Sonus Pty Ltd
17 Ruthven Avenue
ADELAIDE SA 5000
Phone: (08) 8231 2100
Facsimile: (08) 8231 2122
www.sonus.com.au
ABN: 67 882 843 130
Contact: Chris Turnbull
Mobile: +61 417 845 720
ct@sonus.com.au

BOCO ROCK WIND FARM

New South Wales

Environmental Noise Compliance

S5434.1C4

September 2015

EXECUTIVE SUMMARY

Noise compliance testing has been conducted at the Boco Rock Wind Farm (BRWF) for the purpose of determining compliance with the Conditions of Consent and the Environment Protection Licence (EPL).

Continuous post-construction noise logging was conducted in accordance with the *SA Environmental Noise Guidelines: Wind Farms (2003)* at four residences (Coopers Hill, Rockybah, Roselea and Sherwood) between the 4th of March and the 30th of April, 2015. The noise logging demonstrated compliance with the relevant operational noise criteria at each of the residences at all wind speeds. The noise logging, in conjunction with noise predictions conducted by SLR Consulting at the planning stage of the development, are used to demonstrate compliance with the relevant operational noise criteria at all residences.

A one-third octave band tonality assessment was conducted in accordance with the *NSW Industrial Noise Policy* (NSW INP) at each of the receptors where post-construction logging took place. There was a tone detected at Coopers Hill at 400 Hz on less than 3% of the measurement periods, coinciding with times when the noise from the wind farm was low. Applying a penalty to the periods when tonality was detected resulted in no change to the overall noise levels.

The noise associated with substations inherently comprises prominent low-frequency tones at the frequency of the electrical supply line frequency and its harmonics. The one-third octave band tonality analysis was also used to determine if the character of noise typical of the substation installed at the BRWF was present at receptors in to the vicinity of the substation. The tonality assessment determined that there was insignificant tonal character at the frequencies of interest at the receptors and therefore the contribution of the substation to the cumulative noise level at the receptors is negligible. The relevant criteria for the substation as stipulated in the Conditions of Consent are achieved.

An assessment of amplitude modulation was undertaken for the post-construction measurements at Coopers Hill due to its proximity to the BRWF, and therefore high signal-to-noise ratio when measuring noise from the wind farm. The amplitude modulation has been assessed against *New Zealand Standard NZS 6808:2010 Acoustics – Wind farm noise*, and it has been determined that the BRWF does not exhibit excessive (atypical) amplitude modulation for a wind farm.

The post-construction noise measurements therefore confirm that the Boco Rock Wind Farm complies with the Conditions of Consent, and with the Environment Protection Licence.

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

1 INTRODUCTION

Sonus has been engaged by CWP Renewables to conduct noise compliance testing of the Wind Turbine Generators (WTGs) and substation installed at the Boco Rock Wind Farm (BRWF), New South Wales.

The purpose of the testing was to determine compliance with the BRWF Conditions of Consent and the Environment Protection Licence (EPL).

This report addresses the following:

- the operational noise levels from the BRWF at the closest noise sensitive receptors;
- tonality in accordance with the *NSW Industrial Noise Policy* (NSW INP) and complementary *Draft NSW Planning Guidelines for Wind Farms* (Draft NSW Guidelines);
- the noise from the substation; and,
- amplitude modulation from the wind turbines in accordance with New Zealand Standard *NZS 6808:2010 Acoustics – Wind farm noise*.

Continuous noise monitoring at four (associated) receptors has been conducted to determine compliance with the BRWF Conditions of Consent and Environment Protection Licence (EPL).

2 OPERATIONAL NOISE LEVELS

2.1 Criteria

The Conditions of Consent include:

2.17 The Proponent shall design, operate and maintain the project to ensure that the equivalent noise level ($L_{Aeq\ (10\text{-}minute)}$) from the wind turbine component of the project does not exceed the following limits at any existing sensitive receptor:

(a) 35 dB(A); or

(b) the existing background noise level ($L_{A90\ (10\text{-}minute)}$) correlated to the integer wind speed at the turbine hub height at the wind farm site by more than 5 dB(A);

whichever is the greater, for each integer wind speed (measured at hub height) from cut-in to rated power of the wind turbine generator.

2.18 Notwithstanding conditions 2.17 of this approval, the noise limits specified under conditions 2.17 does not apply to any sensitive receptor where a noise agreement is in place between the Proponent and the respective landowner(s) in relation to noise impacts and/or noise limits. Where a noise agreement has been entered into, the noise agreements shall satisfy the requirements of Guidelines for Community Noise (WHO, 1999) and Section 2.3 of Wind Farms: Environmental Noise Guidelines (South Australian Environmental Protection Agency, 2003).

The Environment Protection Licence (EPL) includes:

L3.1 Noise generated from the premises must not exceed:

(a) 35 dB(A); or

(b) the existing background noise level (LA90 (10-minute)), correlated to the integer wind speed at hub height at the wind farm site, by more than 5 dB(A), whichever is greater, for each integer wind speed (measured at the hub height) from cut-in to rated power of the wind turbine generator when determined in accordance with the methodology provided in the Environmental Noise Guidelines: Wind Farms (South Australia EPA, 2003).

L3.2 Notwithstanding Condition L3.1, the noise limit specified under that condition does not apply to any sensitive receiver where a noise agreement is in place between the licensee and the respective landowner(s) in relation to noise impacts and/or noise limits.

2.1.1 Pre-construction Noise Measurements

Prior to approval of the Boco Rock Wind Farm, a noise impact assessment, including background noise monitoring, was reported by Heggies[1] in November, 2009 (the Heggies assessment). The background noise monitoring was carried out at a number of locations, in March and April of 2009. Heggies then correlated the logged noise levels with wind speeds measured at the wind turbine hub height of 80m, and conducted a least squares regression analysis of the data. The correlations were then used to determine the resultant noise criteria at each measurement location (receptor) in accordance with the *SA Environmental Noise Guidelines: Wind Farms (2003)* (SA Guidelines).

Based on the pre-construction noise logging, the Conditions of Consent and the Licence Conditions, the operational noise criteria are as tabulated below in Table 2.1.

Table 2.1: Operational Noise Criteria for the Boco Rock Wind Farm

Receptor	Easting	Northing	Involved	Operational Noise Criteria (dB(A)) Referenced to wind speed at Hub Height								
				4	5	6	7	8.4	9.7	11.1	12.5	13.9
Benbullen	699314	5951354	Yes	35	35	35	35	36	39	41	43	44
Clifton	704525	5953058	No	35	35	35	35	36	39	41	43	44
H3	703854	5951128	No	35	35	35	35	36	39	41	43	44
Hyland Grange	703866	5953807	No	35	35	35	35	36	39	41	43	44
Mohawke	703603	5950719	No	35	35	35	35	36	39	41	43	44
Boco	691374	5948433	Yes	45	45	45	45	45	45	45	45	45
Riverside	690289	5946823	Yes	45	45	45	45	45	45	45	45	45
Rosemount	695166	5942991	No	36	36	36	36	37	38	40	42	44
Brooklyn	688326	5942494	Yes	45	45	45	45	45	45	45	45	45

[1] Boco Rock Wind Farm Noise Impact Assessment, Report Number 40-1738-R1, Revision 3, dated 27 November 2009

Receptor	Easting	Northing	Involved	Operational Noise Criteria (dB(A)) Referenced to wind speed at Hub Height								
				4	5	6	7	8.4	9.7	11.1	12.5	13.9
Bungee	688606	5941567	No	35	35	35	35	37	40	42	44	44
Sherwood	688579	5945345	Yes	45	45	45	45	45	45	45	45	45
Telembugum	687560	5939773	Yes	45	45	45	45	45	45	45	45	45
Windella	689840	5942014	Yes	45	45	45	45	45	45	45	45	45
Kanoute	691256	5939524	No	35	35	35	35	37	40	42	44	44
H2	688457	5935512	No	35	35	35	35	37	40	42	44	44
Kangaroo Camp Retreat	689115	5936116	No	35	35	35	35	37	40	42	44	44
Coopers Hill	684531	5940643	Yes	45	45	45	45	45	45	45	45	45
H1	680925	5942328	No	35	35	35	35	35	36	37	38	38
Wodburn	680399	5942869	No	35	35	35	35	35	36	37	38	38
Belmore	680461	5941821	No	35	35	35	35	35	36	37	38	38
Peters Park	680341	5941115	No	35	35	35	35	35	36	37	38	38
Coombala	685402	5937496	No	35	35	35	35	35	36	37	38	38
Roslyn	680312	5938990	No	35	35	35	35	35	36	37	38	38
Monsatery	683155	5935393	No	35	35	35	35	35	36	37	38	38
Xenmor	683772	5936565	No	35	35	35	35	35	36	37	38	38
Glenfinnian	698804	5955422	Yes	35	35	36	37	40	42	44	45	46
Woodbine	699584	5954091	No	35	35	38	37	40	42	44	45	46
Mia Mia	700779	5956037	No	35	35	38	37	40	42	44	45	40
Old Curry Flat	696738	5957694	No	35	35	36	37	40	42	44	45	46
Curry Flat	699524	5957935	No	35	35	36	37	40	42	44	45	46
Old Springfield	686537	5953315	Yes	45	45	45	45	45	45	45	45	45
Springfield	685789	5953700	Yes	45	45	45	45	45	45	45	45	45
Mountain View	682479	5948755	No	35	35	35	35	38	41	43	44	44

Receptor	Easting	Northing	Involved	Operational Noise Criteria (dB(A)) Referenced to wind speed at Hub Height								
				4	5	6	7	8.4	9.7	11.1	12.5	13.9
Tinbery Lodge	682470	5949856	No	35	35	35	35	38	41	43	44	44
Kenilworth	685288	5954313	No	35	35	35	35	38	41	43	44	44
Edendale	682127	5951369	No	35	35	35	35	38	41	43	44	44
Lyndarra	689266	5957378	No	35	35	35	35	38	41	43	44	44
Rockybah	693247	5953985	Yes	45	45	45	45	45	45	45	45	46
Roselea	691826	5955463	Yes	45	45	45	45	45	45	45	45	45
Lottyvale	689125	5959604	No	36	37	38	40	41	43	44	45	46
Yandra	696387	5954178	Yes	35	35	35	35	38	41	44	46	47
Wyuna	695544	5956531	Yes	35	35	35	35	38	41	44	46	47

2.2 Assessment

2.2.1 Post-construction Noise Measurements

To determine compliance with the operational noise criteria, post-construction continuous noise monitoring was conducted in accordance with the SA Guidelines at four receptors in to the vicinity of the BRWF, between the 4th of March and 30th of April, 2015.

There were two periods when the BRWF was not operational; from the 8th to the 13th of March and from the 16th to the 18th of March, 2015. These periods were excluded from the operational noise assessment.

Post-construction noise monitoring was conducted at Coopers Hill, Rockybah, Roselea and Sherwood. The coordinates of the noise logging equipment are shown in Table 2.2 below.

Table 2.2: Post-construction Noise Monitoring Receptors

Noise Monitoring Receptor	Easting	Northing
Coopers Hill	684549	5940634
Rockybah	693158	5953897
Roselea	691721	5955511
Sherwood	688535	5945299

Figure 2.1 to Figure 2.4 below summarise the locations of the noise logging and weather logger equipment with respect to the dwelling location.

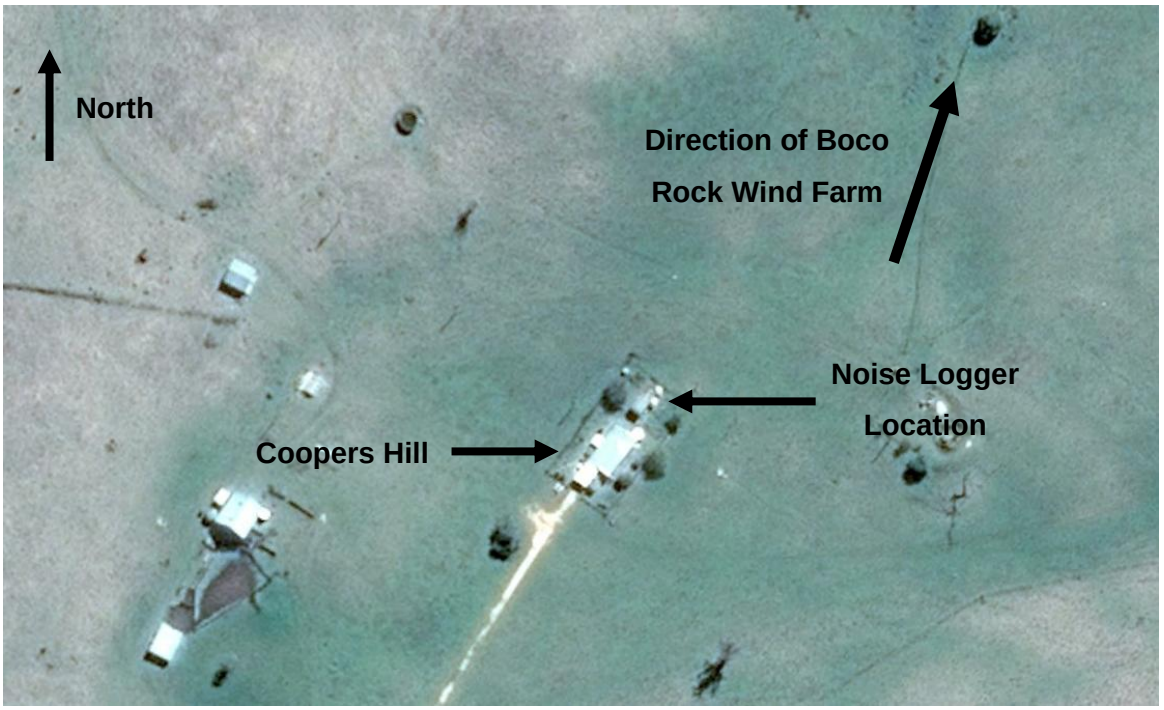


Figure 2.1: Location of Logging Equipment at Coopers Hill

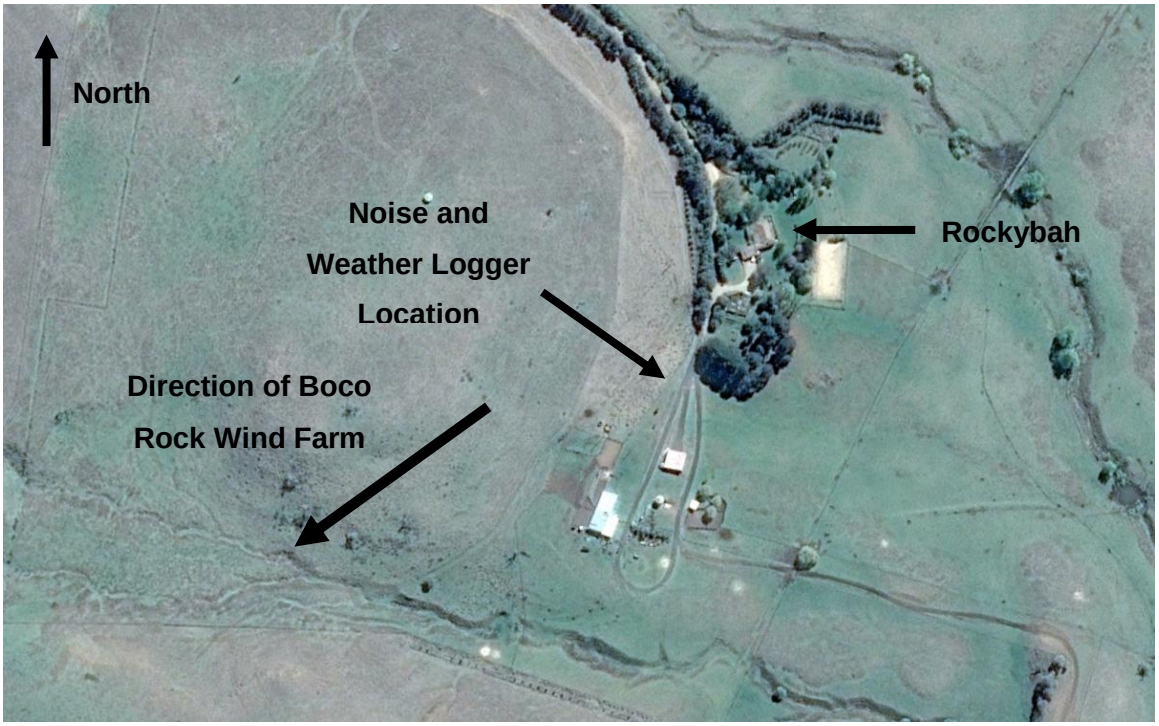


Figure 2.2: Location of Logging Equipment at Rockybah

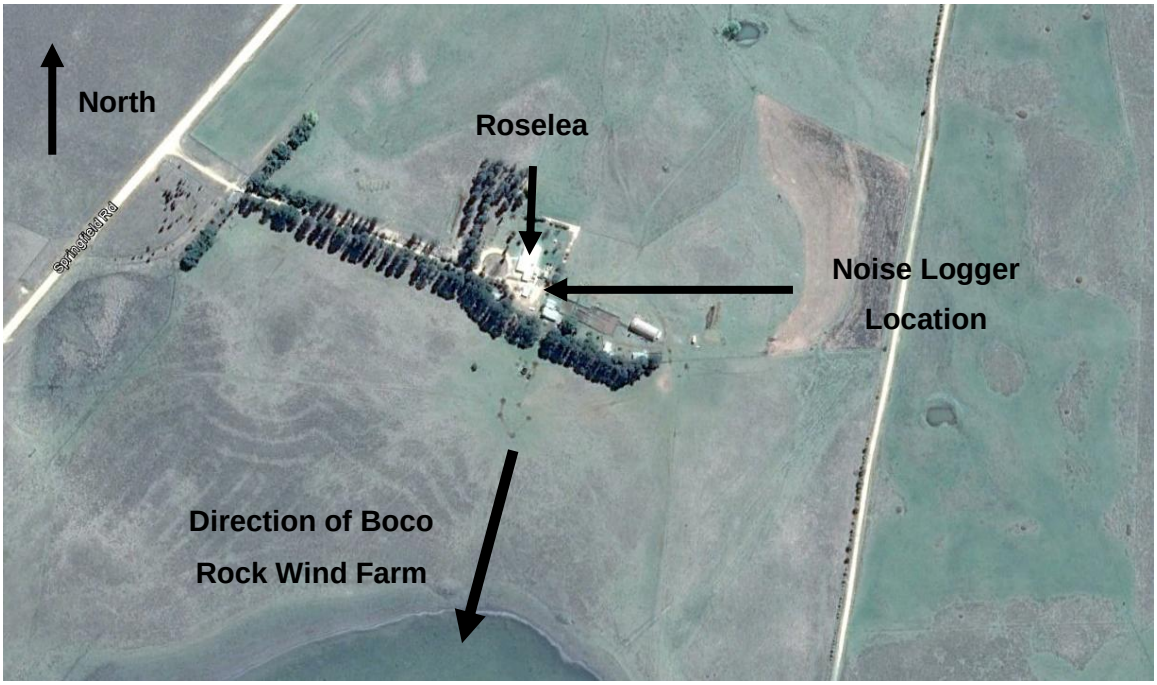


Figure 2.3: Location of Noise Logging Equipment at Roselea

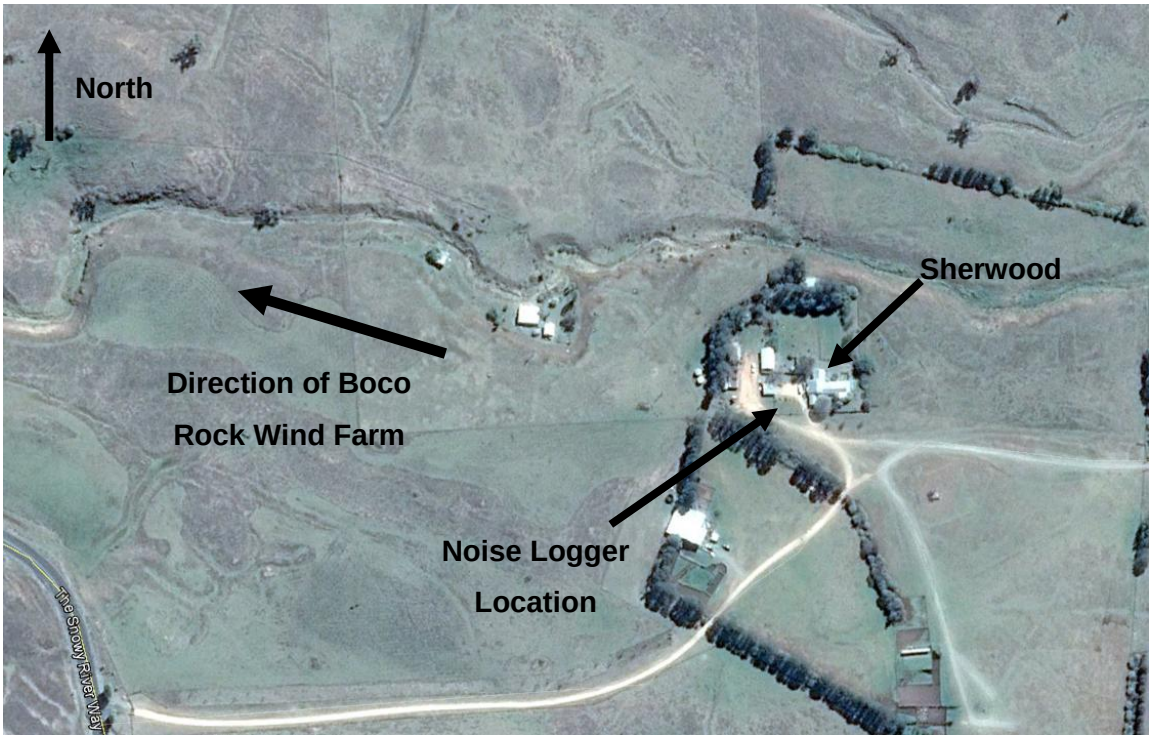


Figure 2.4: Location of Noise Logging Equipment at Sherwood

2.2.1.1 Monitoring Equipment

The noise loggers used at the nominated receptors were Rion NL-52 (Type 1) sound level meters, which have a noise floor of less than 20 dB(A). The sound level meters were calibrated at the beginning and end of the measurement period with a Rion NC74 Calibrator. All microphones were fitted with Rion WS-15 weatherproof windshields, with the microphone positioned approximately 1.5 m above ground level.

Table 2.3 below provides information on the noise measurement instrumentation for the logging conducted at each of the receptors, and the noise calibration certificates are provided in Appendix A.

Table 2.3: Measurement Instrumentation for Noise Logging at Receptors

Receptor	Instrument	Manufacturer	Model	Serial Number	Calibration Date
Coopers Hill	Sound level meter	Rion	NL-52	00320648	31/05/2014
	Microphone	Rion	UC-59	03397	31/05/2014
	Preamplifier	Rion	NH-25	10656	31/05/2014
Rockybah	Sound level meter	Rion	NL-52	00320646	14/08/2014
	Microphone	Rion	UC-59	03395	14/08/2014
	Preamplifier	Rion	NH-25	10654	14/08/2014
Roselea	Sound level meter	Rion	NL-52	00320654	14/08/2014
	Microphone	Rion	UC-59	03403	14/08/2014
	Preamplifier	Rion	NH-25	10662	14/08/2014
Sherwood	Sound level meter	Rion	NL-52	00320651	14/08/2014
	Microphone	Rion	UC-59	3400	14/08/2014
	Preamplifier	Rion	NH-25	10659	14/08/2014
All	Calibrator	Rion	NC-74	34125503	31/05/2014

The noise monitoring equipment was located such that the measured noise levels were representative of the operational noise from the wind farm experienced at the dwellings.

A local weather logger was also deployed, which measured rainfall and wind speed at the approximate height of the microphone. The rainfall and wind speed data were collected to determine the periods when weather directly on the microphone may have influenced the measured background noise levels in the vicinity. The local weather logger was placed at Rockybah, and operated throughout the noise logging period.

Photographs of the noise loggers and weather logger at the nominated receptors are provided in Appendix B.

2.2.1.2 Collected Data

The noise level ($L_{A90,10minute}$) was measured continuously, in 10 minute intervals, at each nominated monitoring location over the monitoring period in accordance with the SA Guidelines.

During the noise monitoring period, the average wind speed and direction was measured at a wind mast located at the BRWF site, named BOCO1. The wind data were measured in 10 minute intervals, at the WTG hub height of 80m.

2.2.1.3 Data Analysis

Prior to a correlation and regression analysis, the following data were removed:

- data points corresponding to any periods of measured rainfall (including the 10 minute periods before and after the recorded period) and/or measured wind speed exceeding 5 m/s at the microphone height for more than 90% of the measurement period;
- data points corresponding to wind speeds outside the specified wind speeds (below 4 m/s and above 13.9 m/s); and,
- data points clearly influenced by extraneous noise sources.

Table 2.4 below summarises the number of data points at each monitoring location and the number of downwind data points, following data removal.

Table 2.4: Number of Total and Downwind Data Points Collected

Noise Monitoring Location	Number of Data Points	
	Total	Downwind
Coopers Hill	4198	407
Rockybah	4208	1716
Roselea	4207	1188
Sherwood	4204	1018

2.2.1.4 Correlations at Receptors

The noise data for each monitoring location was correlated with the wind speed measured at wind mast BOCO1. A least squares regression analysis of the data was undertaken to determine the line of best fit for the correlations, in accordance with the SA Guidelines. The data and the regression curves are shown in Appendix C. Based on the regression analysis, the measured noise level ($L_{A90,10minute}$) at the hub height wind speeds are provided in Table 2.5 below.

Table 2.5: Measured Operational Noise Levels based on Regression Curves

Receptor	Operational Noise Level $L_{90,10\ minute}$ (dB(A)) Measured for Wind Speed (m/s) at 80m AGL								
	4	**5**	**6**	**7**	**8.4**	**9.7**	**11.1**	**12.5**	**13.9**
Coopers Hill	33	33	34	34	36	37	38	39	40
Rockybah	28	29	29	30	32	34	36	36	36
Roselea	28	30	31	33	35	36	38	40	42
Sherwood	29	29	30	31	33	36	38	38	37

The measured levels in the table above include the noise from the wind farm as well as noise from other background noise sources. In normal circumstances, it would be appropriate for the background noise level (measured prior to construction) to be subtracted from the total noise levels in the table. However, for dwellings Rockybah, Roselea and Sherwood, for some or all of the relevant wind speeds, the measured post-construction noise level was below the pre-construction background noise level, as defined in the Heggies Assessment.

Therefore, the post-construction noise measurements at the receptors have not been corrected for the pre-construction background noise levels. This represents a conservative approach and overestimates the contribution of noise from the BRWF.

From Table 2.5 above, the operational noise from the BRWF complies with the operational noise criterion for an involved landowner of 45 dB(A) at all relevant wind speeds.

2.2.2 Extrapolation to Non-Involved Landowners

The measurement of noise at a residence in the vicinity of an operating wind farm includes the noise from the wind farm as well as the noise from other sources. As the distance from the wind farm increases, the signal to noise ratio (noise from the wind farm relative to the noise from other sources) reduces and it is more difficult to determine the component of noise from a wind farm alone.

For the BRWF, the closest non-involved residences are approximately 3000m from the closest turbine. At this distance, the separation of the component of noise from the wind farm is not likely to be practicable. In these circumstances, the noise measured at the closest involved landowner (Coopers Hill) has been extrapolated to the non-involved residences at greater distances.

SLR Consulting conducted a Revised Noise Assessment[2] of the Boco Rock Wind Farm in April of 2014 (the SLR Consulting assessment). The SLR Consulting assessment predicted the noise from the wind farm to noise sensitive receptors based on the constructed layout and WTG types. The SLR Consulting assessment included a table of predicted noise levels for a wind speed of 8m/s, referenced to a height of 10m above ground. The wind speed of 8m/s (at 10m above ground) represents the wind speed where the highest noise levels were predicted. The table from the SLR assessment is reproduced below:

[2] Boco Rock Wind Farm Revised Noise Assessment, 640.10799-R1, Revision 1, dated 4 April 2014

Location	Predicted Noise Level, Leq dBA
Belmore	29.6
Benbullen*	21.8
Boco*	34.3
Brooklyn*	34.1
Bungee	32.7
Clifton	14
Coombala	26.5
Coopers Hill*	38.7
Curry Flat	18.7
Edendale	26.7
Glenfinnan*	21.5
H1	31.1
H2	21.1
H3	14.7
Hyland Grange	14.4
Kangaroo Camp Retreat	25.8
Kanoute	27.6
Kenilworth	28.5
Lofty Vale	23
Lynndarra	25.9
Mia Mia	18.5
Mohawke	15.2

Location	Predicted Noise Level, Leq dBA
Mountain View	29.4
Nestlebrae*	40.8
Old Curry Flat	22.5
Old Springfield*	30.5
Peters Park	27.7
Riverside*	33.7
Rockybah*	38.8
Roselea*	37.6
Rosemount	25.9
Roslyn	26.3
Sherwood*	36.9
Springfield*	29.9
Telembugrm*	31.5
Tinbery Lodge	33
Windella*	32.6
Wodburn	30.5
Woodbine	20
Wyuna*	27
Xenmor	22.9
Yandra*	26.5
Monastery	21.3

Note: * Denotes the location is involved with the project

The SLR table predicted that the noise at Coopers Hill at 8m/s (at 10m above ground) would be 38.7 dB(A) and that the highest noise level at a non-involved receptor would be 33 dB(A) at Tinbery Lodge.

A wind speed of 8m/s referenced to a height of 10m is equivalent to a hub height (80m) wind speed of 11.1m/s. Therefore, to validate the SLR prediction, the predicted level of 38.7 dB(A) should be compared with the component of noise from the BRWF at Coopers Hill at a hub height wind speed of 11.1m/s. From Appendix C, the total (wind farm and other noise) measured noise at Coopers Hill was 38.3 dB(A) and the background noise level measured prior to construction was 32.4 dB(A). The logarithmic subtraction results in a noise component from the BRWF of 37 dB(A). This level is below the predicted level of 38.7 dB(A) and therefore validates the SLR noise model.

With the model validated for the wind speed of highest expected noise, it can be concluded that the noise at non-associated residences is no greater than the predicted noise levels in the SLR table. As the highest predicted noise level in the table for a non-associated residence is 33 dB(A), the most onerous criterion of 35 dB(A) is achieved for all non-associated residences.

Based on the above, the operational noise from the BRWF achieves the relevant operational noise criteria at all receptors for all wind speeds.

3 TONALITY

3.1 Criteria

The Conditions of Consent for the BRWF include:

2.17 … For the purpose of assessment of noise contributions specified under conditions 2.17:

(a) 5 dB(A) shall be applied to measured noise levels where tonality is present. The presence of tonality shall be determined using the methodology detailed in Wind Turbine Generator Systems- Part 11: Acoustic Noise Measurement Techniques IEC 61400-11:2002 or its latest edition; and

(b) noise from the project shall be measured at the most affected point within the residential boundary, or at the most affected point within 20 metres of the dwelling, where the dwelling is more than 20 metres from the boundary.

The EPA recently acknowledged that IEC 61400-11:2002[3] was not the most appropriate method for determining tonality at residences in the vicinity of a wind farm and issued a Notice of Variation of Licence No. 20434 for the Boco Rock Wind Farm. The background to the variation of licence included:

> *At present condition L3.3 of the licence refers to the methodology detailed in the document 'Wind turbines - Part 11: Acoustic noise measurement techniques IEC 61400-11:2012(E) or its latest edition. The EPA has determined that this document is no longer the appropriate document for the purposes of that licence condition and that NSW Industrial Noise Policy should be referenced instead.*

The EPL now includes the following condition:

L3.3 To determine compliance with Condition L3.1, 5dB(A) must be added to measured noise levels where tonality is present. The presence of tonality must be determined using a methodology based on the modifying factor for tonality presented in Section 4 of the NSW Industrial Noise Policy (EPA, 2000).

Based on the above, the tonality from the BRWF has been assessed in accordance with the NSW INP with reference also to the complementary Draft NSW Guidelines at four noise sensitive receptors located in close proximity to the BRWF.

[3] Wind Turbine Generator Systems - Part 11: Acoustic Noise Measurement Techniques IEC 61400-11:2002

3.2 Assessment

The method of the NSW INP was implemented for every 10 minute interval (at times when one-third octave band data were available) at the four receptors where post-construction noise monitoring was conducted. It is noted that one-third octave band data were not collected at Rockybah between the 4th and 26th of March.

The analysis revealed a number of tones at times when the wind farm was operational as well as at times when the wind farm was not operational. A comparison of the percentage of time that the tones were identified, with and without the WTGs operational, has been used as an indication of the potential for tonality from the turbines. The percentage of data points, which qualify for a tonality correction, for the wind farm operating and not operating, are tabulated for each receptor in Appendix D.

The post-construction noise monitoring at Rockybah did not include one-third octaves when the BRWF was not operational, and therefore no analysis is shown in the table in Appendix D for this receptor when the wind farm was not operating.

To determine the potential for the measured tonality to be associated with WTGs, frequencies were identified where tonality was found in at least 1% of the measurement periods and where there was a significant difference between the occurrences with and without the turbines operating. From this analysis, 400Hz, 2000Hz and 3150Hz were identified as potential frequencies where the turbines might be contributing to the tonality at Coopers Hill. This was then refined by listening to the audio, which was continuously recorded at Coopers Hill. The audio analysis identified that the higher frequency tones at 2000Hz and 3150Hz, were associated with insects and/or birds and were therefore not analysed further. However, the audio did not identify any extraneous noise source that might be responsible for the 400Hz tonality recorded at Coopers Hill.

In accordance with the Draft NSW Guidelines, where tonality is identified but is not identified for more than 10% of the measurement periods, a penalty of 5 dB(A) is added to the measured noise level for the data points when tonality is identified.

Therefore, a 5 dB(A) correction for tonality has been applied to those data points which qualify for tonality at 400 Hz at Coopers Hill. These data points typically occurred when wind speeds were low, and the wind direction was not downwind (i.e. the wind direction was not from the wind farm to the receptor). The correlation graph and line of best fit, with and without the tonality correction applied is shown in Appendix E. The graph demonstrates that the correction for tonality has no significant effect on the least squares regression analysis. The measured operational noise levels based on the regression analysis are the same with and without the correction for tonality in accordance with the NSW INP and Draft NSW Guidelines.

4 SUBSTATION

4.1 Criteria

The Conditions of Consent include:

2.20 The Proponent shall design, construct, operate and maintain the collector substation to ensure that the noise contributions from these components to the background acoustic environment do not exceed the maximum allowable noise contributions specified in Table 3, at the nearest existing sensitive receptor to the substation. The maximum allowable noise contributions apply under wind speeds up to 3 ms-1 (measured at 10 metres above ground level), or under temperature inversion conditions of up to 3 ºC/ 100 metres and wind speeds of up to 2m/s at 10 metres above the ground.

Table 3 – Substation Noise Criteria

Day	***Evening***	***Night***	
7:00am to 6:00pm Mondays to Saturdays	*6:00pm to 10:00pm on any day*	*10:00pm to 7:00am Mondays to Saturdays*	
8:00am to 6:00pm Sundays and public holidays		*10:00pm to 8:00am Sundays and public holidays*	
$L_{Aeq(15\ minute)}$	$L_{Aeq(15\ minute)}$	$L_{Aeq(15\ minute)}$	$L_{A1\ (1\ minute)}$
35	*35*	*35*	*45*

For the purpose of assessment of noise contributions specified under this condition, noise from these components shall be:

a) measured at the most affected point within the residential boundary or at the most affected point within 30 metres of the dwelling where the dwelling is more than 30 metres from the boundary to determine compliance with the LAeq(15 minute) noise limits;

b) measured at 1 metre from the dwelling façade to determine compliance with the LA1 (1 minute) noise limits; and

c) subject to the modification factors provided in Section 4 of the New South Wales Industrial Noise Policy (EPA, 2000), where applicable.

Notwithstanding, should direct measurement of noise from these components be impractical, the Proponent may employ an alternative noise assessment method deemed acceptable by the EPA (refer to Section 11 of the New South Wales Industrial Noise Policy (EPA, 2000)). Details of such an alternative noise assessment method accepted by the EPA shall be submitted to the Director-General prior to the implementation of the assessment method.

Unless otherwise agreed to by the Director-General, the modification factors presented in Section 4 of the New South Wales Industrial Noise Policy (EPA, 2000), in relation to low frequency noise, only apply if the difference between the A weighted and the C weighted noise is greater than or equal to 15 dB and the measured sound pressure level is greater than Leq 65 dB(C).

The requirements of condition 2.20 do not apply if a negotiated agreement consistent with the requirements of Section 8.3 of the New South Wales Industrial Noise Policy (EPA, 2000), exists between the Proponent and the relevant sensitive receptor.

3.1 *… The compliance assessment shall be undertaken consistent with the procedures presented in Wind Farms - Environmental Noise Guidelines (South Australian Environmental Protection Agency, 2003) for the wind turbines and the New South Wales Industrial Noise Policy (EPA, 2000) for the substation and at period(s) commensurate with the worst case operational and meteorological factors relevant to the specific project component. Specifically, in relation to the wind turbines this includes monitoring at all relevant rated wind speeds where noise exceedances may occur and the range of stability class conditions expected at receptor locations. The Noise Compliance Report shall specifically consider any modulation related noise generation from the wind turbines and any cumulative noise impacts from the operation of the wind turbines and the substation.*

There are no specific requirements relating to noise from the substation stated in the EPL.

The noise associated with substations inherently comprises prominent tones. The tones occur at the frequency of the electrical supply line frequency and its harmonics. The electrical supply line frequency of the substation installed at the BRWF is 50 Hz. Therefore, the character of the noise from the substation will exhibit tones at 50 Hz and its harmonics, such as 100 Hz and 200 Hz. Where none of these tones are not present, it can be concluded that the substation is not having any significant influence on the measured noise levels

The closest continuous noise logging to the substation was conducted at Sherwood, Rockybah and Roselea. The data collected by these noise loggers have been analysed to determine if the character of noise from the substation is present at the receptors. The analysis was conducted by using the one-third octave band tonality assessment in accordance with the NSW Industrial Noise Policy (NSW INP) to identify the presence of tones at 50 Hz and its harmonics.

4.2 Assessment

To determine the contribution of the substation noise at nearby receptors to the BRWF, the tonality analysis was conducted for the noise monitoring locations closest to the substation. These locations are shown below in Table 4.1.

Table 4.1: Closest Post-construction Noise Monitoring Receptors to Substation

Noise Monitoring Receptor	Easting	Northing	Approximate Distance to Substation (m)
Sherwood	688535	5945299	4900
Rockybah	693158	5953897	5000
Roselea	691721	5955511	5700

All receptors closer to the substation than Sherwood, Rockybah or Roselea are associated with the wind farm, and the closest non-associated receptor is approximately 6500m from the substation.

To determine whether tonality was present at Sherwood, Rockybah or Roselea, a one-third octave band tonality assessment was conducted in accordance with the NSW INP as documented in Section 3.

The results of the assessment at Sherwood, Rockybah and Roselea are shown in Appendix D and summarised in Table 4.2 below, for one-third octave bands at 400 Hz and below.

Table 4.2: Draft NSW Planning Guidelines for Wind Farms Tonality Assessment

Percentage of Data Points Measured which Attract a Correction Factor for Tonality in accordance with the Draft NSW Planning Guidelines for Wind Farms at each One Third Octave Band (Hz)														
Receptor	**BRWF Operation**	**25**	**32**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**	**315**	**400**
Sherwood	On	0.07	0	0	0.17	0	0	0	0	0	0.05	0	0	0
	Off	0	0	0	0	0	0	0	0	0	0	0	0	0
Rockybah	On	0	0	0	0.04	0	0	0	0	0	0	0	0	0
	Off	-	-	-	-	-	-	-	-	-	-	-	-	-
Roselea	On	0.02	0	0	0.05	0	0	0	0	0.02	0.05	0.02	0.07	0.05
	Off	0	0	0	0	0	0	0	0	0	0.24	0	0	0

Section 3 of this report determined that there are no one-third octave bands which are classified as tonal and warrant a penalty under the NSW INP and Draft NSW Guidelines for the receptors Sherwood, Rockybah and Roselea.

Furthermore, the assessment shows that at the one-third octave bands of the electrical supply line frequency and its harmonics (50 Hz, 100 Hz and 200 Hz), less than 0.2% of all data points recorded are defined as tonal in accordance with the NSW INP and the Draft NSW Guidelines. This represents an insignificant number of data points which are classified as tonal. Further, at Roselea, more data points qualified for tonality at 200 Hz when the BRWF was not operating compared to when it was operating.

It is therefore concluded that the contribution of the noise from the substation at Sherwood, Rockybah and Roselea is negligible, and achieves the criteria of the Conditions of Consent. Consequently, the noise from the substation is also negligible at any of the non-associated receptors, which are at greater setback distances from the substation. The noise from the substation therefore achieves the relevant Condition of Consent at all receptors.

5 AMPLITUDE MODULATION

Amplitude modulation (which is the cyclic variation in the emitted noise level) is a fundamental characteristic of wind turbine noise and is therefore a characteristic which is taken into account in the objective criteria specifically developed for wind farms. A higher than usual (excessive) level of amplitude modulation has been reported at a small number of wind farm sites in other countries.

5.1 Criteria

The Conditions of Consent include:

3.1 … The compliance assessment shall be undertaken consistent with the procedures presented in Wind Farms - Environmental Noise Guidelines (South Australian Environmental Protection Agency, 2003) for the wind turbines and the New South Wales Industrial Noise Policy (EPA, 2000) for the substation and at period(s) commensurate with the worst case operational and meteorological factors relevant to the specific project component. Specifically, in relation to the wind turbines this includes monitoring at all relevant rated wind speeds where noise exceedances may occur and the range of stability class conditions expected at receptor locations. The Noise Compliance Report shall specifically consider any modulation related noise generation from the wind turbines and any cumulative noise impacts from the operation of the wind turbines and the substation.

There are no specific requirements in regards to amplitude modulation stated in the EPL.

In the absence of any objective requirements relating to amplitude modulation specified in the Conditions of Consent, the New Zealand Standard *NZS 6808:2010 Acoustics – Wind farm noise* (NZS 6808:2010) is referenced.

NZS 6808:2010 defines an objective "interim test method" to determine the presence of excessive amplitude modulation at a wind farm site:

> *…modulation special audible characteristics are deemed to exist if the measured A-weighted peak to trough levels exceed 5 dB on a regularly varying basis…*

To determine if excessive amplitude modulation exists at the nearby receptors, the rationale of the "interim test method" of NZS 6808:2010 was applied to the BRWF by continuously logging noise at a receptor in close proximity to the wind farm.

5.2 Assessment

As discussed in Section 2, Coopers Hill is in close proximity to the BRWF (approximately 900m) and therefore the post-construction monitoring at Coopers Hill represents a location with a high signal-to-noise ratio when measuring noise from the BRWF.

The continuous noise monitoring conducted at Coopers Hill also included digital audio recording. The closest 10 minute data point to each integer wind speed was post-processed using a measuring interval of 100ms. The post-processed data were assessed for excessive amplitude modulation as a function of the blade pass frequency in accordance with NZS 6808:2010.

The blade pass frequencies of the General Electric WTGs installed at the BRWF are less than 1 Hz and vary depending on the wind speed and the resultant rotational speed of the rotors.

Observations made from listening to the digital audio recordings determined that in subjective terms no excessive amplitude modulation was present.

Objective assessment of the post-processed data in accordance with NZS 6808:2010 also determined that no excessive amplitude modulation was present. The analysis identified periods of time where typical amplitude modulation (inherent of any normal wind farm), can be attributed to the BRWF.

Examples of measured and analysed amplitude modulation from the BRWF are shown in Appendix F. Appendix F illustrates the highest level of amplitude modulation that was observed at the BRWF. The peak to trough levels do not exceed 5 dB(A) on any regularly varying basis. Therefore, based on the above, excessive amplitude modulation wasnot observed at the BRWF site.

APPENDIX A: Noise Measurement Instrumentation Calibration Sheets

NATacoustic
Acoustic Calibration & Testing Laboratory
Level 1, 418A Elizabeth Street., Surry Hills NSW 2010 AUSTRALIA
Ph: (02) 8218 0570 email: service@natacoustic.com.au website: www.natacoustic.com.au
A division of Renzo Tonin & Associates (NSW) Pty Ltd ABN 29 117 462 861

Certificate of Calibration
Sound Level Meter

Calibration Date	31/05/2014	**Job No**	RB275	**Operator**	GGC
Client Name	SONUS PTY LTD.				
Client Address	17 RUTHVEN AVENUE ADELAIDE 5000				

Test Item

Instrument Make	RION	**Model**	NL-52	**Serial No**	#00320648
Microphone Make	RION	**Model**	UC-59	**Serial No**	#03397
Preamplifier Make	RION	**Model**	NH-25	**Serial No**	#10656
Ext'n Cable Make	Nil	**Model**	N/A	**Serial No**	N/A
Accessories	Nil				

SLM Type	1
Filters Class	1

Temp deg C	25.0
RH %	43.0
Bar Pressure hPa	1013

Applicable Standards:
Australian Standard AS1259.1 1990 "Sound Level Meters Part 1: Non-integrating"
Australian Standard AS1259.2 1990 "Sound Level Meters Part 2: Integrating-averaging"

Applicable Work Instruction:
RWI-08 SLM Verification.doc

Traceability:
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

Scope:
This certificate is issued on the basis that the instrument complies with the manufacturer's specification. See "Sound Level Meter Verification - Summary of Tests" page for an itemised list of results for each test.

Uncertainty:
Unless otherwise stated, the uncertainty of measurement is +/-0.14dB. The uncertainty is stated at a confidence level of 95% using a k factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number 14966

Authorized Signatory:

Print Name: Renzo Tonin Date: 2 June 2014

Template Document Name: RQT-02 (rev 54) SLM Verification

NATacoustic
Acoustic Calibration & Testing Laboratory
Level 1, 418A Elizabeth Street., Surry Hills NSW 2010 AUSTRALIA
Ph: (02) 8218 0570 email: service@natacoustic.com.au website: www.natacoustic.com.au
A division of Renzo Tonin & Associates (NSW) Pty Ltd ABN 29 117 462 861

Certificate of Calibration
Sound Level Meter

Calibration Date	14/08/2014	**Job No**	RB283	**Operator**	SD
Client Name	SONUS PTY LTD				
Client Address	17 RUTHVEN AVE ADELAIDE 5000				

Test Item

Instrument Make	RION	**Model**	NL-52	**Serial No**	320646
Microphone Make	RION	**Model**	UC-59	**Serial No**	3395
Preamplifier Make	RION	**Model**	NH-25	**Serial No**	10654
Ext'n Cable Make	Nil	**Model**	N/A	**Serial No**	N/A
Accessories	Nil				

SLM Type	1
Filters Class	N/A

Temp deg C	25.6
RH %	33.2
Bar Pressure hPa	1028

Applicable Standards:
Australian Standard AS1259.1 1990 "Sound Level Meters Part 1: Non-integrating"
Australian Standard AS1259.2 1990 "Sound Level Meters Part 2: Integrating-averaging"

Applicable Work Instruction:
RWI-08 SLM Verification.doc

Traceability:
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

Scope:
This certificate is issued on the basis that the instrument complies with the manufacturer's specification. See "Sound Level Meter Verification - Summary of Tests" page for an itemised list of results for each test.

Uncertainty:
Unless otherwise stated, the uncertainty of measurement is +/-0.14dB. The uncertainty is stated at a confidence level of 95% using a k factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number 14966

Authorized Signatory:

Print Name: Renzo Tonin Date: 15 Aug 2014

Template Document Name: RQT-02 (rev 57) SLM Verification

NATacoustic
Acoustic Calibration & Testing Laboratory
Level 1, 418A Elizabeth Street., Surry Hills NSW 2010 AUSTRALIA
Ph: (02) 8218 0570 email: service@natacoustic.com.au website: www.natacoustic.com.au
A division of Renzo Tonin & Associates (NSW) Pty Ltd ABN 29 117 462 861

Certificate of Calibration
Sound Level Meter

Calibration Date	14/08/2014	**Job No**	RB283	**Operator**	SD
Client Name	SONUS PTY LTD				
Client Address	17 RUTHVEN AVE ADELAIDE 5000				

Test Item

Instrument Make	RION	**Model**	NL-52	**Serial No**	320654
Microphone Make	RION	**Model**	UC-59	**Serial No**	3403
Preamplifier Make	RION	**Model**	NH-25	**Serial No**	10662
Ext'n Cable Make	Nil	**Model**	N/A	**Serial No**	N/A
Accessories	Nil				

SLM Type	1
Filters Class	N/A

Temp deg C	25.4
RH %	32.4
Bar Pressure hPa	1028

Applicable Standards:
Australian Standard AS1259.1 1990 "Sound Level Meters Part 1: Non-integrating"
Australian Standard AS1259.2 1990 "Sound Level Meters Part 2: Integrating-averaging"

Applicable Work Instruction:
RWI-08 SLM Verification.doc

Traceability:
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

Scope:
This certificate is issued on the basis that the instrument complies with the manufacturer's specification. See "Sound Level Meter Verification - Summary of Tests" page for an itemised list of results for each test.

Uncertainty:
Unless otherwise stated, the uncertainty of measurement is +/-0.14dB. The uncertainty is stated at a confidence level of 95% using a k factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number 14966

Authorized Signatory:

Print Name: Renzo Tonin Date: 14 Aug 2014

Template Document Name: RQT-02 (rev 57) SLM Verification

NATacoustic
Acoustic Calibration & Testing Laboratory
Level 1, 418A Elizabeth Street., Surry Hills NSW 2010 AUSTRALIA
Ph: (02) 8218 0570 email: service@natacoustic.com.au website: www.natacoustic.com.au
A division of Renzo Tonin & Associates (NSW) Pty Ltd ABN 29 117 462 861

Certificate of Calibration
Sound Level Meter

Calibration Date	14/08/2014	**Job No**	RB283	**Operator**	SD
Client Name	SONUS PTY LTD				
Client Address	17 RUTHVEN AVE ADELAIDE 5000				

Test Item

Instrument Make	RION	**Model**	NL-52	**Serial No**	320651
Microphone Make	RION	**Model**	UC-59	**Serial No**	3400
Preamplifier Make	RION	**Model**	NH-25	**Serial No**	10659
Ext'n Cable Make	Nil	**Model**	N/A	**Serial No**	N/A
Accessories	Nil				

SLM Type	1
Filters Class	N/A

Temp deg C	25.4
RH %	33.4
Bar Pressure hPa	1028

Applicable Standards:
Australian Standard AS1259.1 1990 "Sound Level Meters Part 1: Non-integrating"
Australian Standard AS1259.2 1990 "Sound Level Meters Part 2: Integrating-averaging"

Applicable Work Instruction:
RWI-08 SLM Verification.doc

Traceability:
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

Scope:
This certificate is issued on the basis that the instrument complies with the manufacturer's specification. See "Sound Level Meter Verification - Summary of Tests" page for an itemised list of results for each test.

Uncertainty:
Unless otherwise stated, the uncertainty of measurement is +/-0.14dB. The uncertainty is stated at a confidence level of 95% using a k factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number 14966

Authorized Signatory:

Print Name: Renzo Tonin Date: 14 August 2014

Template Document Name: RQT-02 (rev 57) SLM Verification

NATacoustic
Acoustic Calibration & Testing Laboratory
Level 1, 418A Elizabeth Street., Surry Hills NSW 2010 AUSTRALIA
Ph: (02) 8218 0570 email: service@natacoustic.com.au website: www.natacoustic.com.au
A division of Renzo Tonin & Associates (NSW) Pty Ltd ABN 29 117 462 861

Certificate of Calibration
Sound Level Meter

Calibration Date	6/01/2014	**Job No**	RB247	**Operator**	GGC
Client Name	SONUS PTY LTD				
Client Address	17 RUTHVEN AVE ADELAIDE SA 5000				

Test Item

Instrument Make	RION	**Model**	NA-28	**Serial No**	#01170623
Microphone Make	RION	**Model**	UC-59	**Serial No**	#00684
Preamplifier Make	RION	**Model**	NH-23	**Serial No**	#70641
Ext'n Cable Make	Nil	**Model**	N/A	**Serial No**	N/A
Accessories	Nil				

SLM Type	1
Filters Class	1

Temp deg C	24.0
RH %	41.0
Bar Pressure hPa	1003

Applicable Standards:
Australian Standard AS1259.1 1990 "Sound Level Meters Part 1: Non-integrating"
Australian Standard AS1259.2 1990 "Sound Level Meters Part 2: Integrating-averaging"

Applicable Work Instruction:
RWI-08 SLM Verification.doc

Traceability:
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

Scope:
This certificate is issued on the basis that the instrument complies with the manufacturer's specification. See "Sound Level Meter Verification - Summary of Tests" page for an itemised list of results for each test.

Uncertainty:
Unless otherwise stated, the uncertainty of measurement is +/-0.14dB. The uncertainty is stated at a confidence level of 95% using a k factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number 14966

Authorized Signatory:

Print Name: Renzo Tonin Date: 9th Jan 2014

Template Document Name: RQT-02 (rev 54) SLM Verification

NATIONAL ACOUSTIC CALIBRATION LABORATORY

Level 1, 418A Elizabeth Street., Surry Hills NSW 2010 AUSTRALIA
Ph: (02) 8218 0570 email: service@natacoustic.com.au website: www.natacoustic.com.au
A division of Renzo Tonin & Associates (NSW) Pty Ltd ABN 29 117 462 861

Certificate of Calibration
Sound Level Calibrator

Calibration Date	31/05/2014	**Job No**	RB275	**Operator**	GGC
Client Name	SONUS PTY LTD				
Client Address	17 RUTHVEN AVE ADELAIDE 5000				

Test Item

Calibrator Make	RION	**Model**	NC-74	**Serial No**	34125503
Accessories	N/A				

Class (1 or 2)	1

Temp deg C	25.0
RH %	40.0
Bar Pressure hPa	1009

Applicable Standards:
AS IEC 60942 2004 Australian Standard "Electroacoustics - Sound calibrators"

Applicable Work Instruction:
RWI-09 Calibrator Verification.doc

Traceability:
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

Scope:
This certificate is issued on the basis that the instrument complies with the manufacturer's specification. See "Sound Level Meter Verification - Summary of Tests" page for an itemised list of results for each test.

Uncertainty:
Unless otherwise stated, the uncertainty of measurement is +/-0.12dB. The uncertainty is stated at a confidence level of 95% using a k factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number 14966

Authorized Signatory:

Print Name: Renzo Tonin Date:2 June 2014

Template Document Name: RQT-03 (rev 23) Calibrator Verification

APPENDIX B: Noise Loggers and Weather Logger Photographs

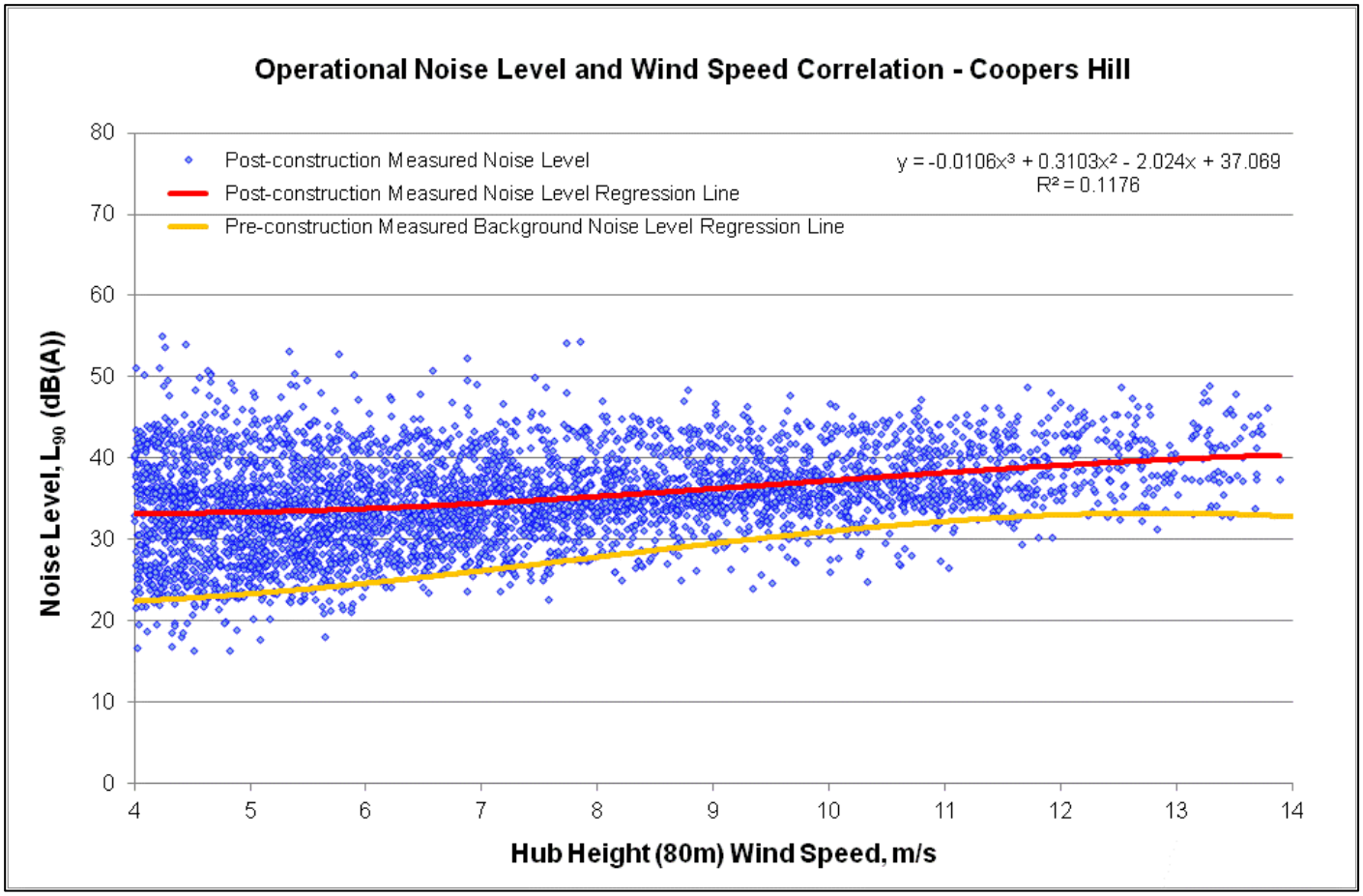
Noise Logger at Coopers Hill

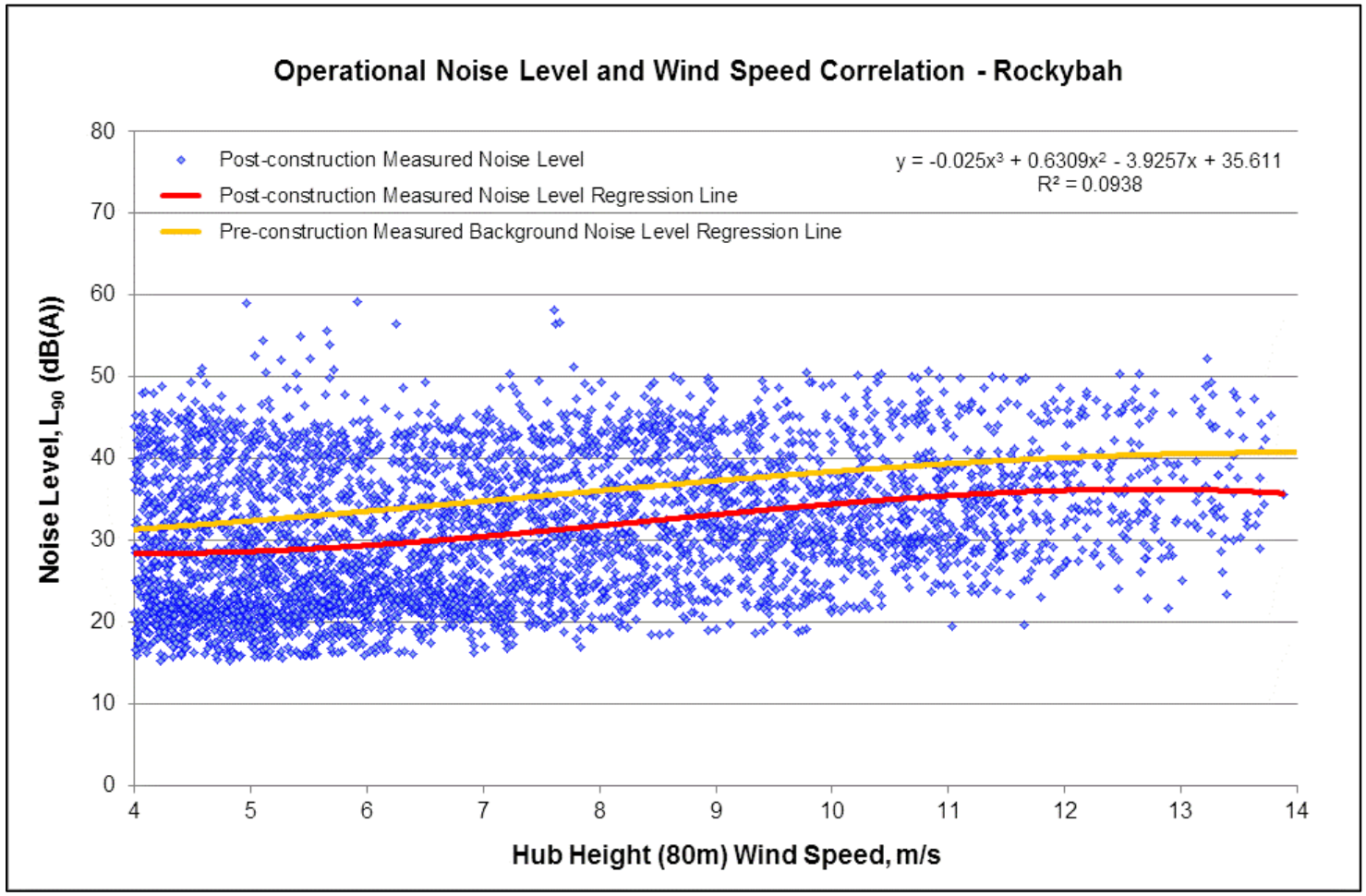
Noise Logger at Sherwood

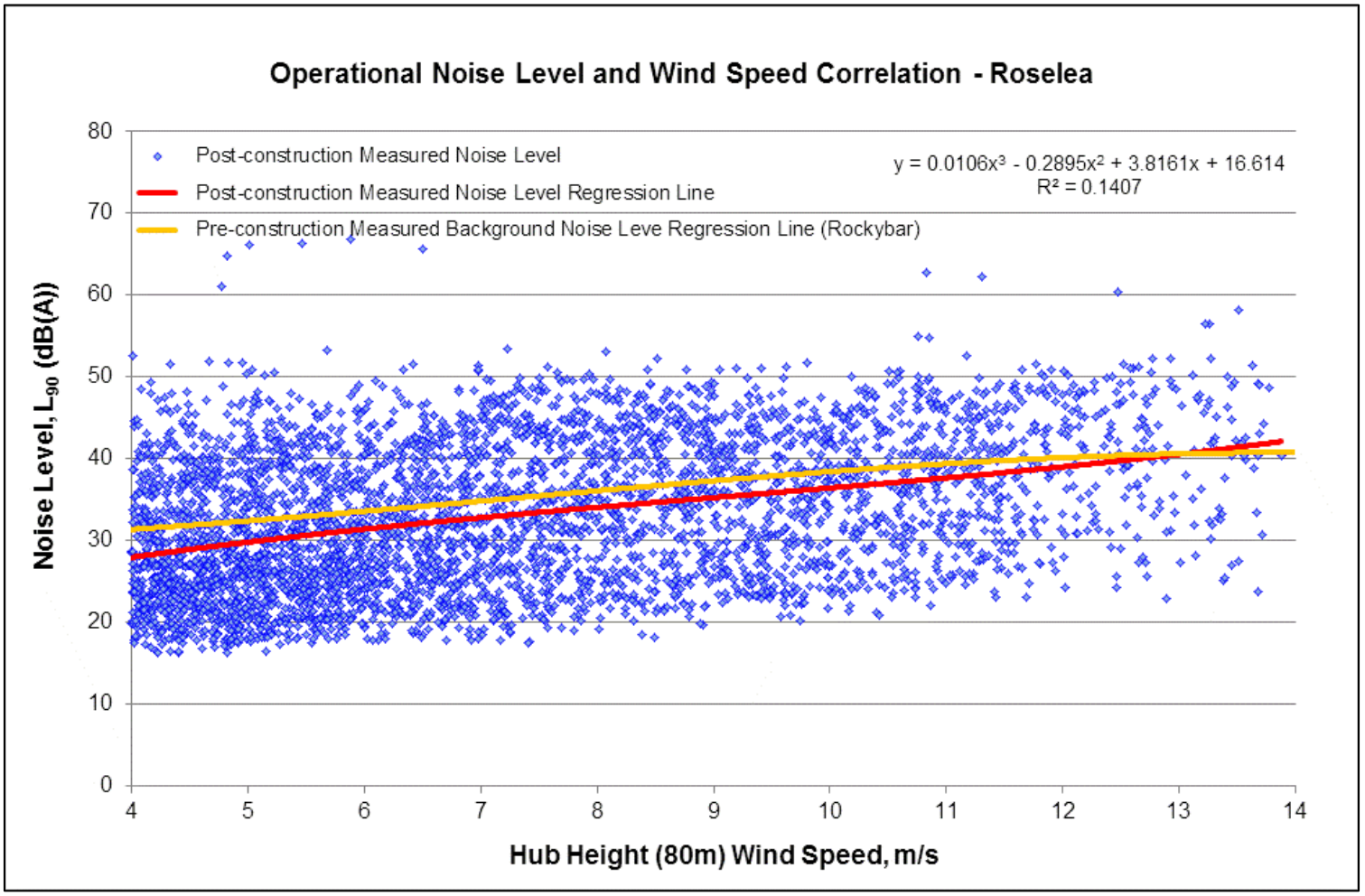
Noise Logger at Roselea

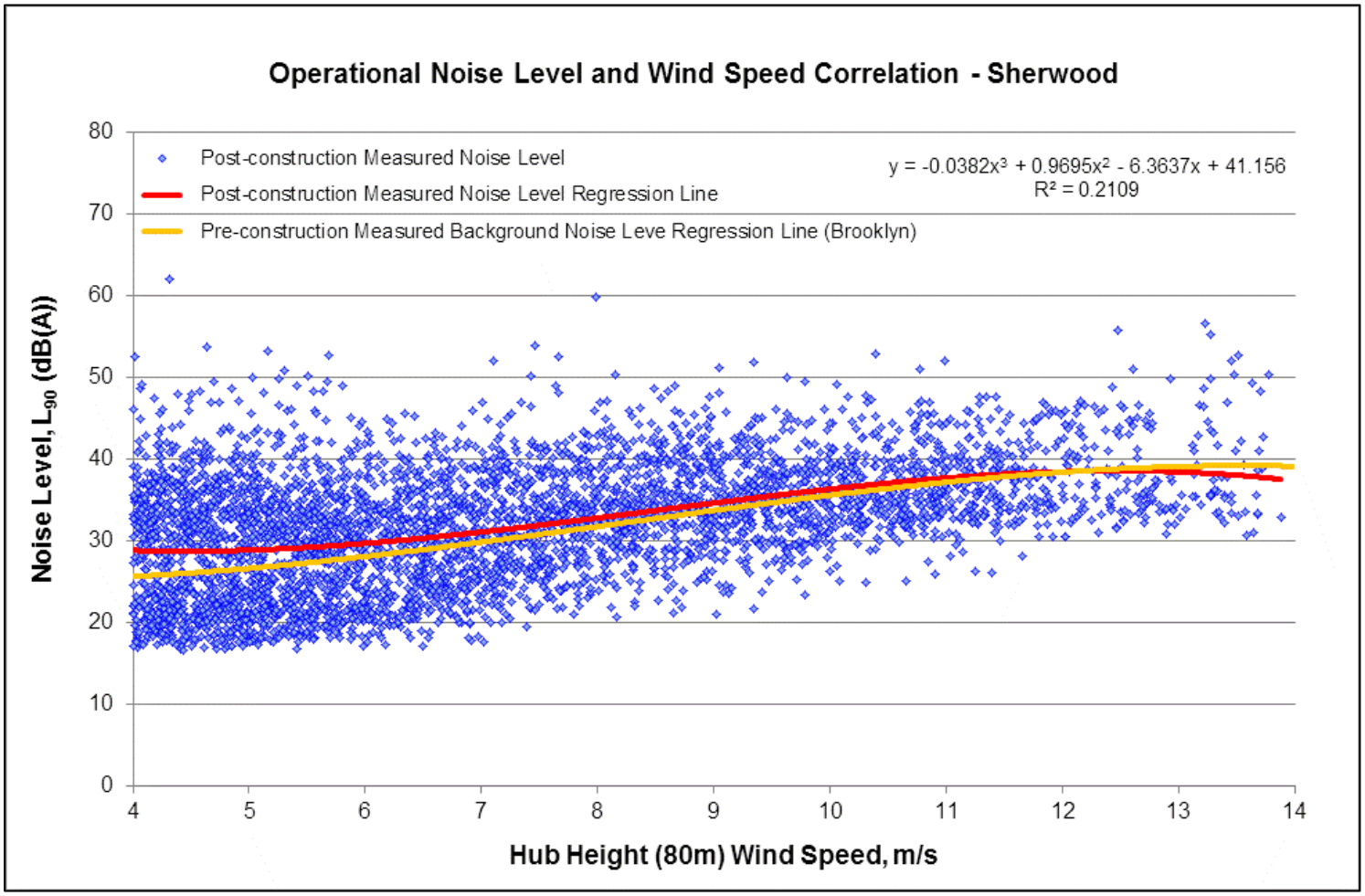
Noise Logger and Weather Logger at Rockybah

APPENDIX C: Noise Level and Wind Speed Correlations




Operational Noise Level and Wind Speed Correlation - Rockybah
Post-construction Measured Noise Level
Post-construction Measured Noise Level Regression Line
Pre-construction Measured Background Noise Level Regression Line
y = -0.025x³ + 0.6309x² - 3.9257x + 35.611
R² = 0.0938
Noise Level, L90 (dB(A))
Hub Height (80m) Wind Speed, m/s
0
10
20
30
40
50
60
70
80
4
5
6
7
8
9
10
11
12
13
14


Operational Noise Level and Wind Speed Correlation - Roselea
Post-construction Measured Noise Level
Post-construction Measured Noise Level Regression Line
Pre-construction Measured Background Noise Leve Regression Line (Rockybar)
y = 0.0106x³ - 0.2895x² + 3.8161x + 16.614
R² = 0.1407
Noise Level, L90 (dB(A))
Hub Height (80m) Wind Speed, m/s
0
10
20
30
40
50
60
70
80
4
5
6
7
8
9
10
11
12
13
14

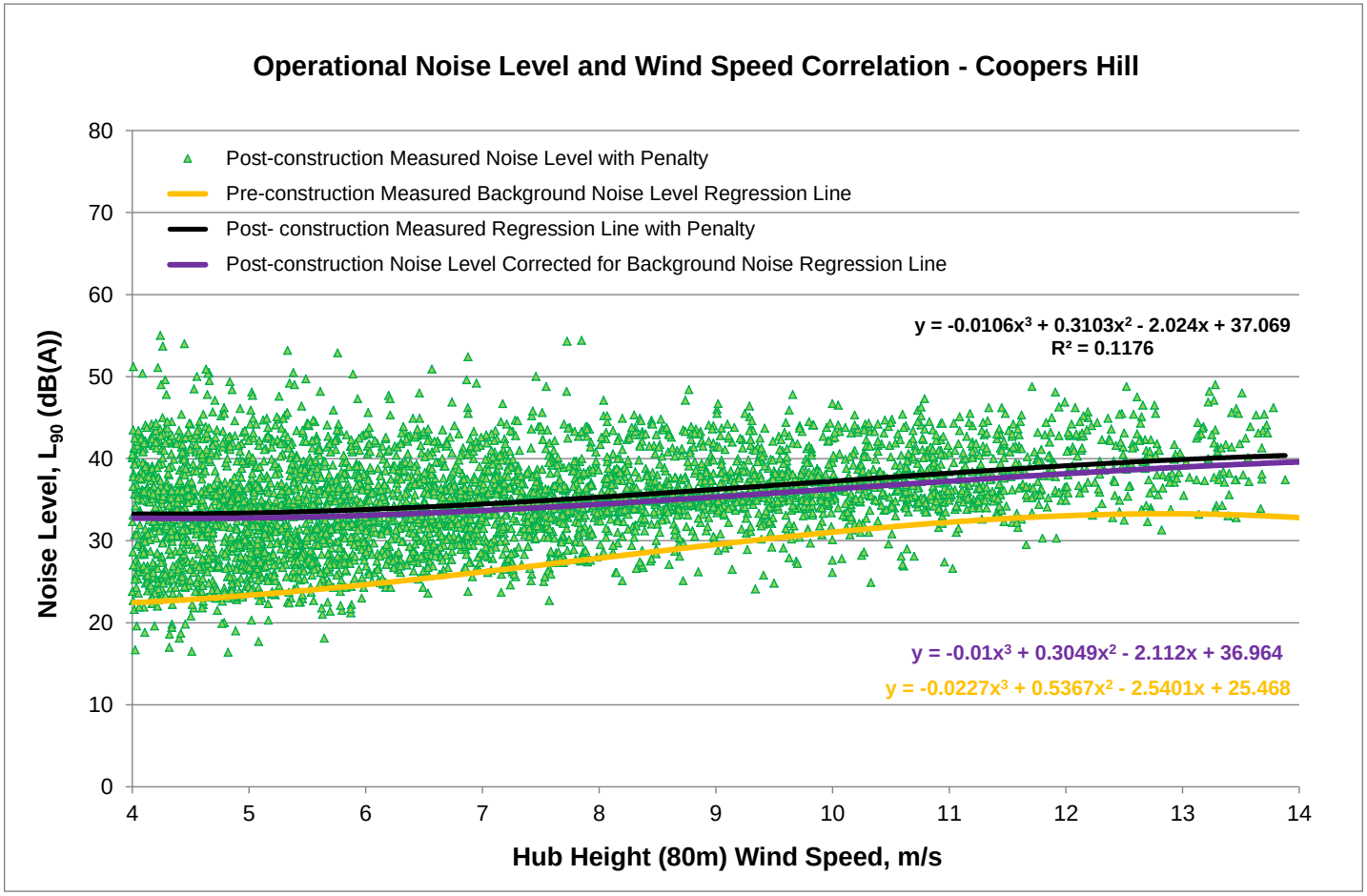

Operational Noise Level and Wind Speed Correlation - Sherwood
Post-construction Measured Noise Level
Post-construction Measured Noise Level Regression Line
Pre-construction Measured Background Noise Leve Regression Line (Brooklyn)
y = -0.0382x³ + 0.9695x² - 6.3637x + 41.156
R² = 0.2109
Noise Level, L90 (dB(A))
Hub Height (80m) Wind Speed, m/s
0
10
20
30
40
50
60
70
80
4
5
6
7
8
9
10
11
12
13
14

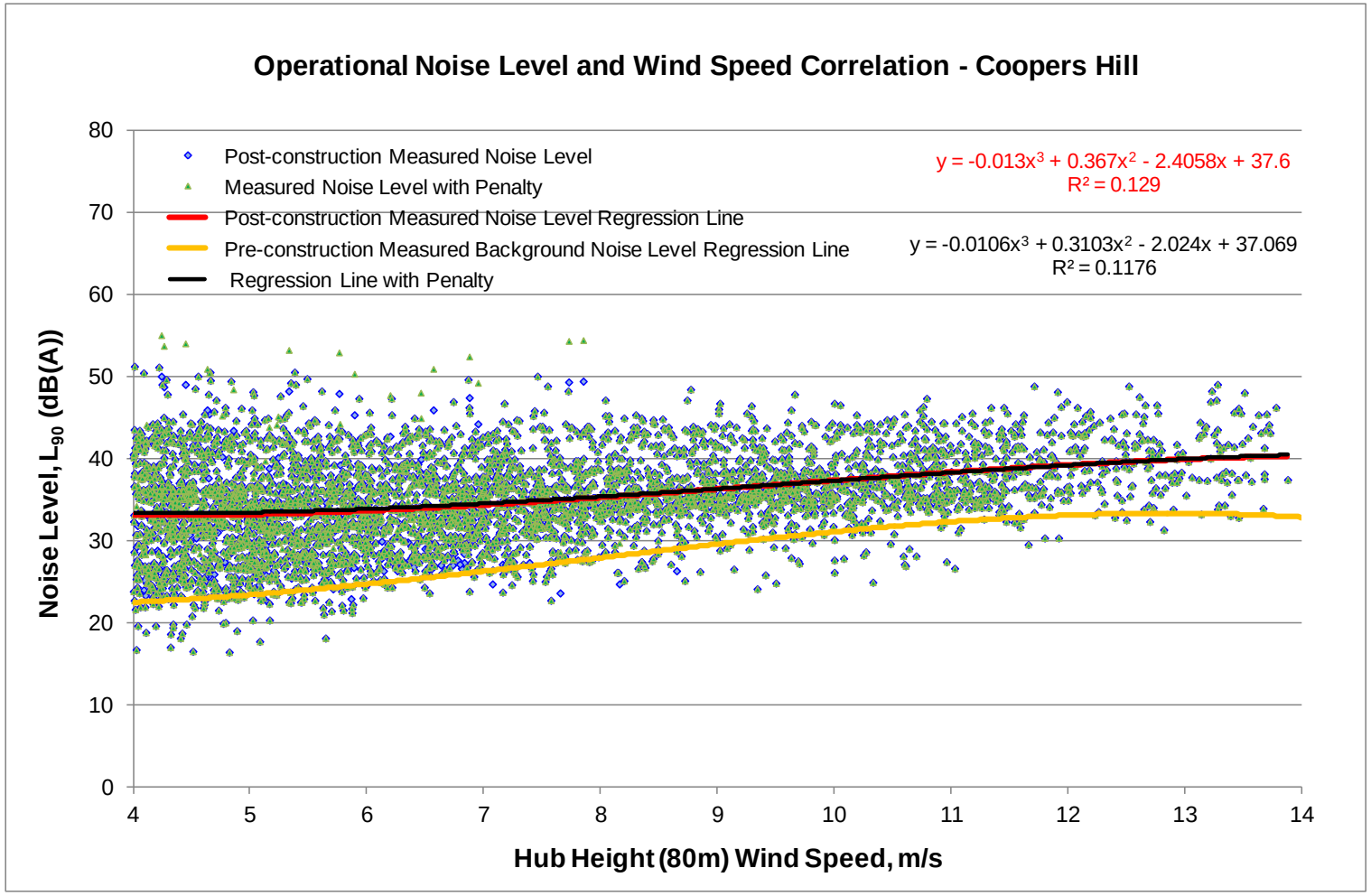
APPENDIX D: Industrial Nosie Policy – Tonality Table

Table: Percentage of Measured Data Points which attract a Correction Factor for Tonality in Accordance with the NSW INP for the operation and non-operation of the BRWF

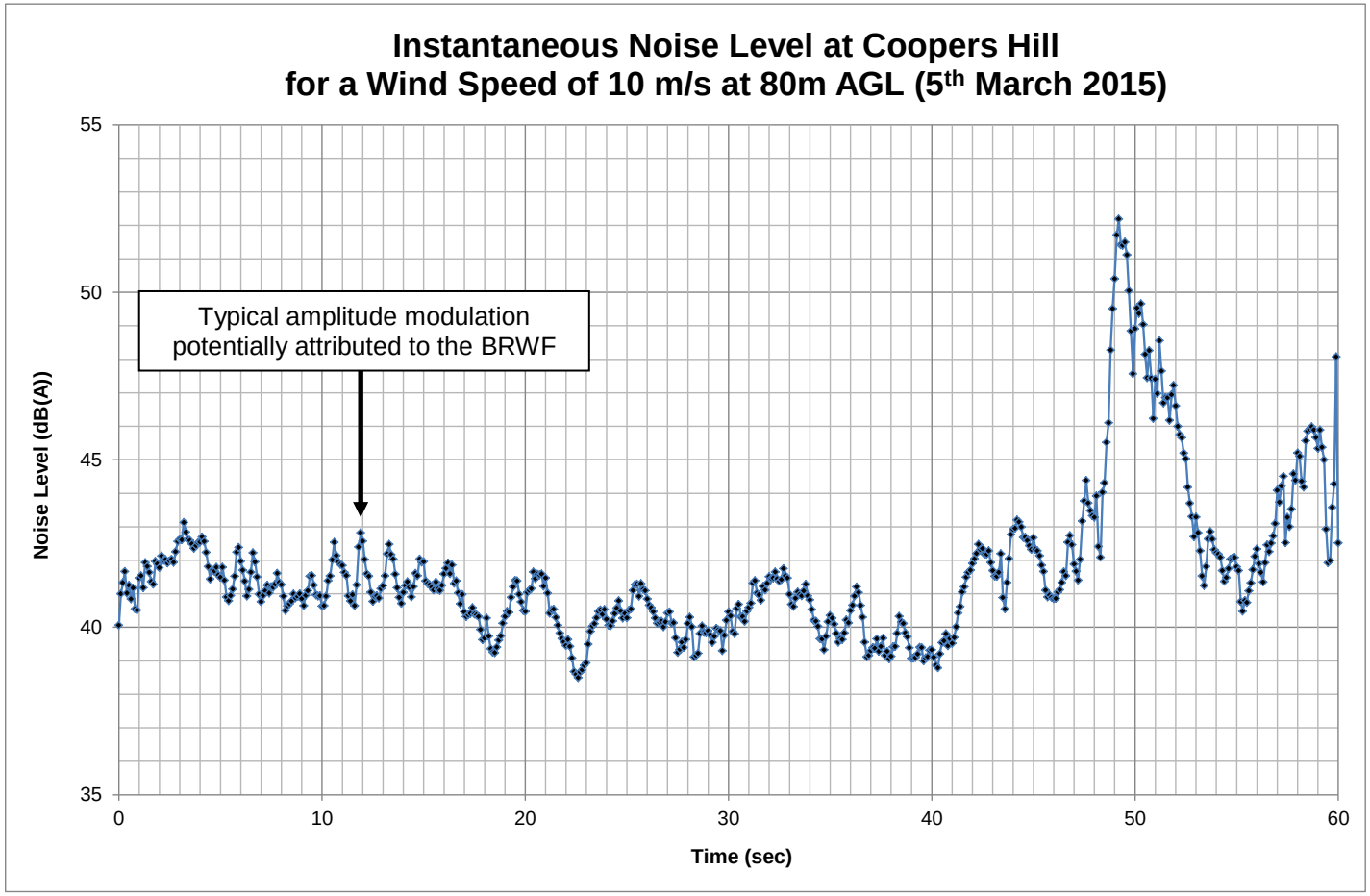
Receptor	Operation of Wind Farm	Percentage of Data Points Measured which Attract a Correction Factor for Tonality in accordance with the NSW INP at each Third-Octave (Hz)																										
		25	32	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	12.5k	16k
Coopers Hill	On	0	0	0	0	0	0	0	0	0	0	0	0	2.88	0.19	0.17	0.05	0.07	0.31	0.02	4.36	0.64	1.14	1.05	0.02	0.10	12.22	2.45	1.41	0.10
	Off	0	0	0	0	0	0	0	0	0	0	0	0	0	0.12	0.12	0.12	0	0.48	0.36	0	0.60	0.12	2.51	0	0	16.89	0.48	2.75	0
Rockybah	On	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0.07	0.69	0.47	0.04	2.83	0.40	2.29	0.18	1.20	2.87	0	0.07	14.13	0.62	0.22	0.07
	Off	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roselea	On	0.02	0	0	0.05	0	0	0	0	0.02	0.05	0.02	0.07	0.05	0.64	0.50	0.19	0.21	1.43	2.78	3.04	0.07	0.33	2.66	0.07	0.10	0.14	1.64	1.33	0.02
	Off	0	0	0	0	0	0	0	0	0	0.24	0	0	0	0.12	0.84	0.48	0.12	1.32	2.87	0.12	0	0.48	7.19	0.24	0.12	0.36	1.68	2.51	0.24
Sherwood	On	0.07	0	0	0.17	0	0	0	0	0	0.05	0	0	0	0.59	0.12	0.07	0.48	0.57	0.52	0.14	0.17	1.78	2.28	0	0.21	1.90	2.45	1.02	0.02
	Off	0	0	0	0	0	0	0	0	0	0	0	0	0	1.80	0.24	0.12	0.36	0	0.36	0.24	0.12	2.28	6.11	0	1.44	3.71	2.63	1.32	0

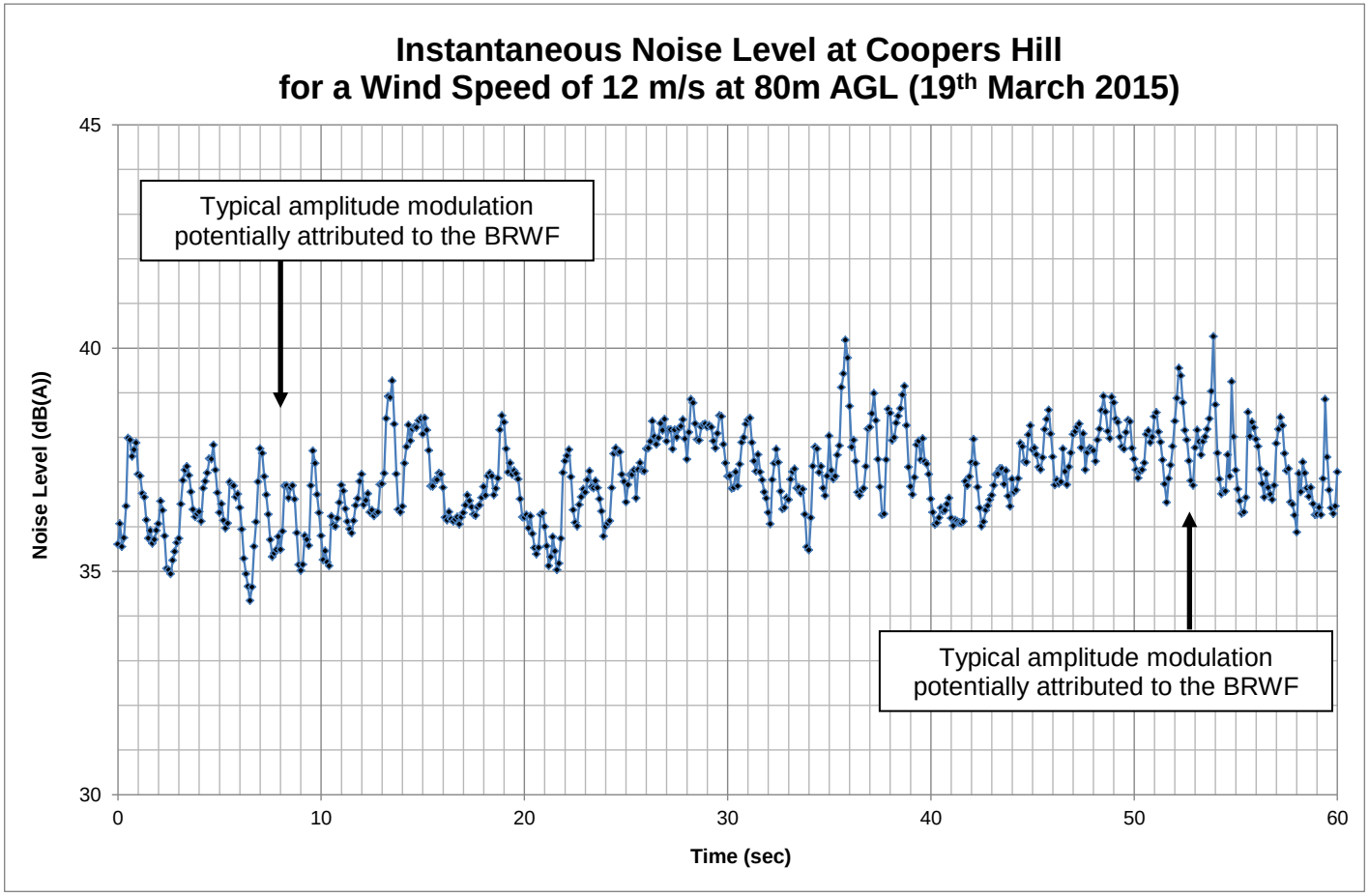
APPENDIX E: Influence of Tonality Penalty on Correlations at Coopers Hill




Operational Noise Level and Wind Speed Correlation - Coopers Hill
Post-construction Measured Noise Level
Measured Noise Level with Penalty
Post-construction Measured Noise Level Regression Line
Pre-construction Measured Background Noise Level Regression Line
Regression Line with Penalty
y = -0.013x³ + 0.367x² - 2.4058x + 37.6
R² = 0.129
y = -0.0106x³ + 0.3103x² - 2.024x + 37.069
R² = 0.1176
Noise Level, L90 (dB(A))
Hub Height (80m) Wind Speed, m/s
0
10
20
30
40
50
60
70
80
4
5
6
7
8
9
10
11
12
13
14

APPENDIX F: Amplitude Modulation Measured at Coopers Hill




Instantaneous Noise Level at Coopers Hill
for a Wind Speed of 12 m/s at 80m AGL (19th March 2015)
Noise Level (dB(A))
45
40
35
30
0
10
20
30
40
50
60
Time (sec)
Typical amplitude modulation potentially attributed to the BRWF
Typical amplitude modulation potentially attributed to the BRWF