
Flyers Creek Wind Farm - Background Noise Monitoring Survey Report

Document No.: 50B-08-0089-TRP-771535-1
7 June 2010



Aurecon Australia Pty Ltd

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EXECUTIVE SUMMARY

Vipac has performed a background noise survey within the vicinity of the proposed Flyers Creek Wind Farm (near Orange, NSW) to determine the existing background noise levels at the site and to develop noise amenity criteria in accordance with the SA EPS Guideline.

The background noise levels at five residential sites in the vicinity of the proposed wind farm have been measured continuously over a period of at least three weeks at each site from 13th November 2009 until the 24th December 2009. The sound level meters monitored noise data simultaneously over the period, in conjunction with the collection of wind data from the wind farm site anemometer, and three ground level anemometers at residential receiver locations.

The noise data and wind data sampling periods were performed in synchronised 10-minute intervals. A total of over 2,400 synchronised data pairs (after exclusion of unsuitable data) were obtained at all five of the sites. A small amount of noise data was omitted where there were periods of significant wind speeds at the noise logger microphones or where there were rainfall events.

A regression analysis of the noise-wind speed data scatter plots has been performed on the entire set of wind and noise data pairs (after exclusion of unsuitable data), which is used to determine the noise criteria for each site (from cut-in to rated wind speeds). A recommended noise criterion level at each of the monitored sites has been based on the level not exceeding 35dB(A) or the regression fitted background noise level curve plus 5 dB(A), in accordance with SA EPA Wind Farm Guidelines 2009.

The overall noise criterion levels in dB(A) for each integer wind speed (at height of 78.6m AGL), determined from the regression equation (rounded to the nearest 0.5dB), for the measured sites are shown in the table below.

Noise Level Criteria at Each Logged Residence at Flyers Creek Wind Farm

Location #	3	4	5	6	7	8	9	10	11	12
12	35.0	35.0	35.5	36.5	38.0	39.0	40.0	41.0	41.5	42.5
25	35.0	35.0	35.0	35.0	36.0	37.0	38.0	39.0	40.0	40.5
27	35.0	35.0	35.0	35.0	35.0	36.5	37.5	39.0	40.0	41.0
78	35.0	35.0	35.0	35.0	35.0	36.0	37.5	39.5	41.0	43.5
89	39.0	40.5	41.5	43.0	44.0	45.0	46.5	47.5	48.5	50.0

The noise criteria to be applied at other residences within 3 kilometres of the Flyers Creek Wind Farm were determined by matching background noise from a similar (representative) site which has had a background noise survey undertaken. The assessment of similarity of acoustic environment at respective residences was based on a number of influencing factors as described in Section 6.2.



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1. INTRODUCTION

Vipac has performed a background noise survey within the vicinity of the proposed Flyers Creek Wind Farm to determine the existing background noise levels at the site.

The proposed Flyers Creek Wind Farm in the Central West region of NSW, is located approximately 20km south of Orange, and approximately 20km west of Blayney. The project is expected to have between 30 and 40 wind turbines and associated ancillary works distributed as shown in Figure A-1 (refer to Appendix A).

While the Director General's requirements for the Environmental Assessment issued in Jan 2009 specified use of the SA EPA Guidelines 2003, the guidelines were updated during 2009. Where practicable it appears relevant to follow the more recent guideline. All measurements, analysis and assessments for background noise at Flyers Creek Wind Farm have been performed in accordance with these guidelines. In previous wind farm developments background noise levels were measured in accordance to the 2003 SA EPA noise guidelines. We note that generally the major differences between the 2009 and 2003 guidelines are outlined below:

- 2009 guidelines move from wind speed being measured at 10m height to hub height
- 2009 guidelines add in extra noise compliance measurement procedures at sites where compliance is marginal, and to determine whether noise is genuinely wind farm induced or other

In general, in regards to background monitoring, either standard will provide little difference in criteria determination results (with the main difference being where wind speeds are referenced to 10m AGL or hub height). We note however that the 2009 guideline (of using hub height wind speeds) gives a more accurate overview of noise levels with the entire wind farm noise assessment process in mind.

This assessment provides criteria references to both hub height and 10m height wind speeds (derived from hub height data). The subsequent noise assessment uses 10m height reference due to the turbine noise specification being referenced to 10m height wind speeds, and uses the same scaling method as used in the turbine noise specification (IEC61400-11:2002+A1:2006).

2. REFERENCES

- 2.1 "Wind Farms: Environmental Noise Guidelines", SA Environment Protection Authority, SA Government, July 2009 (ISBN 978-1-876562-43-9).
- 2.2 AS IEC 61672 (2004) *Electroacoustics – Sound Level Meters* (Parts 1 & 2) [replaces superseded AS 1259-1990]

3. SITE DESCRIPTION

The general area of the wind farm site comprises a mix of pasture and open farming properties. The aspect of the landscape is open, with significant hills and occasional trees and other obstructions. The area is classified as 'General rural'.

Background noise monitoring was undertaken at five locations, which were chosen after investigation (and discussion/agreement with Aurecon and Infigen Energy) showed them as being representative of groups of residences situated in different sectors around the proposed wind farm. A site plan is provided in Appendix A showing the locations of relevant noise sensitive residents, and the monitored locations shown as green circles in squares.



4. EQUIPMENT AND SETUP

Calibrated Type 1 environmental noise loggers were installed at five (5) sites in total (as outlined in Table 4-1 and Figure A.1). The noise loggers installed are outlined in Table 4-1. Noise monitoring was performed over a period of six weeks, and in addition to the five environmental noise loggers, three weather stations per monitoring campaign were to determine local wind conditions, wind speed (at microphone level), wind direction and rainfall. During the monitoring period, the L_{A90} noise descriptor was recorded to enable analysis in accordance with the EPA guidelines [Ref 2.1].

The sound level meters used in the loggers satisfy the requirements of IEC 61672 [Ref 2.2] and were calibrated with a piston-phone calibrator before and after the monitoring survey. Microphones were protected with high wind speed windshields in accordance with the manufacturer's instructions.

Table 4-1 details of the location and name of the property, the noise logger details and whether the site is to be identified as a 'wind farmer' i.e. with a wind turbine to be installed on that property or not. The residential sites are also shown in Figure A.1 in Appendix A. Photographs of the equipment setup at each of the sites are shown in Appendix B.

Location #	Logging Period Start Date	Logging Period End Date	Approximate Location UTM (WGS 84) Zone 55H		Wind farmer	Logger Type	Logger Serial No.
			Easting	Northing			
12	13/11/2009	24/12/2009	689773	6285970	No	LD870	1463
25	13/11/2009	24/12/2009	693785	6291820	No	LD824	A2596
27	13/11/2009	24/12/2009	692031	6292594	No	LD812	529
78	13/11/2009	4/12/2009	693998	6285531	No	ARL EL316	16-004-025
78	4/12/2009	17/12/2009	693998	6285531	No	Brüel & Kjør 2236	1914120
89	13/11/2009	4/12/2009	693581	6289659	No	LD870	0181
89	4/12/2009	10/12/2009	693581	6289659	No	LD812	0711
89	10/12/2009	24/12/2009	693581	6289659	No	ARL EL316	16-004-025

Table 4-1: Details of the Monitoring at Residential Sites in the Vicinity of the Proposed Wind Farm.

We note that at some sites multiple noise loggers were used (during different periods), this was due to equipment failure (and replacement of operational equipment).

Wind speeds at the proposed wind farm site (at representative hub height of 78.6m AGL) were obtained using the central/middle Meteorological Mast (location coordinates 149°04'18.4"E, 33°32'35.0"S). While there are three meteorological masts at the wind farm site, there was only a small difference between average wind speeds between these masts. One meteorological mast was used in the background noise assessments for all sites as it provides greater simplicity, which provides more robust measurement repeatability.

5. MICROPHONE LEVEL WIND SPEED AND RAINFALL DATA

The microphone-level wind speeds and rainfall were also recorded at three locations during the monitoring campaign, as outlined in Table 5-1. All local weather stations measured wind speed and direction, with the weather stations at locations 27 and 89 also logging rainfall data. A number of 10-minute intervals during which the measured wind speed (at the microphone height) exceeded 5ms^{-1} were excluded from the analysis



of the paired noise and hub height wind data. The SA EPA wind farm guidelines [Ref 2.1] recommend that wind speeds are monitored at microphone height at a measurement location per measurement period. If wind speeds at this location exceed 5ms^{-1} then the corresponding noise record (at the nearest noise monitoring locations) is classified as invalid and excluded from analysis.

Similarly if there was any rain measured at the microphone location or measured in the locality, data was excluded from the analysis.

Residential Location	Weather Station Type	Weather Station Serial Number	Period Start	Period End	Easting	Northing	% of excluded data – Wind	% of excluded data - Rain	% of excluded data- Total
27	Weather Master 2000	0603-0811	13/11/2009	24/12/2009	692031	6292594	3%	1%	3.1%
78	Envirodata Weather one	0310-0614	13/11/2009	17/12/2009	693998	6285531	1%	1%	1.1%
89	Weather Master 2000	0802-0123	13/11/2009	24/12/2009	693581	6289659	0%	1.6%	1.6%

Table 5-1: Location of microphone weather stations installations.

The percentage of data excluded as a result of high wind events at the microphone also given in Table 5-1. Data was collected for all wind directions throughout the monitoring period, including a sufficient percentage of worst case wind directions for most receiver locations.

6. RESULTS

6.1. Criteria at Logged Residences

Measurement data was recorded for the following noise descriptors/indices:

- L_{Aeq}
- L_{A10}
- L_{Amax}
- L_{A90}

Plots of the measured noise level over time for all locations are shown in Appendix C. We note that the noise-floor of the noise logger units can be seen to be typically around 18 to 19 dB(A).

The number of valid paired wind and background noise points collected for each site (after exclusion of unsuitable data) are given in Table 6-1.



Site Location	Total Number of Data Points	Number of Data Points Excluded	Number of Data Points Used
12	4769	1888	2811
25	4868	1994	2874
27	3992	1521	2471
78	4771	1384	3387
89	4397	1824	2573

Table 6-1: Number of noise data points measured (after excluding wind and rain affected data).

The SA EPA wind farm guidelines [Ref 2.1] requires that at least 2000 paired noise and wind data points are collected to gain statistically significant background noise levels. With the collected data (after excluding wind and rain affected data), this requirement is met at all the locations (with the number of data points at each location greater than 2400 points).

Regression analysis of the paired background noise (L_{A90}) and 78.6m AGL wind speed data plots for each site was performed and a relevant noise criterion curve at each sensitive receiver was determined. Background noise data (noise/wind data pairs) was omitted from the regression calculations during periods of high wind speeds ($> 5 \text{ ms}^{-1}$) or rain on the microphone and for wind speeds below cut-in at the site meteorological mast.

The scatter plots of noise level against wind speed measured at the wind farm site central/middle Met Mast (at 78.6m AGL, coordinates 149°04'18.4"E, 33°32'35.0"S) are given in Appendix D.

Regression curves were fitted to the plots in accordance with [Ref 2.1]. The formula for the resulting polynomial line of best fit is shown on the plots along with the associated correlation coefficient (R^2). For all locations, a third order equation gave the curve of best fit.

The background (L_{A90}) noise level at each unit wind speed from the cut-in wind speed (assumed to be 3 ms^{-1}) is calculated from the regression analysis in Appendix D and is shown in Table 6-2.

Location #	Wind Speed (ms^{-1} at 78.6m AGL)													
	3	4	5	6	7	8	9	10	11	12	13	14	15	16
12	27.5	29.0	30.5	31.5	33.0	34.0	35.0	36.0	36.5	37.5	38.5	39.0	39.5	40.5
25	24.0	26.0	28.0	29.5	31.0	32.0	33.0	34.0	35.0	35.5	35.5	35.5	35.5	35.0
27	25.0	26.5	27.5	29.0	30.0	31.5	32.5	34.0	35.0	36.0	37.0	38.0	39.0	39.5
78	26.0	26.5	27.5	28.5	29.5	31.0	32.5	34.5	36.0	38.5	40.5	43.0	46.0	48.5
89	34.0	35.5	36.5	38.0	39.0	40.0	41.5	42.5	43.5	45.0	46.5	47.5	49.0	51.0

Table 6-2: Background noise levels at various wind speeds (at 78.6mAGL).

A recommended noise criterion level at each of the monitored sites has been based on the level not exceeding 35dB(A) or the regression fitted background noise level curve plus 5 dB, whichever is greater. The noise criterion level at each integer wind speed from the assumed cut-in wind speed to rated power wind



speed (12 ms^{-1}) is also calculated from the regression equation (rounded to the nearest 0.5dB) and is shown in Table 6-3.

Location #	3	4	5	6	7	8	9	10	11	12
12	35.0	35.0	35.5	36.5	38.0	39.0	40.0	41.0	41.5	42.5
25	35.0	35.0	35.0	35.0	36.0	37.0	38.0	39.0	40.0	40.5
27	35.0	35.0	35.0	35.0	35.0	36.5	37.5	39.0	40.0	41.0
78	35.0	35.0	35.0	35.0	35.0	36.0	37.5	39.5	41.0	43.5
89	39.0	40.5	41.5	43.0	44.0	45.0	46.5	47.5	48.5	50.0

Table 6-3: Noise level criteria at various wind speeds (ms^{-1} at 78.6mAGL).

We note that the sound power data which the noise impact assessment will be performed to will have sound power data referenced to 10m AGL wind speeds (which is derived from hub height wind speed). We therefore have adjusted this criteria set from hub height wind speeds to 10m AGL wind speeds (following the same procedure as outlined in the sound power wind speed derivation, given in IEC61400-11:2002+A1:2006, eq. 7). As the conversion from hub height wind speed to a reference height of 10m AGL gives non-integer wind speeds (and the supplied IEC 61400 sound power data is in integer wind speeds), a linear interpolation of the criteria has been performed on the scaled wind speed (from hub height to 10m AGL) to obtain criteria for integer wind speeds and given in Table 6-4.

Monitored Site	Wind speed ms^{-1} (at 10m AGL)						
	3	4	5	6	7	8	9
R012	35	36	38	39.5	40.5	41.5	42.5
R025	35	35	36	37.5	38.5	40	40.5
R027	35	35	35	37	38.5	40	41
R078	35	35	35	36.5	39	41.5	43.5
R089	40.5	42.5	44	45.5	47	48.5	50

Table 6-4: Resultant noise criteria for each site at 10m AGL reference

The applicable zoning of the land under the Blayney Local Environmental Plan is 'General Rural' The objectives of this zone are to promote the proper management and utilisation of resources including agricultural, soil, water, mineral, heritage and ecological values of the lands within the zone while allowing a range of rural living styles in appropriate locations within the zone and encouraging the establishment of rural and related industries within the zone. The project lands are associated with predominantly pastoral activities but there are scattered rural residences present throughout the project area and surrounding lands.

No special characteristics such as tonality were subjectively detected in the background noise environment at the monitoring locations.

It is noted that the Cadia mine operations occur over 24 hours including haulage of rock and rubble.



6.2. Criteria at Non-Logged Residences

The noise criteria at residences in the vicinity of the Flyers Creek Wind Farm which did not have background noise monitoring undertaken were assigned by matching background noise from a site which has had a background noise survey and has a similar ambient acoustic environment. A number of factors determine the selection of which background site (and criteria) are most applicable to each receiver locations outlined below:

- Degree of exposure to winds
- Type and amount of vegetation at residence location
- Other mechanical sources, pumps, generators, windmill etc.
- Domestic farm animals located near the residence
- Resident activities

It is not possible to be definitive on all of these items as these factors vary over time. The maximum variation between the five monitored sites is approximately 10 dB at wind speeds between 3 and 12ms⁻¹. This exercise aims to identify the representative site that is most similar to a specific neighbour residence location.

In addition, if a resident is associated with the wind farm (i.e. a “wind farmer”) then we classify the residence as a non-relevant receiver. If the resident is a neighbour to the wind farm, and not involved (i.e. not a “wind farmer”) we classify the residence as a relevant receiver.

The background site (and its associated criteria) for non-logged relevant receivers are outlined in Table 6-5.

We note that the criteria of most sites are generally similar for most sites with the exception of site 89. As the criteria for Site 89 are significantly higher (7 to 8dB) than other locations, therefore we have not applied the criteria at 89 to any other location for conservatism.

Background monitoring site	Sites considered to have a similar background noise characteristic
R012	R001, R003, R004, R005, R009, R010, R011, R012, R013, R014, R015, R016, R017, R021, R051, R052, R057, R071, R073, R074, R075, R079, R085, R086, R087, R088, R102, R106, R107, R095, R109, R51B, R022, R112, R126, R128, R129, R130, R131, R132, R158
R025	R023, R024, R025, R034, R042, R043, R080, R082, R098, R114, R115, R116, R137, R152
R027	R020, R026, R027, R028, R036, R037, R044, R045, R092, R093, R094, R096, R117, R118, R119, R120, R121, R122, R123, R124, R125, R127, R138, R139, R140, R141, R142, R143, R144, R145, R146, R153, R154, R155, R156, R157
R078	R002, R046, R047, R048, R049, R050, R054, R055, R056, R072, R076, R077, R078, R090, R099, R100, R101, R108, R110, R111, R133, R134, R136, R147, R148, R149, R150, R151
R089	R089

Table 6-5: representative Background Sites With Similar Noise Criteria



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APPENDIX A FLYERS CREEK WIND FARM SITE PLAN

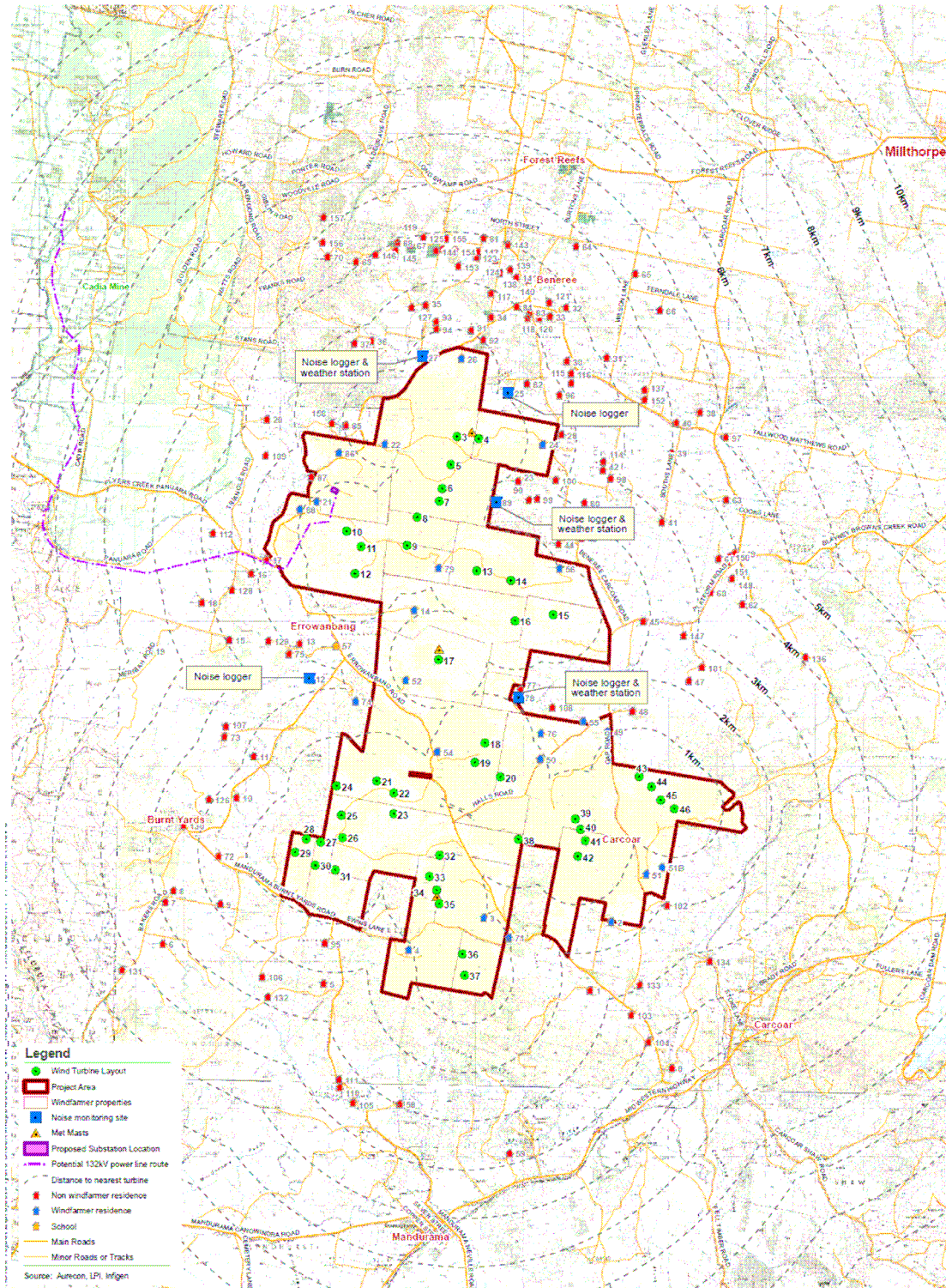


Figure A-1: Site plan showing monitoring locations and met mast locations.



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APPENDIX B PHOTOS OF INSTALLED LOGGERS ON SITE



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Location 12 (residence is behind trees)



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Location 25



Location 27



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Location 78



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Location 89

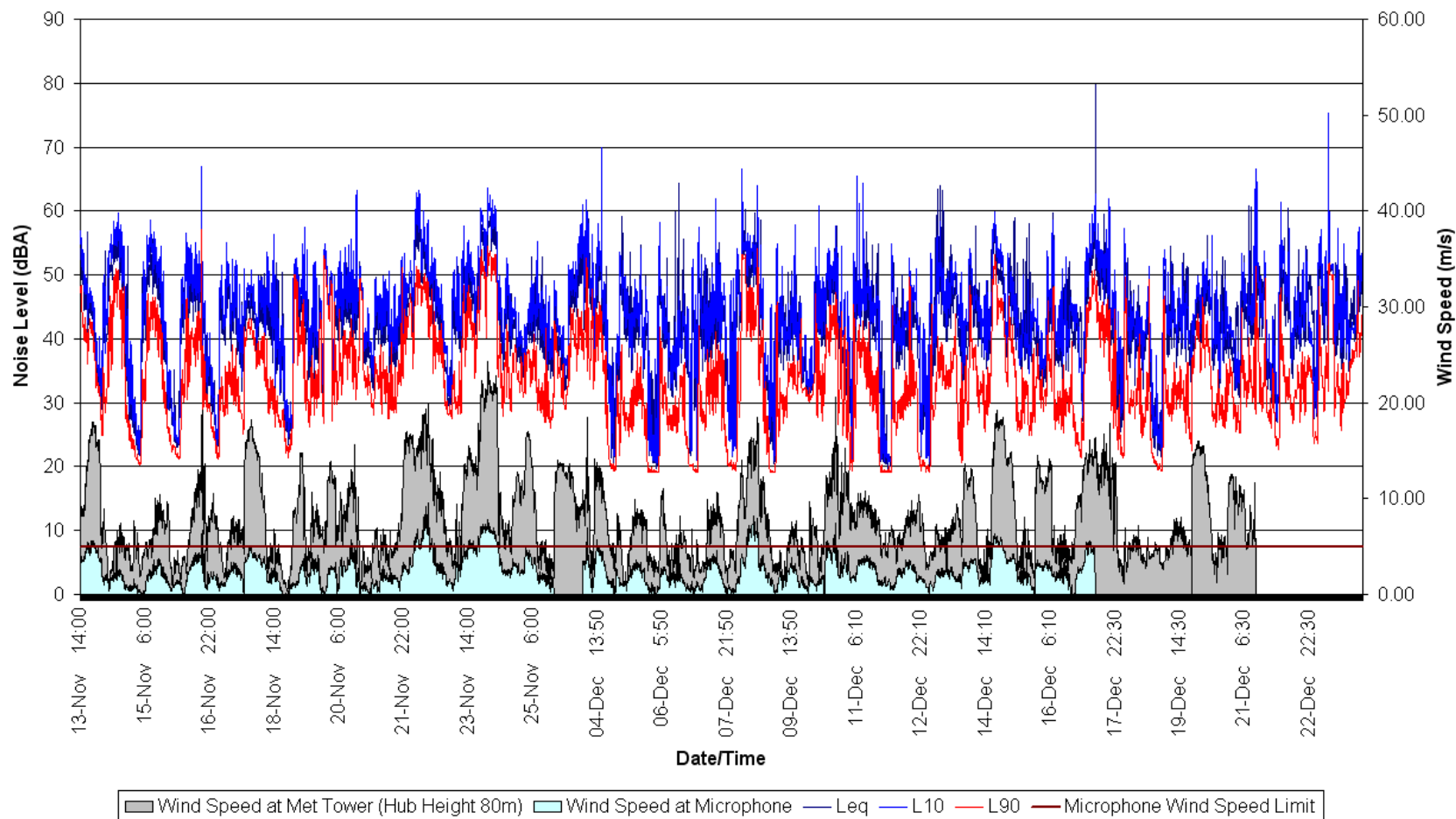


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APPENDIX C CONTINUOUS NOISE PLOTS AT RECEIVERS

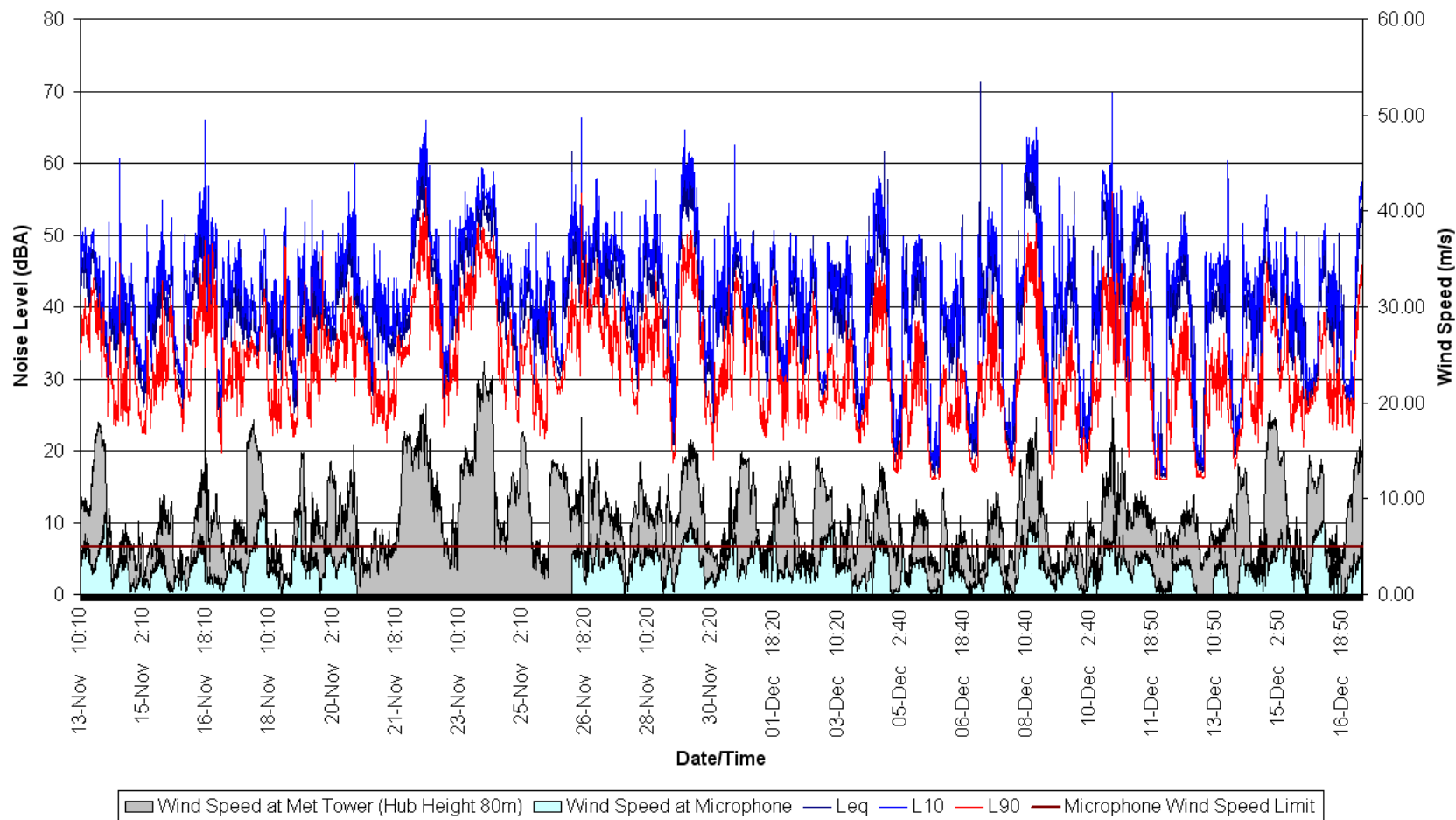


Loc 12: Measured Noise Levels & Wind Speed vs Time



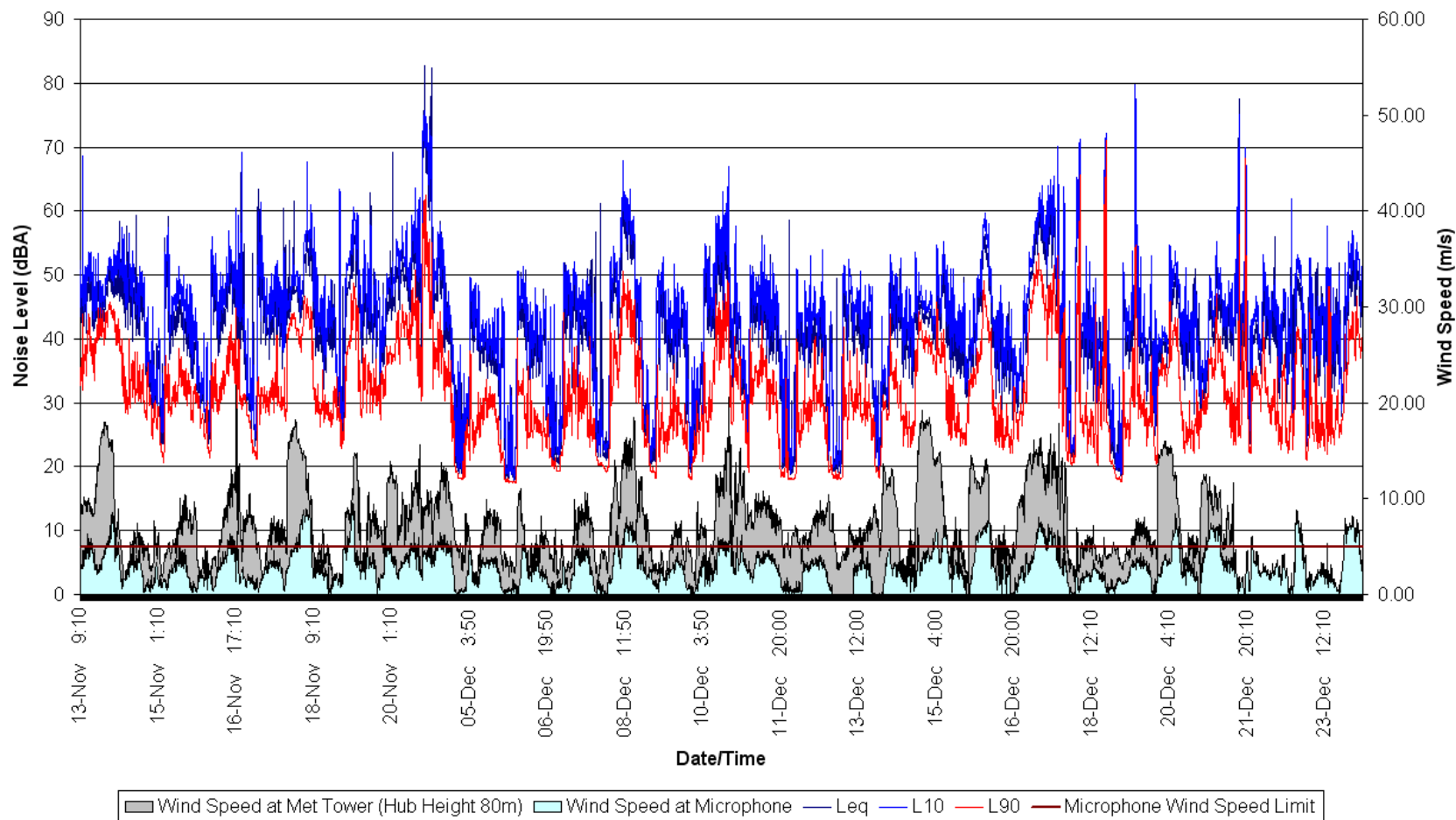


Loc 25: Measured Noise Levels & Wind Speed vs Time



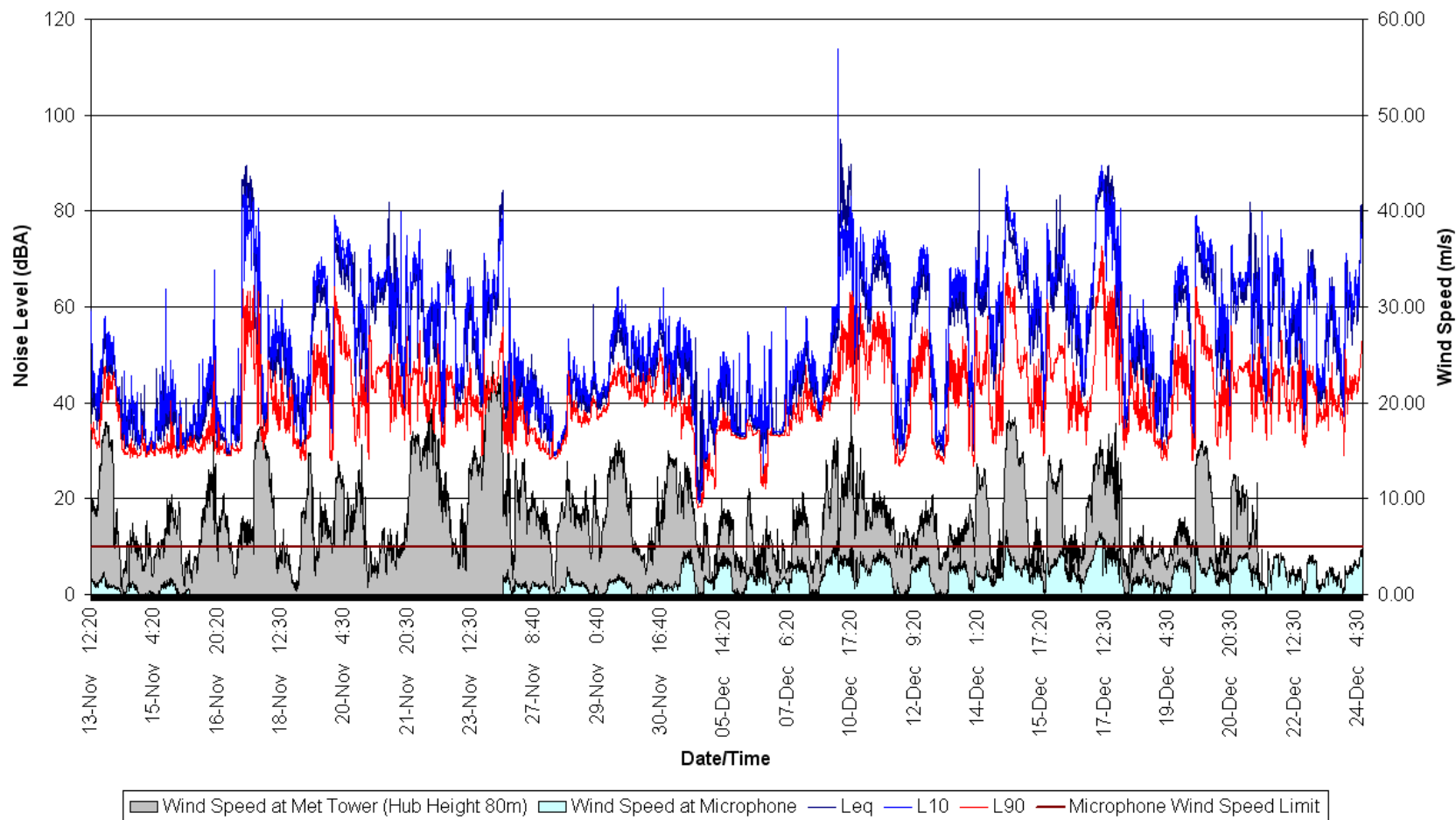


Loc 27: Measured Noise Levels & Wind Speed vs Time





Loc 89: Measured Noise Levels & Wind Speed vs Time



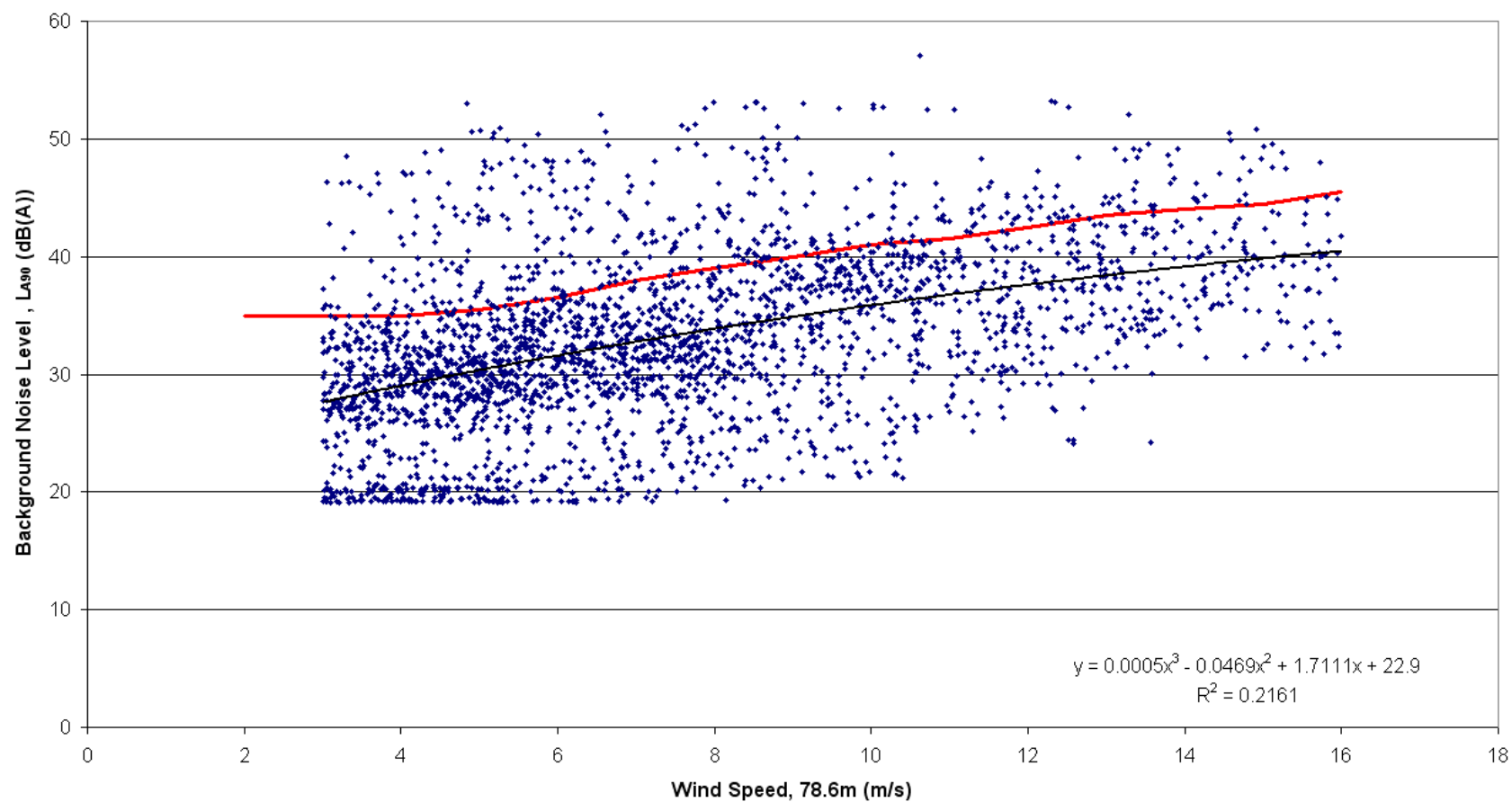


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APPENDIX D REGRESSION ANALYSIS FOR MEASURED DATA

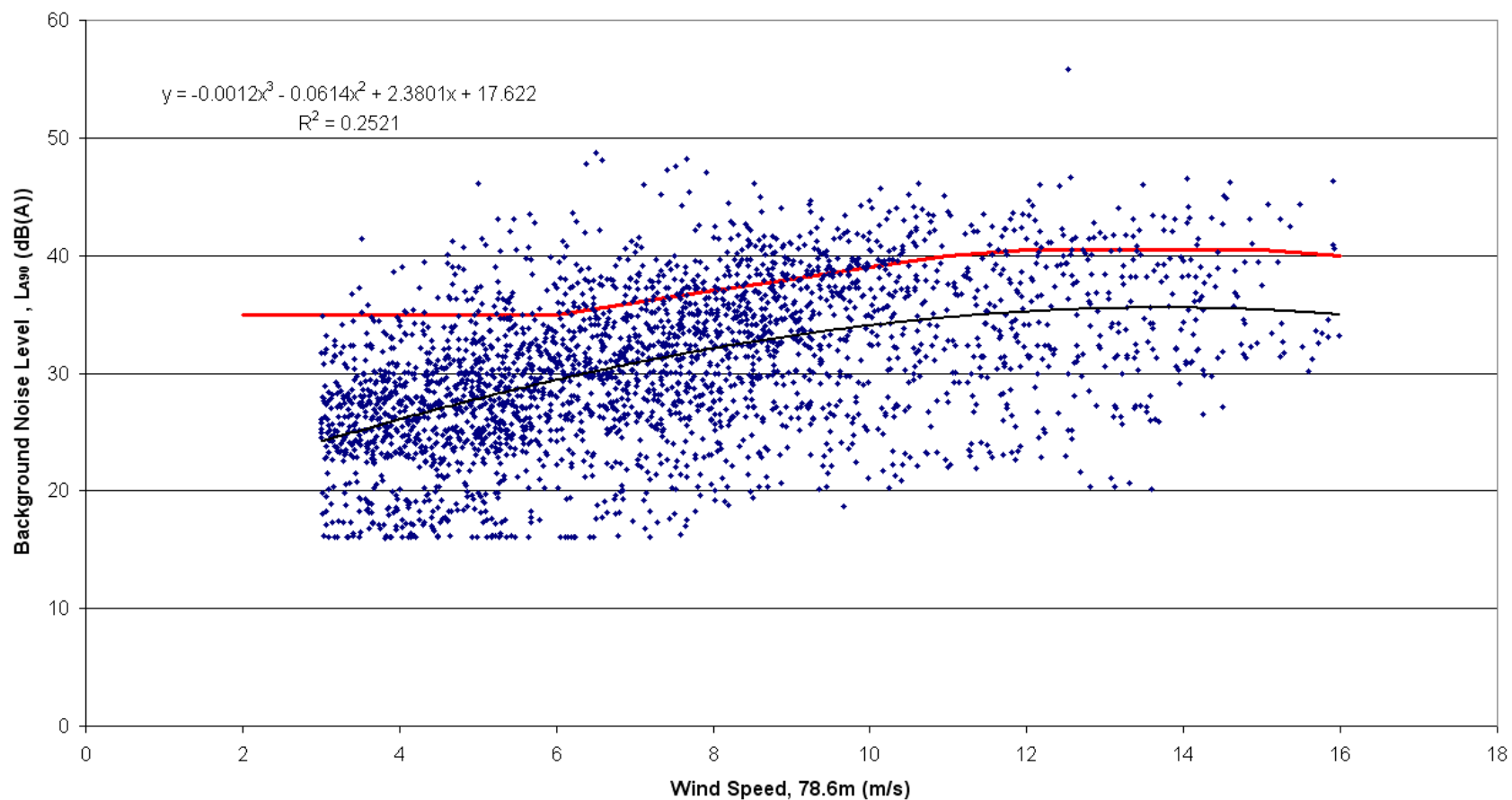


**Loc 12 Background Noise at Receiver vs Wind Speed at Windfarm
78.6m AGL Total Regression**



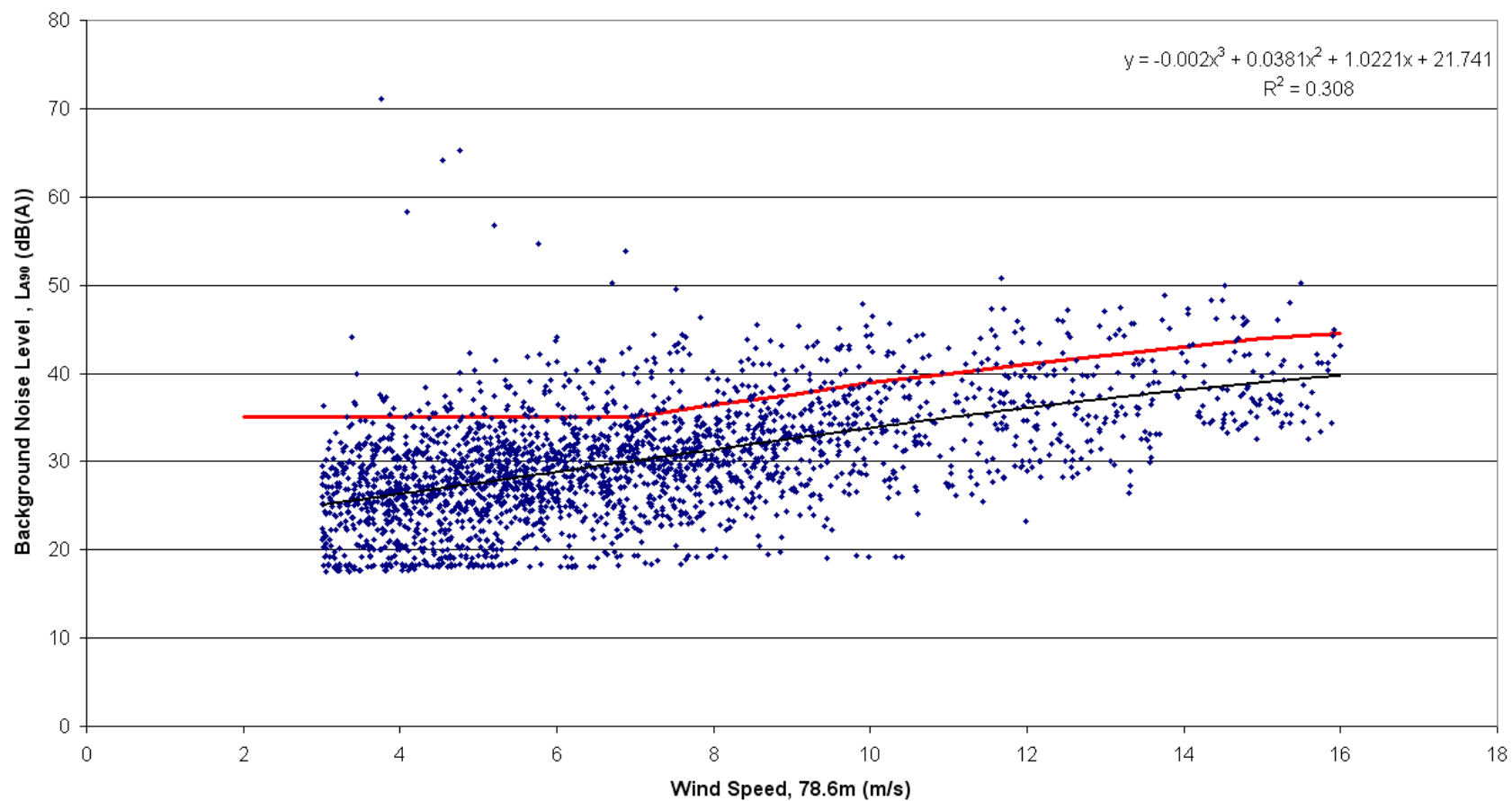


**Loc 25 Background Noise at Receiver vs Wind Speed at Windfarm
78.6m AGL Total Regression**



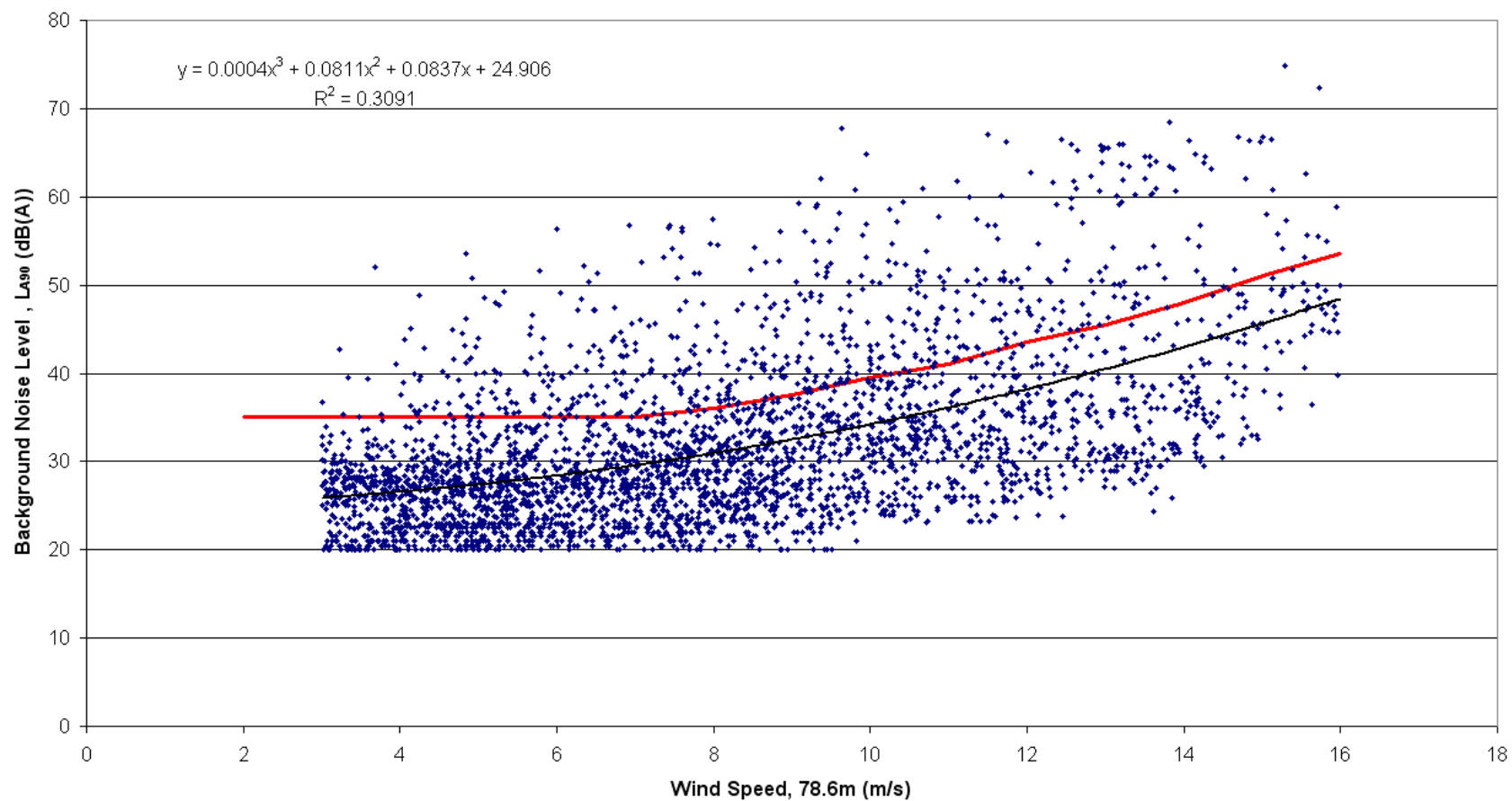


**Loc 27 Background Noise at Receiver vs Wind Speed at Windfarm
78.6m AGL Total Regression**



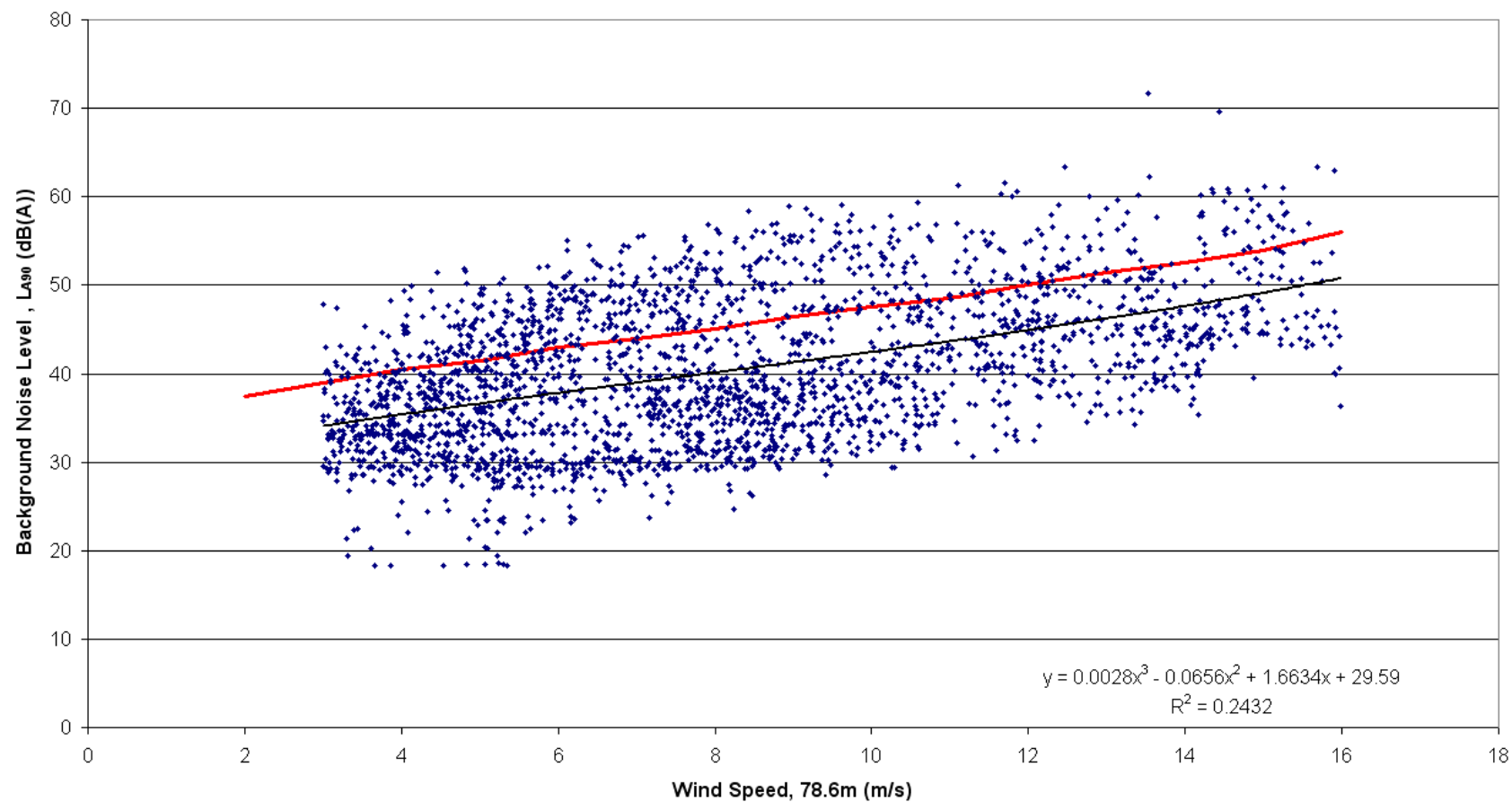


Loc 78 Background Noise at Receiver vs Wind Speed at Windfarm
78.6m AGL Total Regression





**Loc 89 Background Noise at Receiver vs Wind Speed at Windfarm
78.6m AGL Total Regression**





Noise Criteria at all sites Summary

