Noise Assessment

Gunnedah Solar Farm, Gunnedah, NSW.

Prepared for: Pitt&Sherry Operations Pty Ltd

March 2018

MAC

Muller Acoustic Consulting

Document Information

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Gunnedah Solar Farm, Gunnedah NSW.

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Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
MAC170530RP1V1	Final	28 March 2018	Rod Linnett		Oliver Muller	

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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 Gunnedah Solar Farm at Gunnedah, NSW (the 'project'). This report presents the methodology and findings of the NA for the construction and operation of the project.

1.1 Purpose and Objectives

A NA 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 150 Megawatt (MW) Photovoltaic Solar (PV) Farm at 765 Orange Grove Road, Gunnedah, NSW (the 'project'). The project site is approximately 763 hectares, contained within Lot 1 DP1202625, Lot 153 DP754954, Lot 264 DP754954, Lot 2 DP801762, Lot 151 DP754954 and part of Lot 1 DP186590 (the 'subject lands'). The site is currently used for agriculture specifically cropping (irrigated cotton and chick pea). The preliminary design for the Solar Farm would occupy approximately 304 hectares of the project site (the 'site').

Power generated by the project will be transmitted via existing powerlines, in an easement owned by TransGrid, to the local energy grid via a substation to be situated on the south-western corner of the site. Works required to upgrade existing powerlines to support the energy generated from the project are not included in the scope of this assessment.

2.2 Description of Proposed Construction Works

The project includes installation of groups of north facing PV modules (up to 3m in height) on mounting structures approximately 2m in height. An estimated 460,000 PV panels will be installed at a 25° fixed angle or on single axis trackers tilted at +/-60° angle from horizontal. 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.

Access to the site will be via Orange Grove Road, which runs along the southern boundary of the project to Kelvin Road which connects to O'Keefe Avenue and Old Blue Vale Road. The route via Old Blue Vale Road to Blue Vale Road connecting to the Kamilaroi Highway west of Gunnedah would be the major transport route for heavy vehicles during construction. The route via O'Keefe Avenue would be used for light vehicles access and worker transport.

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 40 heavy vehicles (mostly B-double trucks) 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 with a 10-15m 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 inverter and transformer components of the substation. It is noted that emissions from these sources are anticipated to be acoustically insignificant compared to ambient background noise levels at assessed receptors.

When required, maintenance activities will 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 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.

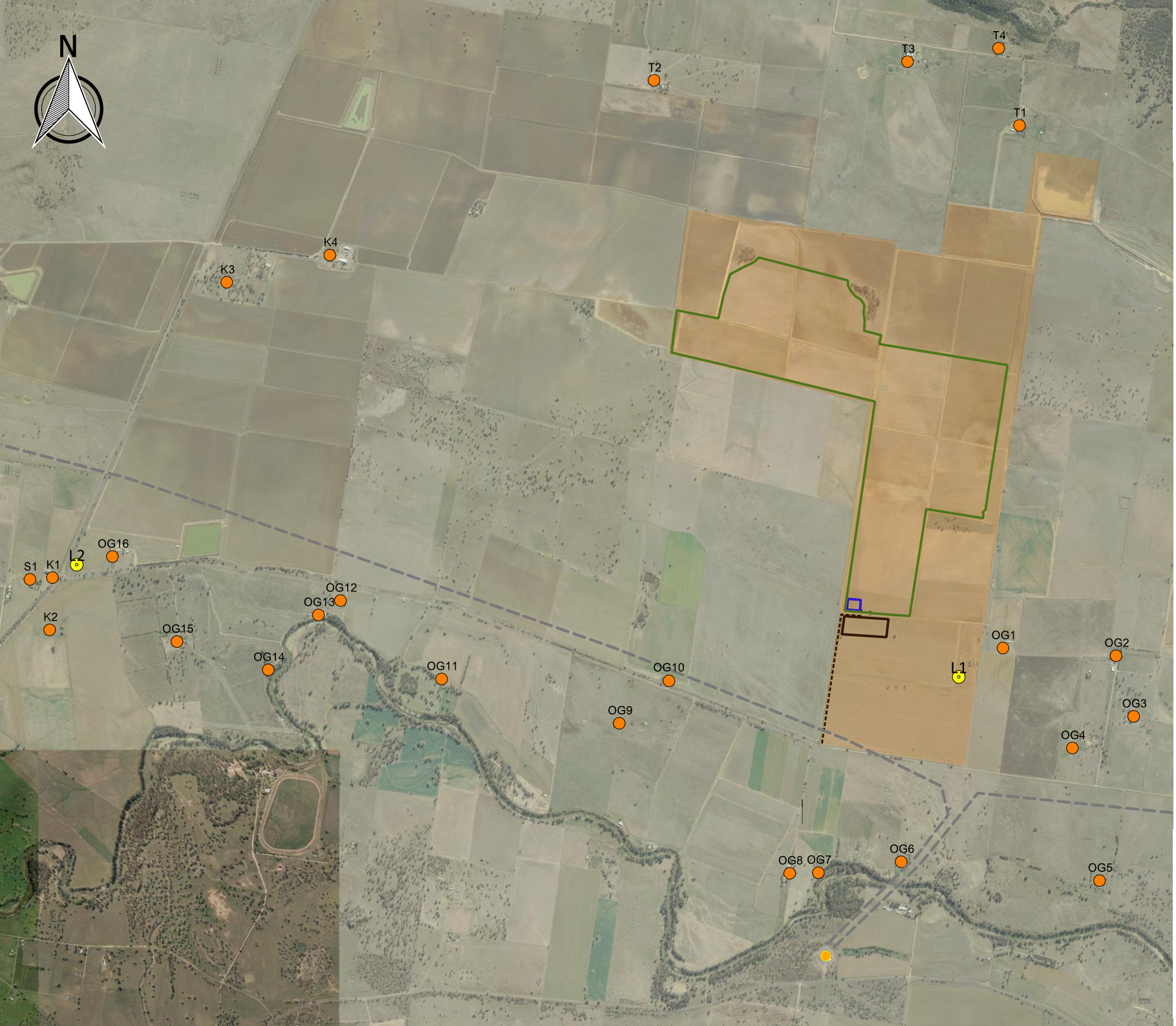

FIGURE 1

PROJECT LAYOUT

REF: MAC170530

0 250 500 750 1000 1250 1500 m

LEGEND

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

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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. **Table 1** 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. **Table 2** 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 + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $LA_{eq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of work to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account times identified by the community when they are less sensitive to noise (such as before and after school for work near schools, or mid-morning or mid-afternoon for work near residences; and if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5dB	A strong justification would typically be required for work outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

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

3.2 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 PINL ($L_{Aeq,15min}$) 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 **Table 3**. 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
K1		351 Kelvin Road	239611	6572958
K2		210 Kelvin Road	239588	6572531
K3		632 Kelvin Road	241037	6575375
K4		554 Kelvin Road	241881	6575598
OG1		767 Orange Grove Road	247389	6572382
OG2		875 Orange Grove Road	248314	6572319
OG3		897 Orange Grove Road	248459	6571823
OG4		851 Orange Grove Road	247957	6571564
OG5		898 Orange Grove Road	248179	6570478
OG6		726 Orange Grove Road	246556	6570632
OG7		640 Orange Grove Road	245879	6570543
OG8		640 Orange Grove Road	245644	6570538
OG9	Rural Residential	476 Orange Grove Road	244250	6571766
OG10		515 Orange Grove Road	244656	6572113
OG11		306 Orange Grove Road	242795	6572129
OG12		242 Orange Grove Road	241968	6572770
OG13		224 Orange Grove Road	241787	6572653
OG14		118 Orange Grove Road	241376	6572204
OG15		88 Orange Grove Road	240629	6572434
OG16		43 Orange Grove Road	240101	6573131
S1		133 Shanley Lane	239427	6572944
T1		Tudgey Road Lot 2 DP1202625	247524	6576659
T2		254 Tudgey Road	244533	6577028
T3		526 Tudgey Road	246608	6577181
T4		615 Tudgey Road	247354	6577291

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 and short-term operator attended noise measurements were performed at representative receptors located near the project. The locations at which the existing noise levels were measured are presented in Table 5.

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 Svantek Type 1 977 noise analysers from Thursday 26 October 2017 to Saturday 4 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	765 Orange Grove Road	6572270	247117
L2	Kelvin Road	Corner of Kelvin Road and Orange Grove Road	6572950	239671

Location L1 is situated on the subject land and is currently used for agriculture and is considered to be representative of this receptor type surrounding the project. Location L2 is situated on the corner of Kelvin Road and Orange Grove Road, situated at the same offset distance from the road as the nearest receiver along the transport route to measure existing road traffic noise levels.

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.

The results of the unattended noise measurements for the background monitoring locations, 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	55
	Evening	30	51
	Night	28	46
L2 Kelvin Road	Day	30	59
	Evening	27	57
	Night	26	55

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 $LA_{eq,15min}$ (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 $LA_{eq,15min}$
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	30	30	35
	Night	28	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 Intrusiveness Noise Level or the PANL. **Table 10** presents the derivation of the PNTLs 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			
$L_{Aeq,15min}$		L_{Amax}	
40dB $L_{Aeq,15min}$ or RBL + 5dB		52dB L_{Amax} 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 'sub arterial road' category, as specified in the RNP, has been adopted for Kelvin Road, and Blue Vale Road. It is acknowledged that the functional classification of Orange Grove Road and Old Blue Vale Road 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	Type of Project/Development	Assessment Criteria - dBA	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub -arterial road	3. Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments	60dBA LAeq,15hr external	55dBA LAeq,9hr 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 Kelvin Road should be considered for mitigation.

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 transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic LAeq,15hr +12dB (external)	Existing traffic LAeq,9hr +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				
Backhoe	100	1	104	104
Light vehicle	50	2	76	76
Total – Trenching & Earthworks				**104**
Piling				
Piling Rig (hydraulic)	100	1	113	113
Tele-handler	80	1	106	105
Light vehicle	50	1	76	73
Total – Piling				**114**
Assembly				
Mobile Crane/ HIAB	100	1	104	104
Tele-handler	100	1	106	106
Light vehicle	50	2	76	76
Hand tools/Power tools	25	1	102	96
Welder	25	1	105	99
Total – Assembly				**109**
Transport (on site)				
Heavy vehicle	100	1	104	104
Tele-handler	100	1	106	106
Total – Transport				**110**

6.2 Operational Assessment Methodology

6.2.1 Operational Noise 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 is yet to be confirmed, therefore, the likely maximum 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	6730	78	99
Transmission Kiosk – each consisting of the following				
Inverter	Constant	34	75	96
Transformer	Constant	34	70	91
Capacitor Battery	Constant	34	75	96
Transmission Kiosk - Total[2, 3]	Constant	34	79	99
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 Bureau of Meteorology's (BOM) Gunnedah Airport weather station located approximately 2km 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	315	23
Autumn	Night	315	29
Winter	Night	315	25
Spring	Night	315	22

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 LA_{eq} 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.

The route via Kelvin Road and O'Keefe Avenue crossing the Namoi River on Cohen's Bridge would be used for light vehicles access and worker transport (mini buses). Receptors (OG10 and K1) are the closest receptors on any of the access routes and are both 40m from the road edge. Therefore, an offset distance of 40m has been adopted as the nearest offset to heavy vehicle movements along the public road network.

As there is potential for construction road traffic noise impacts, road traffic noise was assessed at noise monitoring location L2 – Kelvin Road. Existing road traffic noise levels along Kelvin Road are summarised in Table 18.

Table 18 Existing Road Traffic Noise Levels

Noise Monitoring Location	Period[1]	Existing Road Traffic Noise
L2 Kelvin Road	Day	59dB $LA_{eq,15hr}$
	Night	55dB $LA_{eq,9hr}$

Note 1: Day 7am to 10pm; Night 10pm to 7am.

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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 19** summarises the maximum predicted noise level from each of the construction scenarios at identified residential receptors and comply with the NMLs at all residential receptors for the day period.

Table 19 Predicted Construction Noise Levels

Receiver ID	Description	Highest Predicted Noise Level dB $L_{Aeq,15min}$	NML Standard Hours dB $L_{Aeq,15min}$	Comply
K1	351 Kelvin Road	44	45	Yes
K2	210 Kelvin Road	36	45	Yes
K3	632 Kelvin Road	24	45	Yes
K4	554 Kelvin Road	26	45	Yes
OG1	767 Orange Grove Road	43	45	Yes
OG2	875 Orange Grove Road	32	45	Yes
OG3	897 Orange Grove Road	42	45	Yes
OG4	851 Orange Grove Road	29	45	Yes
OG5	898 Orange Grove Road	38	45	Yes
OG6	726 Orange Grove Road	34	45	Yes
OG7	640 Orange Grove Road	27	45	Yes
OG8	640 Orange Grove Road	29	45	Yes
OG9	476 Orange Grove Road	38	45	Yes
OG10	515 Orange Grove Road	36	45	Yes
OG11	306 Orange Grove Road	36	45	Yes
OG12	242 Orange Grove Road	34	45	Yes
OG13	224 Orange Grove Road	34	45	Yes
OG14	118 Orange Grove Road	33	45	Yes
OG15	88 Orange Grove Road	44	45	Yes
OG16	43 Orange Grove Road	36	45	Yes
S1	133 Shanley Lane	24	45	Yes
T1	Tudgey Road Lot 2 DP1202625	26	45	Yes
T2	254 Tudgey Road	43	45	Yes
T3	526 Tudgey Road	36	45	Yes
T4	615 Tudgey Road	34	45	Yes

7.2 Operational Noise Results

Noise levels were predicted at each assessed receptor assuming receiver heights of 1.5m above ground level. **Table 20** summarises the predicted operational noise levels which are demonstrated to comply with the PNTLs at all residential receptors.

Table 20 Predicted Operational Noise Levels

Receiver ID	Description	Predicted Noise Level dB $LA_{eq,15min}$	Limiting Night time PNTL dB $LA_{eq,15min}$	Compliance
K1	351 Kelvin Road	<15	35	Yes
K2	210 Kelvin Road	<15	35	Yes
K3	632 Kelvin Road	<15	35	Yes
K4	554 Kelvin Road	<15	35	Yes
OG1	767 Orange Grove Road	23	35	Yes
OG2	875 Orange Grove Road	18	35	Yes
OG3	897 Orange Grove Road	<15	35	Yes
OG4	851 Orange Grove Road	<15	35	Yes
OG5	898 Orange Grove Road	<15	35	Yes
OG6	726 Orange Grove Road	<15	35	Yes
OG7	640 Orange Grove Road	<15	35	Yes
OG8	640 Orange Grove Road	<15	35	Yes
OG9	476 Orange Grove Road	19	35	Yes
OG10	515 Orange Grove Road	16	35	Yes
OG11	306 Orange Grove Road	17	35	Yes
OG12	242 Orange Grove Road	<15	35	Yes
OG13	224 Orange Grove Road	<15	35	Yes
OG14	118 Orange Grove Road	<15	35	Yes
OG15	88 Orange Grove Road	<15	35	Yes
OG16	43 Orange Grove Road	<15	35	Yes
S1	133 Shanley Lane	18	35	Yes
T1	Tudgey Road Lot 2 DP1202625	16	35	Yes
T2	254 Tudgey Road	17	35	Yes
T3	526 Tudgey Road	16	35	Yes
T4	615 Tudgey Road	16	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 Blue Vale Road, Old Blue Vale Road, Kelvin Road to Orange Grove Road would be the major transport route for heavy vehicles during construction. The route via Kelvin Road and O'Keefe Avenue crossing the Namoi River on Cohen's Bridge would be used for light vehicles access and worker transport (mini buses).

During construction, traffic generated by the project would include employee/subcontractor vehicles and delivery vehicles. During the peak construction period, the traffic volume over a typical day for standard construction hours is expected to be 40 heavy vehicles, mostly B-double trucks 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 21**.

Table 21 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	40	3.6	7	14	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 an offset distance of 40m from the road edge using the United States (US) Environment Protection Agency's road traffic calculation method is presented in **Table 22**.

Table 22 Predicted Construction Road Traffic Noise Levels

Receiver ID	Description	Predicted Noise Level dB $LA_{eq,15hr}$	RTN Criteria dB $LA_{eq,1hr}$	Comply
K1	351 Kelvin Road	50.9	60	Yes
OG10	515 Orange Grove Road	50.9		

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

- a construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community;
- where possible use localised mobile screens or construction hoarding around plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (eg unloading and laydown areas);
- operating plant in a conservative manner (no over-revving), 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 Gunnedah, 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 construction NMLs; and operational noise levels satisfy the NPI PNTLs for assessed receivers.

Additionally, the NA demonstrates that the road noise criteria as specified in the RNP will be satisfied at receiver distances of greater than 40m from any public road. Notwithstanding, noise management measures during construction are provided to minimise noise emissions from the project.

Based on the NA results, there are no noise related issues which would prevent the approval of the project. The results of the assessment show compliance with the relevant construction, operational and road noise criteria. Additionally, the results of the assessment demonstrate compliance with the relative EPA and DECCW policies, without ameliorative measures being required.

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Appendix A – Glossary of Terms

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

Table A1 Glossary of Terms

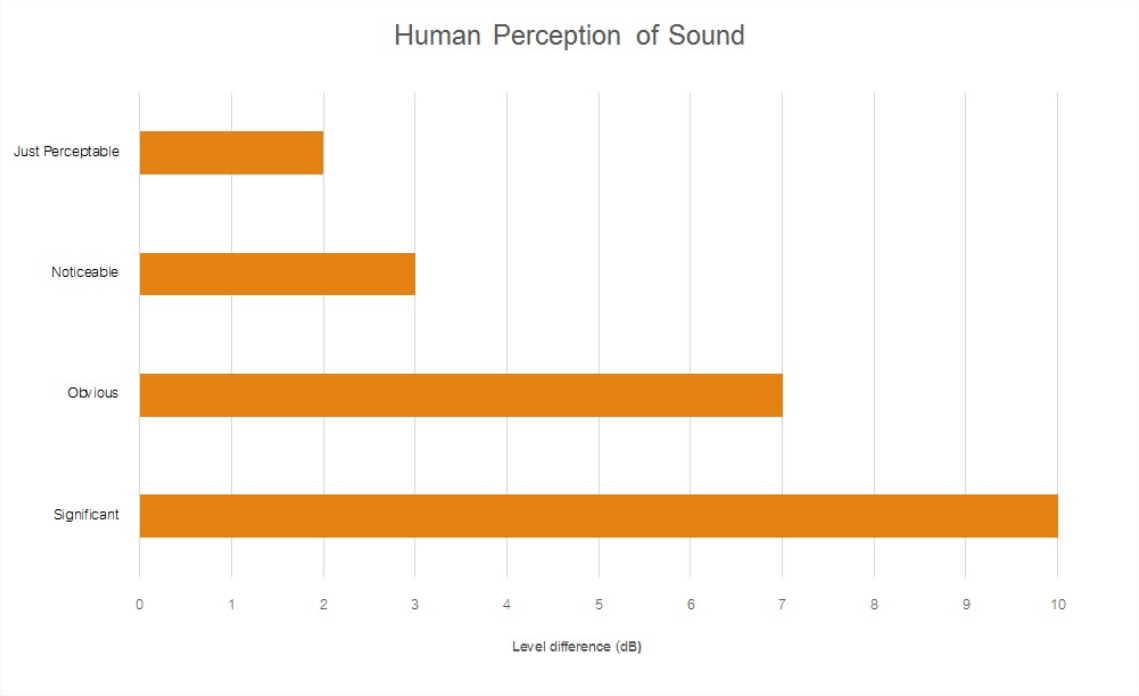
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for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

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

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

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

Figure A1 – Human Perception of Sound



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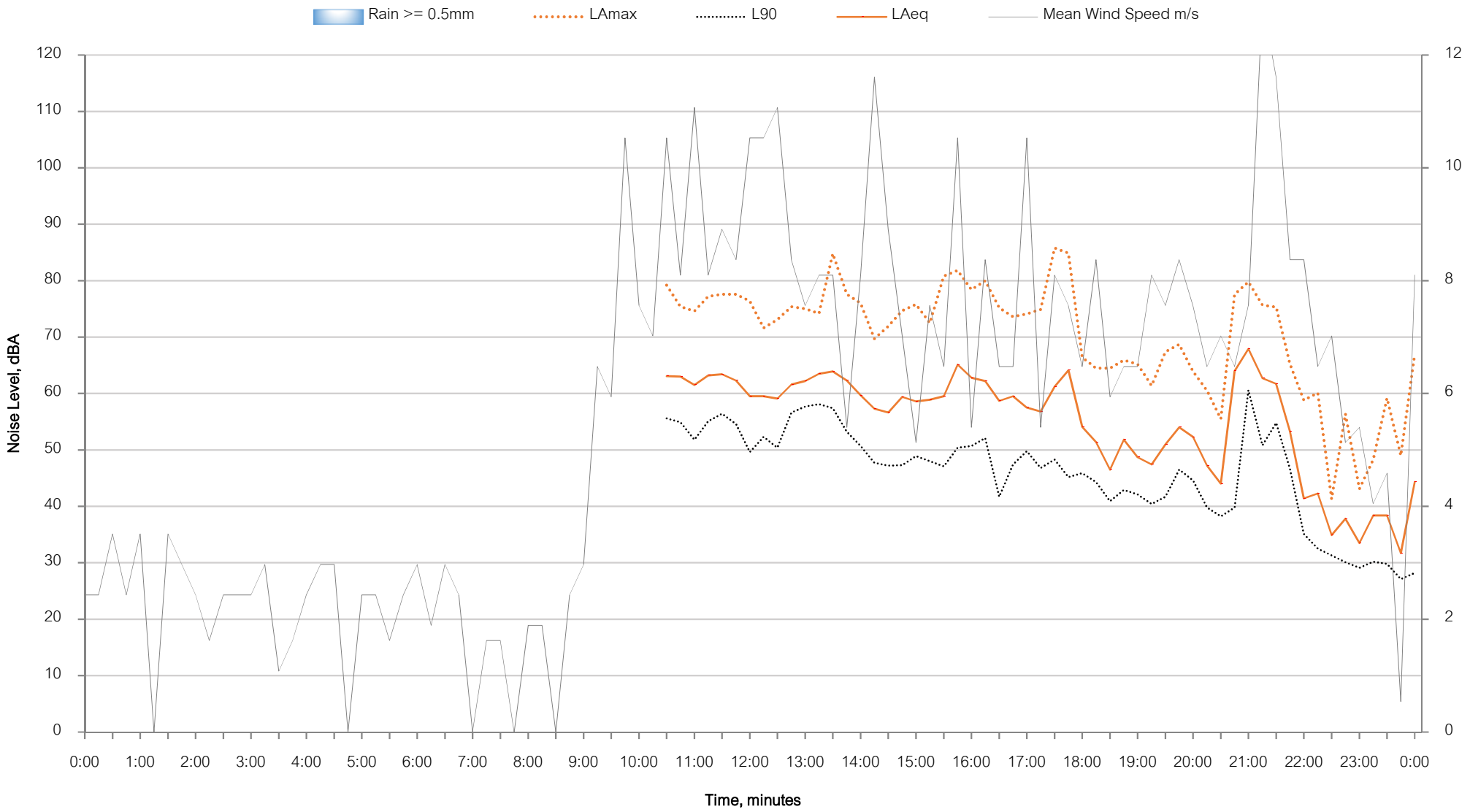
Appendix B – Noise Monitoring Charts

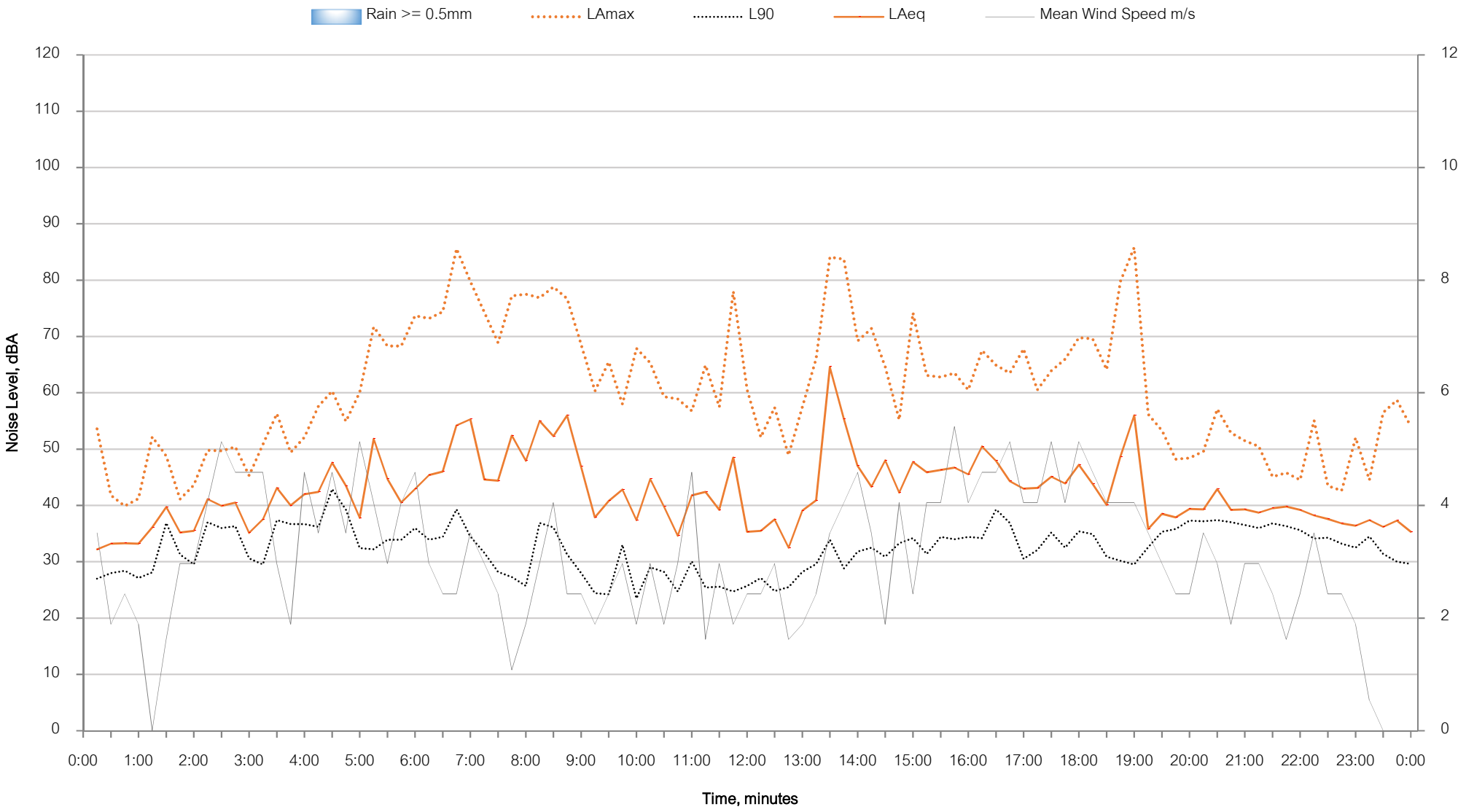
Background Noise Levels

Logger 1 - Photon Site - Thursday 26 October 2017



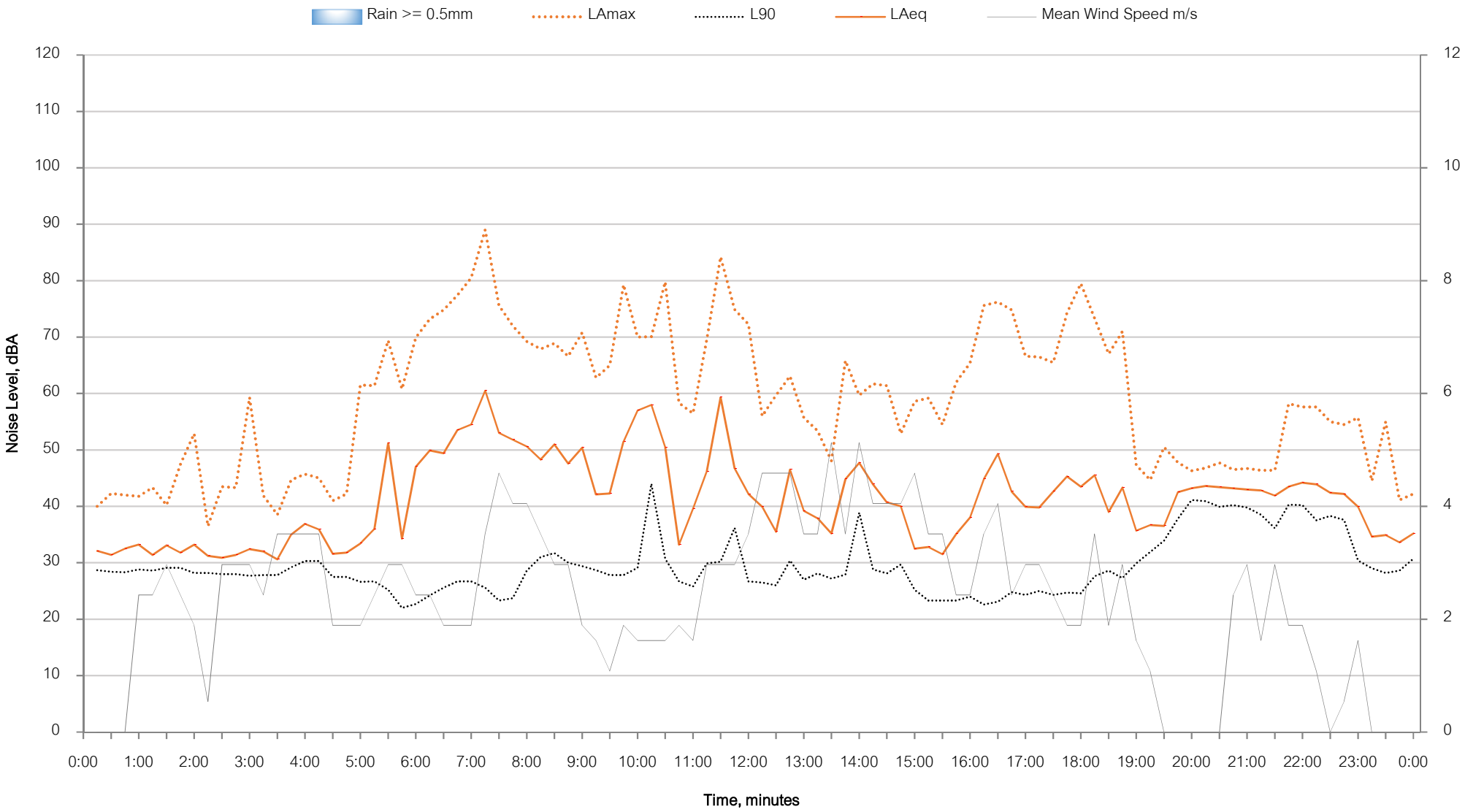
Background Noise Levels

Logger 1 - Photon Site - Friday 27 October 2017



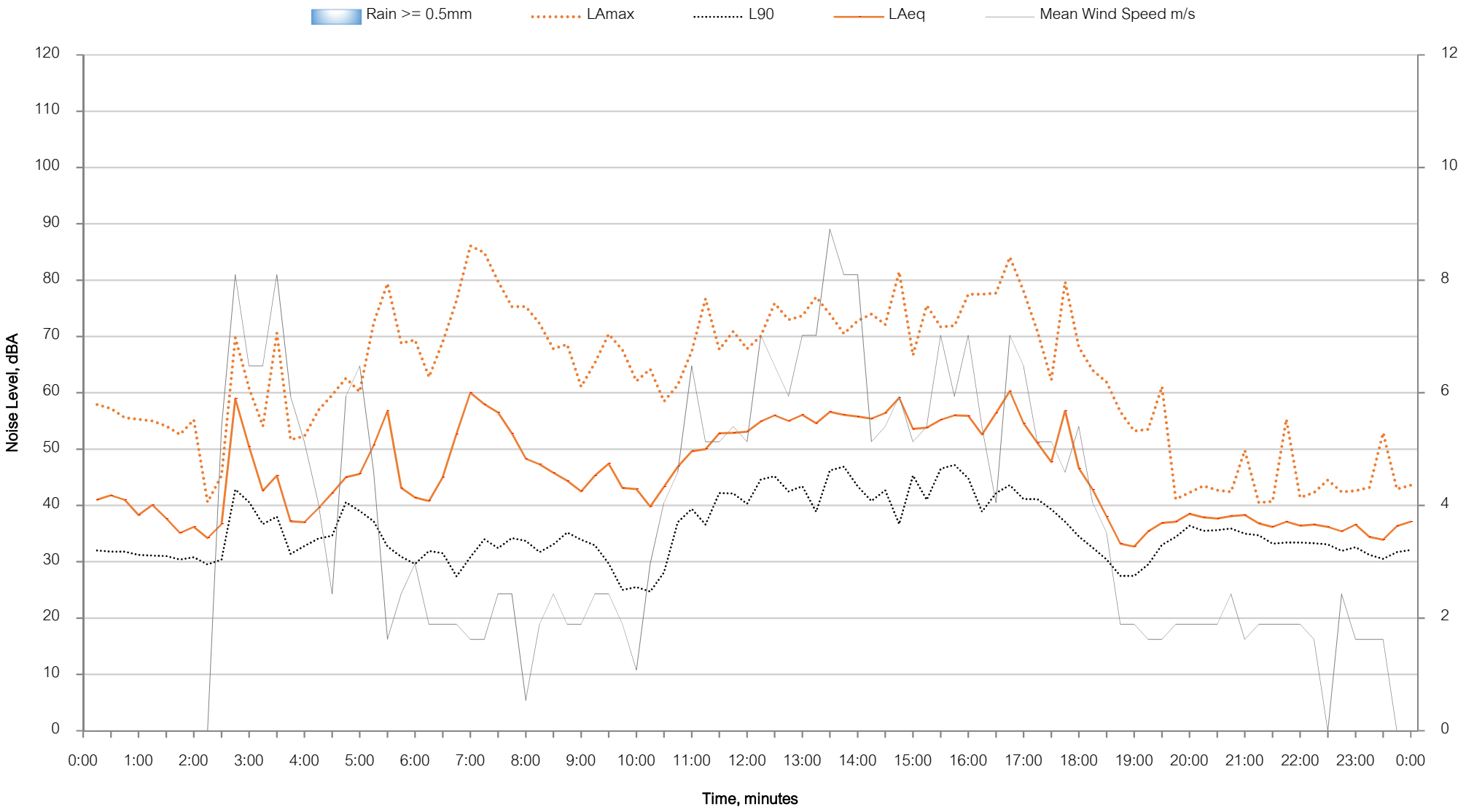
Background Noise Levels

Logger 1 - Photon Site - Saturday 28 October 2017



Background Noise Levels

Logger 1 - Photon Site - Sunday 29 October 2017

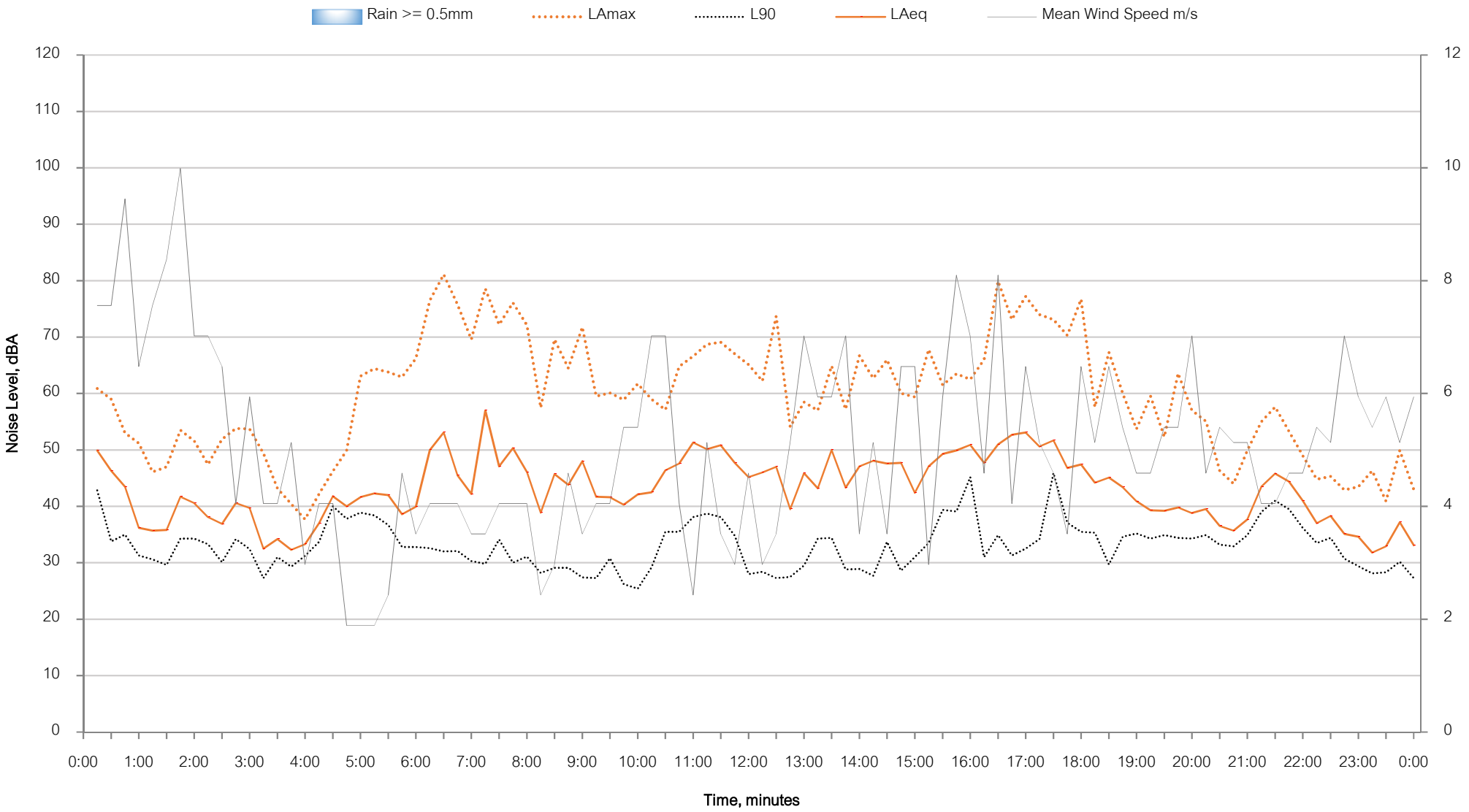


Background Noise Levels

Logger 1 - Photon Site - Monday 30 October 2017

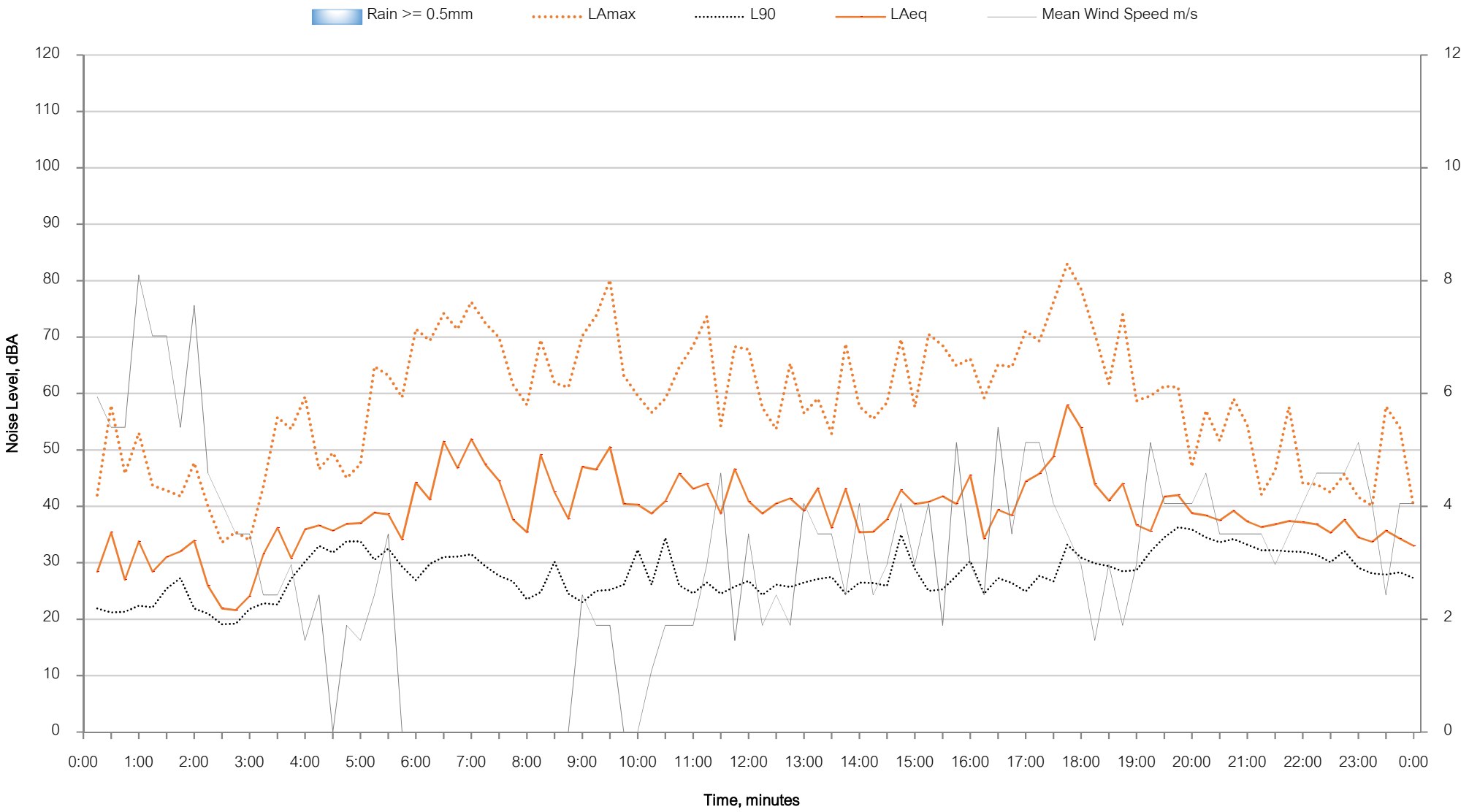
Background Noise Levels

Logger 1 - Photon Site - Tuesday 31 October 2017



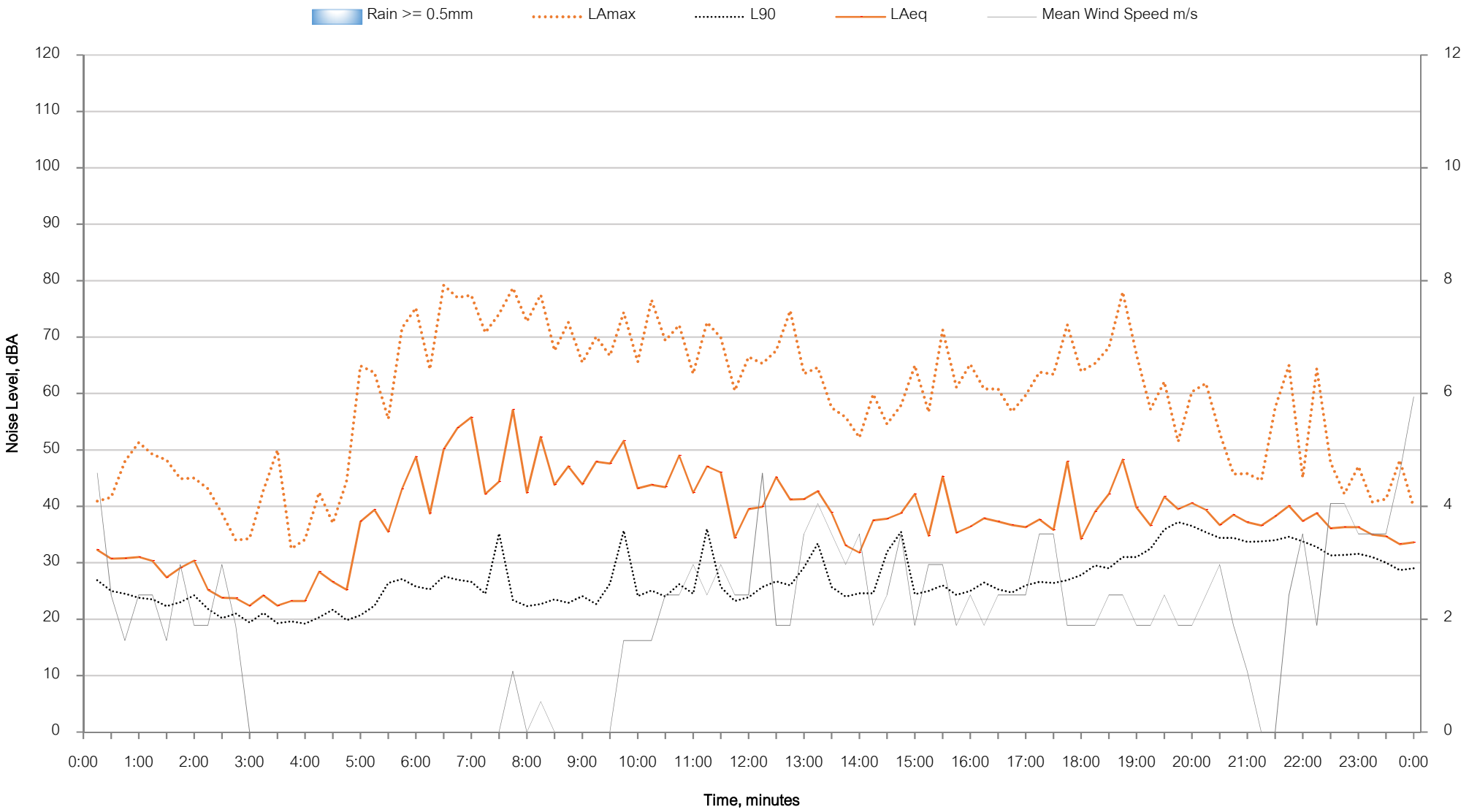
Background Noise Levels

Logger 1 - Photon Site - Wednesday 1 November 2017



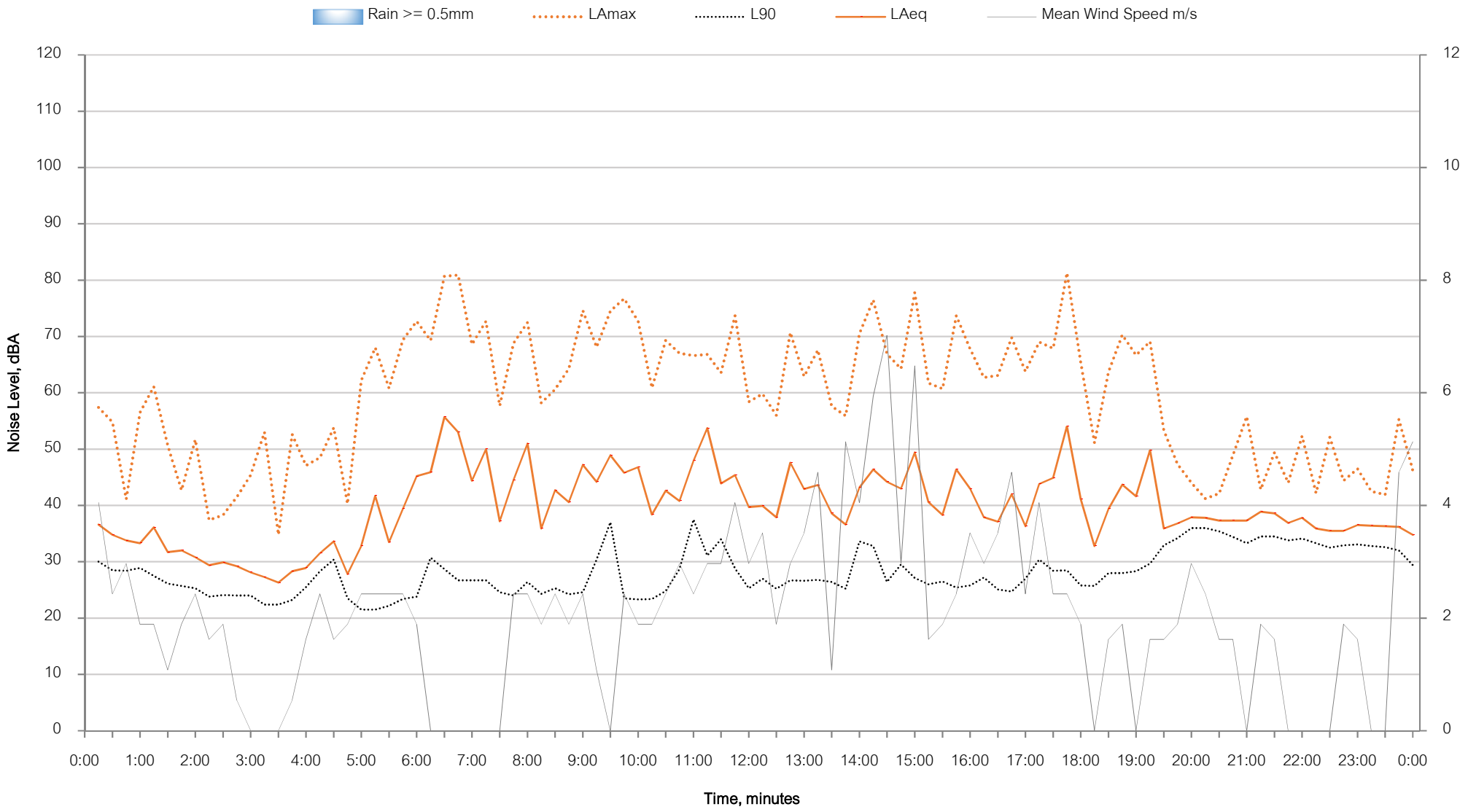
Background Noise Levels

Logger 1 - Photon Site - Thursday 2 November 2017



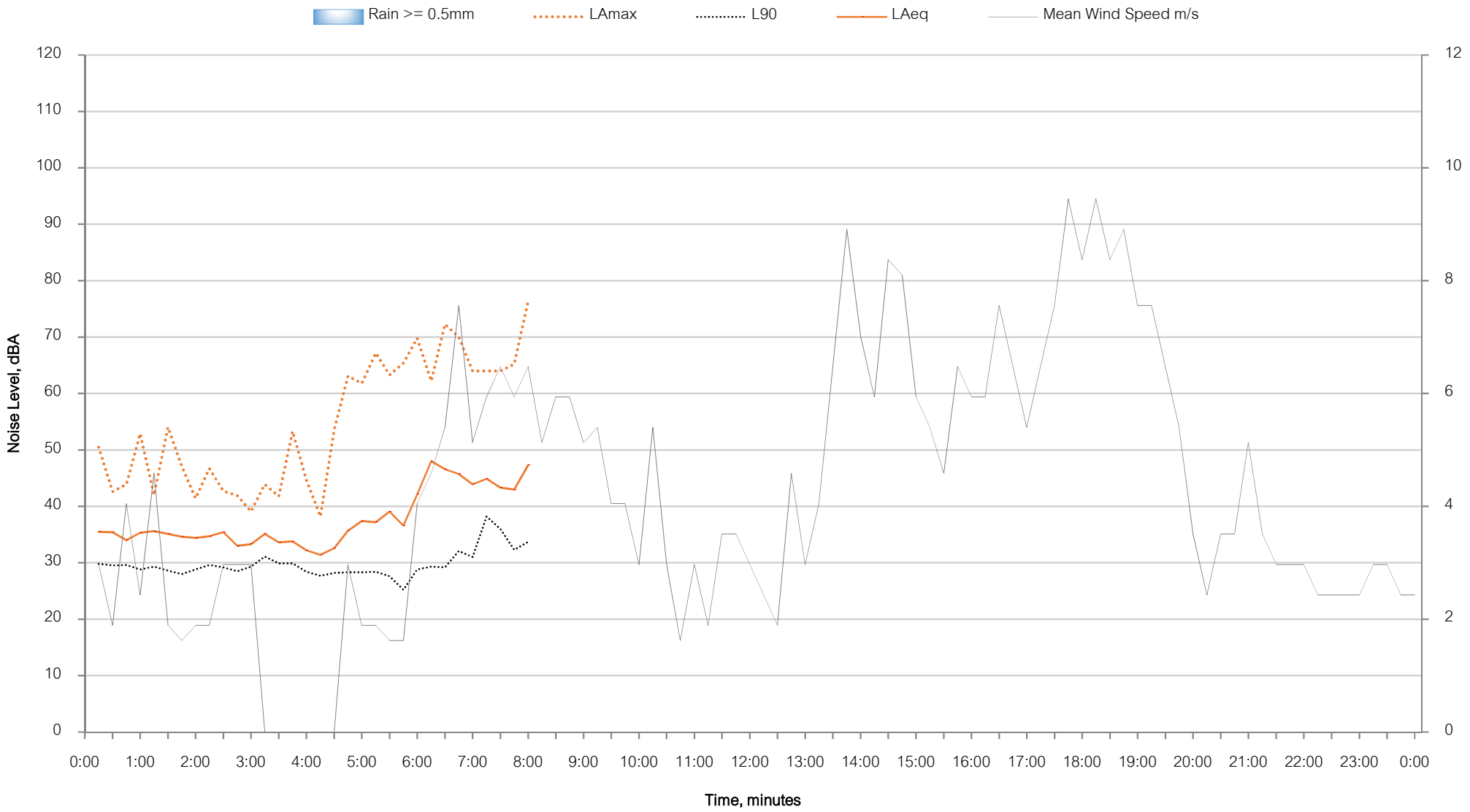
Background Noise Levels

Logger 1 - Photon Site - Friday 3 November 2017



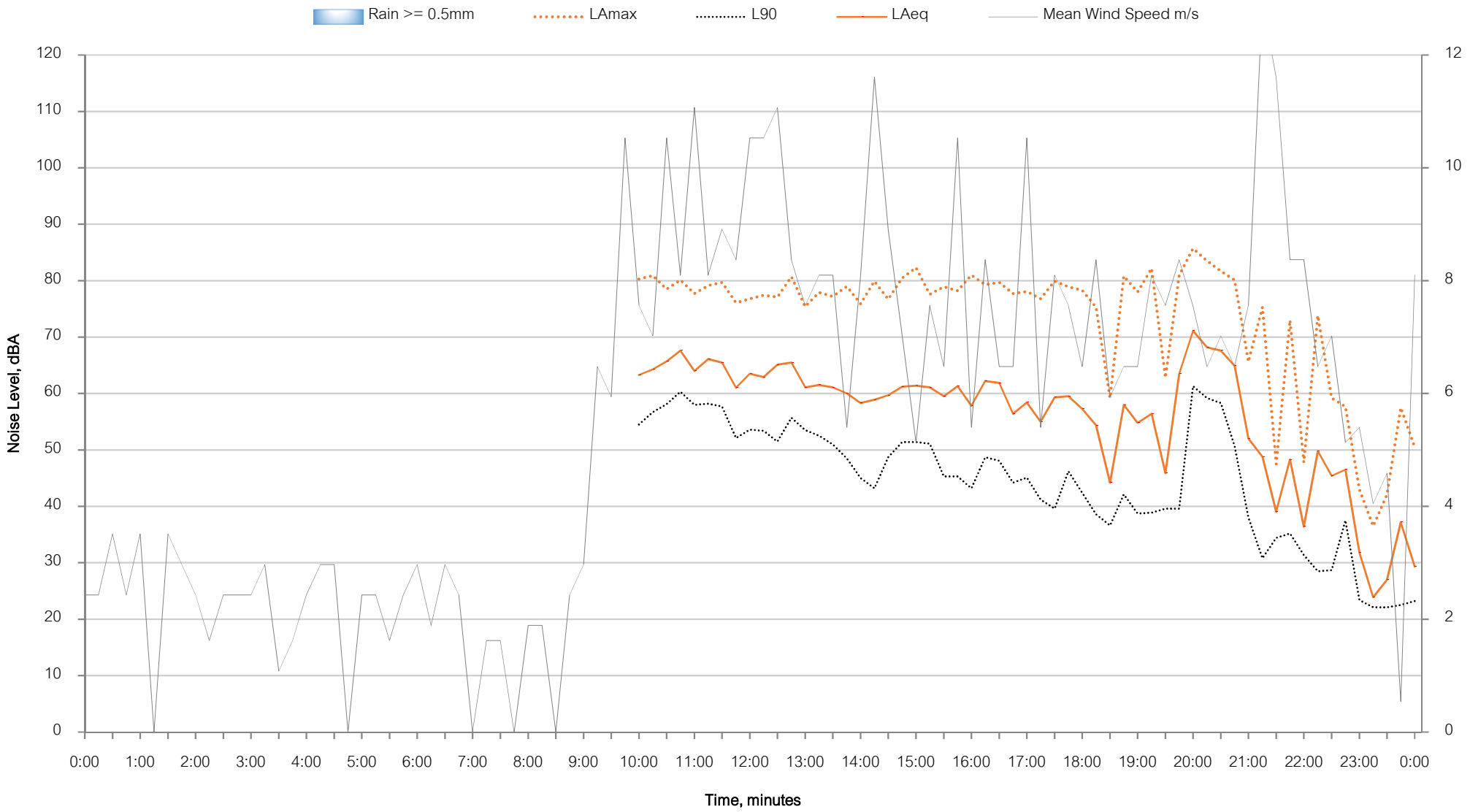
Background Noise Levels

Logger 1 - Photon Site - Saturday 4 November 2017



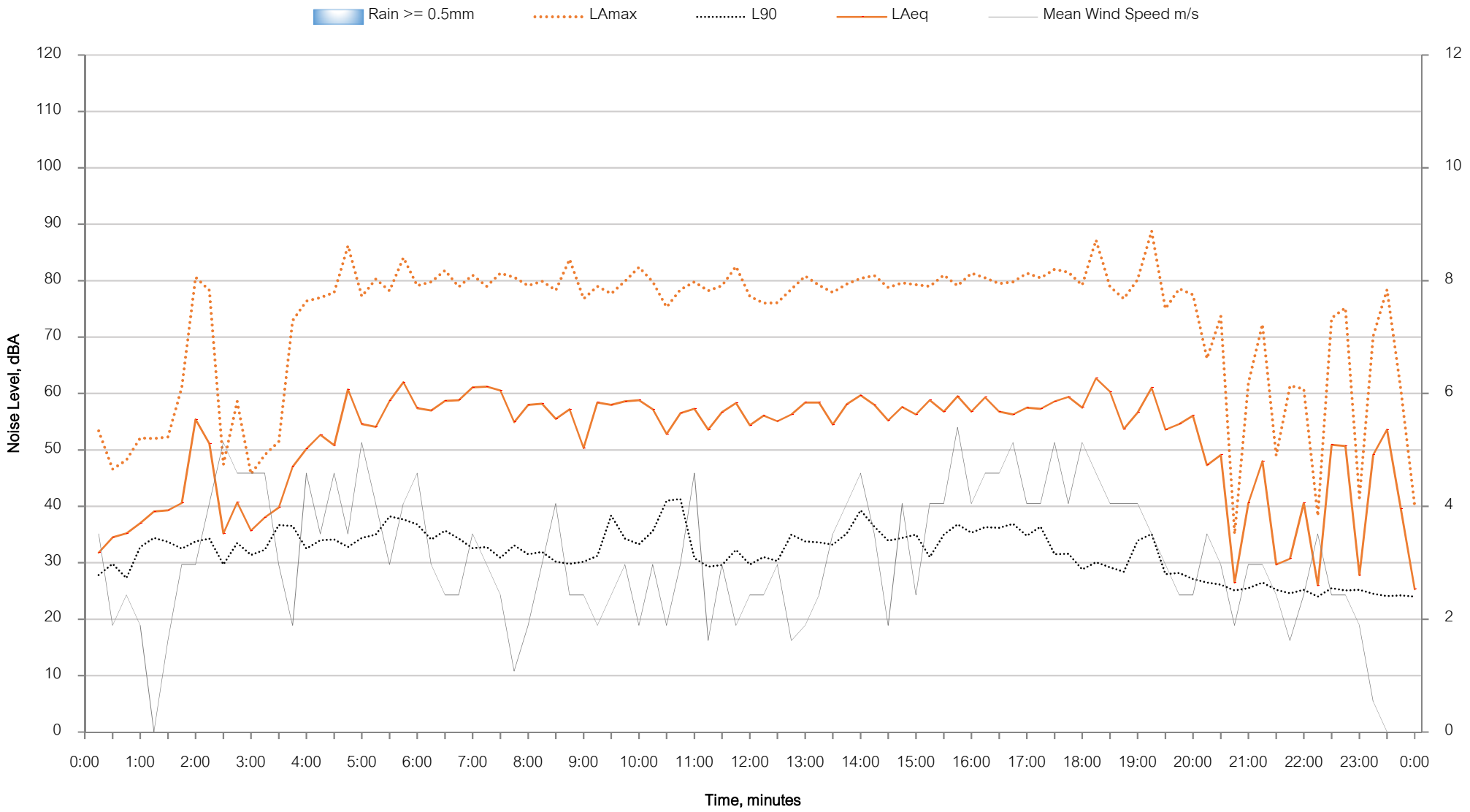
Background Noise Levels

Logger 2 - Kelvin Road - Thursday 26 October 2017



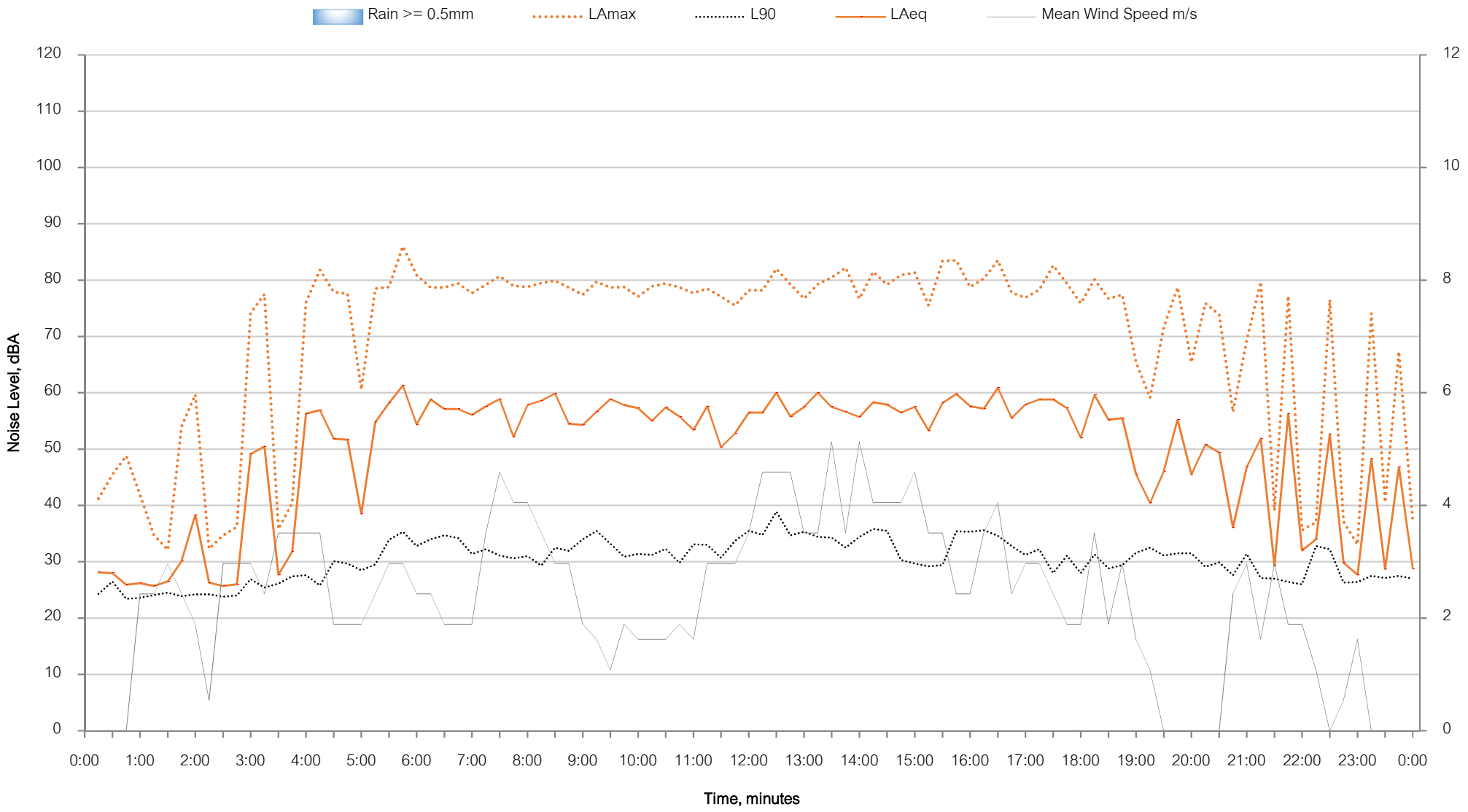
Background Noise Levels

Logger 2 - Kelvin Road - Friday 27 October 2017



Background Noise Levels

Logger 2 - Kelvin Road - Saturday 28 October 2017

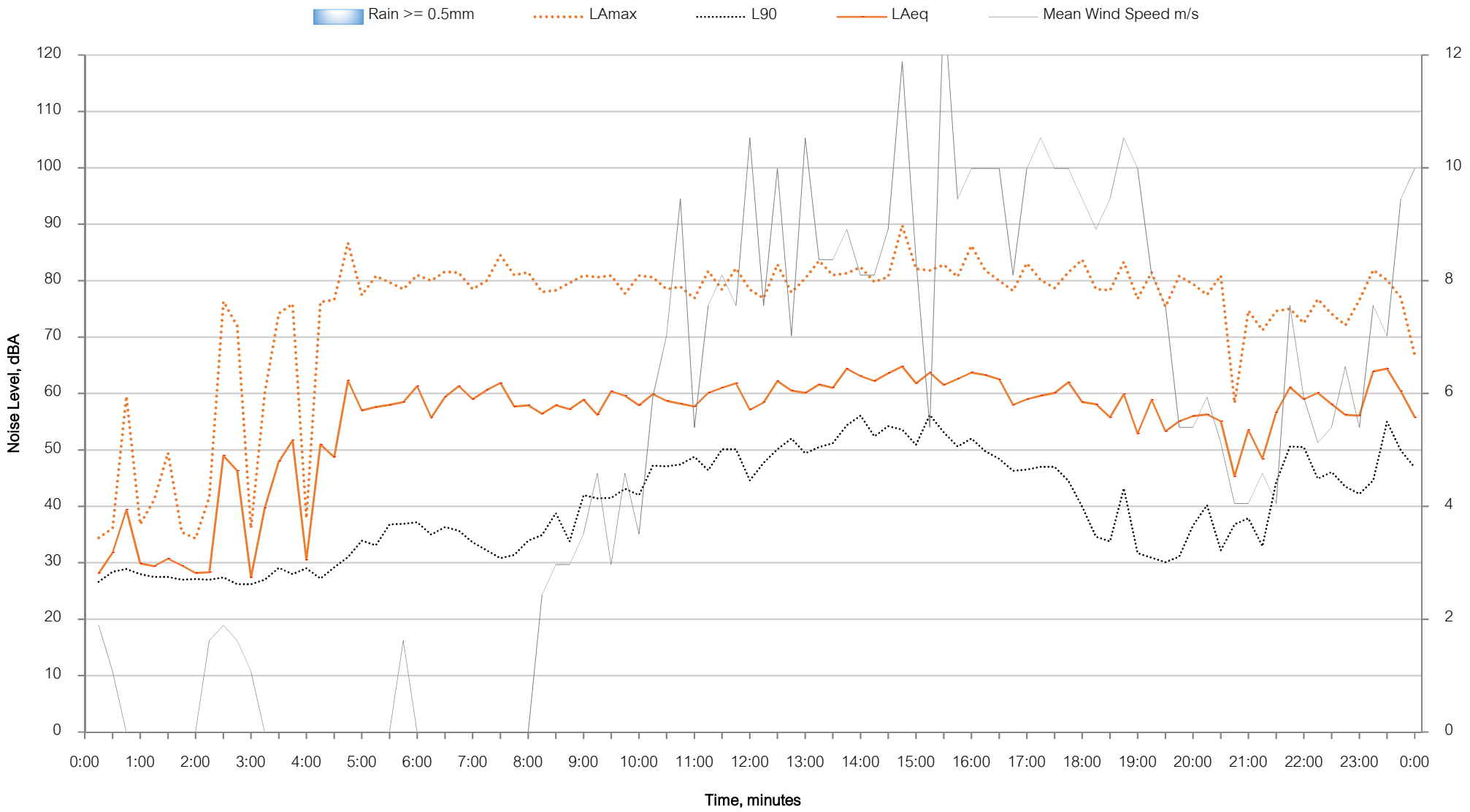


Background Noise Levels

Logger 2 - Kelvin Road - Sunday 29 October 2017

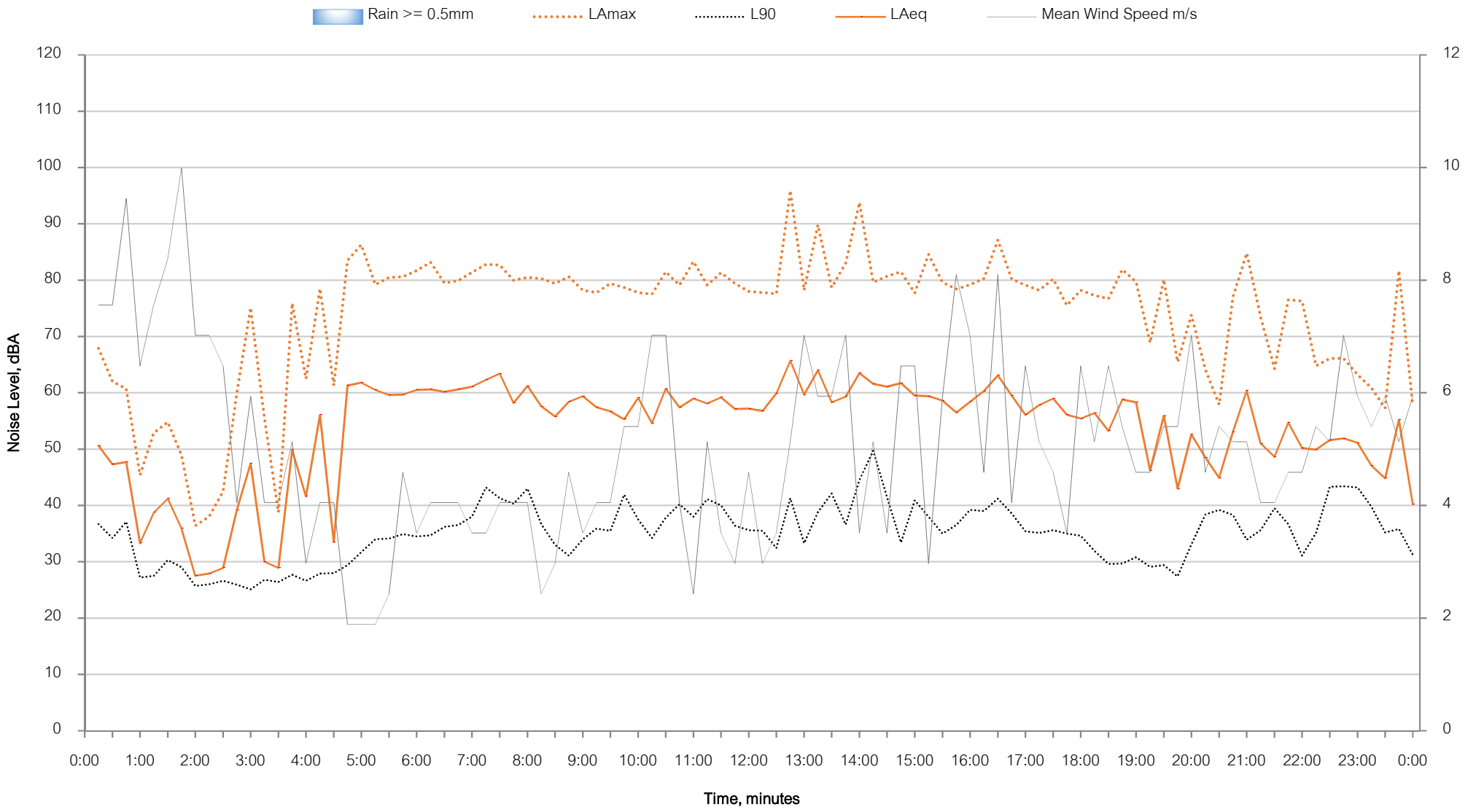
Background Noise Levels

Logger 2 - Kelvin Road - Monday 30 October 2017



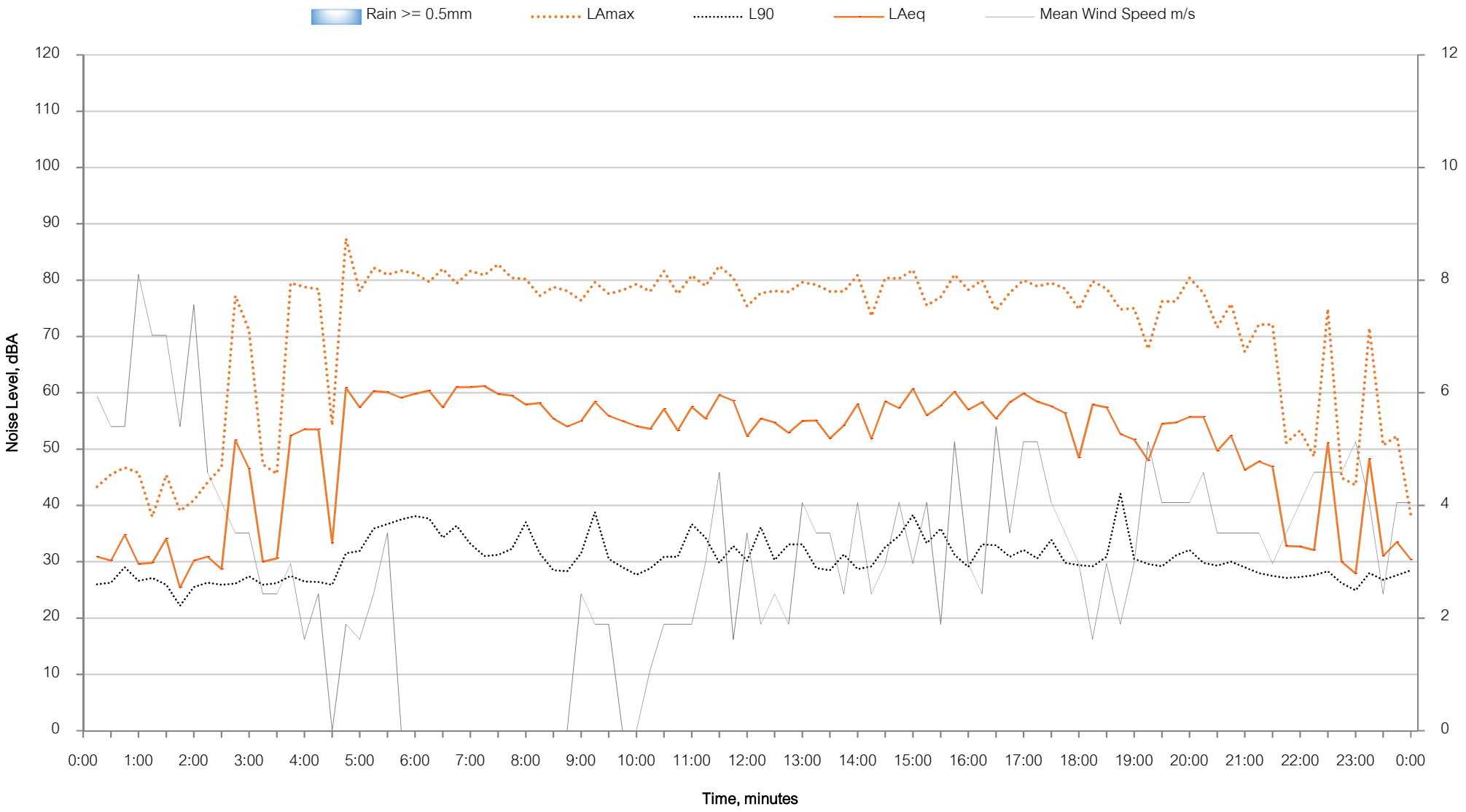
Background Noise Levels

Logger 2 - Kelvin Road - Tuesday 31 October 2017



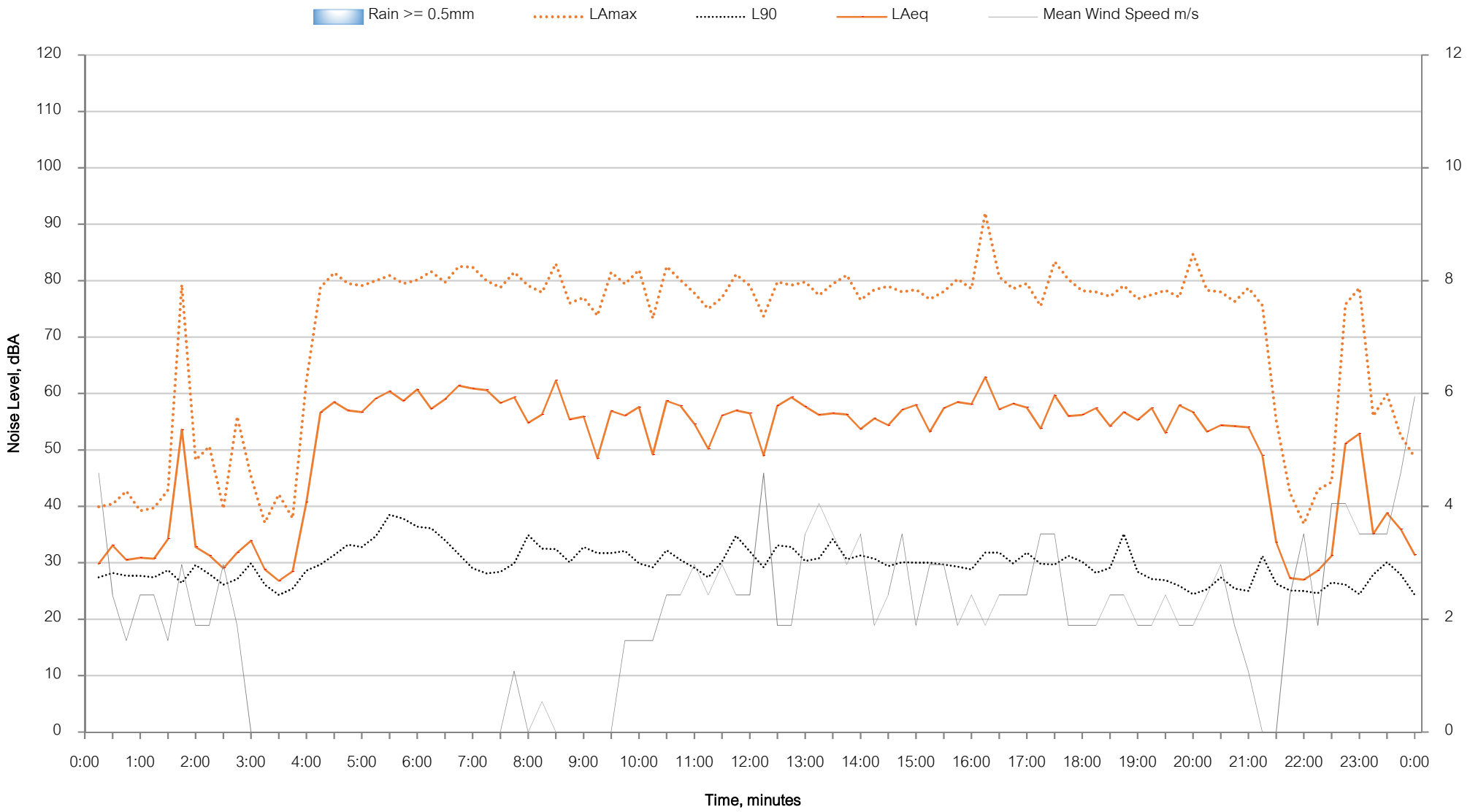
Background Noise Levels

Logger 2 - Kelvin Road - Wednesday 1 November 2017



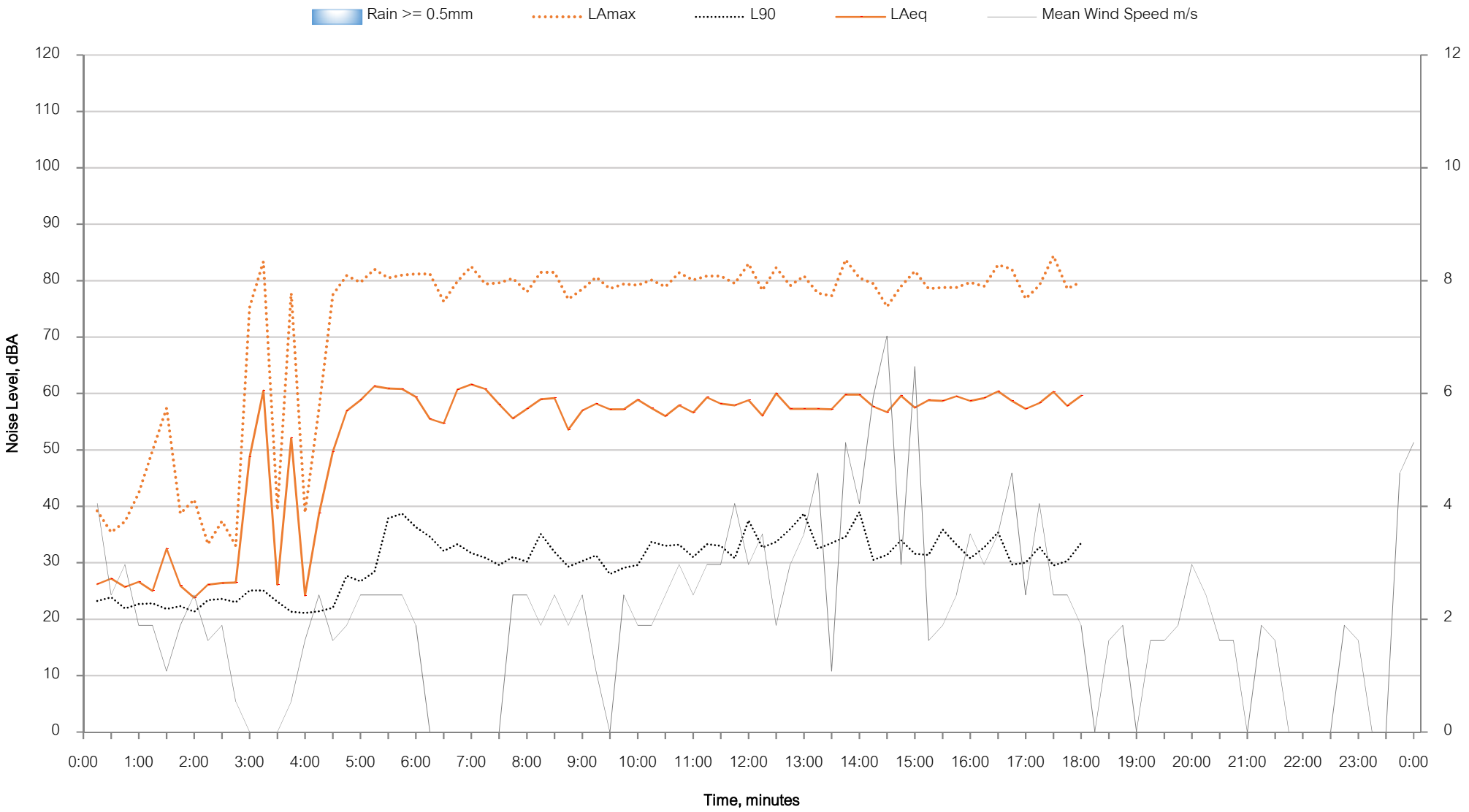
Background Noise Levels

Logger 2 - Kelvin Road - Thursday 2 November 2017



Background Noise Levels

Logger 2 - Kelvin Road - Friday 3 November 2017



Appendix C – NEWA Analysed Meteorology

Table C1 NEWA Analysed Meteorological Conditions, Gunnedah NSW									
Direction ± 45°	Season	Day	Evening	Night	Direction	Season	Day	Evening	Night
		Percentage Occurrence %					Percentage Occurrence %		
0	Summer	7	9	18	180	Summer	8	9	5
0	Autumn	11	16	22	180	Autumn	9	7	5
0	Winter	10	17	18	180	Winter	13	8	6
0	Spring	8	14	17	180	Spring	12	11	7
22.5	Summer	6	8	10	202.5	Summer	8	8	5
22.5	Autumn	8	14	11	202.5	Autumn	8	6	5
22.5	Winter	6	15	10	202.5	Winter	10	8	5
22.5	Spring	6	14	11	202.5	Spring	10	10	6
45	Summer	6	7	6	225	Summer	9	7	7
45	Autumn	8	11	5	225	Autumn	9	7	6
45	Winter	5	12	5	225	Winter	9	8	7
45	Spring	7	13	6	225	Spring	9	7	7
67.5	Summer	7	6	5	247.5	Summer	11	10	10
67.5	Autumn	10	9	4	247.5	Autumn	13	8	10
67.5	Winter	7	13	6	247.5	Winter	12	8	10
67.5	Spring	9	12	7	247.5	Spring	11	8	9
90	Summer	8	7	6	270	Summer	12	10	17
90	Autumn	11	10	5	270	Autumn	16	10	19
90	Winter	10	13	8	270	Winter	17	10	18
90	Spring	11	13	8	270	Spring	13	9	15
112.5	Summer	9	8	6	292.5	Summer	12	11	21
112.5	Autumn	13	10	6	292.5	Autumn	18	14	25
112.5	Winter	15	15	10	292.5	Winter	18	12	23
112.5	Spring	13	15	9	292.5	Spring	14	10	20
135	Summer	9	9	6	315	Summer	12	12	23
135	Autumn	14	9	6	315	Autumn	18	15	29
135	Winter	17	14	10	315	Winter	18	15	25
135	Spring	15	16	9	315	Spring	14	12	22
157.5	Summer	9	9	5	337.5	Summer	8	8	20
157.5	Autumn	11	8	6	337.5	Autumn	13	14	26
157.5	Winter	16	10	9	337.5	Winter	13	15	22
157.5	Spring	14	13	8	337.5	Spring	9	10	19