 'rural' in accordance with the NPI. A rural area, as described in the NPI, is one that has an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. The results of the unattended noise measurements for the background monitoring location, including derived RBLs are summarised in **Table 5**.

Table 5 Unattended Noise Monitoring Results

Unattended Noise Monitoring Location	Period[1]	Measured Background Level RBL L_{A90}, dBA	Measured Ambient Noise Level L_{Aeq}, dBA
L1 Project Site	Day	26	66
	Evening	26	59
	Night	26	59

Note 1: Monday to Saturday: Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Day 8am to 6pm; Evening 6pm to 10pm; Night 10pm to 8am.

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5 Assessment Criteria

5.1 Construction Noise Management Levels

Noise Management Levels (NMLs) for construction activities at all residential receivers are 45dB $L_{Aeq(15min)}$ (RBL +10dB). Although the majority of construction activities are planned for standard hours, the relevant NMLs for standard construction hours and out of hours periods are summarised in **Table 6**.

Table 6 Construction Noise Management Levels

Location	Assessment Period	RBL, dBA	NML dB $L_{Aeq(15min)}$
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)

Note 1: Monday to Saturday: Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Day 8am to 6pm; Evening 6pm to 10pm; Night 10pm to 8am.

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6 Noise Modelling Methodology

A computer model was developed to determine the impact of project noise emissions to neighbouring receivers for typical construction activities. 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 (measured on site at the project), 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'.

6.1 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 three scenarios:

- earthworks involving trenching for cabling;
- piling of panel supports; and
- assembly of the panels.

It is envisaged that all three scenarios have the potential to occur simultaneously at up to 10 locations across the site, together with substation construction, vehicle movements on the site and deliveries of material to site. Noise emission data and assumptions used in this assessment are summarised in **Table 7**.

Table 7 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	2	104	107
Tele-handler	100	1	106	106
Total – Transport				**110**

7 Results

7.1 Construction Results

Noise levels were predicted to each assessed receptor assuming receiver heights of 1.5m above ground level for typical construction activities. **Table 8** summarises the maximum predicted noise level from the construction scenarios at assessed residential receivers for standard hours and OOH periods without additional noise mitigation or management measures.

Table 8 Highest Predicted Construction Noise Levels (All Scenarios)

Receiver ID	Description	Highest Predicted Noise Level dB $L_{Aeq(15min)}$	NML dB $L_{Aeq(15min)}$		Compliance	
			Standard Hours	Period 1 and Period 2	Standard Hours	Period 1 and Period 2
R01	675 Suntop Road	**56**	45	35	No	No
R02	14 Bennetts Road	**51**	45	35	No	No
R03	586 Suntop Road	**46**	45	35	No	No
R04	582 Suntop Road	42	45	35	Yes	No
R05	796 Suntop Road	**51**	45	35	No	No
R06	1834 Arthurville Road	**48**	45	35	No	No
R07	Lot 17 1094 Suntop Road	37	45	35	Yes	No
R08	898 Suntop Road	43	45	35	Yes	No
R09	Lot 86 1094 Suntop Road	29	45	35	Yes	Yes
R10	69 Frogleys Road	32	45	35	Yes	Yes
R11	1570 Renshaw McGirr Way	37	45	35	Yes	No
R12	1420 Renshaw McGirr Way	29	45	35	Yes	Yes
R13	193 Bestwicks Lane	34	45	35	Yes	Yes
R14	233 Bestwicks Lane	36	45	35	Yes	No
R15	433 Suntop Road	35	45	35	Yes	Yes
R16	440 Suntop Road	34	45	35	Yes	Yes
R17	18 Ringwood Road	32	45	35	Yes	Yes

Note: Bold font identifies exceedances at receivers for standard hours of construction.

During standard hours, the activities predicted to exceed the NMLs at receivers along Suntop Road include piling, general assembly and trenching works. These levels would be experienced when activities occur simultaneously along the northern boundary or when a single activity is closest to the specific receiver.

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8 Noise Mitigation for Construction Activities

The results of the EIS NA indicate that noise levels during construction have potential to exceed the NMLs at several surrounding noise sensitive receivers. The noise levels are predicted to be between 3dB to 11dB above the NMLs for standard hours for receivers to the north of the project along Suntop Road. Construction noise levels are predicted to satisfy the highly noise affected criteria of 75dBA $LA_{eq(15min)}$ for all activities. Construction activities, in ranked order of received noise level at these receivers, are: piling, general assembly and trenching works.

The primary objective of the noise management plan is to minimise noise impacts on surrounding receivers. The project construction manager may adopt the following hierarchical strategy to achieve this objective:

- ensure that construction activities meet construction noise management levels within the allowable hours of operation as far as practicable;
- where noise levels are above relevant noise management levels, implement reasonable and feasible best practice noise controls to minimise noise emissions and/or exposure duration at affected receivers; and
- where the use of best practice noise controls does not adequately address exceedance of noise management levels, adopt alternative measures to minimise impacts on the community.

Australian Standard AS 2436-2010 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions. These recommendations include operational strategies, source noise control strategies, noise barrier control strategies, and community consultation.

8.1 Noise Management Recommendations

To fully understand potential impacts, when and where they could occur, a more detailed assessment of each of the activities has been undertaken utilising 3D noise modelling to determine Noise Management Zones (NMZ) highlighting work areas that will require additional noise mitigation measures, allowing for effective noise management during the construction period.

Therefore, NMZ were developed by calculating the work areas, from which NMLs would be achieved across the project site for standard hours and OOH periods. The development of the NMZ are based on triggers used in construction noise management guidelines (consistent with those adopted by Roads and Maritime Services and/or TfNSW) where additional noise mitigation measures and strategies are implemented. Typically, these triggers are based on NML + 10dB for standard hours and NML + 5dB for OOH periods, are summarised in **Table 9**.

Table 9 Construction Noise Management Levels

Location	Assessment Period	RBL, dBA	NML dB $LA_{eq(15min)}$	NMZ dB $LA_{eq(15min)}$
Residential Receivers	Day (Standard Hours)	35	45 (RBL+10dBA)	55 (NML+10dBA)
	Evening (OOH Period 1)	30	35 (RBL+5dBA)	40 (NML +5dBA)
	Night (OOH Period 2)	30	35 (RBL+5dBA)	40 (NML +5dBA)

The NMZ are presented in **Figure 2** and **Figure 3**. Where works are to be undertaken within Zone 1, additional (Level 1) mitigation measures are required. Similarly, where works are to be undertaken within Zone 2, additional (Level 2) mitigation measures are required. Where works are to be undertaken in the remaining area (unshaded area) of the project site, standard mitigation measures are required.

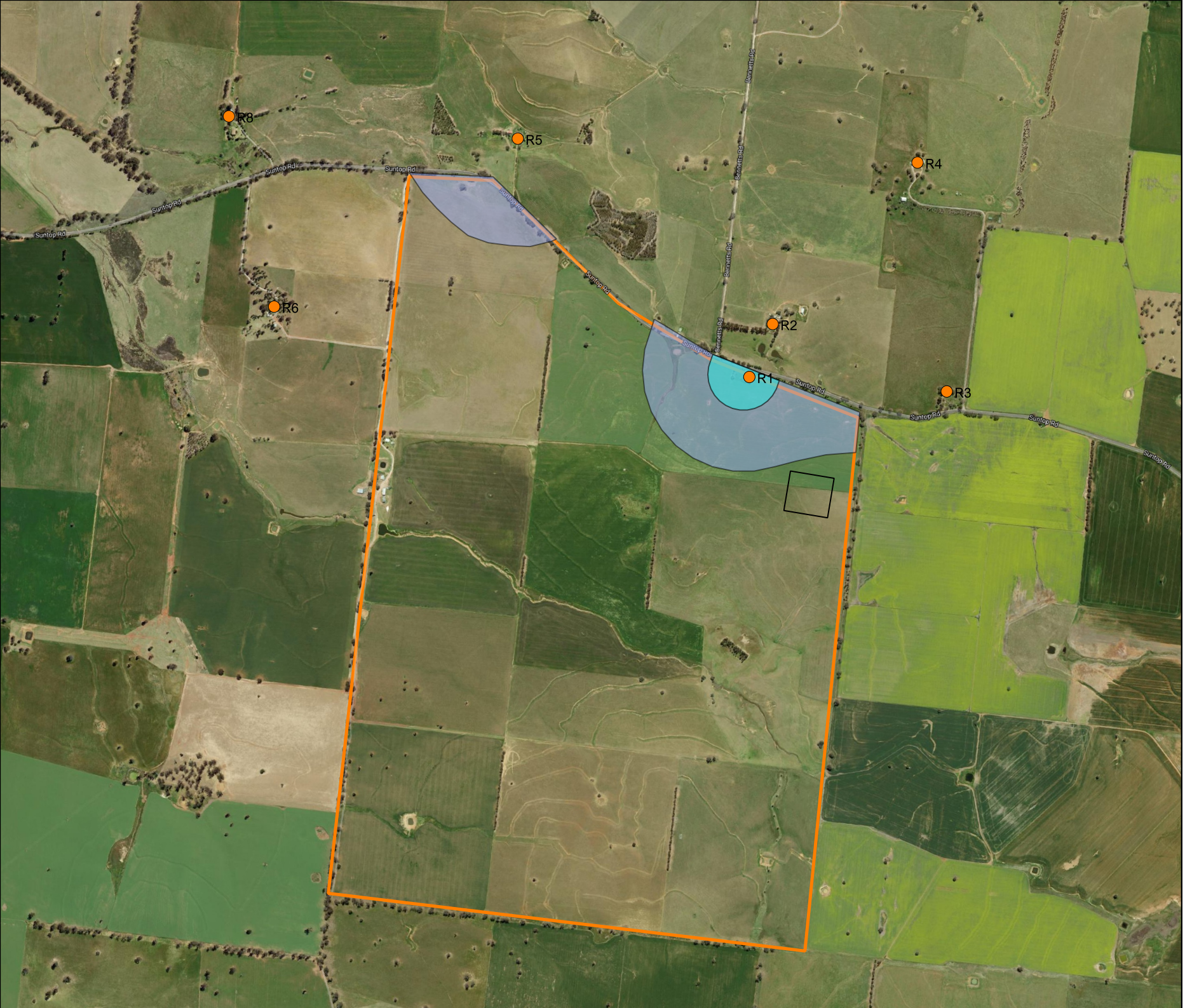


FIGURE 2

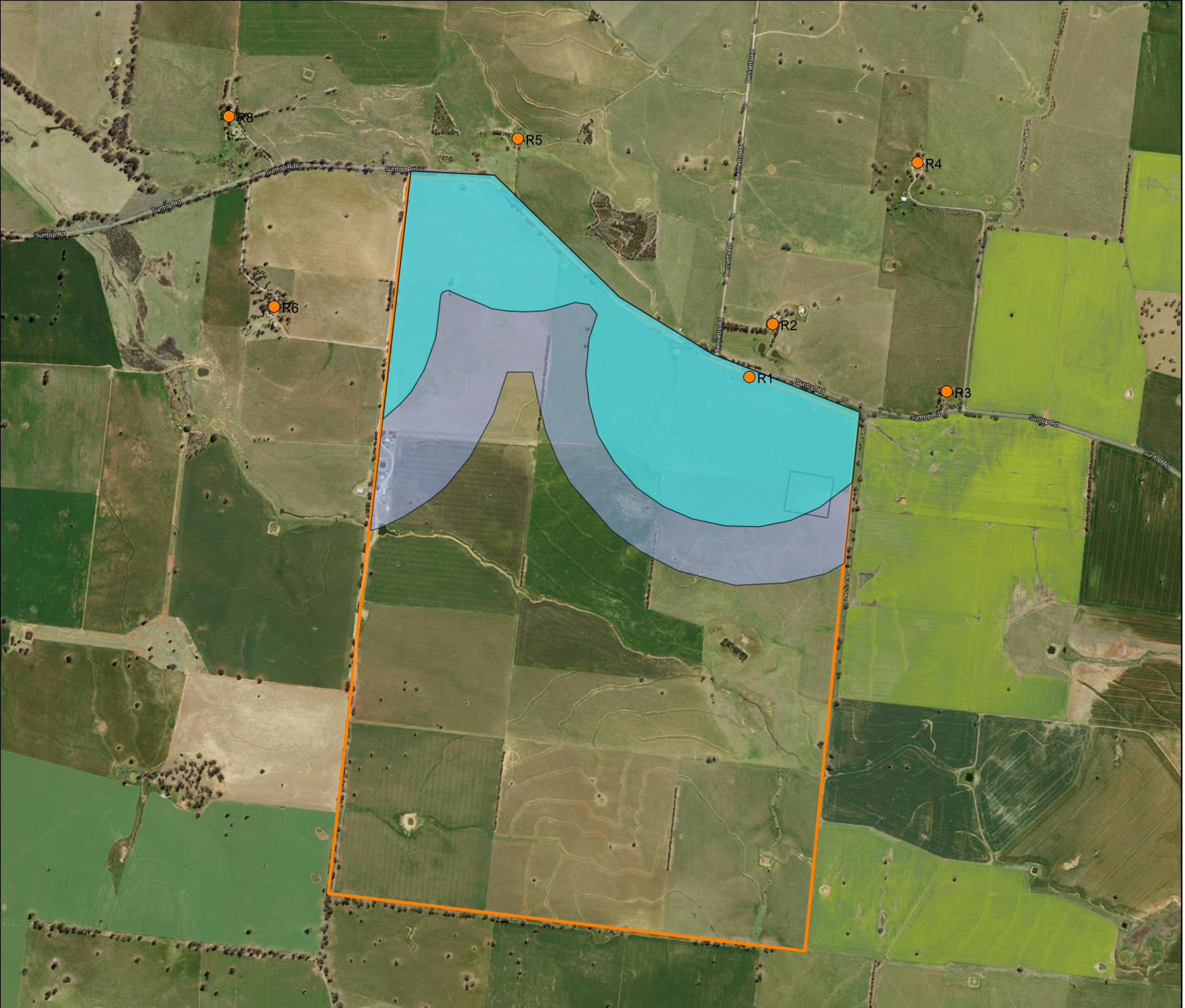
REF: MAC170550RP2

Construction Noise Management Standard Hours

Legend

- Noise Management Zone 1
- Noise Management Zone 2
- Receivers
- Construction Compound
- Suntop Site Boundary

0 200 400 600 800 m



MAC
Muller Acoustic Consulting

FIGURE 3

REF: MAC170550RP2

Construction Noise Management Out of Hours Period 1 & Period 2

Legend

- Noise Management Zone 1
- Noise Management Zone 2
- Receivers
- Construction Compound
- Suntop Site Boundary

0 200 400 600 800 m

Standard, Level 1 and Level 2 mitigation measures are described in **Table 10**.

Table 10 Construction Noise Mitigation Measures

Mitigation Level	Mitigation Measures
Standard Mitigation	▪ Toolbox and induction of personnel prior to shift to discuss noise control measures that may be implemented to reduce noise emissions to surrounding receivers; ▪ Training (of employees to conduct quieter work practices); ▪ Equipment which is used intermittently is to be shut down when not in use; ▪ Where possible, machinery will be located/orientated to direct noise away from the closest sensitive receivers; ▪ Undertake regular maintenance of machinery to minimise noise emissions. Maintenance will be confined to standard daytime construction hours and where possible, away from noise sensitive receivers; ▪ The quietest suitable machinery reasonably available will be selected for each work activity; ▪ Avoid queuing of vehicles adjacent to any receivers; ▪ Where practicable, ensure noisy plant/machinery are not working simultaneously in close proximity to receivers; ▪ Where possible, all plant are to utilise a broad band reverse alarm in lieu of the traditional hi-frequency type reverse alarm; ▪ Minimising the need for reversing or movement alarms.
Level 1 Mitigation (Including Standard Mitigation Level)	▪ Scheduling of construction activities to minimise the number of work fronts and simultaneous activities occurring along the northern boundary to minimise noise levels; ▪ Wherever possible, subject to feasibility and reasonability, the quietest plant and equipment should be utilised in combination with management measures to minimise noise impacts; ▪ Where vehicle queuing is required, for example due to safety reasons, engines are to be switched off to reduce their overall noise impacts on receivers; ▪ Notification of OOH works; ▪ Conduct noise monitoring to validate noise emissions are within NMLs.
Level 2 Mitigation (Including Mitigation Level 1)	▪ Use mobile noise screens (which can achieve noise reductions of up to 8dBA), optimise the positioning of plant and equipment to minimise line of site to receivers or substitute noisy equipment to reduce the noise level at nearby receivers for these activities; ▪ Conduct noise monitoring to validate noise emissions are within NMLs; ▪ Respite periods; ▪ Potential temporary alternative accommodation.

Employing these strategies could potentially result in noise level reductions ranging:

- Standard Mitigation – up to 10dBA in instances where space requirements place limitations on the attenuation options available;
- Level 1 Mitigation – potentially up to 20dBA depending on mixture of measures and noise sources in operation, location and proximity to receivers;
- Level 2 Mitigation – potentially over 20 dBA where the use of enclosures, silencers, etc) can be combined with noise barriers and management techniques (eg avoidance of clustering).

Should compliance noise monitoring indicate exceedances of the noise criteria, a combination of comprehensive noise mitigation treatments (i.e. noise barriers, equipment enclosures, silencers, regular equipment maintenance, etc) and consultation with the local community will be considered on a case by case basis to manage exceedances. Further descriptions of management measures and mitigation options are provided for specific construction activities and work areas in the following sections.

8.1.1 Complaints Handling

- Provide a readily accessible contact point, for example, through a toll-free information and complaints line and give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Records of all community complaints will be maintained on an up-to-date complaints register. The records will include:
    - date and time of the complaint;
    - the means by which the complaint was made (telephone, mail or email);
    - any personal details of the complainant that were provided, or if no details are provided, a note to that effect;
    - the nature of the complaint;
    - any actions taken by the site supervisor/construction contractor in relation to the complaint, including any follow up contact with the complainant and the timing for implementing action; and
    - if no action was taken by site supervisor/construction contractor in relation to the complaint, the reason why no action was taken.

- Community complaints will be allocated to a responsible contractors representative immediately to facilitate the implementation of corrective actions. The details of the complaint will also be circulated to the applicable construction personnel for action, where required.

8.2 Noise Monitoring

A noise monitoring program may be considered by the proponent to guide, manage, quantify and control noise emissions from construction activities in the event of community concerns regarding noise emissions or receipt of a formal noise complaint. Where monitoring indicates exceedances, additional mitigation measures and controls may be considered to minimise impacts to nearby sensitive receivers.

The objectives of the noise monitoring program are as follows:

- assess construction noise levels against derived NMLs presented in this report, with consideration given to non-site related ambient and background noise at the time of measurements;
- identify potential noise sources and their relative contribution to noise impacts from construction;
- specify appropriate intervals for noise monitoring to evaluate, assess and report the noise contribution due to construction;
- outline the methodologies to be adopted for monitoring construction noise, including justification for monitoring intervals or triggers, weather conditions, monitoring location selection and timing; and
- incorporate noise management and mitigation strategies outlined in this plan.

The noise measurement procedures employed throughout the monitoring programme shall be guided by the requirements of AS 1055 1997 “Acoustics - Description and Measurement of Environmental Noise” and the EPA’s Noise Policy for Industry (NPI), 2017. Noise monitoring will be undertaken by a suitably qualified acoustic specialist or suitably qualified and trained environment officer.

Operator attended noise measurements and recordings shall be conducted to quantify the intrusive noise emissions from construction as well as the overall level of ambient noise.

The operator shall quantify and characterise the maximum (L_{Amax}) and the energy equivalent (L_{Aeq}) intrusive noise level from construction over a 15-minute measurement period. In addition, the operator shall quantify and characterise the overall levels of ambient noise over the 15-minute measurement interval. It is recommended that instrumentation used during the monitoring is to be equivalent to a Type 1 meter with 1/3 octave band analysis and have audio recording functionality for post processing source identification. It is noted that 1/3 octave band analysis is required to establish whether modification factors in accordance with the NPI are to be applied.

All acoustic instrumentation used as part of the attended monitoring program must been designed to comply with the requirements of AS IEC 61672.1-2004, "Electroacoustics - Sound level meters - Specifications" and shall have current NATA or manufacturer calibration certificates. All instrumentation shall be programmed to record continuously statistical noise level indices in 15 minute intervals which may include the L_{Amax}, L_{A1}, L_{A5}, L_{A10}, L_{A90}, L_{A99}, L_{Amin} and the L_{Aeq}.

The statistical noise exceedance levels (LAn) are the levels exceeded for n% of the 15-minute interval. The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{Aeq} is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The L_{Amax} is the maximum noise level recorded over the interval.

Instrument calibration shall be checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA. The measurement position(s) should be selected taking into account:

- the weather, rain, wind, noise and insect noise;
- the location and direction of any noise source/s;
- the most sensitive position at the affected receiver; and
- the need to avoid reflecting surfaces (where possible).

8.2.1 Data Presentation and Reporting

The measured $LA_{eq(15min)}$ noise level contributions from construction operations as well as the overall ambient noise levels together with the weather and construction activities at the time of the measurement shall be reported on a regular basis.

In the event of an exceedance of the relevant NMLs, the Construction Manager shall be promptly informed of the location, the margin of exceedance and the source of emission. The noise level, meteorological conditions at the time of the survey and plant operating data shall be documented and forwarded to the Construction Manager so that an appropriate response can be made with respect to conformance.

Reporting of monitoring will include the following:

- monitoring location(s);
- list of operating plant and equipment;
- measured noise and/or vibration levels from construction;
- overall ambient noise levels;
- comparison of results with relevant NMLs;
- monitoring equipment details;
- weather conditions; and
- comments specific to each site.

Compliance reports, discussing compliance against the NMLs, will be prepared and submitted to the Construction Manager as required. Compliance reports will include a summary of the information listed in the preceding sections, specifically issues or non-compliances and the response or management of the issues and non-compliances.

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9 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by pitt&sherry Operations Pty Ltd on behalf of Photon Energy (Photon) to complete a Construction Noise Management Plan for a proposed Solar Farm at Suntop, near Wellington, NSW. The CNMP has quantified potential noise emissions associated with the construction phase of the project and mitigation management measures.

The results of the CNMP demonstrate that construction noise levels for several activities have the potential to be above the relevant NMLs at several receivers in close proximity to the work. Therefore, construction noise mitigation measures as outlined in Section 8 should be considered. **Figure 2** and **Figure 3** provide a visual representation of the NMZ, and when activities occur within these areas, mitigation measures as per **Table 10** should be implemented.

Notwithstanding, the highly affected $LA_{eq(15min)}$ noise management level of 75dBA is expected to be satisfied at all receivers.

In summary, it is recommended that during construction, noise control and management measures provided in this report are adopted to minimise impacts to surrounding receivers, specifically during noise intensive works when they occur adjacent to the northern boundary.

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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

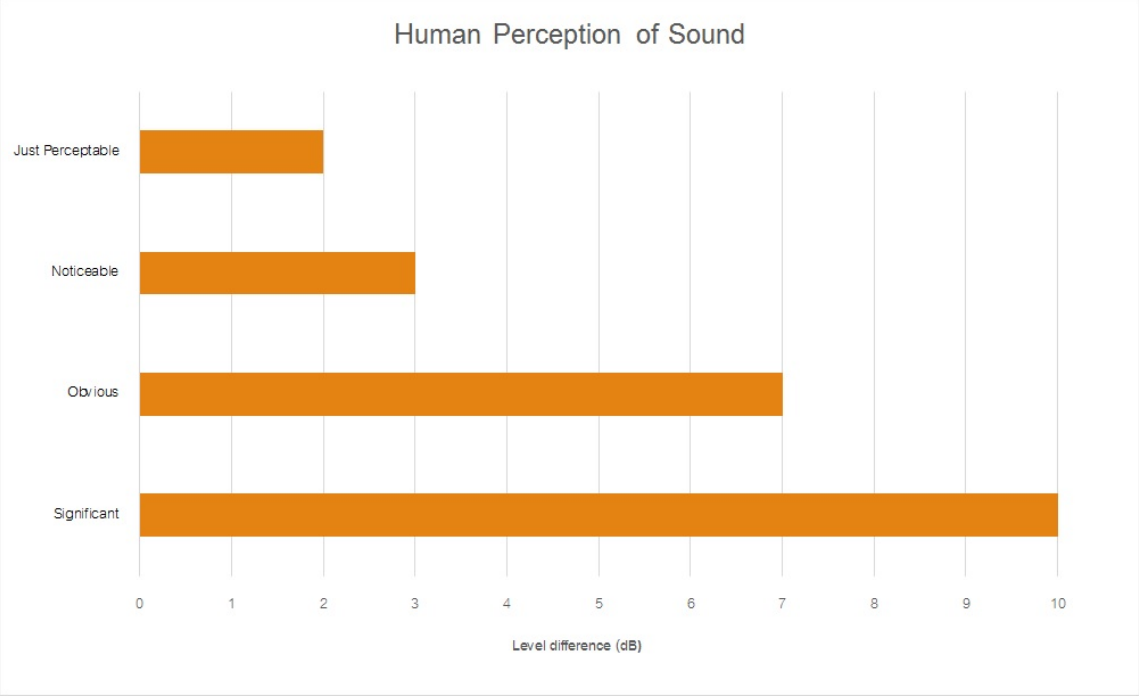
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for 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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