

WOLLAR SOLAR FARM

Construction & Operational Noise & Vibration Assessment

20 February 2019

NGH Environmental

TK161-01D01 Report (r0).docx

Document details

Detail	Reference
Doc reference:	TK161-01D01 Report (r0).docx
Prepared for:	NGH Environmental
Address:	Suite1, 216 Carp St, Bega NSW 2550
Attention:	Mr. Louiza Romane

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Authorised
23.11.2018	Generate report	0	1	A Ahmadi	M Chung	M Chung
26.11.2018	Minor updates	0	2	A Ahmadi	M Chung	M Chung
20.02.2019	Minor updates	0	3	A Ahmadi	M Chung	M Chung

Important Disclaimer:

The work presented in this document was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for the particular requirements of our Client referred to above in the 'Document details' which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Renzo Tonin & Associates. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

In preparing this report, we have relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, we have not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

We have derived data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination and re-evaluation of the data, findings, observations and conclusions expressed in this report.

We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

The information contained herein is for the purpose of acoustics only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics engineering including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing and the like. Supplementary professional advice should be sought in respect of these issues.

Contents

1	Introduction	5
2	Project Description	6
2.1	Background Information	6
2.2	Regulatory Requirements	6
2.3	Receiver Locations	6
2.4	Hours of Operation	7
2.4.1	Construction	7
2.4.2	Operation	7
3	Existing Noise Environment	9
3.1	Noise Monitoring Locations	9
3.2	Existing Background & Ambient Noise Levels	9
4	Construction Noise Assessment	11
4.1	Construction Noise Management Levels	11
4.1.1	Residential Receivers	11
4.2	Construction Noise Sources	12
4.3	Construction Noise Assessment	13
5	Operational Noise Assessment	15
5.1	Operational Noise Criteria	15
5.1.1	Intrusive Noise Impacts	15
5.1.2	Protecting Noise Amenity	15
5.2	Summary of Project Noise Trigger Levels	16
5.3	Operational Noise Sources	17
5.4	'Modifying Factor' Adjustments	18
5.5	Operational Noise Assessment	18
5.6	Sleep Disturbance Assessment	19
6	Vibration Assessment	20
7	Road Traffic Noise Assessment	21
7.1	Road Traffic Noise Criteria	21
7.2	Predicted Road Traffic Noise	22
8	Conclusion	23
APPENDIX A	Glossary of Terminology	24
APPENDIX B	Long-Term Noise Monitoring Methodology	26
B.1	Noise Monitoring Equipment	26
B.2	Meteorology During Monitoring	26
B.3	Noise vs Time Graphs	26
APPENDIX C	Long Term Noise Monitoring Results	27

List of tables

Table 3.1 – Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)	10
Table 3.2 – Rating Background Noise Level, dB(A)	10
Table 4.1 – Noise Management Levels (NML) at Residential Receivers, dB(A)	12
Table 4.2 – Construction Noise Management Levels (NML) at Residential Receivers, dB(A)	12
Table 4.3 – Solar Farm Construction Plant & Equipment & Sound Power Levels, dB(A)	13
Table 4.4 – Predicted $L_{Aeq,15min}$ proposed Solar Farm Construction Noise Levels at Receiver Locations, dB(A)	14
Table 5.1 – NPfl Intrusive Noise Level at Residential Receivers, dB(A)	15
Table 5.2 – NPfl Project Amenity Noise Levels, dB(A)	16
Table 5.3 – Project Noise Trigger Levels, dB(A)	16
Table 5.4 – Typical Operational Plant and Equipment & Sound Power Levels	17
Table 5.5 – Predicted cumulative $L_{Aeq,15min}$ Operational Noise Levels at Receiver Locations, dB(A)	19
Table 7.1 – Summary of the Estimated Construction Traffic Volumes During Peak Construction	21
Table 7.2 – RNP Road Traffic Noise Criteria, dB(A)	21
Table 7.3 – Predicted Road Traffic Noise Contribution Levels Along Public Roads, dB(A)	22

List of figures

Figure 1 – Site, Surrounds and Receiver and Noise Monitoring Locations	8
--	---

1 Introduction

Renzo Tonin & Associates was engaged to conduct an environmental noise and vibration assessment of the proposed solar farm located approximately seven (7) kilometres south of the town of Wollar in New South Wales as part of the Environmental Impact Statement (EIS) for the project. Noise and vibration impacts from the construction and operation phases of the project will be addressed in this report in accordance with the Secretary's Environmental Assessment Requirements (SEARs).

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

2 Project Description

2.1 Background Information

The proposed solar farm project includes the construction and operation of a solar photovoltaic (PV) plant and associated infrastructure, with a capacity of approximately 290MW. The subject site is located approximately Seven (7) kilometres south of the town of Wollar in New South Wales, within the Mid-Western Regional local government area. Moreover, an existing TransGrid Wollar substation rated at 1500 MVA will be used to facilitate connection to the national electricity grid.

2.2 Regulatory Requirements

Noise and vibration impacts are assessed in accordance with a number of policies, guidelines and standards, including:

- NSW 'Interim Construction Noise Guideline' (ICNG – Department of the Environment and Climate Change, 2009);
- NSW 'Noise Policy for Industry' (NPfI – Environment Protection Authority, 2017);
- 'Assessing Vibration: A Technical Guideline' (Department of the Environment and Climate Change, 2006); and
- NSW 'Road Noise Policy' (RNP – Department of Environment, Climate Change and Water, 2011)

2.3 Receiver Locations

The nearest affected receivers were identified by NGH Environmental as follows:

Receiver R1	Lot 1/DP755455, Wollar Residential property located approximately 4km north of the proposed solar farm.
Receiver R2	Lot 65/DP755430, 1066 Barigan Road, Barigan Residential property located approximately 3.5km south-east of the proposed solar farm.
Receiver R3	Lot 1/3/DP758054, Barigan Residential property located approximately 4.5km south-east of the proposed solar farm.
Receiver R4	Lot 94/DP 755430, 358 Tichular Road, Tichular Residential property located approximately 3km south of the proposed solar farm.

Figure 1 provides details of the site, surrounds and receiver locations.

2.4 Hours of Operation

2.4.1 Construction

Construction will occur during the following standard hours of construction:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 8:00am to 1:00pm

In this report, potential noise impact from construction activities during the standard hours is assessed. However, any construction works outside of these standard or agreed working hours, if required, would only be undertaken with prior approval from relevant authorities, or unless in emergency circumstances e.g. to make work safe.

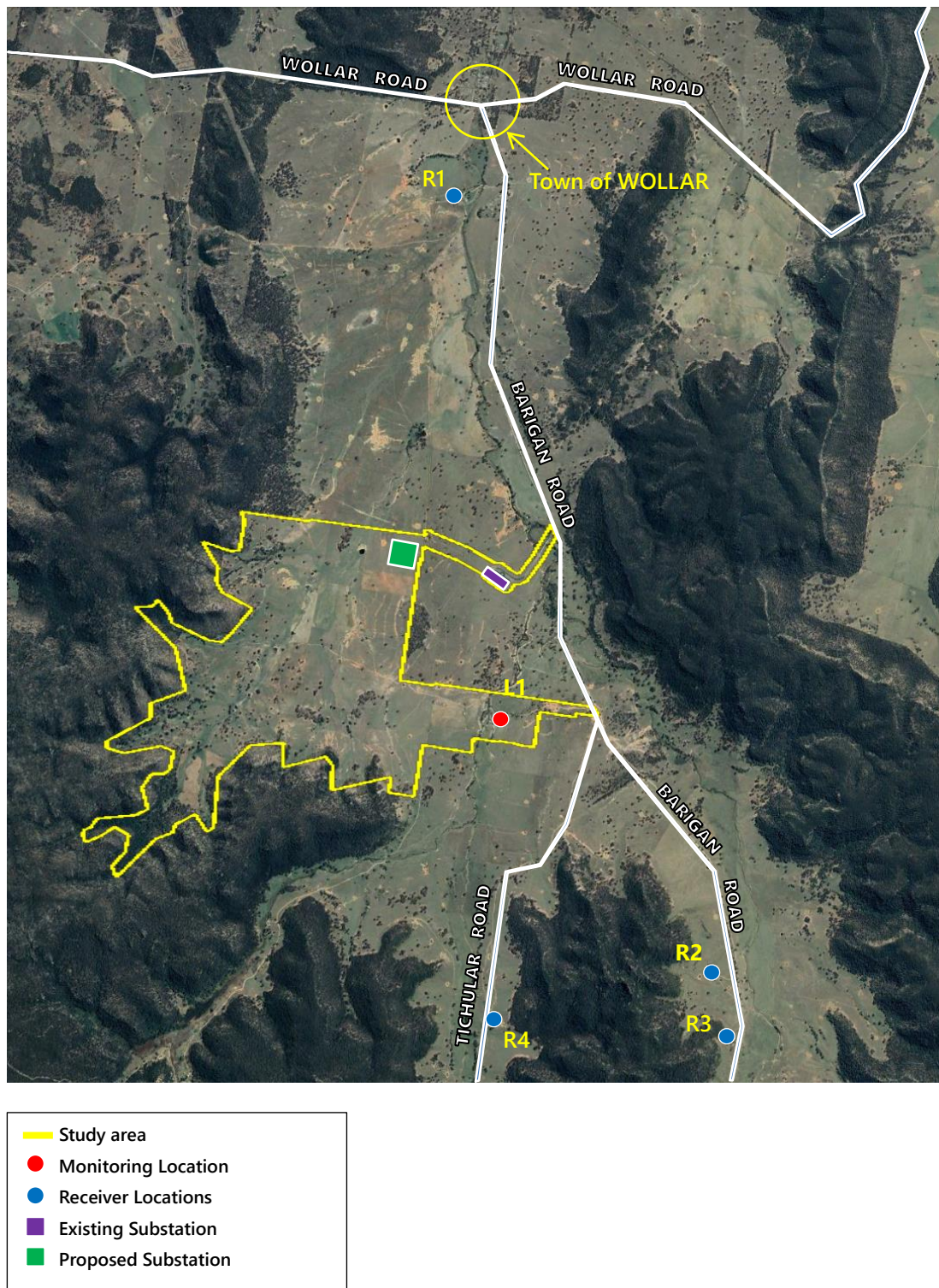
2.4.2 Operation

The proposed solar farm will operate autonomously during times when there is sunlight. This will predominantly be during day and evening periods (7am-6pm and 6pm-10pm, respectively) throughout the year and potentially part of the night time period (prior to 7am) during the summer months.

Furthermore, there will be five (5) equivalent full time staff on site during the following standard hours:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 8:00am to 1:00pm

Figure 1 – Site, Surrounds and Receiver and Noise Monitoring Locations



3 Existing Noise Environment

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW 'Noise Policy for Industry' (NPfI, 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The NSW NPfI defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

3.1 Noise Monitoring Locations

Noise monitoring is to be undertaken at the nearest or potentially most affected receiver locations; or if this is not available, then at a location considered to have a noise environment representative of the nearest or potentially most affected receiver locations. In this case the representative location where noise monitoring was undertaken was as follows.

- **Location L1 – 96 Maree Road, Tichular NSW 2850**
Noise monitor was installed in the 'free field' (ie. away from building facades) within the eastern side of the proposed solar farm. Noise data represents the background and ambient noise environment for receivers surrounding the proposal area.

To quantify the existing ambient noise environment, long-term (unattended) noise monitoring was conducted at Location L1 between Tuesday 22nd May and Sunday 10th June 2018.

Appendix A of this report presents a description of noise terms. Appendix B details the noise monitoring methodology and the graphical recorded outputs from long term noise monitoring are included in Appendix C. The graphs in Appendix C were analysed to determine an assessment background level (ABL) for each day, evening and night period in each 24 hour period of noise monitoring and based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NSW NPfI.

3.2 Existing Background & Ambient Noise Levels

Existing background and ambient noise levels are presented in Table 3.1 below. The noise monitor was positioned outdoors in the 'free-field' (ie. away from building facades). Construction and operation

noise from the site should be assessed away from the facade at the potentially most affected residential boundaries and therefore, the representative noise levels listed in Table 3.1 are directly applicable.

Table 3.1 – Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)

Location	L ₉₀ Background Noise Levels			L _{eq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
L1 – 96 Maree Road, Tichular	23	26	23	45	40	39

The identified receivers surrounding the subject site are all classified as rural under NPfI guidelines. It was found that the background noise levels were typical for a rural area.

Based on Table 2.1 on page 10 of the NPfI, where background noise levels are less than the minimum assumed RBLs, the minimum assumed RBL's are adopted instead for all receiver locations nominated in Section 2.3. Therefore, the background noise levels have been set at the levels detailed in the fourth column of Table 3.2 below.

Table 3.2 – Rating Background Noise Level, dB(A)

Time of Day	Measured Existing Background (L_{90}), dB(A)	Minimum Assumed RBLs, dB(A) ¹	Applicable Rating Background Level, dB(A)
Day	23	35	35
Evening	26	30	30
Night	23	30	30

Notes: 1. In accordance with Table 2.1 of the NSW NPfI

4 Construction Noise Assessment

4.1 Construction Noise Management Levels

The NSW 'Interim Construction Noise Guideline' (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- *Use of L_{Aeq} as the descriptor for measuring and assessing construction noise*

NSW noise policies, including the NPfl, RNP and RING have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

- *Application of reasonable and feasible noise mitigation measures*

As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice and is practical to build given the project constraints.

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

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the length of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

4.1.1 Residential Receivers

Table 4.1 reproduced from the ICNG, sets out the noise management levels and how they are to be applied for residential receivers.

Table 4.1 – Noise Management Levels (NML) at Residential Receivers, dB(A)

Time of Day	Management Level L _{Aeq} (15 min)	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured L _{Aeq} (15 min) 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 works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	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: <ul style="list-style-type: none"> times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(A)	A strong justification would typically be required for works 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 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Table 4.2 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring results presented in Table 3.1, the proposed construction hours and the above ICNG requirements. The receiver locations are marked in Figure 1.

Table 4.2 – Construction Noise Management Levels (NML) at Residential Receivers, dB(A)

Location Description	Day L _{A90} Background Noise Level (RBL)	Day Noise Management Level L _{Aeq} (15min)
All residential receivers (Receivers R1 to R4)	35 ¹	45

Notes: 1. Construction works occur during the daytime period only; hence, only the day period is assessed

4.2 Construction Noise Sources

Table 4.3 lists typical plant and equipment to be used by the contractor to carry out the necessary construction works within the proposed solar farm site.

Table 4.3 – Typical Solar Farm Construction Plant & Equipment & Sound Power Levels, dB(A)

Plant Item	Plant Description	Number of Items	L _{Aeq} Sound Power Levels, dB(A) re. 1pW (single item)
1	Small pile driving rig	10	114
2	Crane	4	110
3	Drum roller	4	109
4	Padfoot roller	4	109
5	Wheeled loader	3	109
6	Dump truck	6	108
7	30t Excavator	10	107
8	Grader	6	107
9	Chain trencher	4	104
10	Water truck	4	104
11	Telehandler	4	98
12	Forklift	4	90

The sound power levels for the majority of activities presented in the above table are based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', the ICNG, information from past projects and/or information held in our library files.

4.3 Construction Noise Assessment

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using CadnaA (version 2018) noise modelling computer program. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction model takes into account:

- Location of noise sources and receiver locations;
- Height of sources and receivers;
- Separation distances between sources and receivers;
- Ground type between sources and receivers (soft); and
- Attenuation from barriers (natural and purpose built).

Noise levels at any receptors resulting from construction would depend on the above and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary substantially over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Table 4.4 presents construction noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant equipment associated with the works conducted within the proposed solar farm. The noise level ranges represent the noise source being located at the furthest to the closest proximity to each receiver location.

Table 4.4 – Predicted $L_{Aeq,15min}$ Proposed Solar Farm Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq(15min)}$ Construction Noise Levels			
		Receiver R1	Receiver R2	Receiver R3	Receiver R4
Noise Management Level ¹		45	45	45	45
1	Small pile driving rig	<20-26	<20-29	<20-26	<20-31
2	Crane	<20-<20	<20-21	<20-<20	<20-23
3	Drum roller	<20-<20	<20-20	<20-<20	<20-22
4	Padfoot roller	<20-<20	<20-20	<20-<20	<20-22
5	Wheeled loader	<20-<20	<20-<20	<20-<20	<20-20
6	Dump truck	<20-<20	<20-20	<20-<20	<20-22
7	30t Excavator	<20-<20	<20-22	<20-<20	<20-24
8	Grader	<20-<20	<20-<20	<20-<20	<20-21
9	Chain trencher	<20-<20	<20-<20	<20-<20	<20-<20
10	Water truck	<20-<20	<20-<20	<20-<20	<20-<20
11	Telehandler	<20-<20	<20-<20	<20-<20	<20-<20
12	Forklift	<20-<20	<20-<20	<20-<20	<20-<20

Notes: 1. Noise Management Levels for day period (ie. standard construction hours)

Based on the construction noise levels presented in Table 4.4, construction noise management levels are complied with when construction works are conducted at closest proximity to the receivers.

Therefore, no further reasonable and feasible noise mitigation measures are required to reduce construction noise impacts.

5 Operational Noise Assessment

5.1 Operational Noise Criteria

Noise impact from the general operation of the proposed solar farm is assessed against NSW 'Noise Policy for Industry' (NPfI, 2017). The assessment procedure in terms of the NPfI has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for residences and other land uses.

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level which is the lower value of the project intrusiveness noise levels and project amenity noise levels.

5.1.1 Intrusive Noise Impacts

According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does not exceed the background noise level measured in the absence of the source by more than 5dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$$L_{Aeq,15minute} \text{ Intrusiveness noise level} = \text{Rating Background Level (RBL) plus 5dB(A)}$$

Based on the RBLs set in Table 3.2, the intrusiveness noise levels for the residential receivers are presented in Table 5.1.

Table 5.1 – NPfI Intrusive Noise Level at Residential Receivers, dB(A)

Period	Rating Background Level, dB(A)	Intrusiveness Noise Level, $L_{Aeq,15min}$, dB(A)
Daytime	35	$35+5 = \mathbf{40}$
Evening	30	$30+5 = \mathbf{35}$
Night-time	30	$30+5 = \mathbf{35}$

5.1.2 Protecting Noise Amenity

The project amenity noise levels for different time periods of a day are determined in accordance with Section 2.4 of the NSW NPfI. The NPfI recommends amenity noise levels ($L_{Aeq, period}$) for various receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These "recommended amenity noise levels" represent the objective for **total** industrial noise experienced at a receiver location. However, when assessing a **single** industrial development and its impact on an area, "project amenity noise levels" apply.

To ensure that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level that applies for each new industrial noise source is determined as follows:

$$L_{Aeq,period} \text{ Project amenity noise level} = L_{Aeq,period} \text{ Recommended amenity noise level} - 5\text{dB(A)}$$

Furthermore, given that the intrusiveness noise level is based on a 15 minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, the NPfI provides the following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15min}$ level in order to standardise the time periods.

$$L_{Aeq,15min} = L_{Aeq,period} + 3\text{dB(A)}$$

The policy, in accordance with the NPfI, applies an adjustment of (+3 dB) to the recommended noise levels ($L_{Aeq, period}$) in order to standardise the time periods for the intrusiveness and amenity noise levels. The project amenity noise levels ($L_{Aeq, 15min}$) applied for this project are reproduced in Table 5.2.

It is noted that the residential receivers in the vicinity of the site have been categorised as being in a 'rural' area in accordance with Table 2.3 of the NPfI.

Table 5.2 – NPfI Project Amenity Noise Levels, dB(A)

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended Noise Level	
			$L_{Aeq, Period}$	$L_{Aeq, 15min}$
Residence	Rural	Day	$50 - 5 = 45$	$45 + 3 = 48$
		Evening	$45 - 5 = 40$	$40 + 3 = 43$
		Night	$40 - 5 = 35$	$35 + 3 = 38$

- Notes:
1. Monday-Saturday, Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
 2. On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am.
 3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

5.2 Summary of Project Noise Trigger Levels

In accordance with the NPfI the project noise trigger levels, which is the lower (ie. more stringent) value of the project intrusiveness noise level and project amenity noise level, have been determined for each sensitive receiver locations and reproduced in Table 5.3 below.

Table 5.3 – Project Noise Trigger Levels, dB(A)

Receiver Location	$L_{Aeq, 15min}$ Project Noise Trigger Levels		
	Day	Evening	Night
Receiver R1 – Lot 1/DP755455, Wollar	40	35	35
Receiver R2 – Lot 65/DP755430, 1066 Barigan Road, Barigan	40	35	35

Receiver Location	L _{Aeq, 15min} Project Noise Trigger Levels		
	Day	Evening	Night
Receiver R3 – Lot 1/3/DP758054, Barigan	40	35	35
Receiver R4 – Lot 94/DP 755430, 358 Tichular Road, Tichular	40	35	35

- Notes:
1. Monday-Saturday, Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
 2. On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am.
 3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
 4. Project Noise Trigger Levels only apply when premises are in use.

5.3 Operational Noise Sources

The proposed solar farm is to use single axis sun tracking systems for the solar panels. The single axis tracking system involves the panels being driven by motors to track the arc of the sun to maximise the solar effect. Hence, the tracking motors are a potential source of mechanical noise and therefore, has been included for a more conservative assessment. Up to a total of 13,000 tracking motors (NexTracker or equivalent) will be employed to drive the solar panels and are to be evenly distributed across the proposed solar farm site. The tracking motors would turn no more than five (5) degrees every 15 minutes and would operate no more than one (1) minute out of every 15-minute period.

In addition to the trackers, the site will require the operation of up to 58 Power Conversion Units (PCU) composed of two inverters (Ingeteam 1640TL B630) which will be evenly distributed across the proposed solar farm site. A new substation will also be located near the north eastern end of the site and will include two (2) 230MVA transformers. Furthermore, it is proposed that the existing 1500MVA transformer located at the existing TransGrid Wollar substation near the north eastern corner of the proposed solar farm site will also be used during the operation of the proposed solar farm.

The sound power level data for the existing and proposed transformers were estimated using AS/NZS 60076.10:2009 *"Power Transformers, Part 10: Determination of sound levels"*.

Based on the above, the following table lists the associated plant and equipment likely to be used for the operation of the proposed solar farm and their corresponding sound power levels.

Table 5.4 – Typical Operational Plant and Equipment & Sound Power Levels

Plant Item	Plant Description	L _{Aeq} Sound Power Levels, dB(A) re. 1pW
1	Tracker Motor (up to 13,000 in total)	78 (each)
2	Ingeteam 1640TL B630 Inverters (up to 58)	88 (each)
3	New 230MVA transformer (2 in total)	82 (each)
4	Existing 1500MVA transformer	96

- Notes:
1. The sound power levels for the plant and equipment presented in the above table are provided by the manufacturer, information from past projects and/or information held in our library files.

5.4 'Modifying Factor' Adjustments

Further to the above and in accordance with the NPfl, where the character of the noise in question is assessed as particularly annoying (i.e. if it has an inherently tonal, low frequency, impulsive or intermittent characteristic), then an adjustment of 5dB(A) for each annoyance aspect, up to a total of 10dB(A), is to be added to the predicted value to penalise the noise for its potential increase in annoyance.

Table C1 in Fact Sheet C of the NSW NPfl provides definitive procedures for determining whether a penalty or adjustment should be applied from increased annoyance. For the assessment of the solar farm, the noise from the inverters and transformers are considered to be tonal in nature. Therefore, a 5dB(A) penalty has been applied to the predicted noise contributions from the inverters and transformers.

5.5 Operational Noise Assessment

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using CadnaA (version 2018) noise modelling computer program. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction models takes into account:

- Location of noise sources and receiver locations;
- Height of sources and receivers;
- Separation distances between sources and receivers;
- Ground type between sources and receivers (soft); and
- Attenuation from barriers (natural and purpose built).

Furthermore, in accordance with the NPfl noise predictions were prepared for each of the following meteorological conditions:

1. Calm & isothermal conditions (acoustically neutral) – no wind and no temperature inversion
2. Slight to gentle breeze – 3m/s wind velocity at 10m from ground level between each noise source and each noise receiver (as per NPfl default wind conditions). Wind direction was based on wind travelling from the source to the receiver.
3. Moderate temperature inversion – applicable for noise predictions during night time periods only

Table 5.5 below present the predicted noise levels for the worst case scenario based on concurrent operation of all the plant and equipment shown in Table 5.4. The tracker motors were time corrected based on their operation of one (1) minute out of a 15 minute period.

Table 5.5 – Predicted Cumulative $L_{Aeq,15min}$ Operational Noise Levels at Receiver Locations, dB(A)

Receiver Location	Project Noise Trigger Levels			Predicted Operational Noise Levels, $L_{Aeq, 15min}$			Comply? (Yes/No)
	Day	Evening	Night	Calm & Isothermal Conditions	Slight to Gentle Breeze	Moderate Temperature Inversion ¹	
Receiver R1	40	35	35	<20	24	24	Yes
Receiver R2	40	35	35	<20	21	21	Yes
Receiver R3	40	35	35	<20	<20	<20	Yes
Receiver R4	40	35	35	<20	26	26	Yes

Notes: 1. Applicable for the night time period only

Based on the predicted noise levels presented in the table above, the predicted cumulative noise levels from the operation of the solar farm and the existing TransGrid Wollar substation comply with the project trigger levels at each receiver location, under all meteorological conditions.

Therefore, no further reasonable and feasible noise mitigation measures are required to reduce operational noise impacts.

5.6 Sleep Disturbance Assessment

To assess the likelihood of sleep disturbance, the potential of maximum noise level events from premises during the night-time period has been considered in this assessment. In accordance with NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is the greater, and/or
- L_{AFmax} 52dB(A) or the prevailing RBL plus 15dB, whichever is the greater.

Where there are noise events found to exceed the initial screening level, further analysis is undertaken to identify:

- The likely number of events that might occur during the night assessment period,
- The extent to which the maximum noise level exceeds the rating background noise level.

During the night time period, only mechanical plant will be operating, including the tracking motors, inverters and the substations. Noise emissions from these plant items are considered to be continuous with no potential for high peak noise level events. Therefore, the L_{Amax} noise levels experienced at the identified receivers will be similar to the predicted $L_{Aeq,15min}$ noise levels shown in Table 5.5. Hence, it is expected that both the $L_{Aeq,15min}$ and L_{AFmax} will be well below the nominated sleep disturbance criteria of 40dB(A) and 52dB(A), respectively.

6 Vibration Assessment

Vibration generating activities would occur only during the construction phase of the project. There are no vibration generating activities expected during the operational phase. As the nearest identified receivers are in excess of 3km from the subject site, structural damage due to vibration and vibration impact on human comfort are not expected and will not be assessed further.

7 Road Traffic Noise Assessment

Noise impact from the potential increase in traffic on the surrounding road network due to construction and operational activities is assessed against the NSW 'Road Noise Policy' (RNP, 2011). The RNP sets out criteria to be applied to particular types of road and land uses. These noise criteria are to be applied when assessing noise impact and determining mitigation measures for sensitive receivers that are potentially affected by road traffic noise associated with the construction and operation of the subject site, with the aim of preserving the amenity appropriate to the land use.

Vehicle access to the proposed solar farm site will be via Wollar Road, Phillip Street, Maitland Street and Barigan Road. Based on information provided by the client, the estimated vehicle movements per day throughout the construction stage are presented in Table 7.1. Furthermore, vehicle movements will only occur during the day time period when construction works occur. Therefore, to determine the average hourly vehicle movements to and from the site, the daily vehicle movements were divided by 11 to represent the weekday construction hours from 7am to 6pm.

Table 7.1 – Summary of the Estimated Construction Traffic Volumes During Construction

Vehicle Type	Movements per Day	Average Hourly Movements ¹
Cars/ light vehicles	40 (20 in / 20 out)	4
Trucks/ heavy vehicles	Up to 24 (12 in / 12 out)	3

Notes: 1. Average hourly movements based on movements per day ÷ 11, representing construction hours from 7am to 6pm

During the operational stage, up to five (5) light vehicles per week would access the site, which would occur on an irregular basis. Therefore, traffic noise impacts during the operational stage of the project would be minimal and insignificant and will not be assessed further.

7.1 Road Traffic Noise Criteria

Based on functionality; Wollar Road, Phillip Street and Maitland Street are categorised as sub-arterial roads and Barigan Road is categorised as a local road. For existing residences affected by additional traffic on existing sub-arterial and local roads generated by land use developments, the following RNP road traffic noise criteria apply.

Table 7.2 – RNP Road Traffic Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria, dB(A)	
		Day 7am – 10pm	Night 10pm – 7am
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	L _{Aeq,(15 hour)} 60 (external)	L _{Aeq,(9 hour)} 55 (external)
Local road	Existing residences affected by additional traffic on existing local roads generated by land use developments	L _{Aeq,(1 hour)} 55 (external)	L _{Aeq,(1 hour)} 50 (external)

7.2 Predicted Road Traffic Noise

The average hourly vehicle movements presented in Table 7.1 were used to represent the additional traffic along Wollar Road, Phillip Street, Maitland Street and Barigan Road during construction of the proposed solar farm. Results of the road traffic noise predictions are presented in the table below. It is noted that the predicted noise levels represent the traffic noise contribution from the vehicle movements associated with the construction works and does not take into account existing traffic noise levels as existing traffic volumes along Wollar Road, Phillip Street, Maitland Street and Barigan Road are unknown.

Table 7.3 – Predicted Road Traffic Noise Contribution Levels Along Public Roads, dB(A)

Receiver	Criteria (external)	Average Traffic Movements		Speed (km/h)	Approx. Distance to Road	Predicted Noise Level dB(A)	Exceed?
		Light Vehicle	Heavy Vehicle				
Nearest Residence on Wollar Road, Phillip Street, Maitland Street	$L_{Aeq,(15\text{ hour})}$ 60	40 / per 15 hours	24 / per 15 hours	50	13.1m	55	No
Nearest Residence on Barigan Road	$L_{Aeq,(1\text{ hour})}$ 55	4 / per one (1) hour	3 / per one (1) hour	50	460m	35	No

From the above table, it can be seen that predicted road traffic noise level contributions from the vehicle movements associated with the construction works comply with the applicable noise criteria at the nearest affected receivers along Wollar Road, Phillip Street, Maitland Street and Barigan Road.

As the construction traffic noise levels are temporary and comply with the RNP criteria set above, it indicates that the traffic noise levels due to the construction works for the solar farm would not adversely affect the existing residences along Wollar Road, Phillip Street, Maitland Street and Barigan Road during construction of the proposed solar farm.

8 Conclusion

Renzo Tonin and Associates has completed an environmental noise and vibration assessment of the proposed solar farm located approximately seven (7) kilometres south of the town of Wollar in New South Wales.

Noise emissions from the construction phase and the operational phase of the project were predicted to comply the applicable noise criteria at the nearest affected receivers.

Given the large separation distance between the nearest affected receivers and the proposal site, vibration impacts resulting in structural damage to buildings at the nearest affected receivers are determined to be negligible and there would be no risk of adverse comments from occupants of the nearest dwellings due to construction vibration.

Road traffic noise impacts on residential properties along the access route were found to comply with the relevant RNP criteria.

APPENDIX A Glossary of Terminology

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

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 110dB Operating a chainsaw or jackhammer 120dB Deafening
dB(A)	A-weighted decibels. The A-weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L _{Max}	The maximum sound pressure level measured over a given period.
L _{Min}	The minimum sound pressure level measured over a given period.

L ₁	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L ₁₀	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L ₉₀	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L _{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain L _{eq} sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Long-Term Noise Monitoring Methodology

B.1 Noise Monitoring Equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave Band Data	Logger Location(s)
RTA04 (CESVA SC310)	Type 1	1/1	L1

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology During Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW NPfI. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B.3 Noise vs Time Graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10} , L_{90} , and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Long Term Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Background & Ambient Noise Monitoring Results - NSW 'Industrial Noise Policy', 2000

Date	L _{A90} Background Noise Levels ⁴			L _{Aeq} Ambient Noise Levels		
	Day ¹	Evening ²	Night ³	Day ¹	Evening ²	Night ³
Tuesday-22-May-2018	31.0	23.5	19.5	47.6	40.6	28.9
Wednesday-23-May-2018	23.5	21.0	19.5	42.5	42.1	24.5
Thursday-24-May-2018	21.5	23.5	19.0	41.7	35.7	27.5
Friday-25-May-2018	23.8	23.5	20.5	41.9	38.8	39.6
Saturday-26-May-2018	22.0	22.5	21.0	41.3	35.2	32.0
Sunday-27-May-2018	22.0	23.0	23.0	40.6	40.6	31.7
Monday-28-May-2018	24.0	23.5	22.0	41.7	30.8	28.0
Tuesday-29-May-2018	23.0	24.0	28.0	42.1	38.5	47.6
Wednesday-30-May-2018	27.0	27.0	26.0	49.7	44.1	33.7
Thursday-31-May-2018	24.5	27.5	17.5	48.3	39.1	28.1
Friday-01-June-2018	21.5	27.5	18.0	44.1	45.4	39.8
Saturday-02-June-2018	18.5	25.0	21.0	41.6	34.6	45.0
Representative Weekday⁵	23.6	26.0	22.3	46.4	40.8	39.3
Representative Weekend⁵	22.0	23.5	22.5	41.8	37.6	39.2
Representative Week⁵	23.3	25.0	22.5	45.4	40.2	39.2

Notes:

- Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
- Evening is 6:00pm to 10:00pm
- Night is the remaining periods
- Assessment Background Level (ABL) for individual days
- Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
- Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at facade

96 Maree Road, Tichular NSW 2850

Road / Rail Noise Monitoring Results (at one metre from façade)

Date	L _{Aeq} Noise Levels		L _{Aeq 1hr} Noise Levels			
	Day ¹	Night ²	Day - Up ⁴	Day - Low ⁵	Night - Up ⁴	Night - Low ⁵
Tuesday-22-May-2018	48.2	31.4	51.3	38.7	32.1	27.8
Wednesday-23-May-2018	44.9	27.0	47.0	35.8	28.8	24.5
Thursday-24-May-2018	42.7	27.8	47.5	35.8	29.3	25.7
Friday-25-May-2018	43.4	42.1	46.8	37.7	41.0	27.9
Saturday-26-May-2018	42.5	34.5	46.5	33.4	33.2	28.5
Sunday-27-May-2018	43.1	34.2	46.2	40.2	35.2	32.6
Monday-28-May-2018	41.5	30.5	46.6	30.8	31.5	28.9
Tuesday-29-May-2018	43.7	50.1	46.9	36.0	54.1	36.4
Wednesday-30-May-2018	51.3	36.2	54.8	39.6	38.3	32.5
Thursday-31-May-2018	49.6	30.6	53.3	37.9	35.0	24.6
Friday-01-June-2018	46.4	42.3	50.8	34.0	44.1	27.7
Saturday-02-June-2018	42.6	47.5	44.9	34.2	52.8	29.4
Representative Weekday³	47.3	36.2	51.0	35.9	37.8	28.4
Representative Weekend³	42.5	34.5	45.5	34.7	35.2	29.4
Representative Week³	44.5	36.1	47.7	35.8	37.4	28.9

Notes:

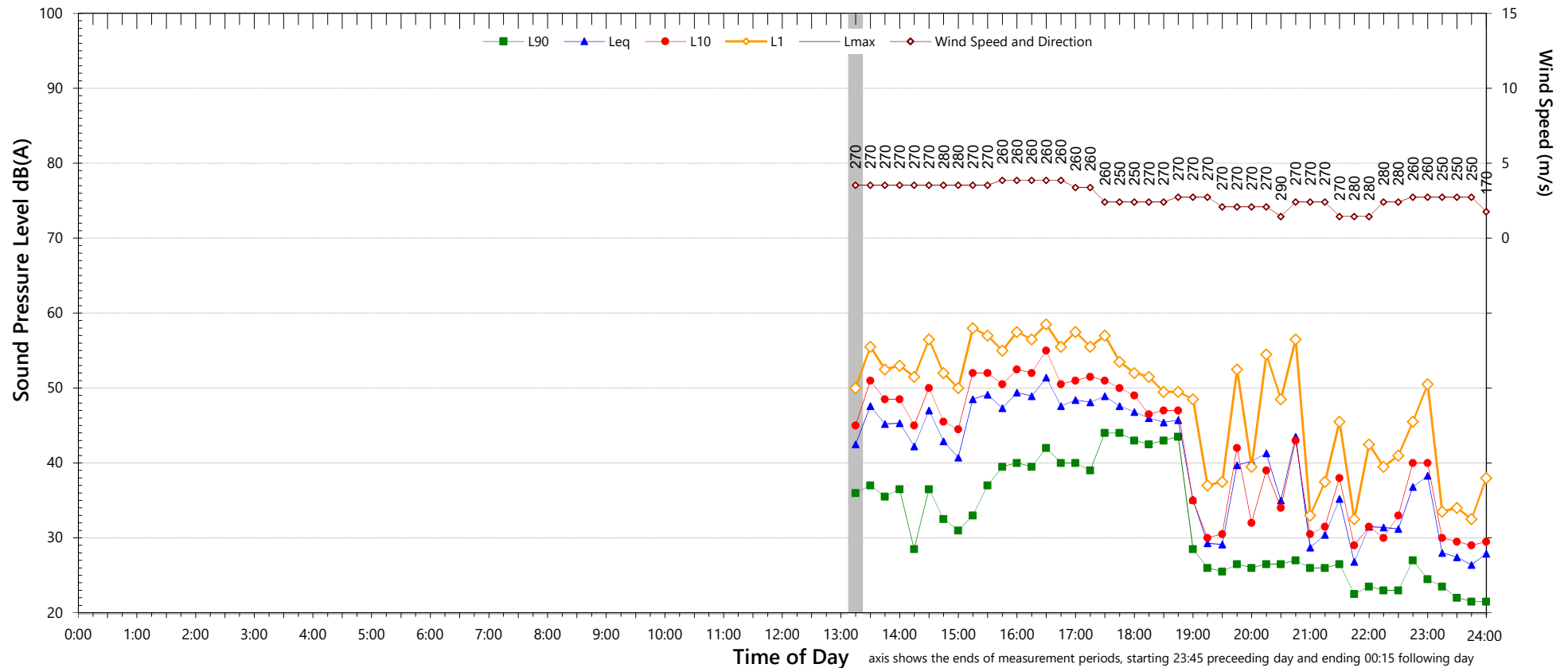
- Day is 7:00am to 10:00pm
- Night is 10:00pm to 7:00am
- Median of daily L_{Aeq}
- Upper 10th percentile L_{Aeq 1hr}
- Lower 10th percentile L_{Aeq 1hr}
- Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Tuesday, 22 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	32	25	20
LA _{eq}	48	41	29

Night Time Maximum Noise Levels		(see note 7)	
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

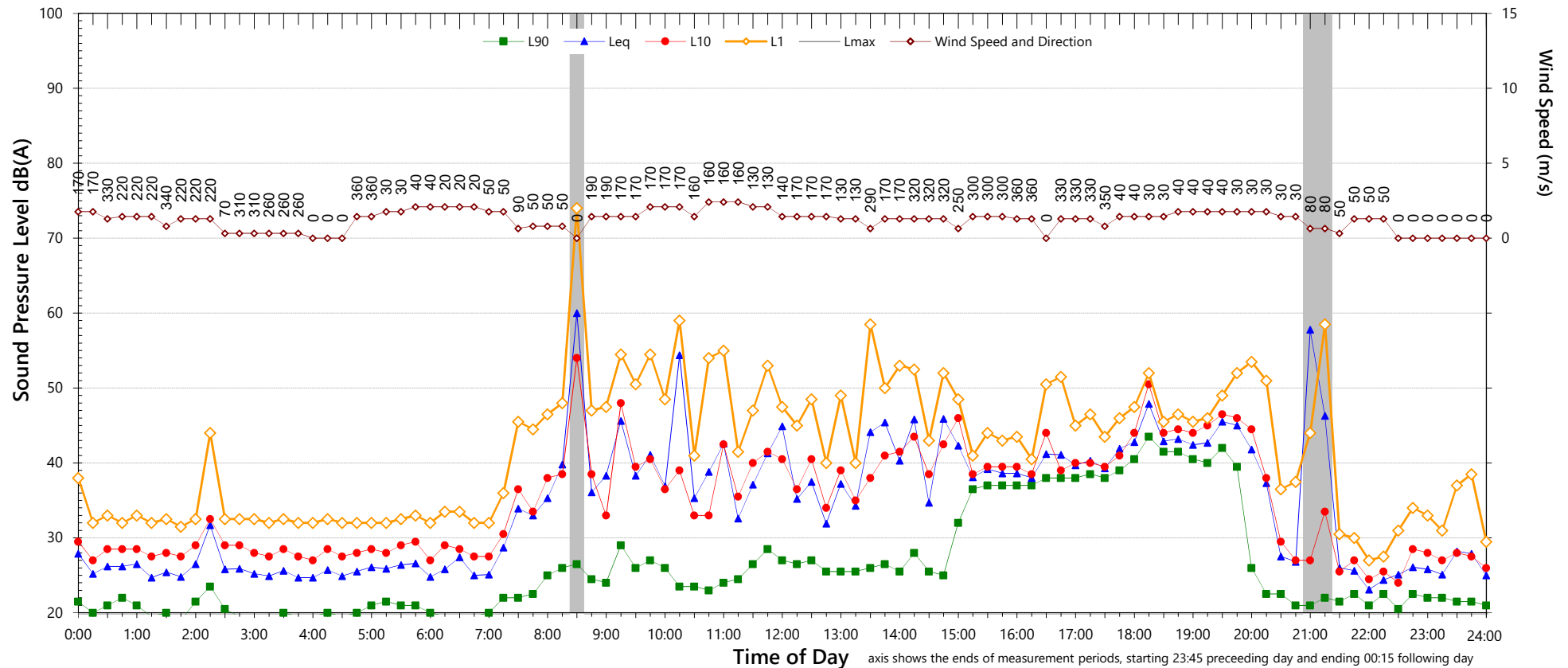
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	48.2	31.4
L _{eq} 1hr upper 10 percentile	51.3	32.1
L _{eq} 1hr lower 10 percentile	38.7	27.8

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Wednesday, 23 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	24	21	20
LA _{eq}	42	42	25

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

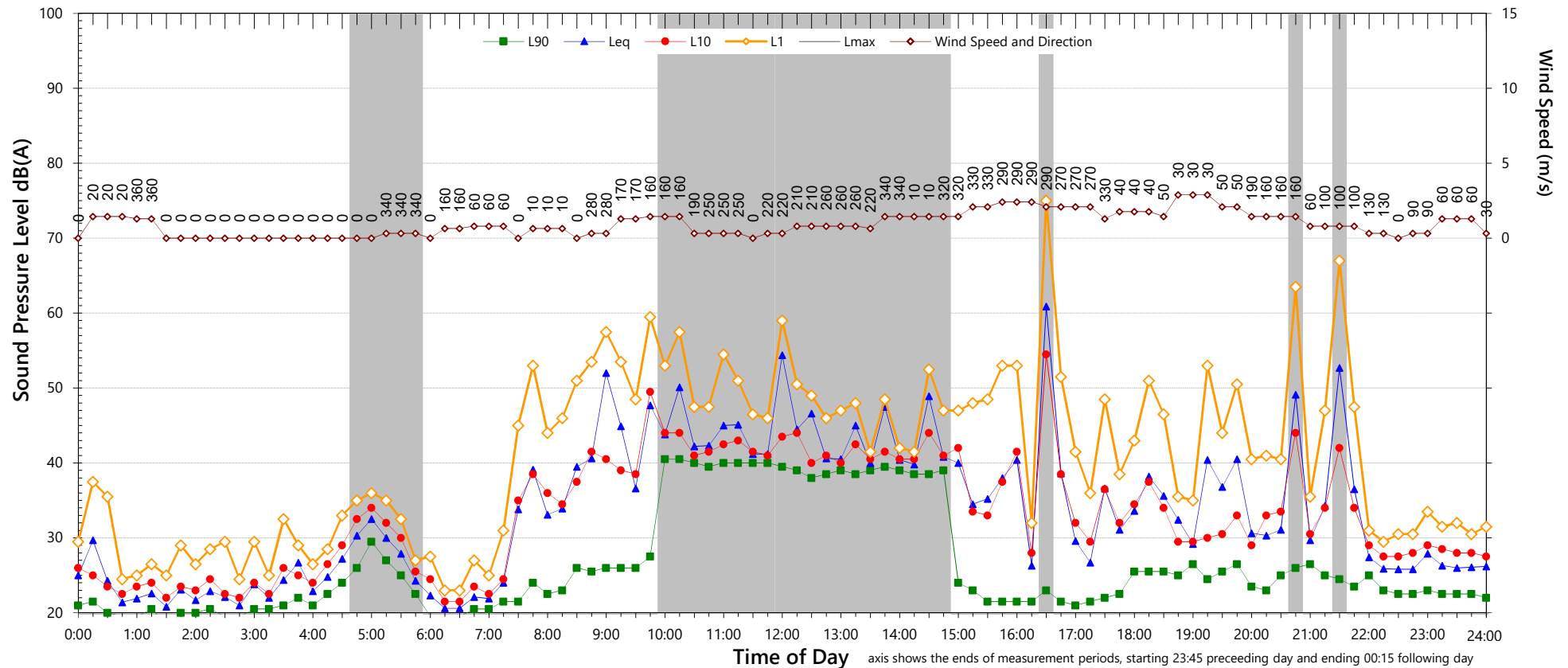
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	44.9	27.0
L _{eq} 1hr upper 10 percentile	47.0	28.8
L _{eq} 1hr lower 10 percentile	35.8	24.5

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Thursday, 24 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	22	24	19
LA _{eq}	42	36	28

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

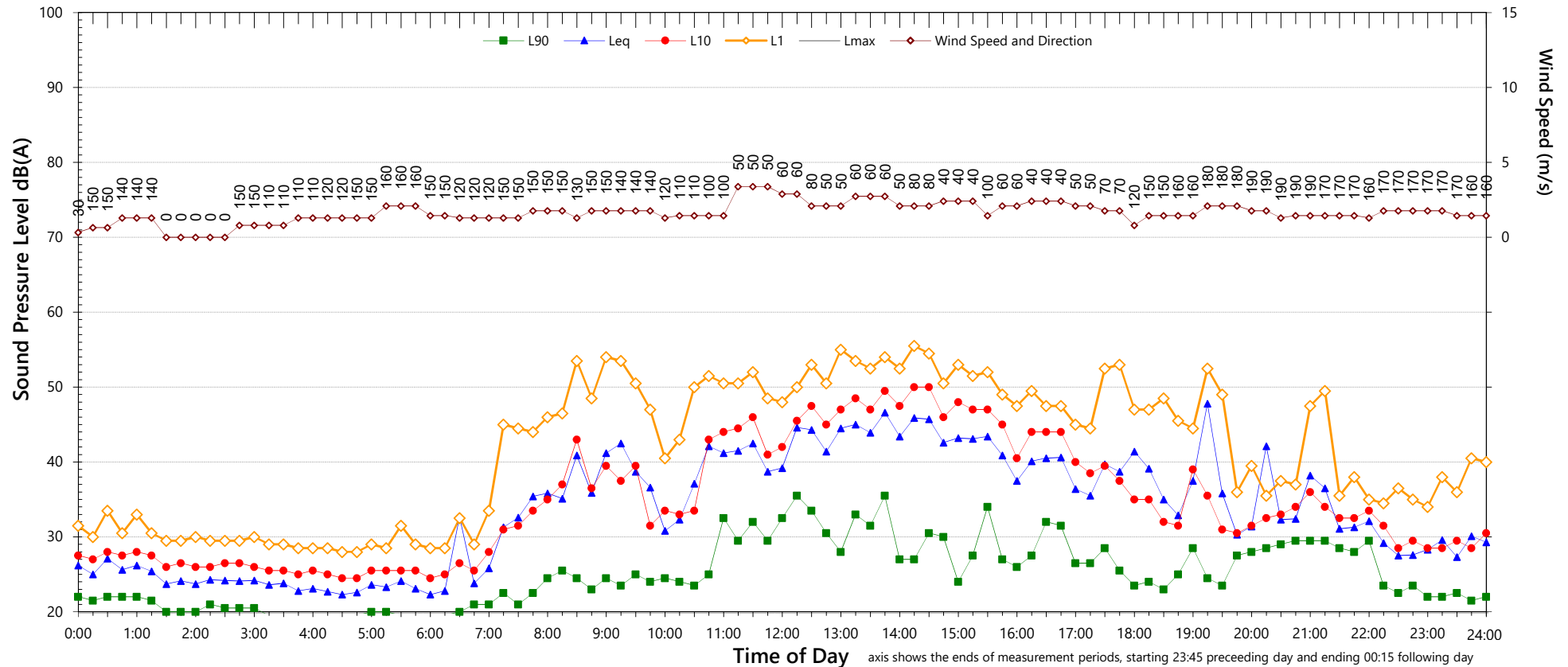
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	42.7	27.8
L _{eq} 1hr upper 10 percentile	47.5	29.3
L _{eq} 1hr lower 10 percentile	35.8	25.7

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Friday, 25 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	24	24	21
LA _{eq}	42	39	40

Night Time Maximum Noise Levels		(see note 7)	
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

3. "Evening" is the period from 6pm till 10pm

6. Graphed data measured in free-field; tabulated results facade corrected

4. "Night" relates to the remaining periods

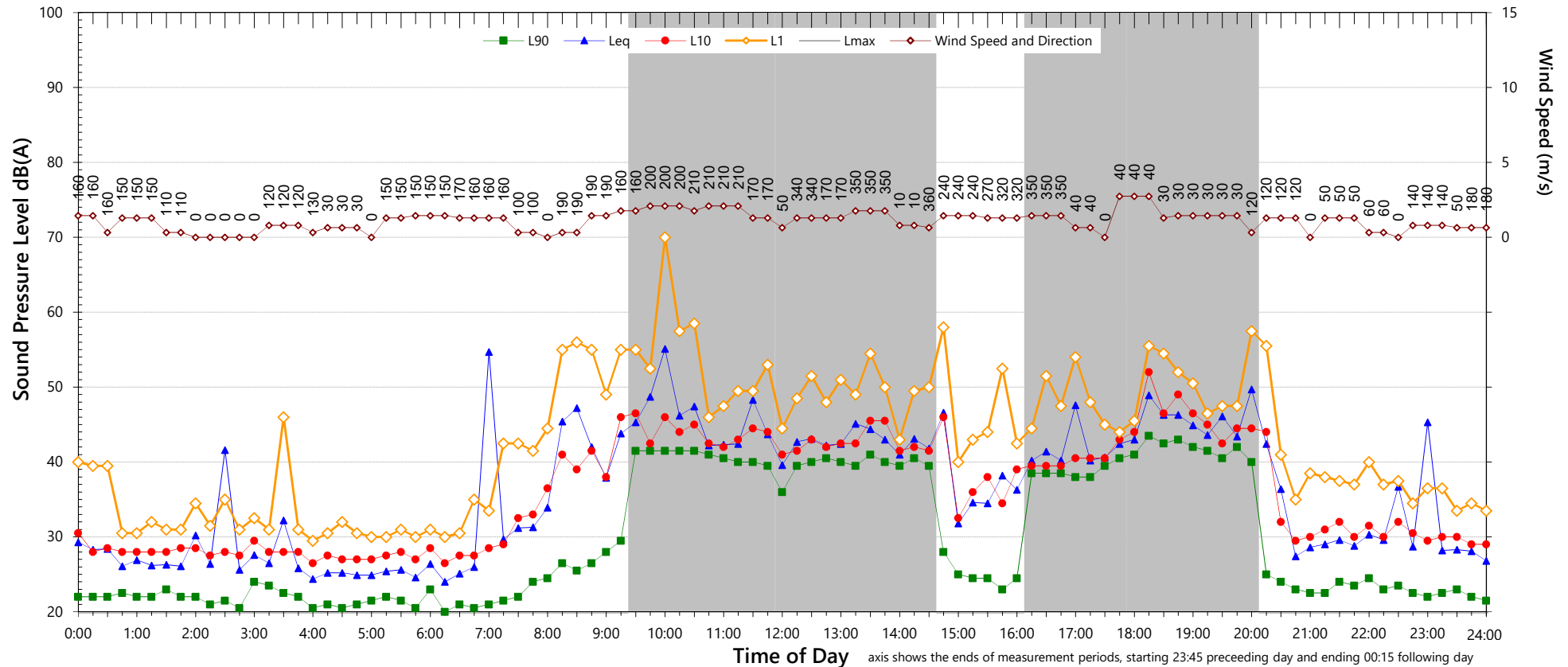
7. Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	43.4	42.1
L _{eq} 1hr upper 10 percentile	46.8	41.0
L _{eq} 1hr lower 10 percentile	37.7	27.9

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Saturday, 26 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	22	23	21
LA _{eq}	41	35	32

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

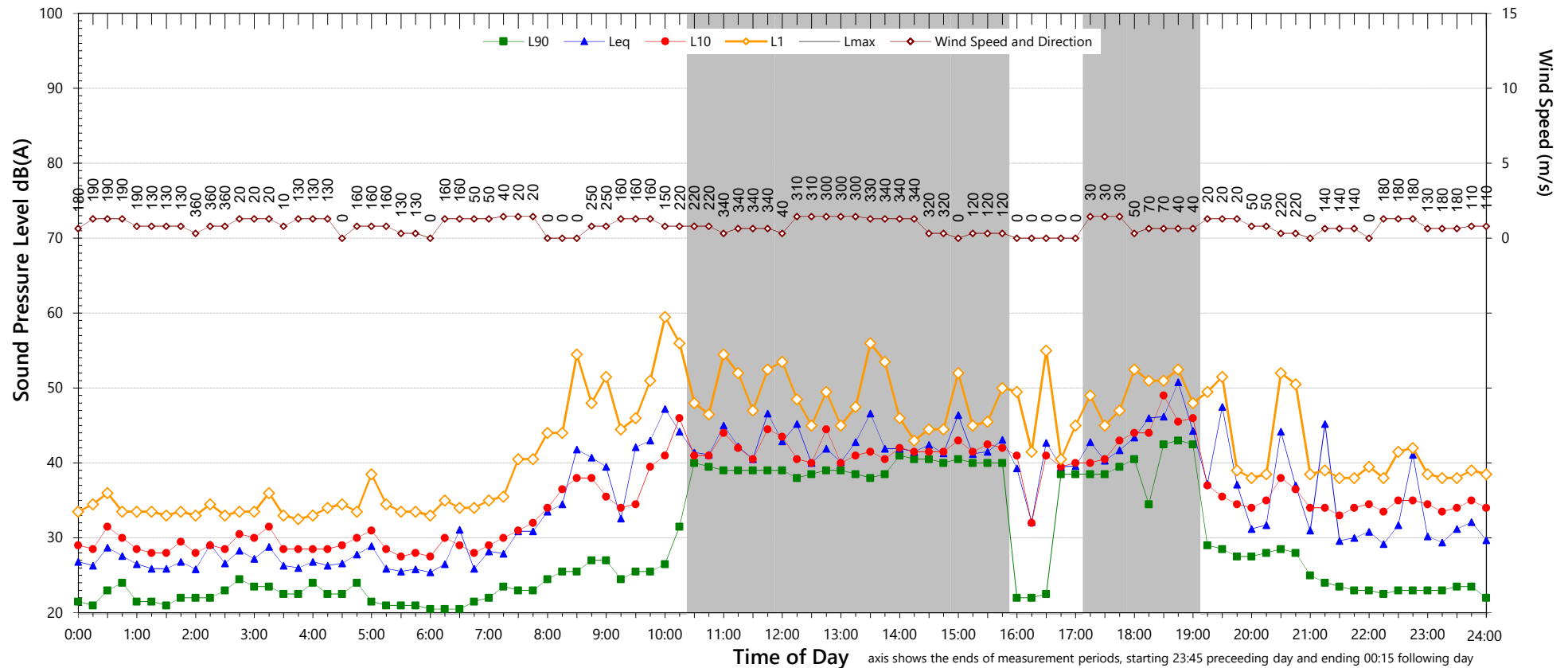
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	42.5	34.5
L _{eq} 1hr upper 10 percentile	46.5	33.2
L _{eq} 1hr lower 10 percentile	33.4	28.5

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Sunday, 27 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	22	23	23
LA _{eq}	41	41	32

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

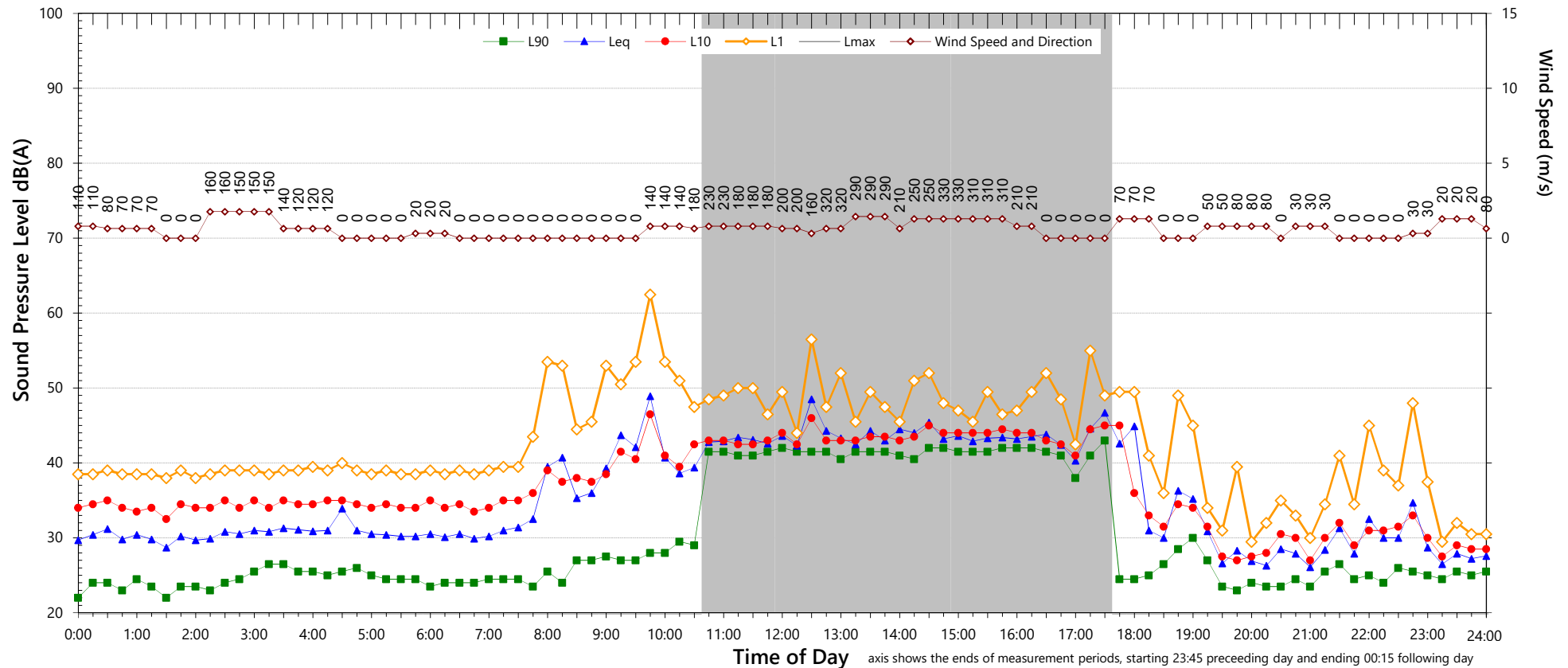
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	43.1	34.2
L _{eq} 1hr upper 10 percentile	46.2	35.2
L _{eq} 1hr lower 10 percentile	40.2	32.6

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Monday, 28 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	24	24	23
LA _{eq}	42	31	28

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

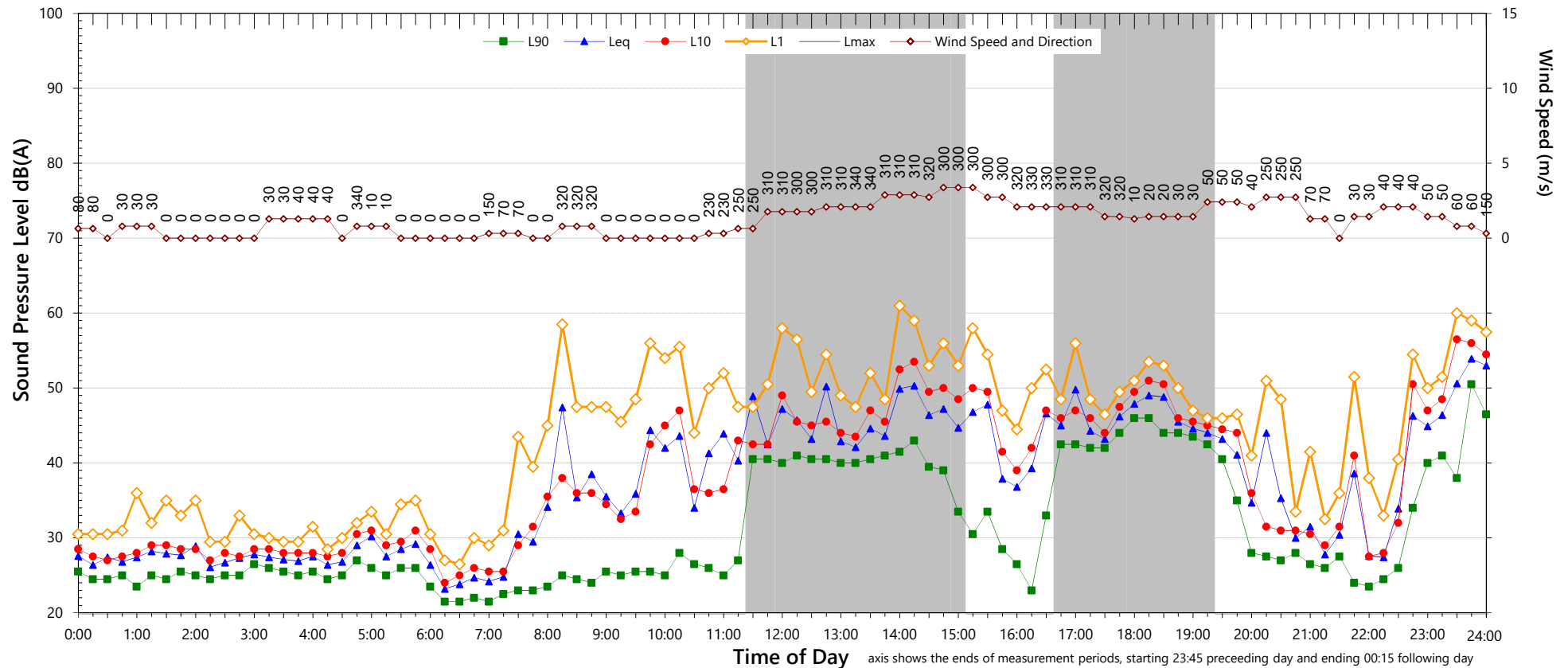
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	41.5	30.5
L _{eq} 1hr upper 10 percentile	46.6	31.5
L _{eq} 1hr lower 10 percentile	30.8	28.9

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Tuesday, 29 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	23	24	28
LA _{eq}	42	38	48

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

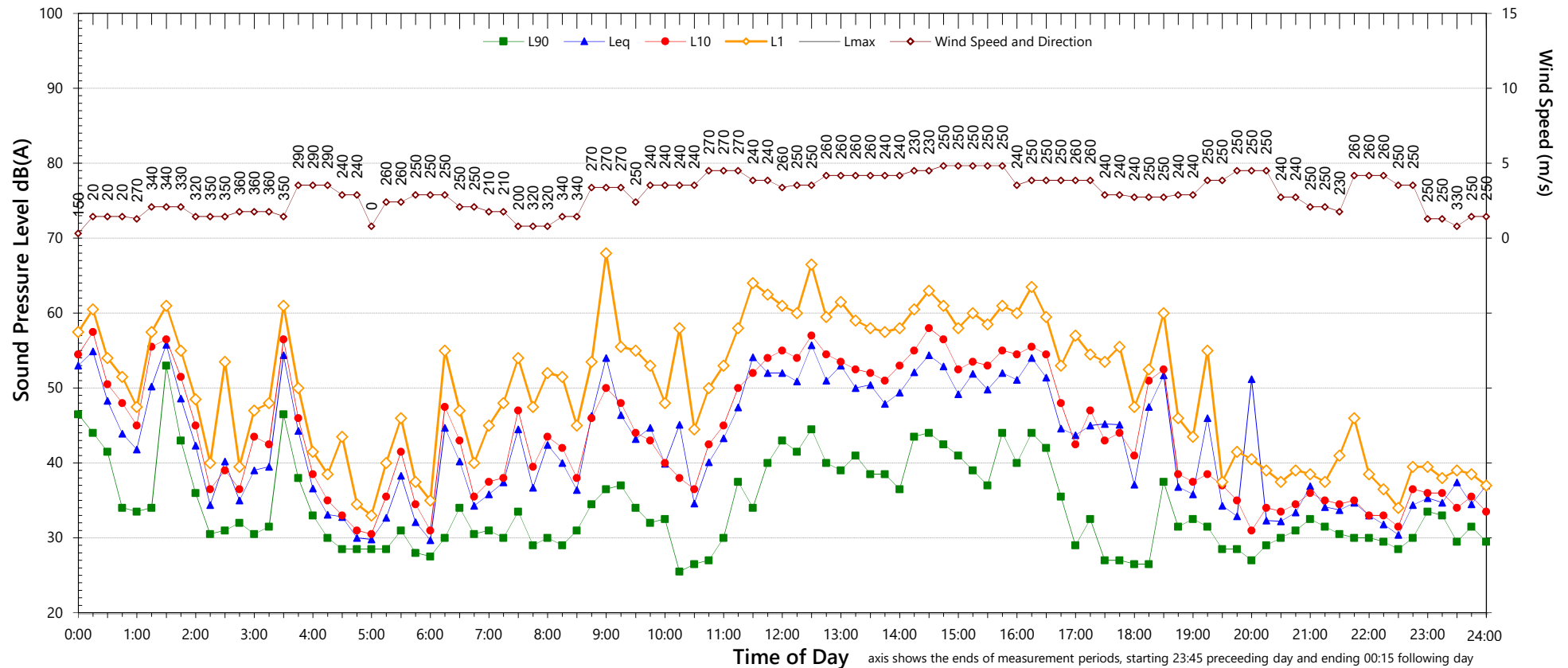
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	43.7	50.1
L _{eq} 1hr upper 10 percentile	46.9	54.1
L _{eq} 1hr lower 10 percentile	36.0	36.4

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Wednesday, 30 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	27	28	27
LA _{eq}	50	44	34

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

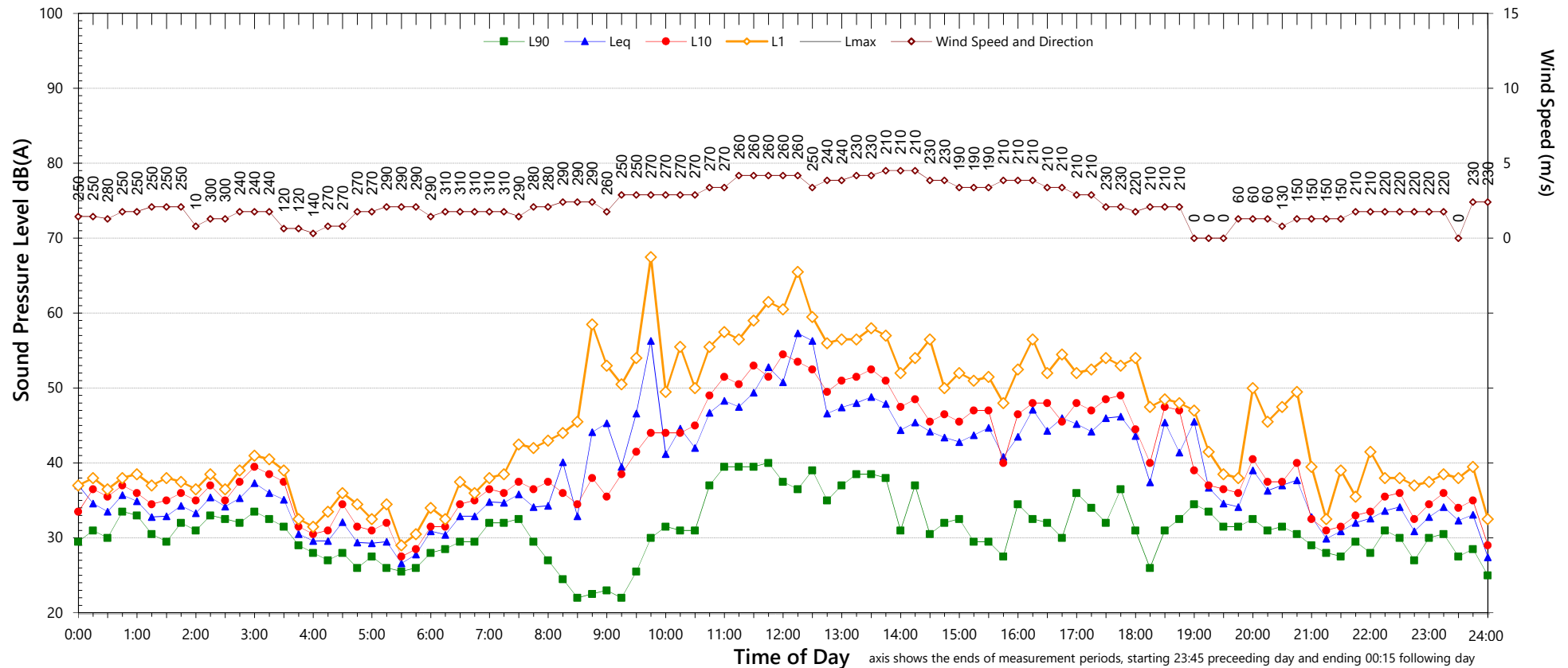
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	51.3	36.2
L _{eq} 1hr upper 10 percentile	54.8	38.3
L _{eq} 1hr lower 10 percentile	39.6	32.5

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Thursday, 31 May 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	25	28	18
LA _{eq}	48	39	28

Night Time Maximum Noise Levels		(see note 7)	
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

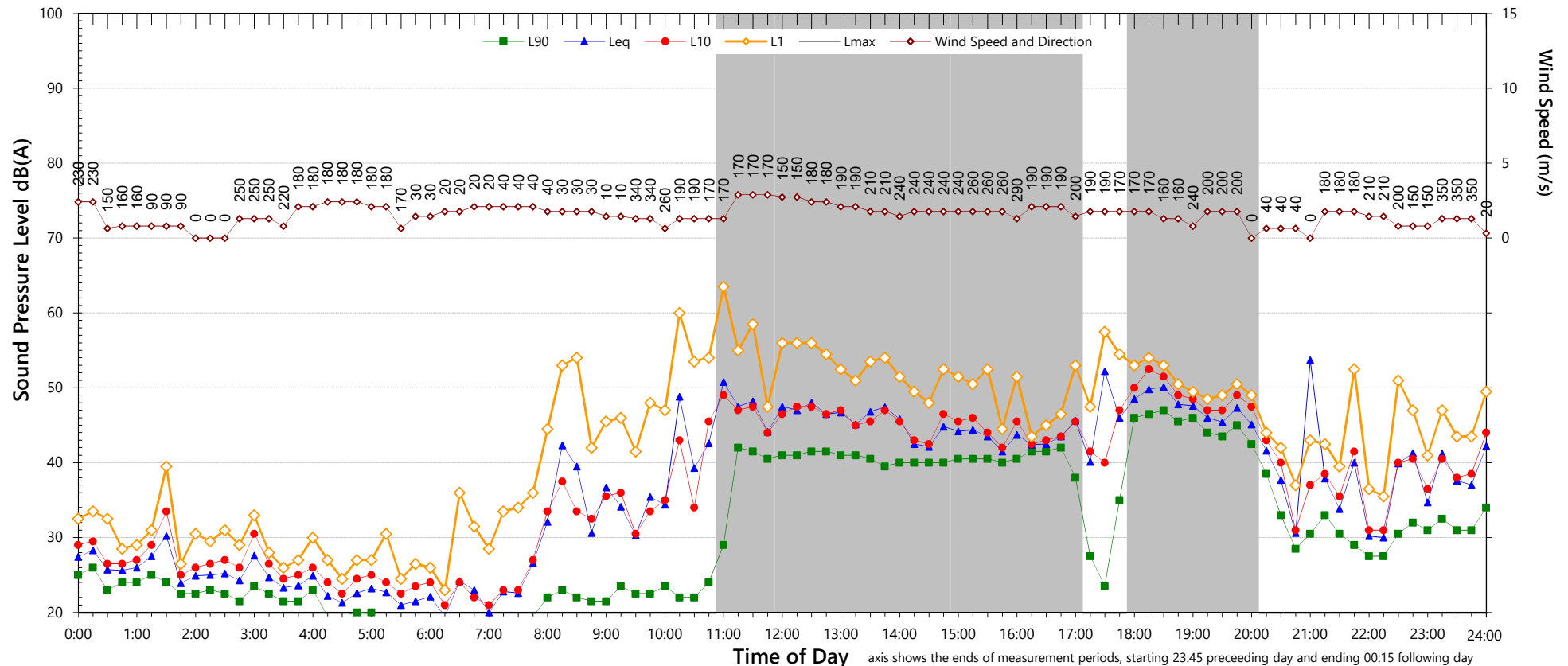
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	49.6	30.6
L _{eq} 1hr upper 10 percentile	53.3	35.0
L _{eq} 1hr lower 10 percentile	37.9	24.6

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Friday, 1 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	22	28	18
LA _{eq}	44	45	40

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

3. "Evening" is the period from 6pm till 10pm

6. Graphed data measured in free-field; tabulated results facade corrected

4. "Night" relates to the remaining periods

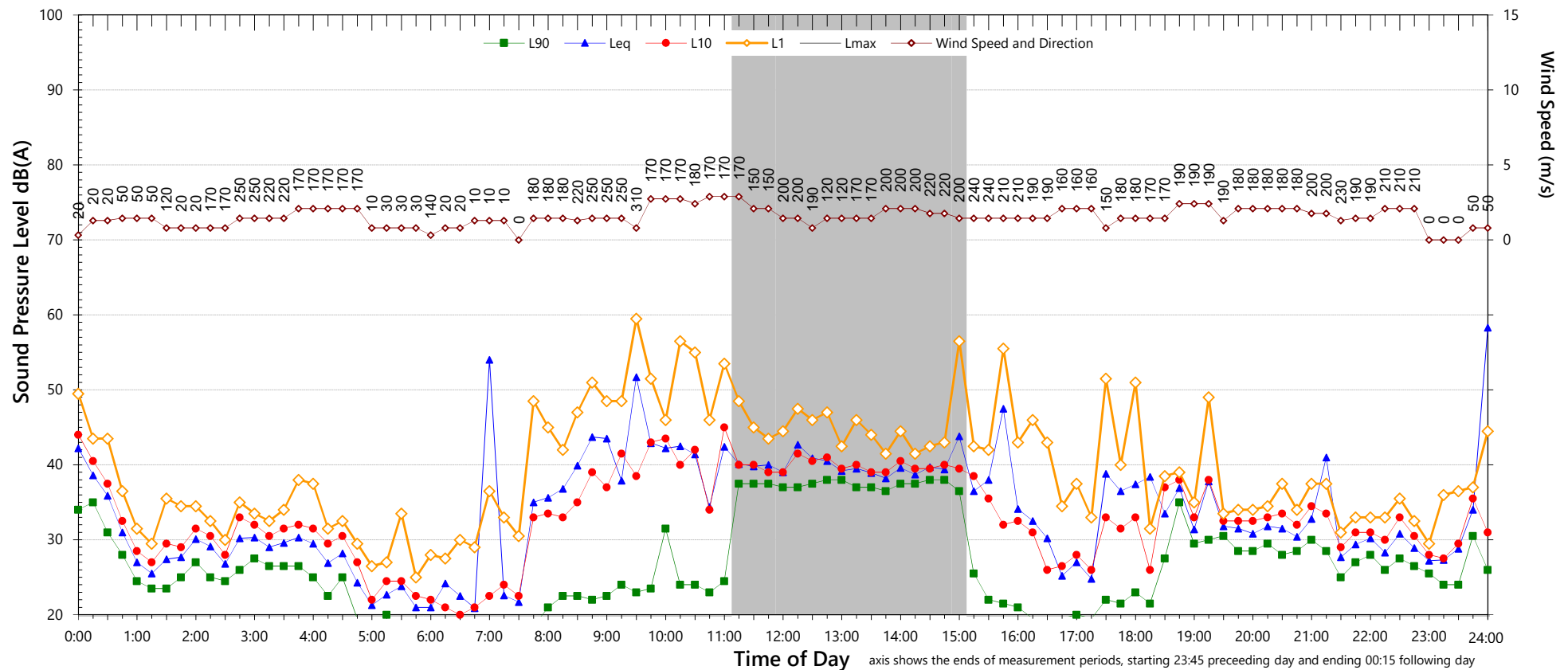
7. Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	46.4	42.3
L _{eq} 1hr upper 10 percentile	50.8	44.1
L _{eq} 1hr lower 10 percentile	34.0	27.7

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Saturday, 2 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	19	26	21
LA _{eq}	42	35	45

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

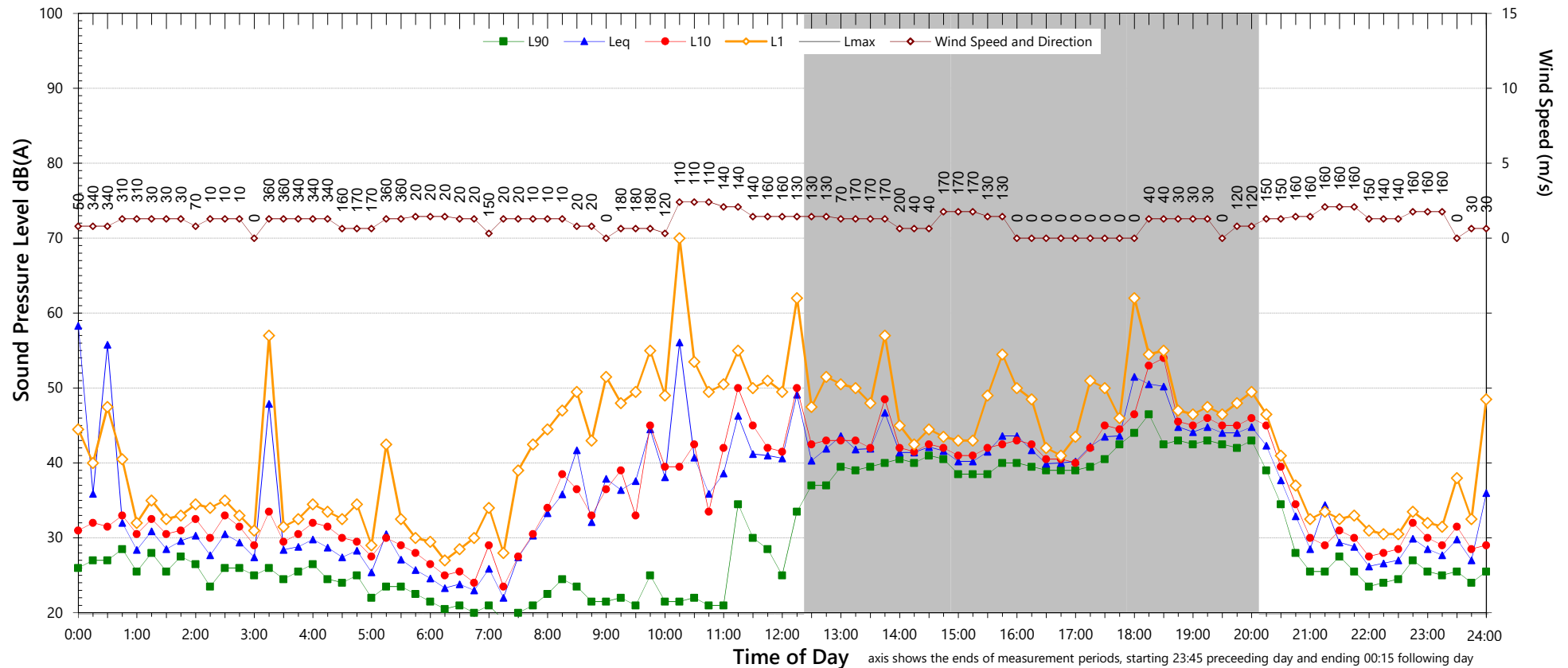
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	42.6	47.5
L _{eq} 1hr upper 10 percentile	44.9	52.8
L _{eq} 1hr lower 10 percentile	34.2	29.4

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Sunday, 3 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	21	25	23
LA _{eq}	45	36	29

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

3. "Evening" is the period from 6pm till 10pm

6. Graphed data measured in free-field; tabulated results facade corrected

4. "Night" relates to the remaining periods

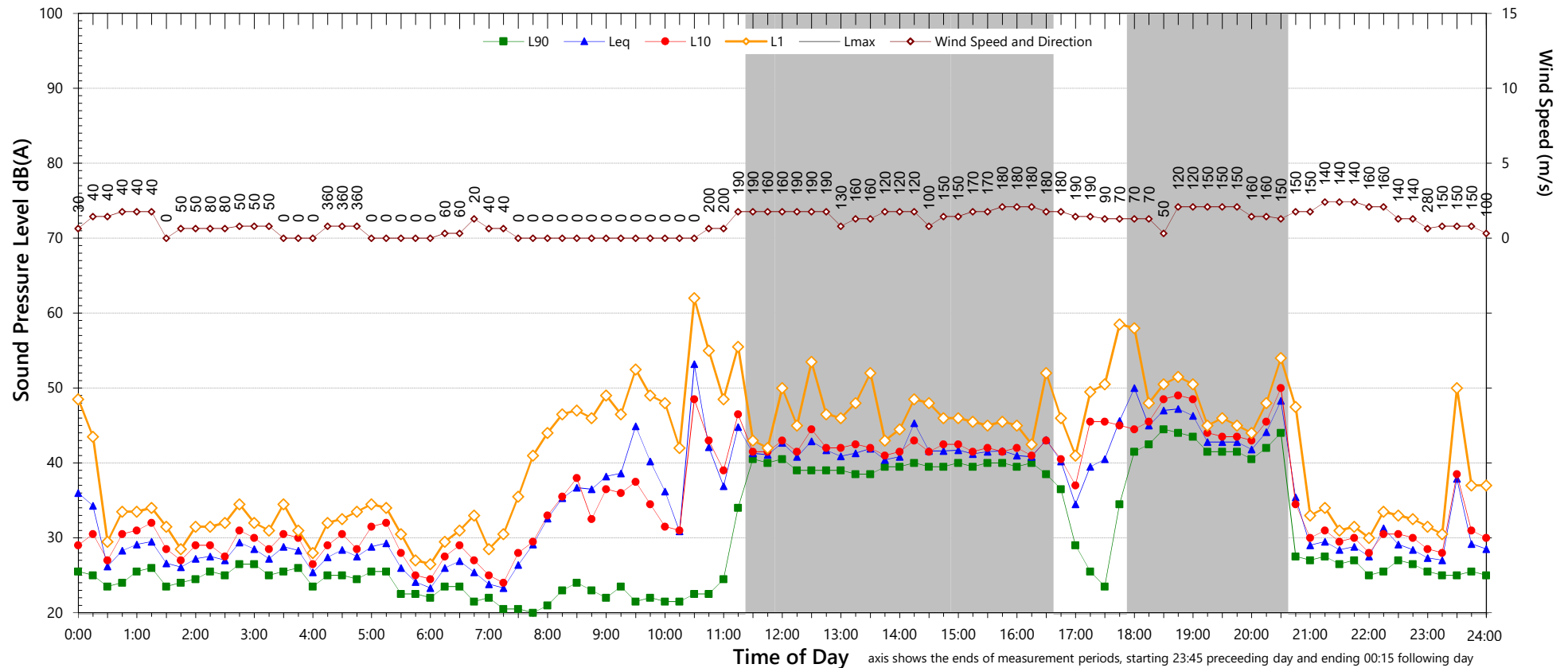
7. Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	46.3	31.1
L _{eq} 1hr upper 10 percentile	52.0	33.3
L _{eq} 1hr lower 10 percentile	33.0	28.7

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Monday, 4 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	21	26	23
LA _{eq}	43	31	29

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

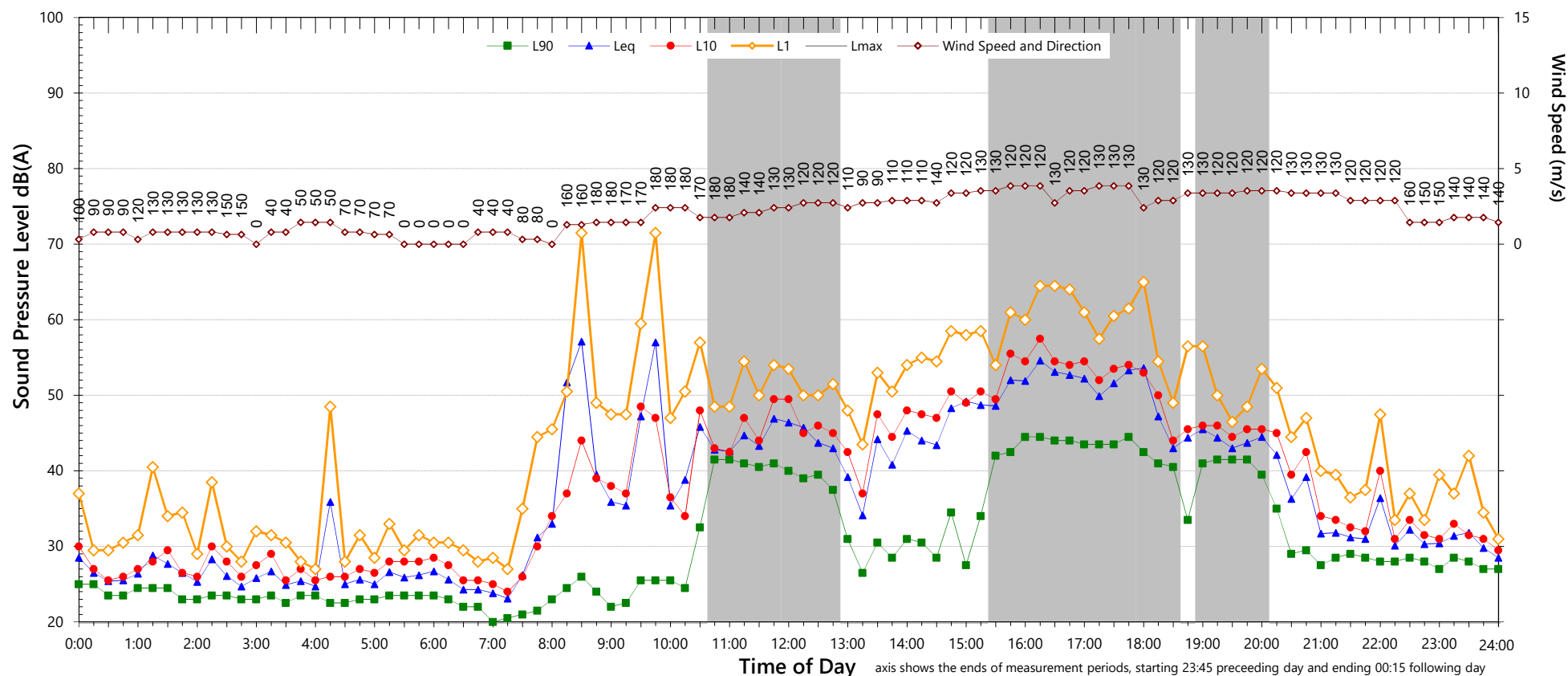
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	44.2	31.1
L _{eq} 1hr upper 10 percentile	47.9	33.8
L _{eq} 1hr lower 10 percentile	31.5	27.8

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Tuesday, 5 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	22	28	26
LA _{eq}	48	39	38

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

3. "Evening" is the period from 6pm till 10pm

6. Graphed data measured in free-field; tabulated results facade corrected

4. "Night" relates to the remaining periods

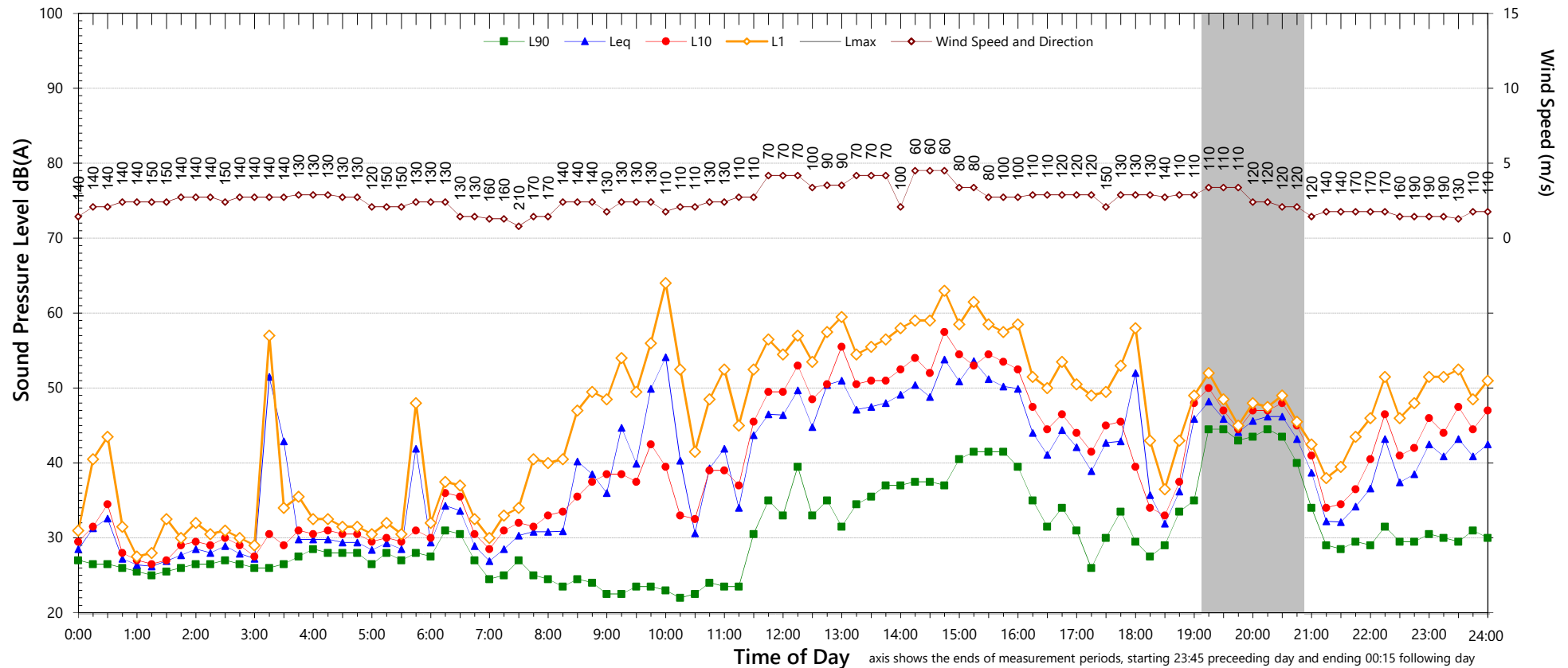
7. Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	49.6	40.1
L _{eq} 1hr upper 10 percentile	54.0	40.9
L _{eq} 1hr lower 10 percentile	35.8	30.4

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Wednesday, 6 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	23	28	29
LA _{eq}	48	39	44

Night Time Maximum Noise Levels		(see note 7)	
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

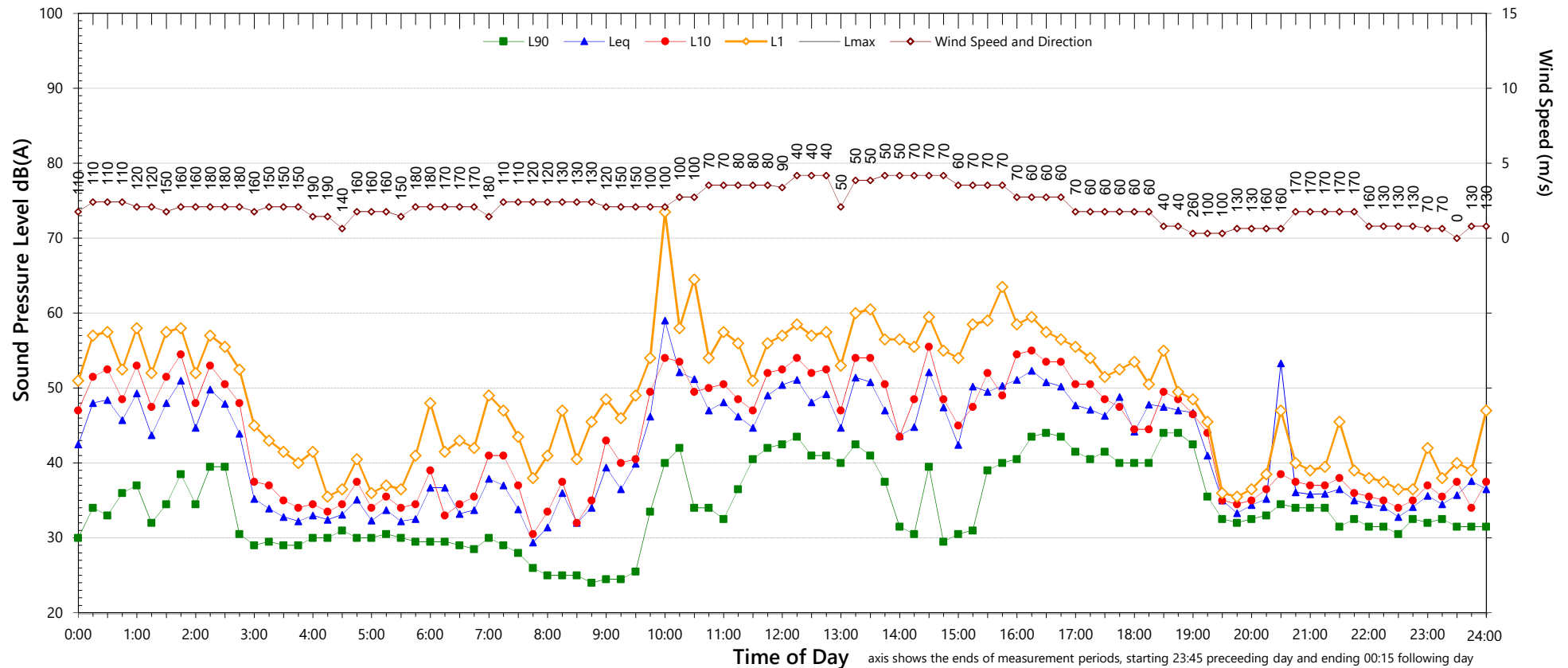
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	49.5	46.2
L _{eq} 1hr upper 10 percentile	53.4	50.4
L _{eq} 1hr lower 10 percentile	37.7	35.8

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Thursday, 7 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	25	32	30
LA _{eq}	49	45	33

Night Time Maximum Noise Levels		(see note 7)	
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

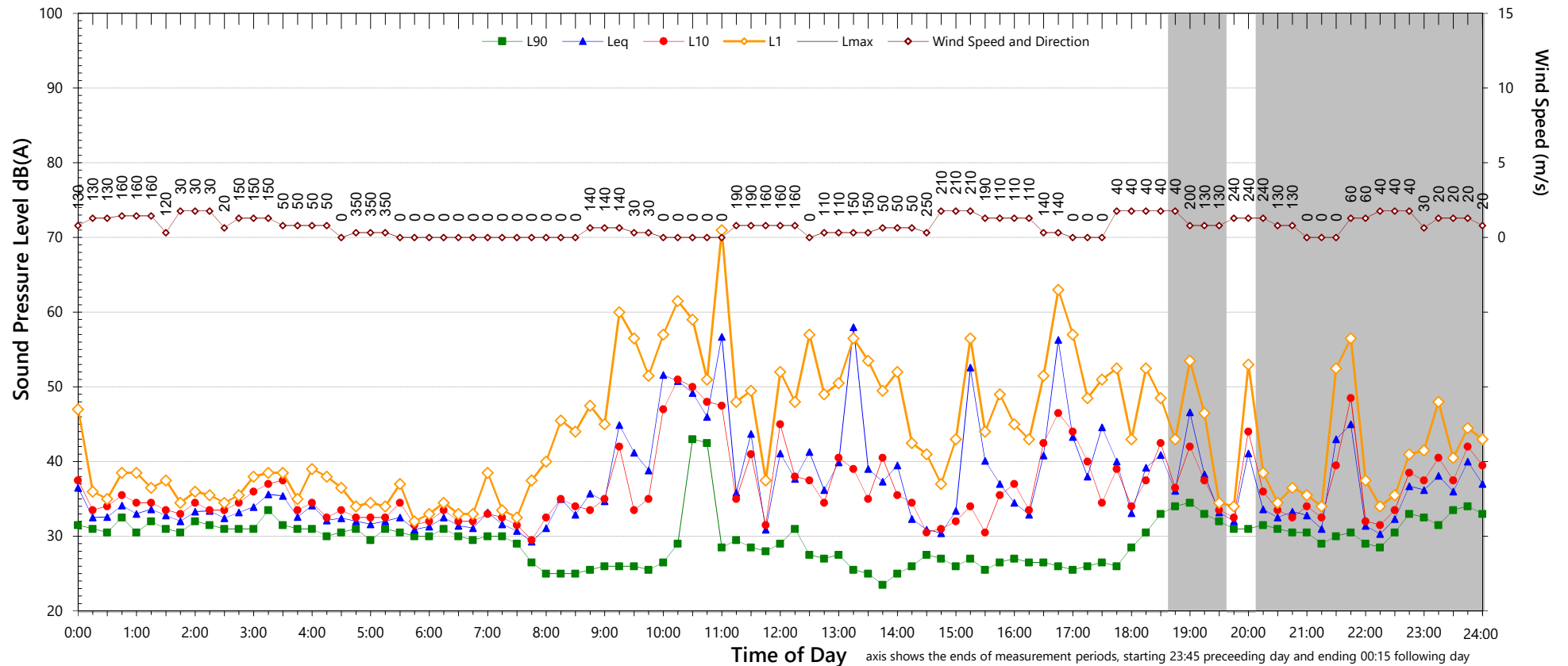
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	50.7	36.1
L _{eq} 1hr upper 10 percentile	53.0	37.4
L _{eq} 1hr lower 10 percentile	38.3	34.5

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Friday, 8 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	25	31	29
LA _{eq}	48	39	37

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

3. "Evening" is the period from 6pm till 10pm

6. Graphed data measured in free-field; tabulated results facade corrected

4. "Night" relates to the remaining periods

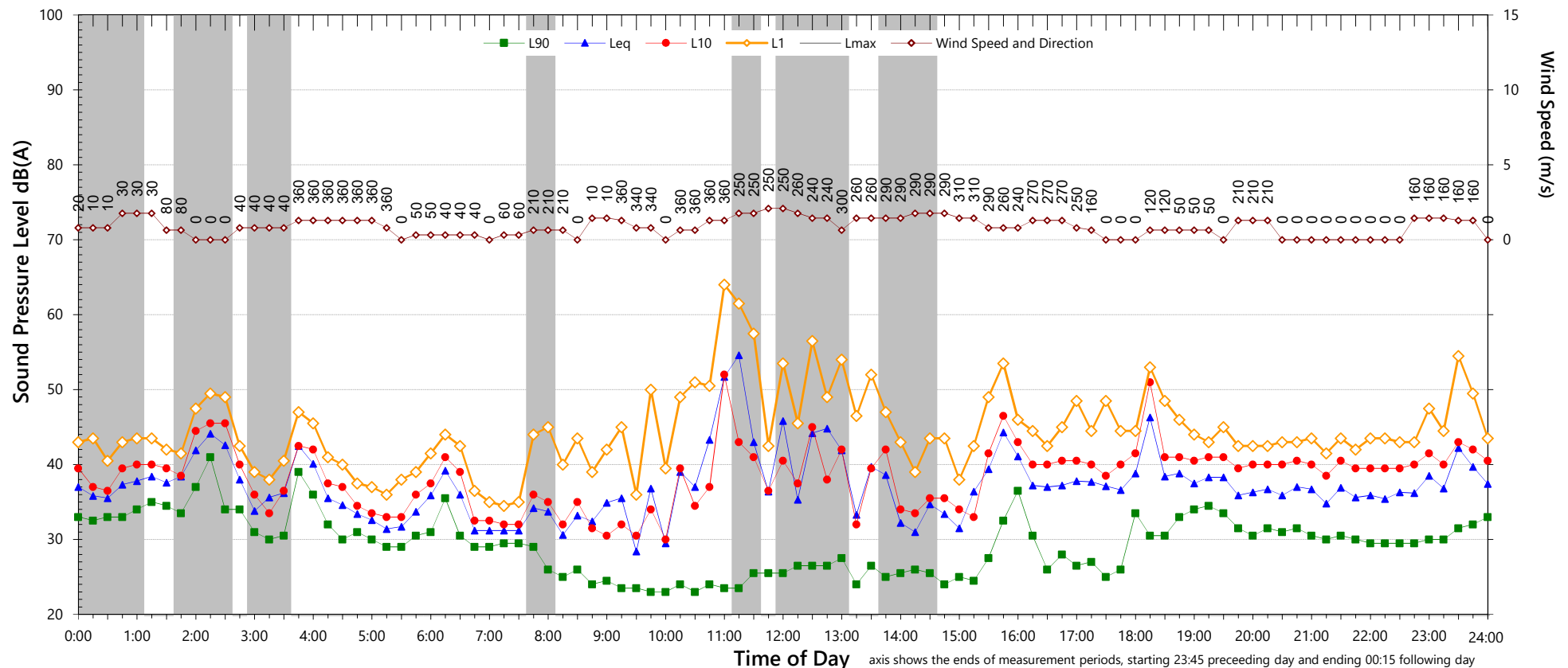
7. Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	49.5	39.3
L _{eq} 1hr upper 10 percentile	54.3	42.2
L _{eq} 1hr lower 10 percentile	35.0	36.4

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Saturday, 9 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	24	30	29
L _{Aeq}	40	39	37

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

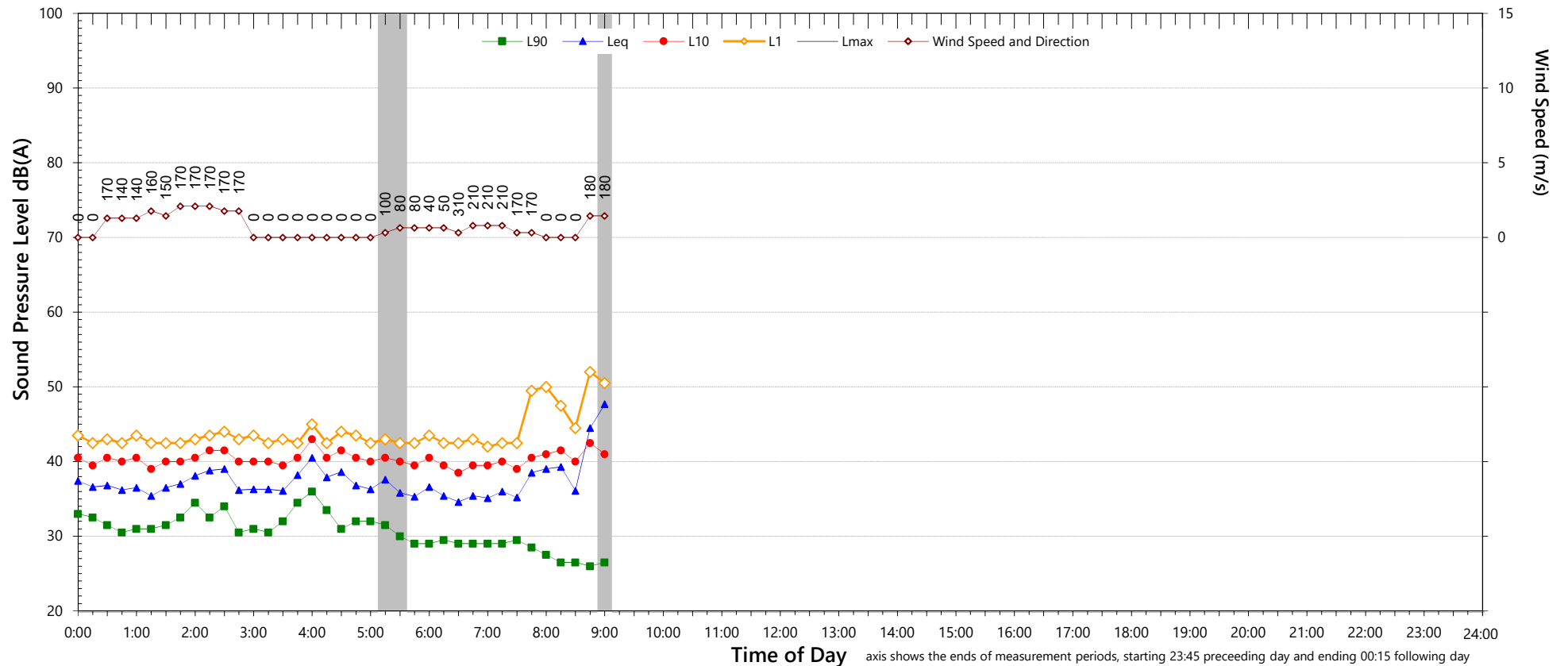
- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	42.2	39.9
L _{eq} 1hr upper 10 percentile	44.2	40.9
L _{eq} 1hr lower 10 percentile	35.2	38.3

Unattended Noise Monitoring Results

96 Maree Road, Tichular NSW 2850

Sunday, 10 June 2018



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day ²	Evening ³	Night ^{4 5}
L ₉₀	26	-	-
LA _{eq}	40	-	-

Night Time Maximum Noise Levels (see note 7)			
L _{Max} (Range)	-	to	-
L _{Max} - L _{eq} (Range)	-	to	-

Notes:

- Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
- "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
- "Evening" is the period from 6pm till 10pm
- "Night" relates to the remaining periods
- "Night" relates to period from 10pm on this graph to morning on the following graph.
- Graphed data measured in free-field; tabulated results facade corrected
- Night time L_{Max} values are shown only where L_{Max} > 65dB(A) and where L_{Max} - L_{eq} ≥ 15dB(A)

NSW Road Noise Policy (1m from facade) (see note 6)		
Descriptor	Day	Night ⁵
	7am-10pm	10pm-7am
L _{eq} 15 hr and L _{eq} 9 hr	42.0	-
L _{eq} 1hr upper 10 percentile	43.4	-
L _{eq} 1hr lower 10 percentile	40.4	-