

LAL LAL WIND FARM COMPLIANCE

Baseline Noise Monitoring

Prepared for:

Lal Lal Wind Farms Nom Co Pty Limited ACN 625 768 774
Lal Lal Wind Farms Partnership
c/- Res Australia Pty Limited
Suite 4, Level 1
760 Pacific Highway
Chatswood NSW 2067

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 11, 176 Wellington Parade
East Melbourne VIC 3002 Australia

T: +61 3 9249 9400
E: melbourne@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Lal Lal Wind Farms Nom Co Pty Limited ACN 625 768 774 (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
640.11872-R01-v1.1	16 February 2021	Minh Nguyen	Gustaf Reutersward	Gustaf Reutersward
640.11872-R01-v1.0	11 February 2021	Minh Nguyen	Gustaf Reutersward	Gustaf Reutersward

CONTENTS

1	INTRODUCTION	4
2	PREVIOUS MEASUREMENTS	4
3	2019 NOISE SURVEY DETAILS	6
4	NOISE SURVEY RESULT.....	10
4.1	Background noise levels.....	10
4.2	Noise limits	11

DOCUMENT REFERENCES

TABLES

Table 1	Measurement details	9
Table 2	Background Noise Measurements – LA90 vs Wind speed	11
Table 3	Noise Limit.....	12

FIGURES

Figure 1	Baseline monitoring locations (ref: LLWFBNM Report)	5
Figure 2	Monitoring locations at K15aa	6
Figure 3	Background Noise Measurements – LA90 vs Wind speed - All-time	10
Figure 4	Background Noise Measurements – LA90 vs Wind speed – Night-time	11

PHOTOS

Photo 1	Logger setup at receiver K15aa in 2019 survey	7
---------	---	---

APPENDICES

Appendix A	Glossary
Appendix B	Time histories

1 Introduction

SLR Consulting was engaged by Lal Lal Wind Farms Nom Co Pty to provide a supplementary baseline noise monitoring survey for the Lal Lal Wind Farm at receiver K15aa as detailed in *Marshall Day - Lal Lal Wind Farm Background Noise Monitoring Report* (ref: 001 R01 20170649) (2018 LLWFBNM Report) dated 1 March 2018. Two previous baseline monitoring surveys at this location were partially invalidated by interference of localised extraneous noise.

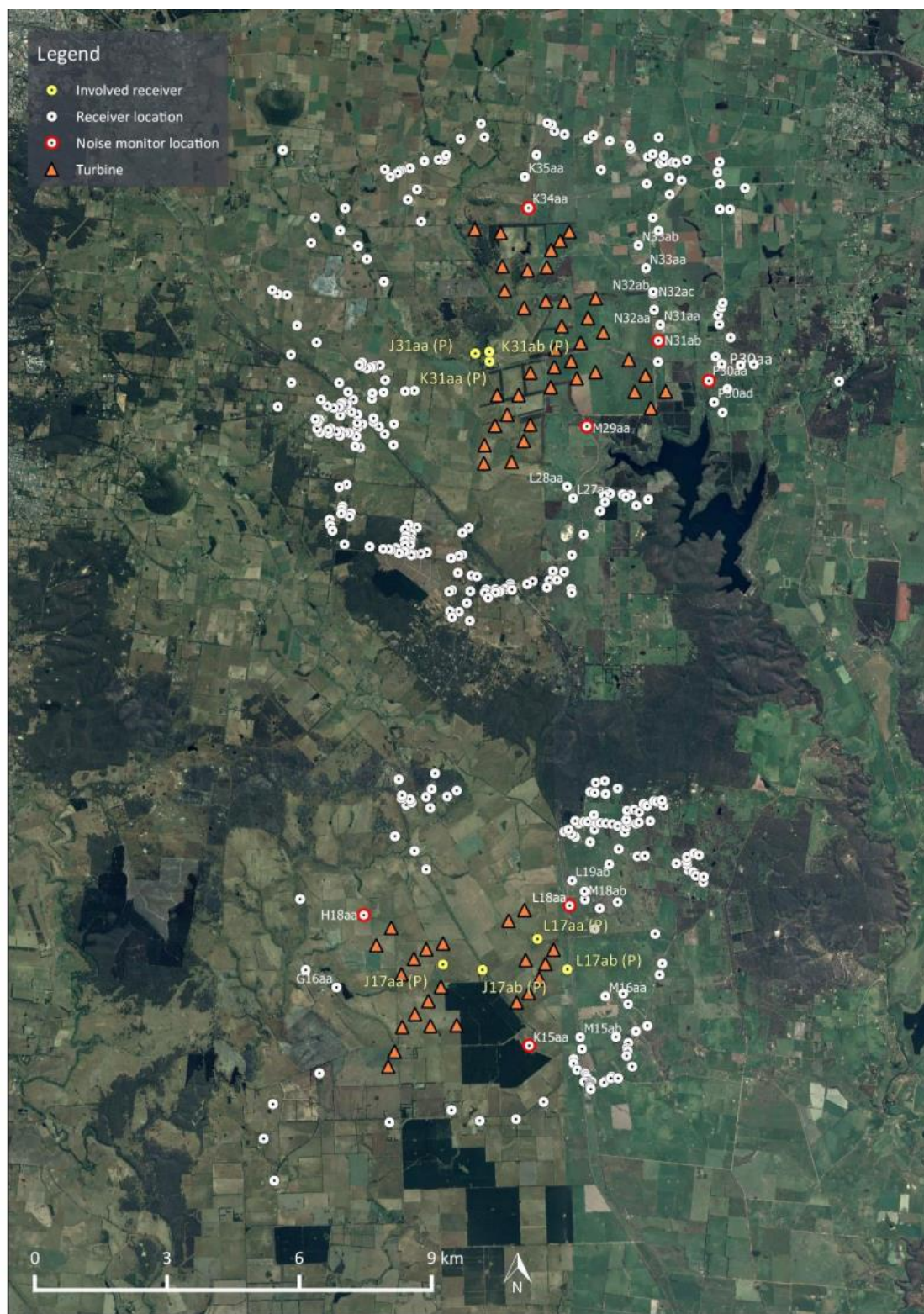
This supplementary noise survey was conducted by SLR Consulting in 2019 to obtain valid baseline noise levels prior to the windfarms operation e and determine appropriate operational noise limits in accordance with the planning permit for the Lal Lal Wind Farm (Planning Permit No. PL-SP/05/0461/A amended April 2018).

2 Previous Measurements

Previous baseline noise surveys and analysis has been conducted at seven receiver locations in 2016 and 2017 as listed in the 2018 LLWFBNM Report. This report stated that *“two (2) separate surveys at K15aa were affected by local sources of noise which are believed to relate to a number of sources close to the dwelling, including domestic air-conditioning systems. As a result, the data for this location is not considered suitable for representing typical background noise levels during other times which may be quieter in the absence of extraneous noise.”*

The seven locations chosen for background noise measurements, which were previously selected and monitored during 2016 and 2017 as part of the 2018 LLWFBNM Report, are shown in **Figure 1** below. Location K15 aa is the most southern monitoring location.

Figure 1 Baseline monitoring locations (ref: LLWFBNM Report)



3 2019 Noise Survey Details

Baseline noise monitoring campaigns in 2019 have been conducted at receiver K15aa in accordance with the following:

- The planning permit for the Lal Lal Wind Farm (Planning Permit No. PL-SP/05/0461/A amended April 2018).
- New Zealand Standard 6808:2010 Acoustics – Wind farm noise (NZS 6808:2010), as referenced in the planning permit.

The location of the 2019 noise surveys as well as the previous two 2017 surveys at receiver K15aa are shown in **Figure 2**.

Figure 2 Monitoring locations at K15aa



Photo 1 Logger setup at receiver K15aa in 2019 survey



Unattended noise monitoring was undertaken between 31 July 2019 and 26 August 2019 (Batch 1). Unfortunately no hub height wind speed was available for this period and hence no detailed data regression analysis was able to be completed with the collected noise data.

A further period of noise monitoring was conducted for the period from 22 October 2019 to 14 November 2019 (Batch 2) at the same location, with hub height wind speed being collected at the nearest energised WTG nacelle (ref: E 16 - easting 236922 northing 5817477). No WTGs were operating during the Batch 2 period as it was prior to any operational commissioning.

A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (UK Institute of Acoustics, 2013) ("IOA GPG") suggests that:

"Noise measurement equipment and calibrators used on site should comply with Class 1/Type 1 of the relevant standard(s). Enhanced microphone windscreens should be used. Standard windshields of a diameter of less than 100 mm cannot be relied upon to provide sufficient reduction of wind noise in most circumstances"

At this location a B&K Sentinel with a B&K 2250 Sound Level Meter (SLM) was placed in the vicinity of the residence; see

Table 1 for equipment serial numbers of the logger in situ. This Class 1 SLM has microphone mounted at approximately 1.5 m above ground level and fitted with 150 mm-diameter G.R.A.S. outdoor microphone windscreen on the design recommendations detailed in the UK IOA good practice guide.

The noise loggers measured all major noise statistics at 10-minute intervals in accordance with the NZS 6808:2010. A small weather station was also installed with the noise logger to log local wind speeds and rainfall for data exclusion purposes. Winds speed data at hub height was provided by RES Australia in an email dated 19 December 2019. The noise loggers recorded ambient noise levels over a period of approximately one month as shown in

Table 1.

A Valid data set was obtained by excluding data intervals in accordance with the following criteria:

- Local wind speeds exceeding 5 m/s (10-minute average);
- Periods of rain;
- Hub height wind speed exceeding 20 m/s;
- Hub height wind speed below cut-in wind speed (3 m/s).
- The measured sound frequencies (one-third octave bands) in each 10-minute interval are used to identify periods that are significantly affected by bird or insect sounds. 10-minute interval are identified as being potentially influenced by extraneous noise where both of the following conditions are satisfied¹:
 - the highest A-weighted one-third octave band noise level is within 5 dB of the broadband A-weighted background noise level for that interval; and
 - the identified one-third octave band A-weighted noise level is greater than a level of 20 dB LA90.

The NZS 6808:2010 requires a set of at least 1,440 valid data points during a minimum of 10 days of continuous monitoring for analysis.

In accordance with the planning permit, the data sets are considered for separate periods including all periods and night periods: 2200 to 0700 hours.

The measured background noise levels (LA90) are then plotted against the hub height wind speed to obtain a background versus wind speed characteristic. The line of best fit for the data set is then determined, as required by NZS 6808:2010 using a linear, quadratic or cubic polynomial. The standard requires that the regression curve with the highest correlation coefficient will be used. As required, the R^2 value, which is a measure of the correlation coefficient for each of the three types of line of best fit are also shown in

Table 1. At this location, the cubic polynomial gave the highest correlation and was therefore used for the line of best fit.

¹ Griffin, D., Delaire, C., & Pischedda, P. (2013). Methods of identifying extraneous noise during unattended noise measurements. 20th International Congress of Sound & Vibration.

All the key aspects of the conducted noise survey are summarised in

Table 1.

Table 1 Measurement details

Item	Batch 1	Batch 2
Measurement Location	K15aa – At 5449 Midland Hwy, Elaine VIC 3334 (see Figure 2)	
Measurement period	31/7/2019 13:30 26/8/2019 23:50	22/10/2019 - 16:00 14/11/2019 - 23:50
Noise Logger Model #Serial Number	B&K 2250 #3008630	
Total No. of monitoring intervals	3744	3359
No. of valid data points analysed	0 – Due to missing wind data	All time: 2796 Night-time: 1034
Derived Background Noise Equation	N/A – Due to missing wind data	All time: $y = -0.0018x^3 + 0.0393x^2 + 1.3135x + 24.223$ Night-time: $y = -0.0059x^3 + 0.1978x^2 - 0.1613x + 22.19$ Where y is LA90 noise levels (dBA) and x is wind speed at hub height (m/s)
Correlation coefficient (R^2)	N/A – Due to missing wind data	All time: $R^2 = 0.4666$ Night-time: $R^2 = 0.6729$

4 Noise Survey Result

4.1 Background noise levels

As discussed above, wind data was missing during Batch 1 (31 July 2019 - 26 August 2019) measurement period. No further analysis was undertaken.

The results of the background noise monitoring taken during Batch 2 (22 October 2019 - 14 November 2019), showing the excluded data points, filtered data points and the regression curve are shown in **Figure 3** and **Figure 4**. Also shown are the two regression curves obtained by Marshall Day Acoustics in 2017.

Figure 3 Background Noise Measurements – LA90 vs Wind speed - All-time

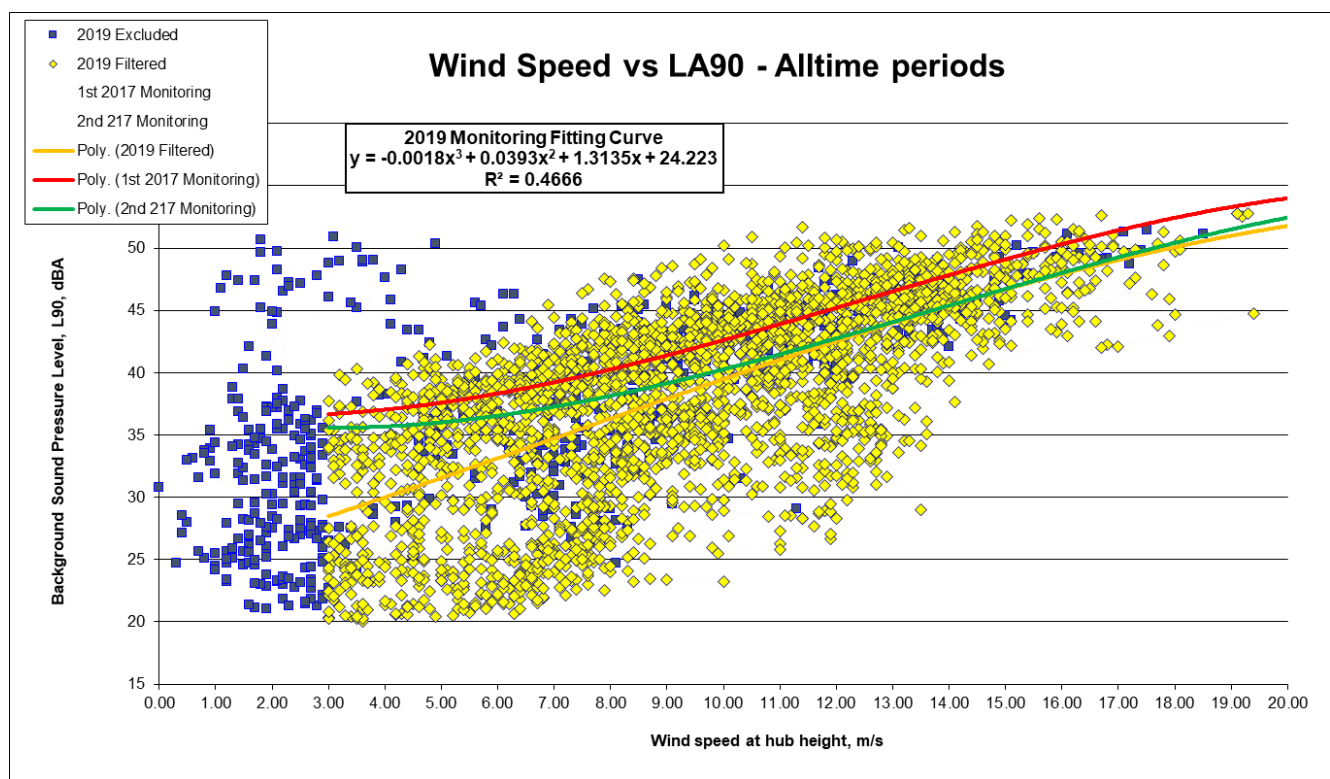
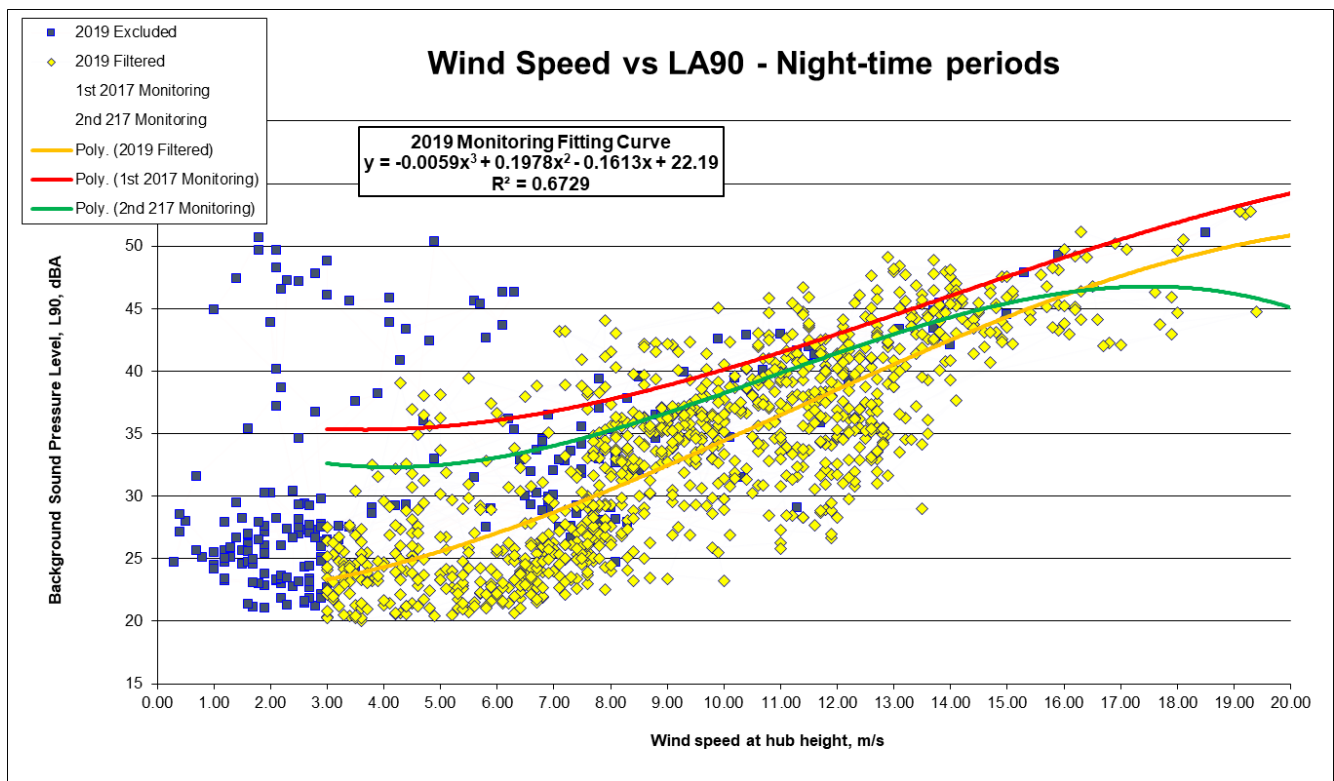


Figure 4 Background Noise Measurements – LA90 vs Wind speed – Night-time



Graphically represented L90 (10 min), together with wind speed and excluded data are presented in **Appendix A**.

The interpolated background noise levels at integer hub height wind speeds from 3m/s to 15 m/s are tabulated in **Table 2** to assist with determining the noise limits in **Section 4.2** below.

Table 2 Background Noise Measurements – LA90 vs Wind speed

Time period	Hub height wind speed (m/s)												
	3	4	5	6	7	8	9	10	11	12	13	14	15
All-time	28.5	30.0	31.5	33.1	34.7	36.3	37.9	39.5	41.0	42.5	44.0	45.4	46.7
Night-time	23.3	24.3	25.6	27.1	28.7	30.5	32.5	34.5	36.5	38.5	40.6	42.5	44.4

4.2 Noise limits

Condition 23(a) of the planning permit requires that:

The operator must ensure that at any wind speed, wind farm sound levels, determined in accordance with the Standard at noise sensitive locations (as defined in the Standard) do not exceed a noise limit of 40dB LA90,10min or background (LA90,10min) plus 5dB, whichever is greater.

The results for the noise survey in 2019 presented above have been analysed to derive noise limits in accordance with the planning permit. Specifically, noise limits have been derived at integer hub-height wind speeds as the greater of a minimum limit of 40 dBA and the background level plus 5 dBA. The noise limits are shown in **Table 3** below.

Table 3 Noise Limit

Time period	Hub height wind speed (m/s)												
	3	4	5	6	7	8	9	10	11	12	13	14	15
All-time	40.0	40.0	40.0	40.0	40.0	41.3	42.9	44.5	46.0	47.5	49.0	50.4	51.7
Night-time	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.5	43.5	45.6	47.5	49.4

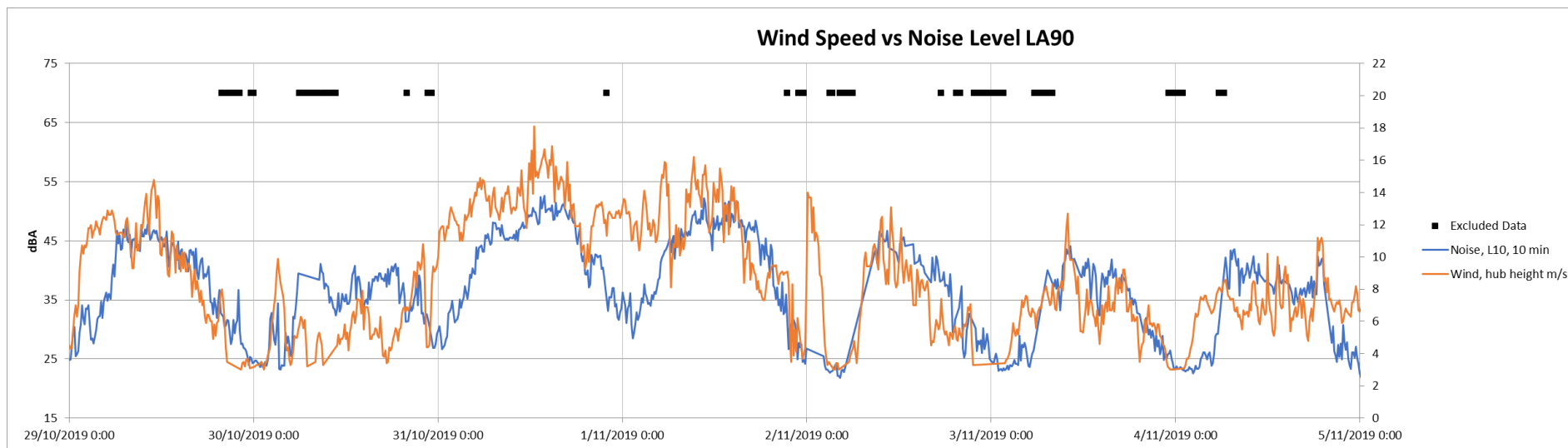
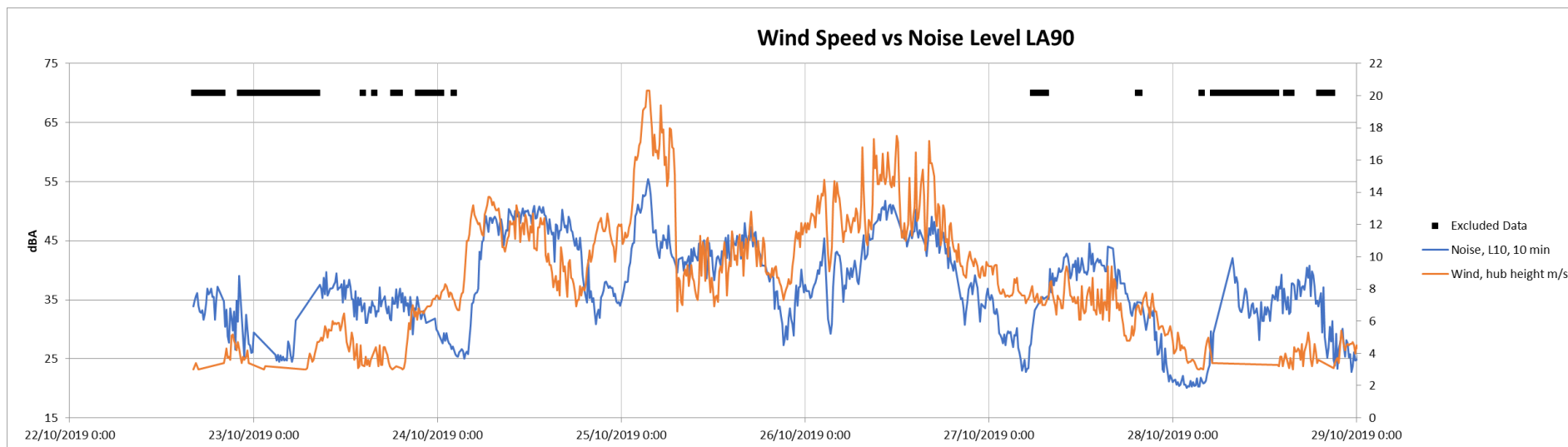
APPENDIX A

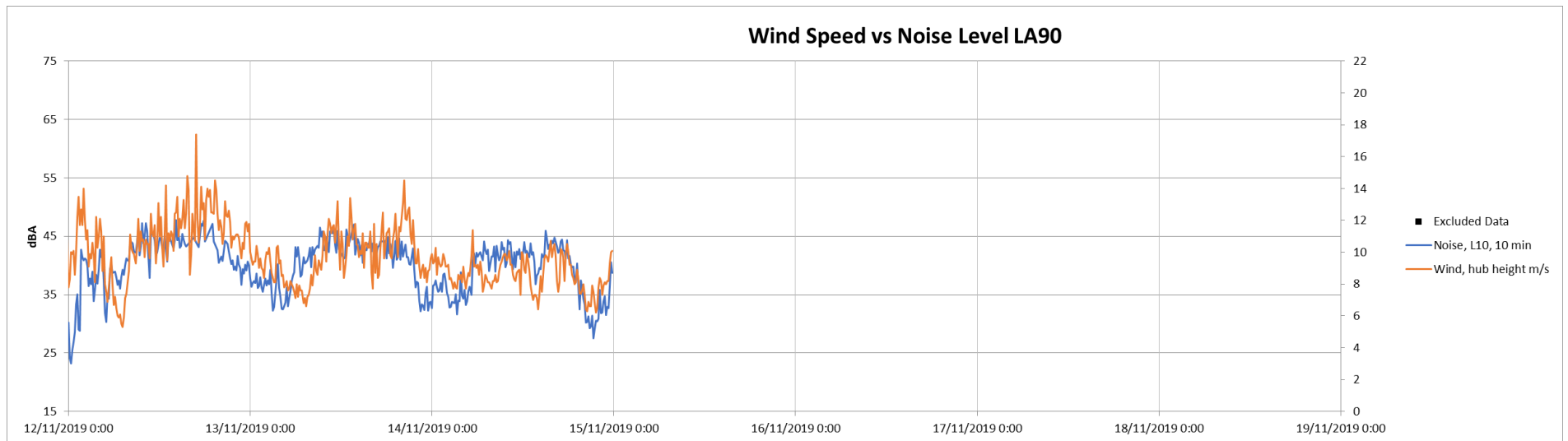
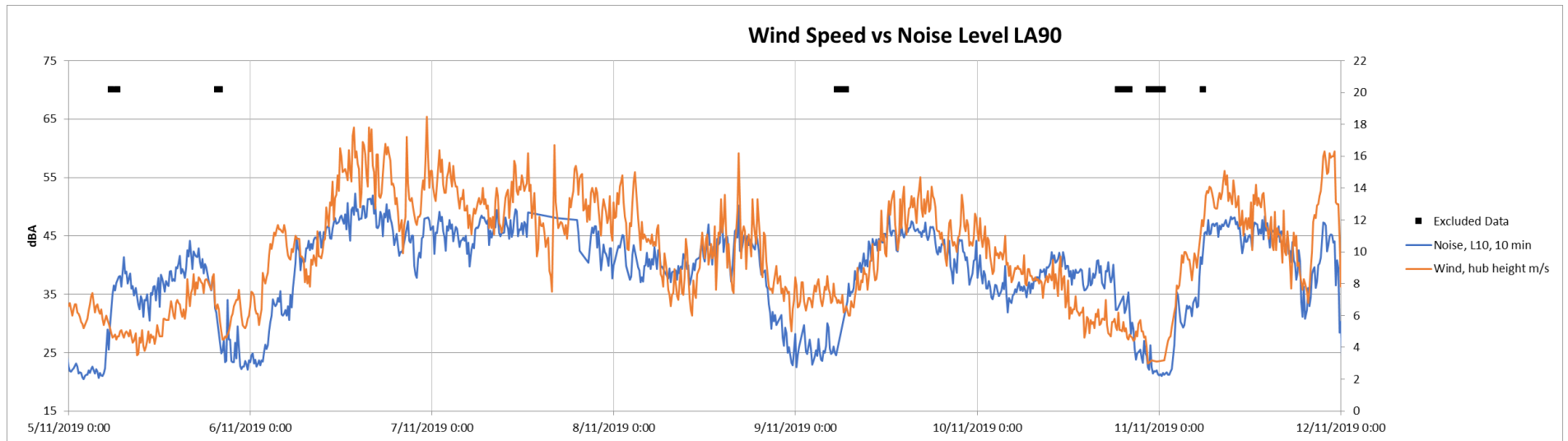
Glossary

Term)	Description
'A' weighted	A frequency adjustment which represents how humans hear sounds.
ABL	Assessment Background Level. The single-figure background level representing each assessment period (day, evening and night). Defined in the <i>Noise Policy for Industry</i> .
Ambient noise level	The all-encompassing sound associated with an environment or area.
Background creep	The incremental increase in background noise levels over time as new developments are built in an area.
dB	Decibel
dBA	'A' weighted decibel
DW	The weighted level difference between two rooms, that is, the on-site sound insulation between two spaces.
Facade affected	A monitoring location which is influenced by facade reflections. Measurements at facades are typically taken at a distance of 1 m away and the measured noise level generally regarded as being +2.5 dB higher than 'free field'.
Free field	A monitoring location where the microphone is positioned sufficiently far from nearby surfaces for the measured data to not be influenced by reflected noise.
Hz	Hertz
Impulsive noise	Noise with a high peak of short duration, or sequence of peaks.
Intermittent noise	Noise which varies in level with the change in level being clearly audible
L ₉₀ , L ₁₀ , etc.	Statistical exceedance levels, where LN is the sound pressure level exceeded for N% of a given measurement period.
LAE (or SEL)	Sound Exposure Level. This is the constant sound level that has the same amount of energy in one second as the original noise event.
LA _{eq}	The 'A' weighted equivalent noise level. It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.
L _{Amax}	The A' weighted maximum sound pressure level of an event.
Term	Description
Low frequency	Noise containing energy in the low frequency range.
L _p or SPL	Sound Pressure Level
L _w or SWL	Sound Power Level
Noise logger	A self-contained, battery powered item of equipment that is used to measure noise levels over several days.
Noise reduction	The difference in sound pressure level between any two areas.
NR noise rating	Single number evaluation of the background noise level in a space. The NR level is typically around 5 to 6 dB below the 'A' weighted noise level.
Octave-band	A frequency band where the highest frequency is twice the lowest frequency.
Offensive noise	Noise that is considered harmful or which interferes unreasonably with affected receivers.
PNTL	Project Noise Trigger Levels. Target noise levels for a particular noise generating development.
RBL	Rating Background Level. The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. Defined in the <i>Noise Policy for Industry</i> .
Steady state noise	Noise which remains relatively constant in level over time, as opposed to time-varying noise which fluctuates over time.
Time weighting	Sound level meters can be set to 'fast' or 'slow' response. 'Fast' corresponds to a 125 ms time constant and 'slow' corresponds to a 1 second time constant.
Tonality	Noise containing a prominent frequency.
Transmission loss (or sound transmission loss or sound reduction index)	A test which rates the sound transmission properties of a wall, floor or roof construction.

APPENDIX B

Time histories





ASIA PACIFIC OFFICES

BRISBANE

Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

MACKAY

21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

SYDNEY

2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

AUCKLAND

68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

CANBERRA

GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

MELBOURNE

Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

TOWNSVILLE

Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

NELSON

6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

DARWIN

Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

NEWCASTLE

10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

TOWNSVILLE SOUTH

12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

GOLD COAST

Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

PERTH

Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

WOLLONGONG

Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922