9. Background Noise Assessment

MARSHALL DAY Acoustics

WIMMERA PLAINS ENERGY FACILITY
BACKGROUND NOISE ASSESSMENT

Rp 003 20190083 | 17 April 2020

MARSHALL DAY Acoustics

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1.0 INTRODUCTION

This report presents the results of background noise monitoring undertaken for the proposed Wimmera Plains Energy Facility.

The Wimmera Plains Energy Facility is proposed to comprise fifty-four (54) wind turbines.

BayWa r.e. Pty Ltd propose to develop the wind farm and commissioned this survey to obtain background noise data which could be used to determine operational noise limits.

If the development is approved, the data may also be used to assist the analysis of noise data obtained from compliance monitoring after the wind farm commences operating.

This report documents the survey methodology, the background noise monitoring results, and the derived noise limits.

The report includes reference to the findings of the environmental noise assessment report[1] prepared for submission with the planning application for the facility.

Acoustic terminology used throughout this report is presented in Appendix A. Site layout and proposed turbine coordinates are detailed in Appendix B.

[1] Marshall Day Acoustics report reference Rp 002 20190083 titled *Wimmera Plains Energy Facility – Operational Noise Assessment* dated 4 March 2020

2.0 BACKGROUND NOISE SURVEY & ANALYSIS METHODOLOGY

The background noise survey and analysis were conducted in accordance with the following:

- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010)
- Supplementary guidance contained in UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* dated May 2013 (UK IOA good practice guide).

This section of the report presents:

- An overview of the survey methodology
- Details of the selected noise monitoring locations
- A summary of the data analysis procedures.

2.1 Monitoring locations

Background noise monitoring was carried out at two (2) receiver locations listed in Table 1.

Table 1: Background noise monitoring locations

Receiver	Direction from wind farm	Distance from nearest turbine
5	South of mid section	approximately 1200 m
19	North of mid section	approximately 1450 m

The location of each of these receivers is illustrated in Figure 1.

The monitoring locations were selected on the basis of:

- A total of fifty-four (54) turbines located at the coordinates detailed in Appendix B
- The noise monitoring procedures outlined in NZS 6808:2010
- Upper predicted operational wind farm noise levels as detailed in the environmental noise assessment report.

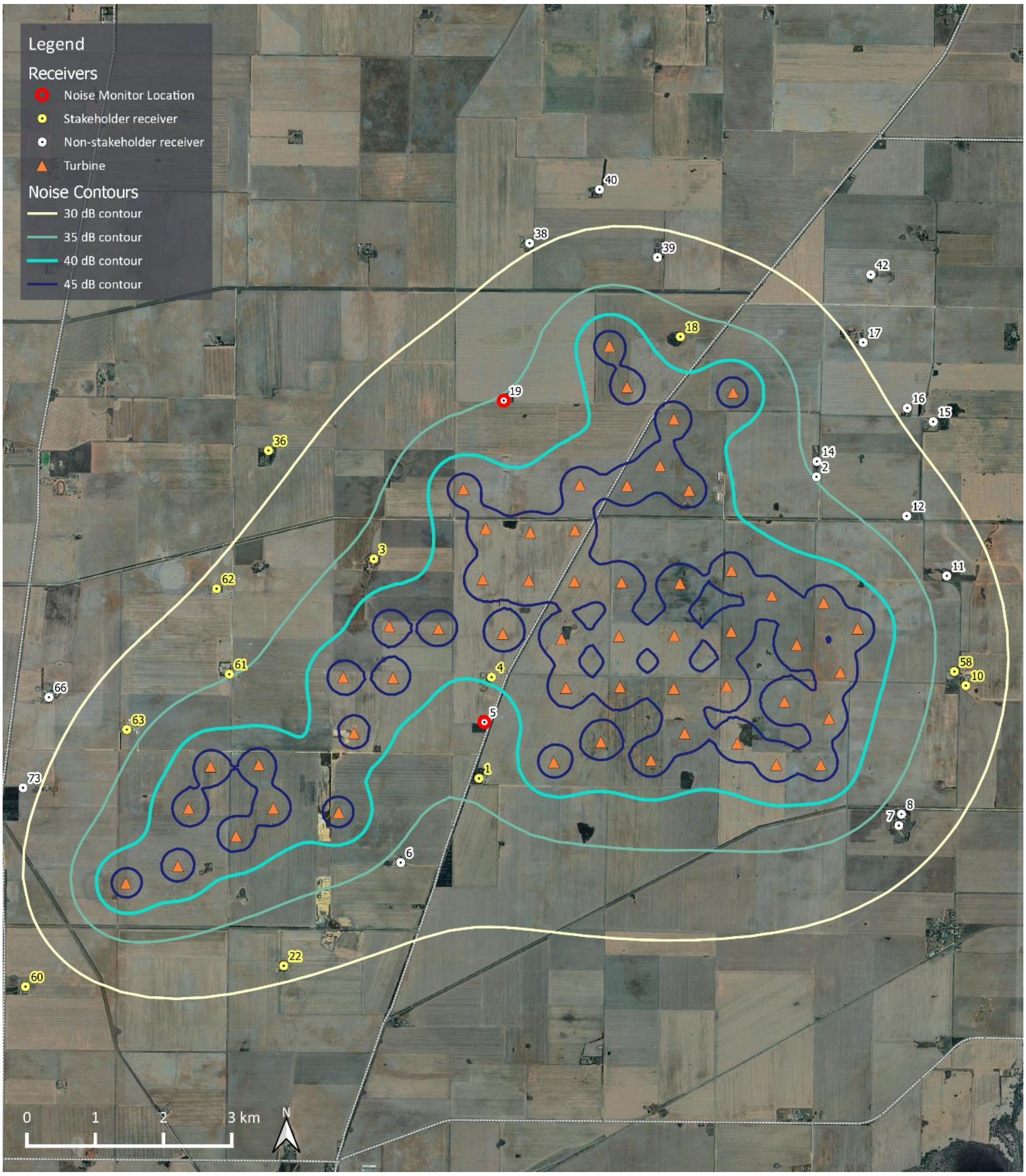
The above information was used to identify the locations where background noise levels would inform an assessment of compliance with the noise criteria. Specifically, in accordance with NZS 6808:2010, receivers 5 and 19 were nominated for background noise monitoring on account of being non-stakeholder receivers located between the 35 dB and 40 dB L_{A90} predicted noise contours (all other non-stakeholder receivers are located outside the 35 dB L_{A90} predicted noise contour).

At each of the receiver locations where noise monitoring was carried out, the choice of location relative to the dwelling was made on account of the range of considerations specified in NZS 6808:2010. The following specific considerations were factored:

- The noise monitors were located on the proposed wind farm side of the dwelling
- The noise monitors were located at least 5 m away from the dwelling and any significant vertical reflecting structures
- The noise monitors were located as far as practical from taller vegetation at each dwelling and any obvious sources of extraneous noise.

Coordinates and photographs for the noise monitoring locations are provided in Appendix E to Appendix F.

Figure 1: Monitoring locations relative to the Wimmera Plains Energy Facility



2.2 Survey description

The background noise survey comprised unattended monitoring over a number of weeks to measure sound levels for a range of environmental conditions. Site wind speeds and local weather conditions were simultaneously recorded throughout the survey, along with periodic audio samples, to enable the relationship between background noise levels and site wind speeds to be assessed.

The key elements of the background noise survey are summarised in Table 2 below.

Table 2: Summary of key elements of background noise survey

Item	Description
Monitoring locations	Two (2) residential receiver locations as described in Section 2.1.
Monitoring Period	4/2/2020 to 26/3/2020 equating to approximately 7 weeks at each location. The duration was chosen to satisfy the guidance of NZS 6808:2010 which indicates the measurements should be made for a representative range of wind speeds and directions for the site, and that a minimum of 1,440 individual 10-minute measurements, equivalent to 10 days of monitoring is normally required to obtain a satisfactory range.
Sound level meters	Class 1 automated sound loggers (most accurate class rating for field usage). Microphones mounted at approximately 1.5 m above ground level and fitted with enhanced wind shielding systems based on the design recommendations detailed in the UK IOA good practice guide. See equipment specifications and calibration records in Appendix C.
Noise measurement data	A-weighted average and statistical sound pressure levels. One-third octave band frequency noise levels and a brief audio sample every ten (10) minutes to aid the identification of extraneous noise influences.
Local wind speed and rainfall data	A weather station was installed beside one of the noise monitoring locations to concurrently record rainfall and wind speeds at microphone height. This data was recorded to identify periods when local weather conditions may have resulted in excessive extraneous noise at the microphone (i.e. rainfall).
Site wind speed data	Hub height wind speeds for correlating background noise levels with site wind speeds. Site wind speed data was sourced from a SoDAR at the site which remotely collects data at multiple heights ranging from 40 m to 150 m. Hub height wind speed data (166 m above ground level) was provided by BayWa Pty Ltd, based on analysis conducted by K2 Management to synthesise a complete data set using site-specific wind shear calculations. Documentation summarising the analysis process is reproduced in Appendix D.

2.3 Data analysis

The analysis of the survey data was conducted in accordance with the NZS 6808:2010.

This analysis broadly involves:

- Collating the measured noise levels, site wind speeds and local weather data into a single dataset
- Filtering the data set to remove measurement results affected by extraneous or atypical noise
- Filtering the data for the range of site wind speeds in which the turbines are expected to operate
- Filtering the data where necessary to account for site wind directions
- Plotting a chart of noise levels versus wind speeds and determining the line of best fit to the data.

A summary of the key steps in the analysis of the data is presented in Table 3.

Table 3: Background noise data analysis

Process	Description
Data collation	Time stamps for each source of measurement data are reviewed to clarify start or end times and measurement time zone. Measured noise levels, site wind speeds and local weather conditions are then collated for each ten-minute measurement interval.
Local weather data filtering	10-minute intervals are identified and filtered from the analysis if rainfall was identified for any ten-minute measurement interval
Extraneous noise filtering	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 intervals were identified, and filtered from the analysis, when the following conditions[2] were satisfied: • the highest A-weighted one-third octave band noise level was 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 was greater than a level of 20 dB L_{A90}.
Time periods	To account for the variation in noise levels which was evident between the day and night periods, the data sets are considered for separate periods as follows: • All periods: no restriction on hours (i.e. data during day and night hours included) • Night period: 2200 to 0700 hours

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

Process	Description
Regression analysis	Two datasets are plotted on a chart of noise levels versus wind speeds: • All data points that have been removed from the analysis using the above processes • The filtered dataset comprising all retained measurement data The chart of filtered noise levels versus wind speed is reviewed to determine if there are any distinctive trends or gaps in the data which could warrant separation of the measurement results into subgroups (e.g. subgroups for time of day or wind direction). A line of best fit is determined for the filtered data and, where applicable, any subgroups of the filtered data. The line of best fit is determined using a regression analysis of the range of noise levels and wind speeds or, where necessary, analysis of noise levels at individual wind speeds.
Noise limits	Noise limits are defined at each wind speed in accordance with NZS 6808:2010. The environmental noise assessment determined that the high amenity noise limits referred to in NZS 6808:2010 are not applicable to receiver locations around the facility (refer to section 6.1.1 of the environmental noise assessment report). The noise limits are therefore defined by a value of 40 dB or the background plus 5 dB, whichever is higher. The value of the background noise level at each integer wind speed is defined by the line of best fit to the measurement results. To account for the variation in noise levels which was evident between the day and night periods, the noise limits are separately defined for all periods (i.e. including all hours of the day and night) and the night period.

3.0 SURVEY & ANALYSIS RESULTS

This section presents a summary of the background noise measurement results, analysed in accordance with the methodology described in Section 2.3.

The analysis results include the derived non-stakeholder noise limits applicable to the operational noise of the Wimmera Plains Energy Facility.

3.1 Background noise levels

The tabulated data presented in Table 4 and Table 5 summarise the derived background noise levels for the all-time and night-time periods respectively.

The data in these tables are provided for the key wind speeds relevant to the assessment of wind farm noise. The results for all surveyed wind speeds are illustrated in the graphical data provided for each receiver location in Appendix E to Appendix F.

Table 4: All-time period – background noise levels (dB L_{A90})

Location	Hub height wind speed (m/s) [1]									
	3	4	5	6	7	8	9	10	11	12
5	28.0	29.0	29.9	30.7	31.5	32.2	33.0	33.8	34.6	35.5
19	24.5	26.3	28.2	30.2	32.1	34.1	36.0	37.8	39.4	40.9

Note 1: 166 m above ground level at 617,554 E / 5,953,694 N (MGA 94 Zone 54)

Table 5: Night-time period – background noise levels (dB L_{A90})

Location	Hub height wind speed (m/s) [1]									
	3	4	5	6	7	8	9	10	11	12
5	- [2]	- [2]	20.3	20.8	21.9	23.5	25.3	27.3	29.4	31.4
19	- [2]	- [2]	22.7	23.8	25.6	27.8	30.2	32.7	35.1	37.1

Note 1: 166 m above ground level at 617,554 E / 5,953,694 N (MGA 94 Zone 54)

Note 2: Outside valid range of regression analysis

3.2 Noise limits

The limits presented herein are based on background noise levels presented in Section 3.1 and the status of each receiver at the time of preparation of this report. In particular, the receivers are considered non-stakeholder locations and the minimum limit is therefore set at 40 dB L_{A90} in accordance with NZS 6808:2010.

As per the background noise data, the tabulated data are provided for the key wind speeds relevant to the assessment of wind farm noise. The derived noise limits for all surveyed wind speeds are illustrated in the graphical data provided for each receiver location in Appendix E to Appendix F.

Table 6: All-hours period operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]									
	3	4	5	6	7	8	9	10	11	12
5	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
19	40.0	40.0	40.0	40.0	40.0	40.0	41.0	42.8	44.4	45.9

Note 1: 166 m above ground level at 617,554 E / 5,953,694 N (MGA 94 Zone 54)

Table 7: Night period operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]									
	3	4	5	6	7	8	9	10	11	12
5	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
19	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	42.1

Note 1: 166 m above ground level at 617,554 E / 5,953,694 N (MGA 94 Zone 54)

4.0 SUMMARY

Background noise monitoring has been conducted at two (2) receiver locations around the proposed Wimmera Plains Energy Facility.

The survey and analysis were carried out in accordance with New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010)

The results have been analysed to derive noise limits applicable to non-stakeholder receivers. Specifically, noise limits have been derived at integer hub-height wind speeds as the greater of a minimum limit (40 dB L_{A90}) and the background level plus 5 dB.

If the development is approved, the data may also be referenced during the compliance monitoring phase of the project as an indication of potential background noise levels during compliance measurements.

APPENDIX A GLOSSARY OF TERMINOLOGY

The basic quantities used within this document to describe noise adopt the conventions outlined in ISO-1996-1:2016 *Acoustics - Description measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures*. Accordingly, all frequency weighted sound pressure levels are expressed as decibels (dB) in this report. For example, sound pressure levels measured using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels such as dBA or dB(A) are therefore not used within this report.

Term	Definition	Abbreviation
A-weighting	A method of adjusting sound levels to reflect the human ear's varied sensitivity to different frequencies of sound.	See discussion above this table.
A-weighted 90th centile	The A-weighted pressure level that is exceeded for 90 % of a defined measurement period. It is used to describe the underlying background sound level in the absence of a source of sound that is being investigated, as well as the sound level of steady, or semi steady, sound sources.	L_{A90}
Centile level	The sound pressure level that is exceeded for a set percentage of a defined measurement period. The percentage is denoted N and the time is denoted as t. For example, a centile level represents the sound pressure level that is exceeded for N % of a time period of duration t.	$L_{N,t}$
Decibel	The unit of sound level.	dB
Hertz	The unit for describing the frequency of a sound in terms of the number of cycles per second.	Hz
Octave Band	A range of frequencies. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.	-
Sound power level	A measure of the total sound energy emitted by a source, expressed in decibels.	L_W
Sound pressure level	A measure of the level of sound expressed in decibels.	L_p

APPENDIX B TURBINE COORDINATES

The following table sets out the coordinates of the proposed fifty-four (54) turbine layout of the Wimmera Plains Wind Farm (data supplied by BayWa on 3 March 2020).

Table 8: Wimmera Plains Wind Farm turbine coordinates – MGA 94 zone 54

Turbine	Easting (m)	Northing (m)	Terrain elevation (m)	Turbine	Easting (m)	Northing (m)	Terrain elevation (m)
T1	619,688	5,950,302	140	T28	616,853	5,954,390	140
T2	619,038	5,950,302	140	T29	617,333	5,954,683	140
T3	618,466	5,950,616	140	T30	618,404	5,955,757	140
T4	617,696	5,950,763	140	T31	617,538	5,955,364	140
T5	617,200	5,950,371	140	T32	616,852	5,955,834	140
T6	616,467	5,950,635	140	T33	616,593	5,956,437	140
T7	615,777	5,950,339	140	T34	616,159	5,954,401	140
T8	615,957	5,951,427	140	T35	614,455	5,954,338	140
T9	616,748	5,951,442	140	T36	614,782	5,953,760	140
T10	617,536	5,951,419	140	T37	615,434	5,953,704	140
T11	618,309	5,951,457	140	T38	616,088	5,953,738	140
T12	619,157	5,951,224	140	T39	615,412	5,953,002	140
T13	619,810	5,950,981	140	T40	614,737	5,953,017	140
T14	619,974	5,951,652	140	T41	615,031	5,952,219	140
T15	620,230	5,952,297	140	T42	614,090	5,952,296	140
T16	619,337	5,952,057	140	T43	613,368	5,952,328	140
T17	618,376	5,952,252	140	T44	613,423	5,951,573	140
T18	617,543	5,952,192	140	T45	612,695	5,951,583	140
T19	616,733	5,952,185	140	T46	612,850	5,950,765	140
T20	615,893	5,952,147	140	T47	611,458	5,950,302	140
T21	616,080	5,952,987	140	T48	610,749	5,950,278	140
T22	616,771	5,952,972	140	T49	610,429	5,949,663	140
T23	617,626	5,952,957	140	T50	611,671	5,949,664	140
T24	618,379	5,953,147	140	T51	611,126	5,949,257	140
T25	618,970	5,952,782	140	T52	610,273	5,948,818	140
T26	619,730	5,952,674	140	T53	609,512	5,948,566	140
T27	617,761	5,954,323	140	T54	612,628	5,949,604	140

APPENDIX C SURVEY INSTRUMENTATION

Table 9: Sound level measurement instrumentation summary

Item	Description
Equipment type	Automated/unattended integrating sound levels
Make & model	01dB Cubes & Duos
Instrumentation class	Class 1 (precision grade) in accordance with AS/IEC 61672.1:2019[3]
Instrumentation noise floor	Less than 20 dB
Time synchronisation	Internal GPS clocks
Wind shielding	Enhanced wind shielding system based on the design recommendations detailed in the UK IOA good practice guide. The system comprises an inner solid primary wind shield and an outer secondary large diameter hollow wind shield

Table 10: Sound level meter installation records

Receiver	System	Unit serial number	Microphone serial number	Independent calibration date [1]	Calibration drift [2,3]
5	01DB CUBE	10523	207224	30/10/2019	-0.19
19	01DB CUBE	10521	207208	20/8/2018	-0.19
-	01dB-Stell CAL21	34924044	-	7/09/2019	-

Note 1: Independent (laboratory) calibration date to be within 2 years of measurement period as per AS 1055:2018[4]

Note 2: Difference between reference level checks during deployment and collection of instruments

Note 3: Calibration drift should not be greater than 1 dB as specified in AS 1055:2018

Table 11: Wind speed measurement instrumentation

Wind speeds	Description
Local wind speeds	Vaisala VTX 250 weather station (serial number 4) positioned at receiver 19
Site wind speeds	Third party owned and operated system comprising 1 x SODAR measurement system (location reference *JUN-SOD1*) Further information provided in Appendix D.

[3] AS/IEC 61672.1:2019 Electroacoustics - Sound level meters Specifications, which is identical to IEC 61672.1:2.0 Electroacoustics - Sound Level Meters - Part 1: Specifications published 2013

[4] AS 1055:2018 *Acoustics – Description and measurement of environmental noise*

APPENDIX D SITE WIND SPEED DATA DERIVATION

This appendix reproduces correspondence provided by K2 Management documenting the process used to derive the 166 m AGL wind speeds required to analyse the measured background noise data (documented in email received 17 April 2020).

Wind data processing

Time offset

NASA-MERRA2 reanalysis data has been used to ensure that data logger timestamps are in local standard time (UTC +10:00). SoDAR JUN-SOD1 has been adjusted to the local standard time (UTC+10) from UTC+0. Timestamps are designated as end of timestamp.

Direction offset

NASA-MERRA2 reanalysis data has been used to ensure that data logger timestamps are oriented to True North. Fulcrum SoDAR JUN-SOD1 has recorded data in magnetic north, and a declination of 10.1 degrees corresponding to the installation date has been applied to align with True North.

Data cleaning

Wind data has been provided with Fulcrum's recommended data filtering already applied. Wind data has been manually inspected for evidence of erroneous operation of the instruments or logging system. Such periods have been removed in order to avoid biasing results.

Site data quality

Data coverage at the remote sensing device is shown to vary across measurement heights, time of day, wind speed and direction.Figure Figure 1 and Figure Figure 2 below illustrate the variation in coverage as a function of these variables. These data coverage plots were produced by comparing data coverage across the entire JUN-SOD1 data period against full coverage NASA-MERRA2 reanalysis data.

There is a risk of bias in the timeseries data as a result of low data coverage at both low and high wind speeds. Furthermore, atmospheric stability variation throughout the day may be causing a drop in data coverage at the device during night hours. Without a co-located mast it is not possible to quantify the impact of the low data coverage and therefore this dataset is subject to elevated uncertainty.

Height [m]	Total coverage [%]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
150.0	76	63	66	68	70	71	72	71	75	80	86	90	89	85	81	77	73	62	53	44	42	51	58	63	64
140.0	81	68	71	73	75	76	76	76	80	83	89	93	92	89	86	84	79	72	62	52	49	58	64	68	69
130.0	86	72	75	77	79	79	81	80	83	86	91	95	94	92	90	89	87	80	70	59	56	66	70	73	73
120.0	90	77	78	80	81	81	83	82	85	88	93	96	96	95	93	92	91	87	76	67	62	70	74	77	77
110.0	92	78	79	81	81	83	83	83	85	90	93	97	97	95	95	95	94	90	80	68	66	73	77	78	78
100.0	93	80	81	82	83	83	84	84	87	90	94	97	97	96	96	96	94	91	81	70	68	74	78	81	81
90.0	95	83	84	85	85	86	86	86	88	91	95	97	97	96	97	96	95	92	84	73	73	77	81	84	84
80.0	97	86	87	88	87	88	87	86	90	92	95	98	98	96	97	97	96	93	86	77	76	80	83	86	86
70.0	97	87	87	88	87	87	87	86	90	92	95	98	98	97	97	97	96	92	85	77	76	81	85	86	87
60.0	96	86	86	85	86	86	86	87	91	93	96	98	98	98	97	97	95	90	83	75	75	80	84	85	87
50.0	98	88	88	86	87	87	87	88	92	94	97	99	99	98	98	98	96	91	85	77	78	82	86	89	90
40.0	[illegible]	89	90	90	89	90	90	92	94	95	97	98	98	98	98	98	96	92	88	83	84	88	90	91	92

Figure 1: Hourly data coverage plot of JUN-SOD1 against MERRA2 data

Height [m]	Total coverage [%]	0	30	60	90	120	150	180	210	240	270	300	330
150.0	76	61	57	65	68	80	77	71	66	74	75	69	57
140.0	81	66	63	69	72	83	81	76	72	80	80	74	62
130.0	86	72	71	72	74	85	85	81	78	84	84	78	68
120.0	90	75	76	76	76	87	88	85	81	87	88	81	73
110.0	92	77	78	78	78	88	89	85	83	89	89	83	76
100.0	93	79	80	80	80	88	90	86	84	90	90	84	78
90.0	95	81	82	82	82	90	92	88	86	92	92	86	80
80.0	97	83	85	86	85	91	93	89	88	93	93	87	82
70.0	97	84	86	87	85	92	93	88	89	93	93	87	83
60.0	96	86	87	88	83	91	92	86	87	92	92	86	83
50.0	98	90	88	91	87	93	92	86	90	93	92	88	84
40.0	100	93	92	94	92	94	93	89	92	95	93	88	87

Figure 2: Data coverage plot of JUN-SOD1 against MERRA2 data by direction

Self-synthesis from JUN-SOD1 at 100 m to 150 m

To improve data coverage at the SoDAR JUN-SOD1 at 150 m, prior to completing the vertical extrapolation to hub height at 166 m, a time series at JUN-SOD1 at 150 m was derived using a 10-minutely directional correlation with JUN-SOD1 at 100 m using the Principle Component Analysis (PCA) correlation method. Wind speed data at JUN-SOD1 at 100 m was correlated to the JUN-SOD1 dataset at 150 m in 30 degree direction sectors. This method was selected due to quality of observed correlations in all direction sectors.

Prior to correlation, wind speed data at both the 100 and 150 m measurement heights have been filtered by time of day in order to account for the potential impact of wind shear variation throughout the day. These night and day periods, corresponding to high and low shear, have been identified to be between 18:00-7:00 and 7:00-18:00, respectively. Priority was given to the measured wind data in the creating of the final timeseries.

Wind direction correlations between 100 m and 150 m were also undertaken.

The synthesis method described above has resulted in a period of 0.14 years of data for the specified period with a final coverage of 95.1 % at JUN-SOD1 at 150 m. The dataset is comprised of 10.3 % synthesised data and 89.7 % measured data within the specified period. The full 24-hour period correlations can be seen in Figure 4.

Diurnal sensitivity to self-synthesis at JUN-SOD1

Diurnal shear variation

Seasonal-diurnal variations to shear have been observed at the JUN-SOD1 remote sensing device. Although a vertical extrapolation has not been undertaken between measurement heights 100 and 150 m, the self-synthesis data recovery method applied may be impacted by the variation of shear as a function of time of day and atmospheric stability. Figure 3 below illustrates the variation in the shear coefficient throughout the day. These night and day periods, corresponding to high and low shear, have been identified to occur between the hours 18:00-7:00 and 7:00-18:00, respectively.

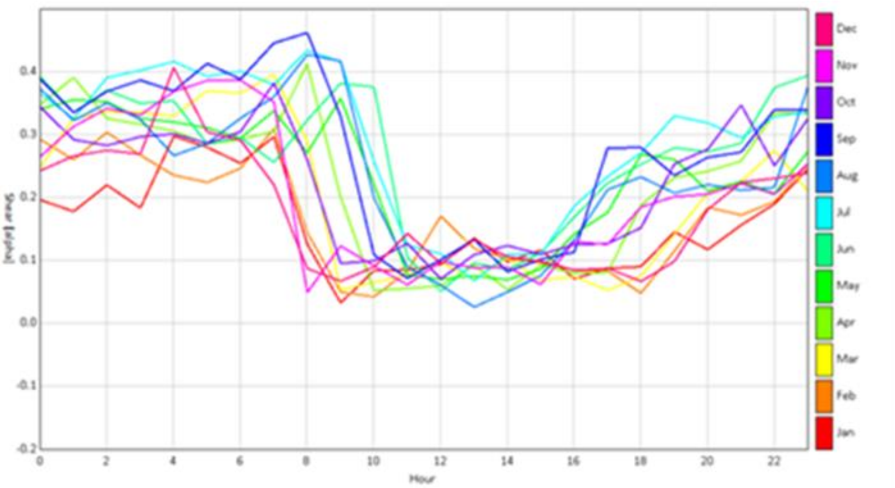


Figure 3: Diurnal shear summary plot at JUN-SOD1

Diurnal self-synthesis at JUN-SOD1

The potential effect of wind speed variation across heights as a function of time has been reviewed by filtering timeseries data for day and night hours and comparing the respective correlations to the complete 24-hour timeseries dataset. On average across the entire data post self-synthesis, the day/night split synthesized dataset is approximately 0.1 % higher wind speed than the 24-hour dataset.

Table Table 1 below summarizes the differences to the calculated all-directional slope, self-synthesis uncertainty, and R-squared value. The all-directional correlation slope for the 24-hour dataset is 1.09, whereas the slopes for the day and night datasets were calculated to be 1.06 and 1.12, respectively. This means that the adjustment made to generate synthesized 150 m wind speed data is lower or higher during the day and night than compared to the 24-hour dataset.

	24-hour dataset	Day	Night
Slope	1.09	1.06	1.12
Uncertainty	0.51%	0.68%	0.70%
Rsquared	0.90	0.91	0.87

Table 1: Sensivity summary to self-synthesis from 100 to 150 m

The figure below shows the wind speed correlation between 100 and 150 m coloured by time of day. For certain direction sectors, between sectors 330 – 60, the calculated slope and offset varies significantly by day/night compared to the 24-hour dataset.

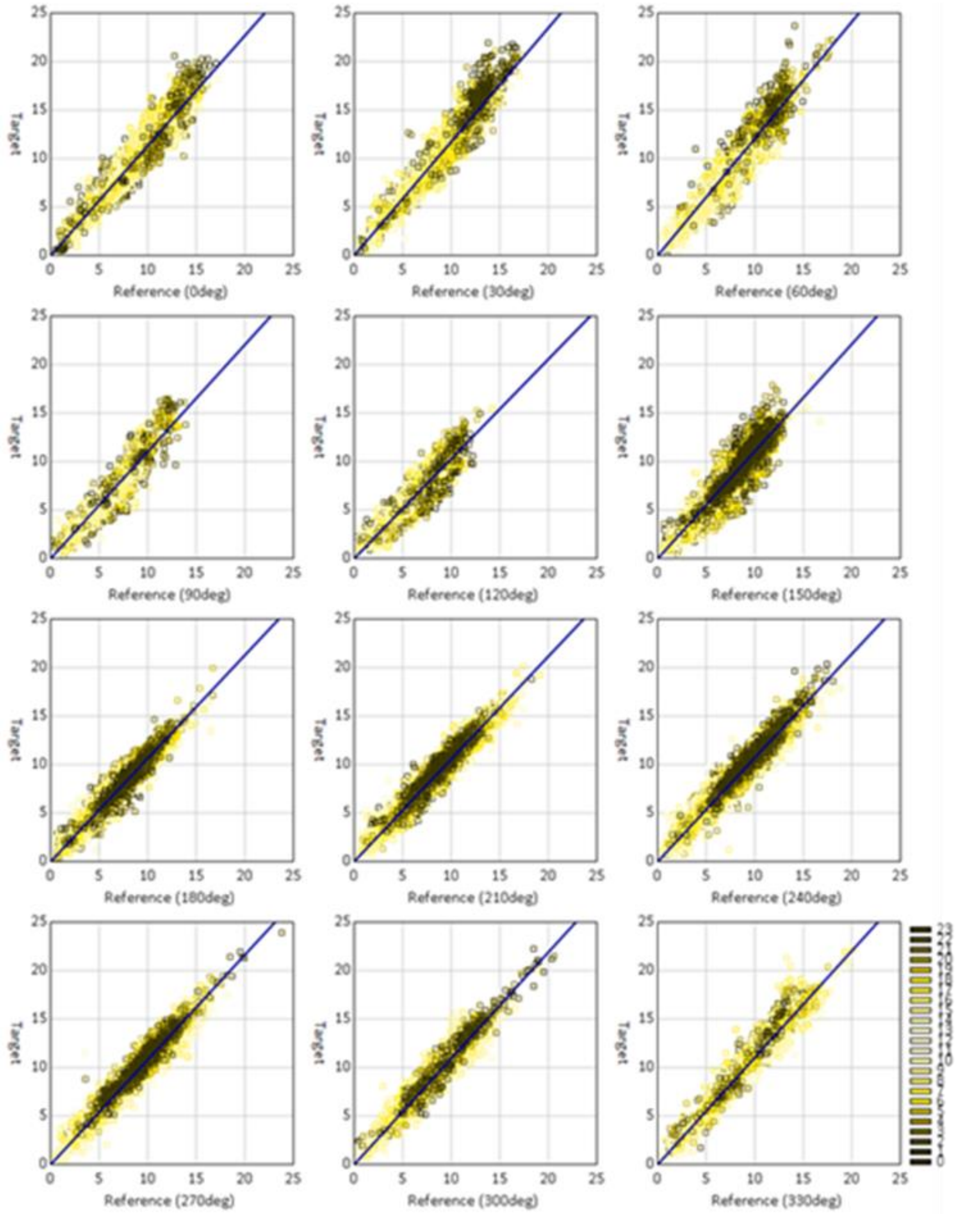


Figure 4: JUN-SOD1 directional correlation plots between 100 and 150 m wind speeds, coloured by hour

However, it is unclear whether the variation in day/night correlations are the result of diurnal variation to shear alone. As discussed previously in site data quality, the JUN-SOD1 SoDAR fails to record data at higher measurement heights and during certain times of the day. This makes it difficult to establish whether the trends in the correlations are the result of variations or a failure of the device to record wind speed under certain conditions. Without a nearby met mast, it is impossible to determine the effect of the low coverage bias at the remote sensing device. Furthermore, as there are fewer data points available for correlation at night than during the day, and higher scatter at night, there is a higher uncertainty when calculating the slopes and offsets separately for night and day hours.

However, based on the correlation detailed in Figure 4Figure , it appears there may be an upward trend to the 150 m self-synthesized dataset from 100 m within certain direction sectors. Though without a high quality co-located met mast with similar exposure it is not possible to confirm the trend at this time.

Finally, in the data coverage figures 1 and 2 above, low data coverage is shown during night hours and for wind direction between 330 - 60 degrees. There is additional potential for low coverage bias in these direction sectors. This bias may be increased if considering correlations on a day/night basis as the nightly data points correspond to a specific wind conditions measurable by the SoDAR and is not fully representative of the range of conditions that might occur at night.

APPENDIX E RECEIVER 5 DATA

E1 Receiver 5 location data

Table 12: Receiver 5 dwelling and noise monitor coordinates– MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	614,762	5,950,924
Background noise monitoring location	614,788	5,950,950

Figure 2: Receiver 5 aerial view - dwelling and noise monitor locations

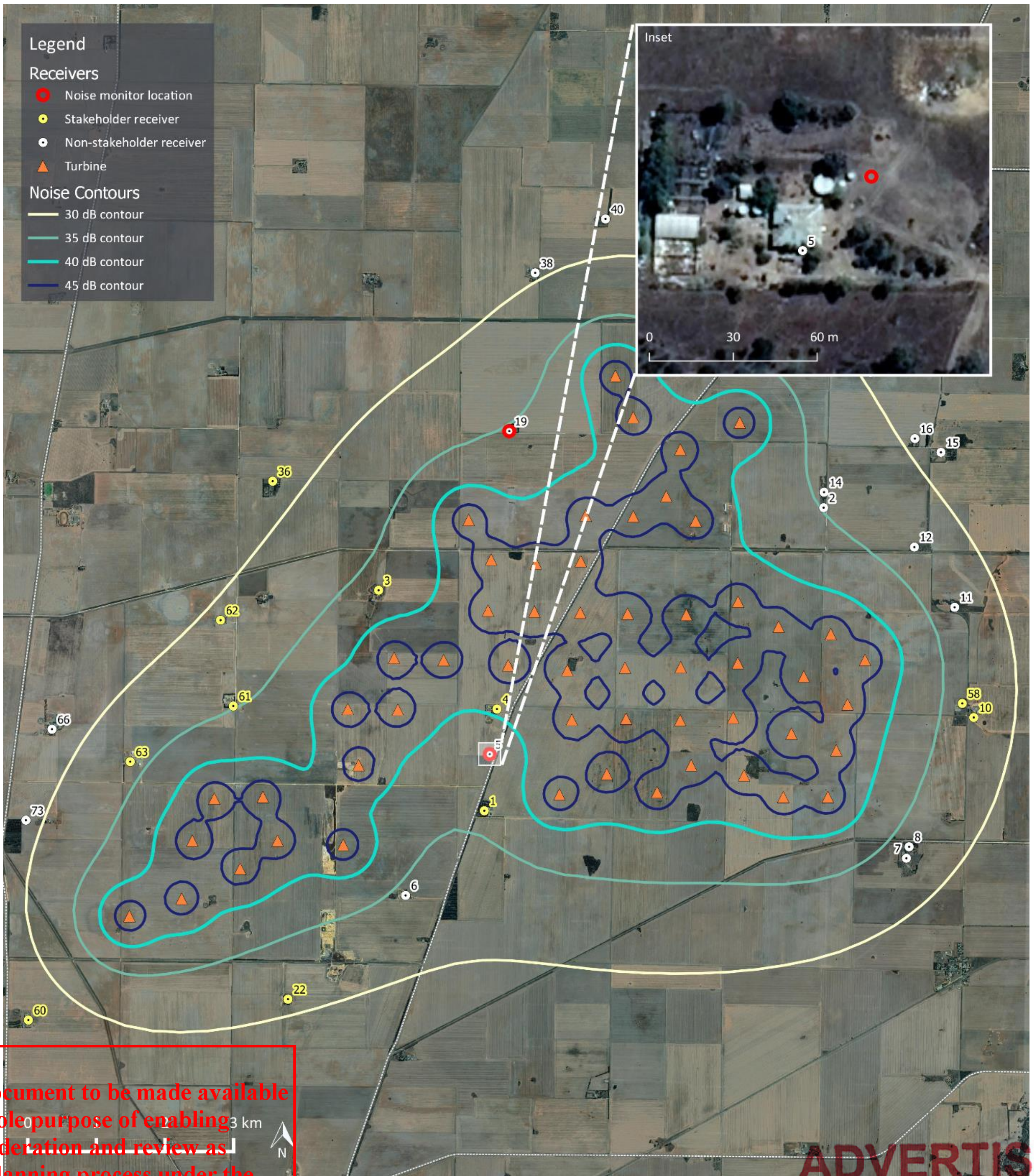


Table 13: Receiver 5 monitor installation photos

Looking North	Looking East
	
Looking South	Looking West
	

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E2 Receiver 5 measurement data summary

Table 14: Receiver 5 background noise level analysis summary

Item	All-time (day & night combined)	Night-time (2200 – 0700 hrs)
Number of data points collected	6847	2521
Number of data points removed	397	308
Number of data points for analysis	6450	2213

Figure 3: Receiver 5 background noise level and wind speed time history

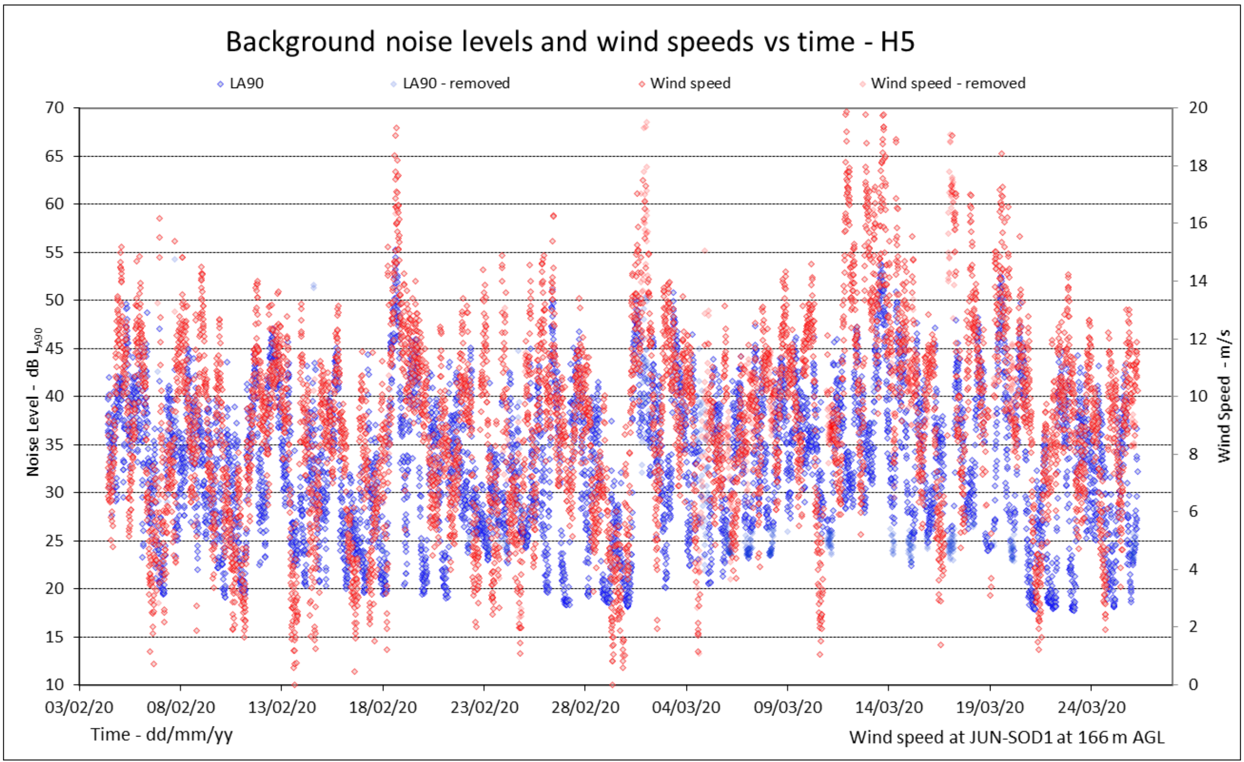


Figure 4: Receiver 5 all-time periods – derived background noise levels and noise limits

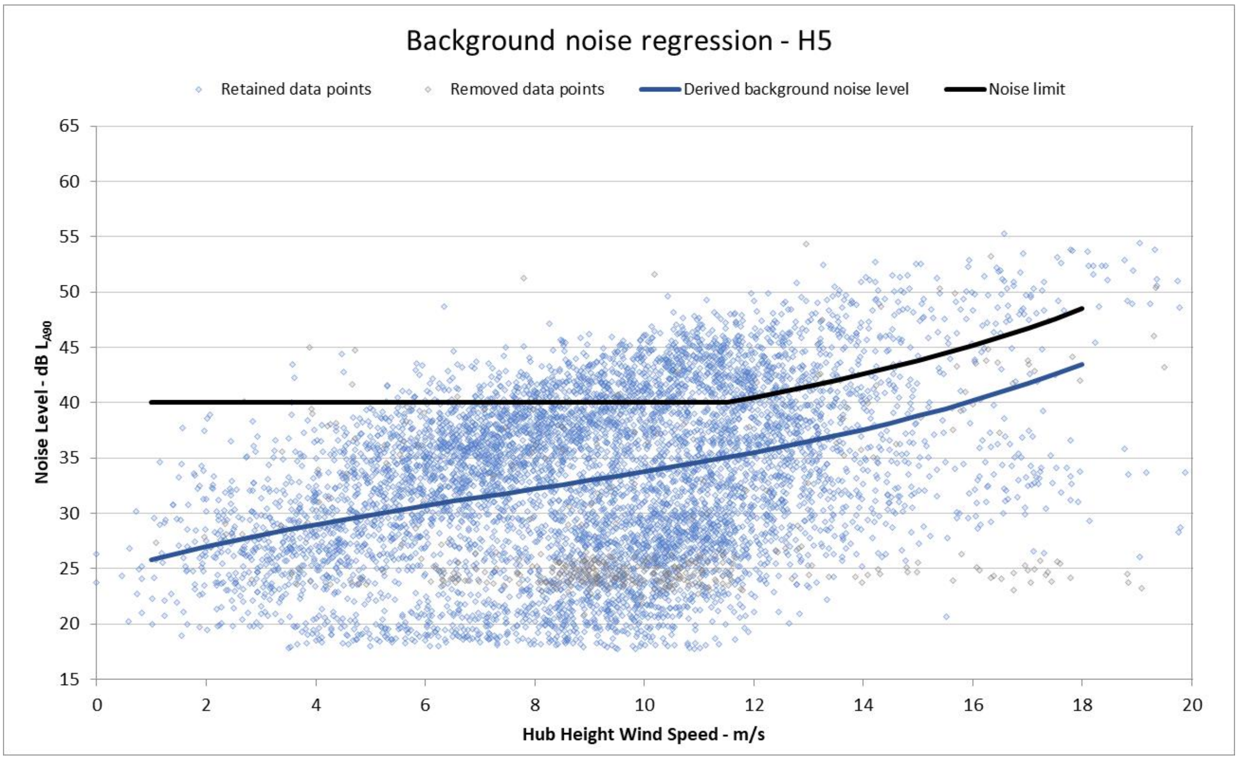
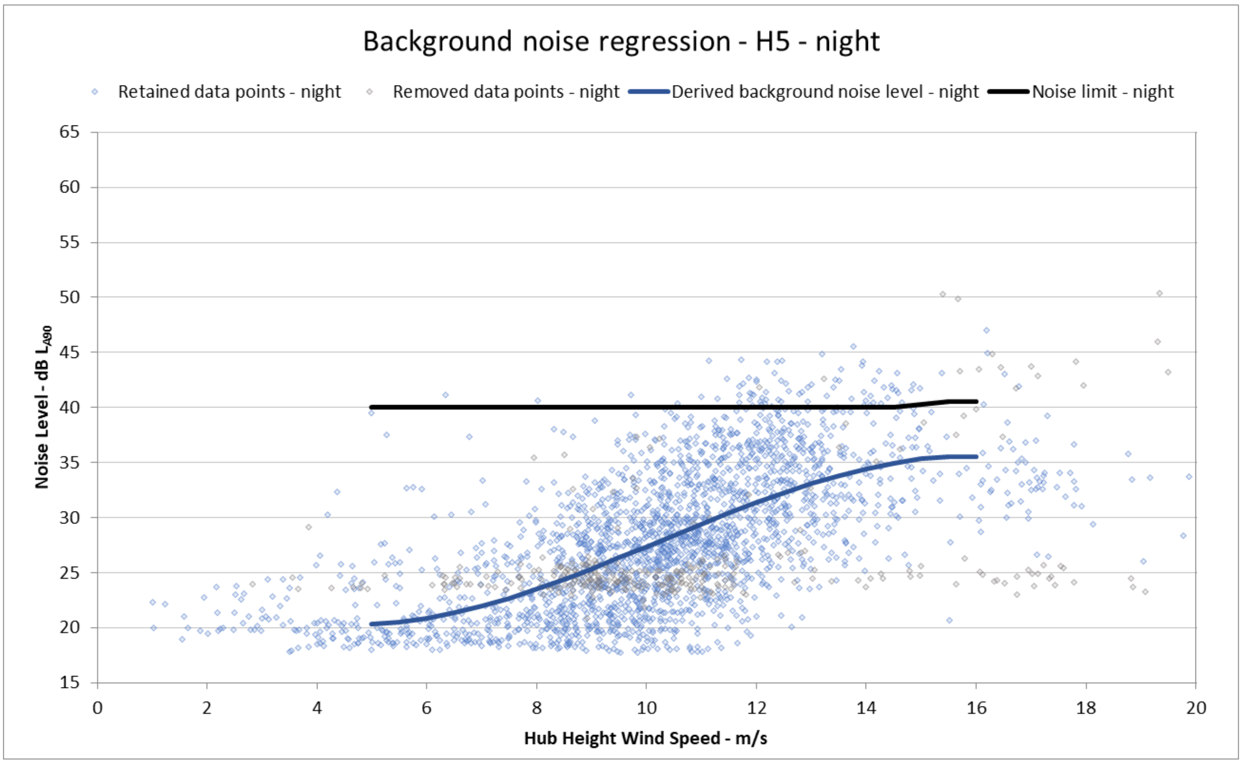


Figure 5: Receiver 5 night-time periods – derived background noise levels and noise limits



APPENDIX F RECEIVER 19 DATA

F1 Receiver 19 location data

Table 15: Receiver 19 dwelling and noise monitor coordinates– MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	615,046	5,955,633
Background noise monitoring location	615,052	5,955,618

Figure 6: Receiver 19 aerial view - dwelling and noise monitor locations

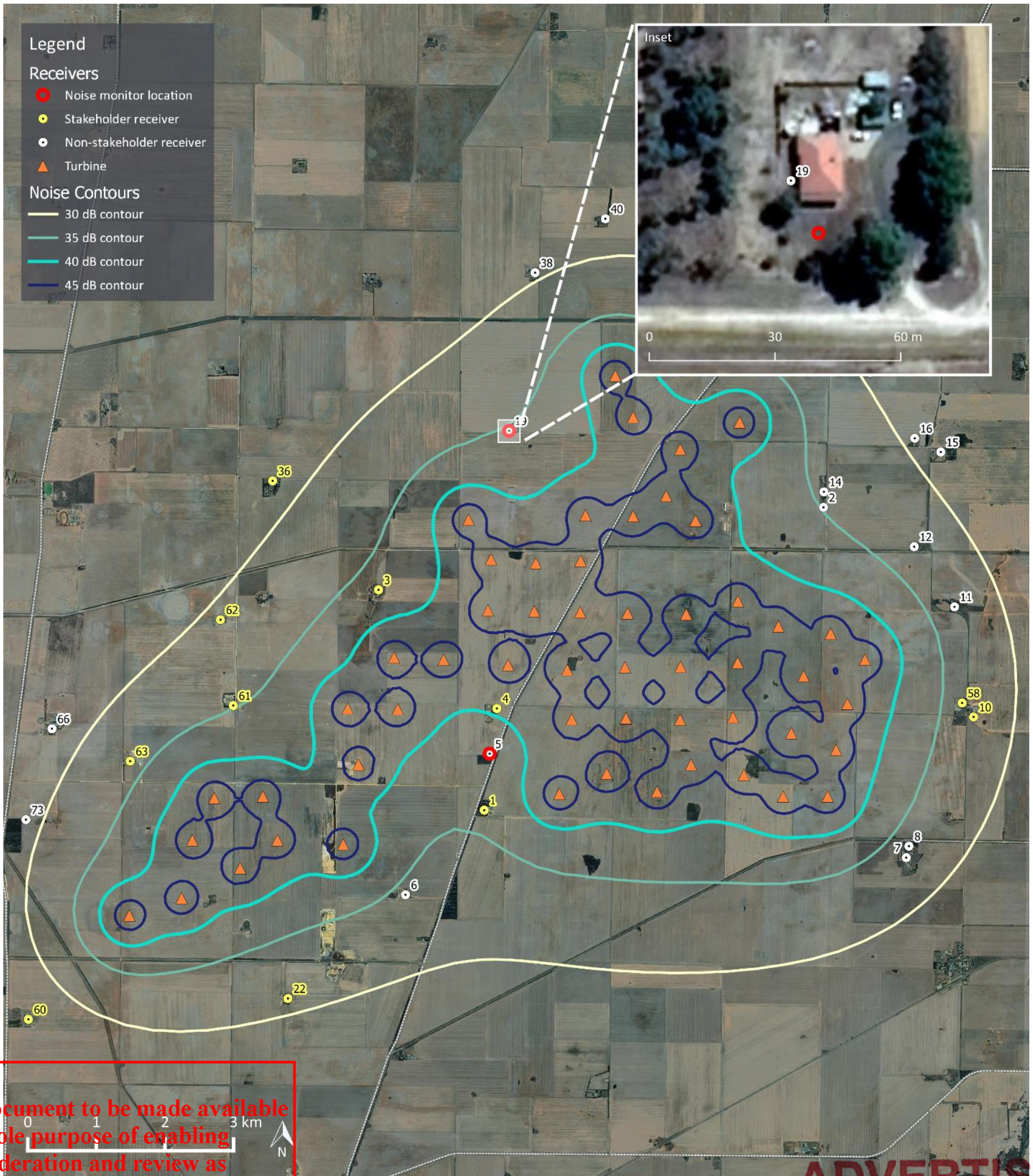


Table 16: Receiver 19 monitor installation photos

Looking North	Looking East
	
Looking South	Looking West
	

F2 Receiver 19 measurement data summary

Table 17: Receiver 19 background noise level analysis summary

Item	All-time (day & night combined)	Night-time (2200 – 0700 hrs)
Number of data points collected	6758	2470
Number of data points removed	477	263
Number of data points for analysis	6281	2207

Figure 7: Receiver 19 background noise level and wind speed time history

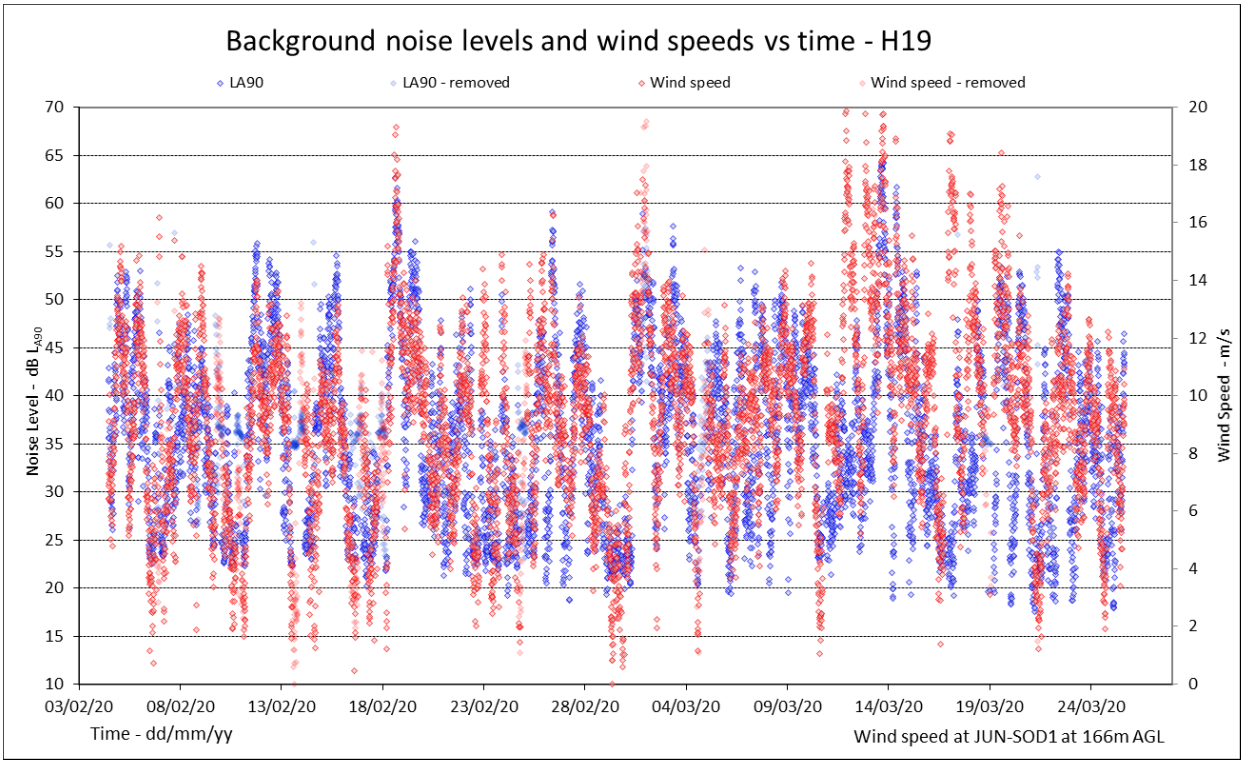


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Figure 8: Receiver 19 all-time periods – derived background noise levels and noise limits

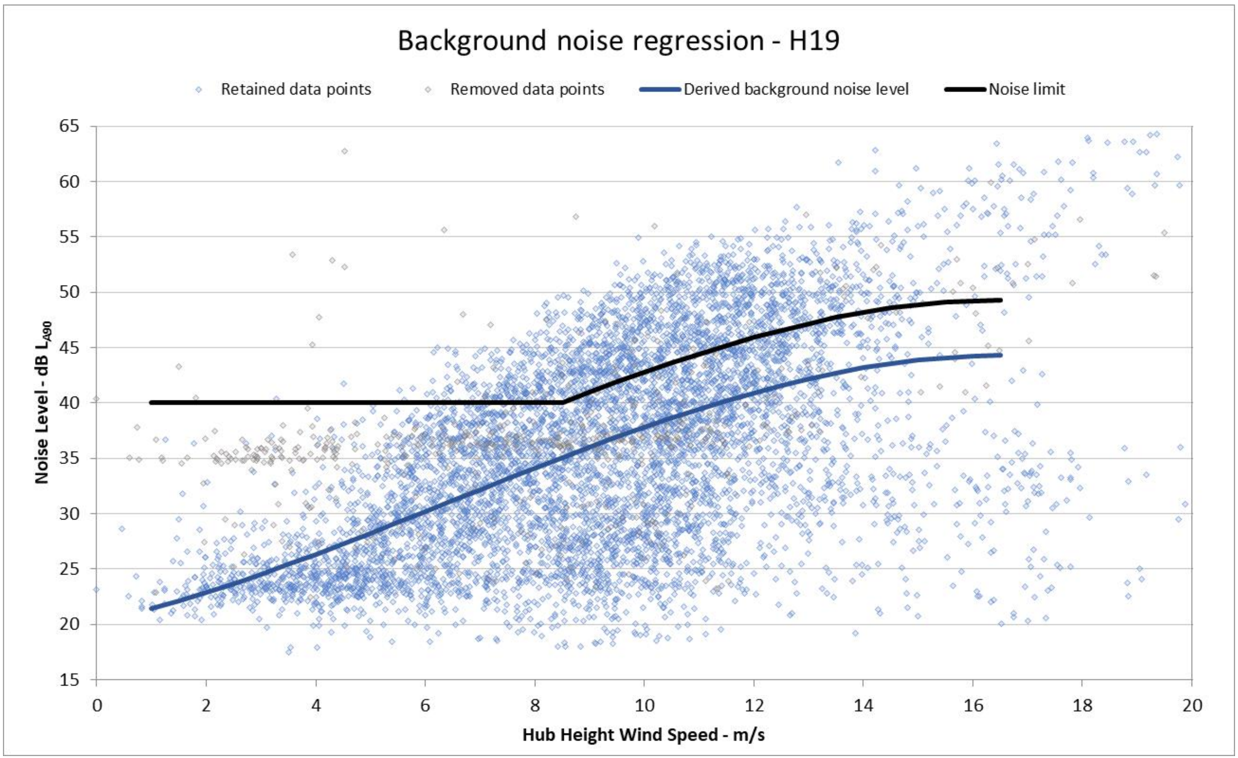

Figure 9: Receiver 19 night-time periods – derived background noise levels and noise limits