Renewable Power Ventures

Noise Impact Assessment Report

Capital Wind Farm

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EXECUTIVE SUMMARY

A noise impact assessment has been performed of the proposed Capital Wind Farm development near Tarago, New South Wales.

The likely noise impact of the proposed wind farm configuration has been predicted for a range of operational and wind scenarios using an accurate Predictive Noise Model (based on the accepted Concawe algorithm for meteorological conditions and the ISO9613 standard). The algorithms used in the model take into account the likely effects of atmospheric absorption, ground absorption/reflection, diffraction and attenuation by topographic features, screening effect of barriers and the propagation effect of wind speed and direction.

The proposed wind farm configuration will consist of 63 Suzlon S88 2.1MW Wind Turbine Generators (WTGs) distributed in an array along crests of the Great Dividing Range.

There are a total of about 50 residential premises in the vicinity of the proposed wind farm, of which approximately 17 are within about 1.5 km, with 14 of these classified as non-relevant (or are "windfarmers" with wind turbines on their properties) and only 3 are relevant receivers.

The background noise measurements were taken at 8 representative residential dwellings that are in the closest proximity to the proposed wind farm (and represent a range in immediate terrain types). The monitoring was carried out over a two to three week measurement period per site and represented a statistically significant sample (over a range of wind conditions).

Regression curves were fitted to the background noise versus adjusted 10mAGL wind speed plots, and a recommended wind farm noise compliance level determined for each receiver.

The noise model was run for the maximum power WTG setting, for neutral and wind-affected propagation conditions. The model was run for the complete range of 16 wind directions for the range of wind speeds from 4 to 12 ms^{-1}, to determine whether any WTGs would need to be removed or alternatively if the operation of any turbine could be modified to ensure compliance.

The predicted levels were assessed against the SA EPA *"Environmental Noise Guidelines: Wind Farms"*. The predicted L_{Aeq} noise levels for neutral propagation conditions range between about 24 and 36 dB(A) at the nearest relevant receivers.

The predicted L_{Aeq} noise levels, for $8ms^{-1}$ wind conditions (for worst case WNW wind propagation), range between about 21 and 39 dB(A) at the relevant receivers. These predicted levels at maximum WTG power setting at $8ms^{-1}$ achieve the appropriate criteria for all relevant receivers. The criteria at the relevant receivers are achieved at most wind speeds, with the exception of sites G2, G10 and E7 where the criterion is just exceeded or on criterion at wind speeds between $4ms^{-1}$ and $7ms^{-1}$. Therefore, acoustic mitigation measures may be warranted. The options available for achieving the noise criteria – WTGs being relocated, removed or switched-off at certain wind speeds/directions – are outlined in this report.

The criteria at most other relevant receivers are achieved at many wind speeds and directions, with the exception of some sites where the criterion is exceeded.

Due to the absence of noise characteristics (such as tonality, impulsiveness, modulation or low frequency components), no penalty adjustments are required to be applied to the levels.

Predicted noise levels for worst case wind conditions at non-relevant receivers associated with the wind farm range between 30 and 44 dB(A), with levels up to 59 dB(A) at E2/E3 (L'Orizon). The predicted levels at the non-relevant receivers are not likely to cause unreasonable interference or sleep disturbance, except potentially at receivers E2/E3. These two residences are close to turbine sites and Renewable Power Ventures has advised that it has arranged to take over the lease of these residences.

The wind farm developer should ensure that there is a formal agreement between the developer and potential landowner wind farmers, which includes a description of the expected noise impact and the degree of interference that this may cause under certain conditions.

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1. INTRODUCTION

This report describes the noise impact assessment performed of the proposed Capital Wind Farm near Tarago, New South Wales.

The likely noise impact of the proposed wind farm configuration is predicted for a range of operational and wind scenarios using a noise model and accepted noise propagation algorithms.

Predicted noise levels are assessed against the SA EPA *"Environmental Noise Guidelines : Wind Farms"*.

2. REFERENCES

Ref 1 : *Environmental Noise Guidelines : Wind Farms*, SA Environment Protection Agency, 2003.

Ref 2 : Concawe Report No. 4/81: "*The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*", Manning C.J., 1981.

Ref 3 : International Standard ISO 9613 *Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation*, 1996.

Ref 4 : *Background Noise Monitoring Report, Capital Wind Farm*, Vipac Document No. 505608-TRP-017528-00, Vipac Engineers & Scientists, 27 April 2005.

Ref 5 : Letter to David Griffin from Department of Environment and Conservation (NSW) *Re: Capital Wind Farm Project, near Tarago*, Ref: 290757A1 (QUF5904), 11 August 2005.

Ref 6 : *Woodlawn Wind Farm Noise Assessment*, Wilkinson Murray Report No 04098, September 2004.

Ref 7 : *"Guidelines for Community Noise"*, World Health Organization (WHO), Geneva, Switzerland, 1999.

3. NOISE CRITERIA GUIDELINES

The NSW Department of Environment and Conservation has advised in [Ref : 5] that the primary criteria to be used for the Capital Wind Farm development are provided in the SA EPA *"Environmental Noise Guidelines : Wind Farms"* [Ref : 1].

The EPA guidelines [Ref : 1] state that: "The predicted equivalent noise ($L_{Aeq\ 10mins}$), adjusted for tonality in accordance with these guidelines, should not exceed 35dB(A) or the background noise ($L_{A90\ 10mins}$) by more than 5 dB(A), whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG."

The EPA guidelines [Ref : 1] also state all noise measurements are to be taken outdoors at 1.2 to 1.5 metres above the ground and within 20 metres of a noise sensitive premises (and at least 5m from any major reflecting surface). The background noise monitoring survey should be carried out (for representative sensitive or relevant receivers within 1.5km of the wind farm) over a period of at least 2 weeks to ensure the collection of at least 2000 valid data points. All wind speed measurements are to be taken at, or adjusted to, 10m AGL.

In addition, in accordance with the EPA guidelines [Ref : 1], an adjustment of 5dB(A) should be added if tonality, impulsiveness or low frequency components are present in the noise generated by the wind farm.

The criteria for this proposed wind farm (for relevant receivers) are determined from the background noise measurements at the site (see section 5). Corrections for the influence of wind-induced background noise are determined from the application of regression techniques described in [Ref : 1] and [Ref : 4].

For non-relevant receivers (associated with the wind farm), the World Health Organisation (WHO) criterion level for unreasonable interference or sleep disturbance is applicable [Ref : 7].

A glossary of acoustic terminology is provided in Appendix A.

4. PROJECT AND SITE DESCRIPTION

The proposed wind farm near Tarago is situated in proximity of Map Grid of Australia (MGA) reference 6,110,000 m N, 730,000 m E. The wind farm area is in the southern tablelands area of New South Wales. Note that the coordinate system used throughout is MGA (equivalent to UTM WGS84).

The site is located on the eastern side of Lake George, and is shown in Appendix B. In this area, the Great Dividing Range runs in an approximately north-south direction. 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 would be classified as rural or predominantly rural with some agricultural industry. The land use in the area mainly comprises intermediate-sized farming properties.

The proposed wind farm configuration will consist of 63 Wind Turbine Generators (WTGs) distributed in an array along the crests of the Great Dividing Range and are shown in Appendix B.

The proposed WTG type is a Suzlon S88 2.1MW with a three-bladed rotor, a diameter of 88m and a hub height of 80m. Rotation speed will vary up to a maximum of 15.5 rpm. The cut-in wind speed is $4ms^{-1}$, the cut-out wind speed is $25ms^{-1}$ and the rated wind speed is $14ms^{-1}$ (equivalent to $11.2ms^{-1}$ at hub height). The sound power output, measured at the reference wind speed of 8 ms^{-1} at 10mAGL (in accordance with IEC 61400-11), is 105.9 dB(A) (see also section 6).

Padmount transformers will be located near the base of the turbine towers. An electrical substation on the wind farm site will include a 33,000V/330,000V transformer rated at 135 MVA (together with switchgear and circuit breakers).

5. BACKGROUND NOISE MEASUREMENTS AND CRITERIA

The existing environment is defined from background noise monitoring that has been carried out at the proposed site and is detailed in [Ref : 4].

There are a total of about 50 residential premises (receivers) within 4 km of the proposed wind farm, with a total of 16 receivers within about 1.5 km of the nearest turbine, of which only three (G2, G6 and H24) are relevant receivers. The numbering of receivers in this report uses an alphabetic prefix relative to the nearest turbine group (ie., G – Groses Hill, E – Ellenden, H – Hammonds Hill). The receivers are listed, with details, in Appendix C and are also shown (with their corresponding numbers) in Appendix B. The residences associated with the wind farm ("windfarmers", with wind turbines on their properties) are noted in Appendix C.

The background noise levels at eight receiver sites in the vicinity of the proposed wind farm have been measured continuously over a period of two to three weeks. Noise monitoring equipment was installed at two additional sites, however no useful data was obtained at these locations. Monitoring was carried out over a two to three week measurement period per site and represented a statistically significant sample (over a range of wind conditions). The background noise levels in the vicinity of the proposed Capital Wind Farm site have been measured in accordance with [Ref : 1].

The background monitoring was undertaken with the use of Type 1 and Type 2 noise loggers (Type 2 noise loggers are approved for use, as per the SA Guidelines). The noise floor for the Type 1 loggers varied between about 20 and 25 dBA and for the Type 2 loggers varied between about 25 and 28 dBA. Such noise floors typically only affect the regression analysis at low wind speeds (around cut-in speed) and would usually affect the criterion determination by less than 1 dB. The highest noise floor (28 dBA) was for site 5 (H15, The Patch) where predicted levels are greater than 5 dB lower than the criterion (see section 6).

The background noise measurements were taken at the eight representative residential dwellings that are in the closest proximity to the proposed wind farm (and represent a range in immediate terrain types). The locations surrounding the wind farm where background noise measurements have been obtained are:

- Luckdale (G2)
- Euroka (G7)
- Sunnybrook1 (G8)
- The Patch (H15)
- Gray Lot 7 (H5)
- L'Orizon (E2)
- Currandooley (H2)
- Wyoming (E1)

In addition, two nearby background noise monitoring sites, shown below, have been assessed and reported by Wilkinson Murray in the Woodlawn Wind Farm EIS [Ref : 6]:

- Torokina (G18)
- Bonnie Doon (H25)

Therefore ten background sites are available surrounding the wind farm site which can be used for the assessment of the wind farm's noise impacts.

The background noise levels and associated criteria for the ten representative locations can be applied to the other residence locations, depending on location and degree of exposure to prevailing meteorological conditions and similarities in characteristics that contribute to the ambient noise environment. Therefore, the following background sites (and associated criteria) are considered representative for the residences shown:

Background monitoring site	Sites considered to have a similar background noise characteristic
Luckdale (G2)	G3, G4
Euroka (G7)	G5, G6
Sunnybrook 1 (G8)	G9, G10, G11, G12, G13, G14, G15, G16, G17, H3
The Patch (H15)	H13, H17, H18, H20, H21, H22, H26, H27
Gray Lot 7 (H5)	H4, H6, H7, H11, H14, H16, H19, H24, H25
L'Orizon (E2)	E3, E6
Currandooley (H2)	E4, E5, E7, H1
Wyoming (E1)	Not applied to any other sites
Bonnie Doon (H25)	H8, H9, H10, H12
Torokina (G18)	Not applied to any other sites

Table 1: Representative background sites with similar noise criteria

For residential sites which have WTGs on their property, the criteria above are not strictly applicable to the noise from the Capital Wind Farm. These residences are classified as "windfarmers" or non-relevant receivers and are identified in Appendix C.

The results of the analysis of the noise and wind monitoring are given in [Ref : 4]. Reference wind measurements were obtained at the 65mAGL high "Sunnybrook" mast location at the site, simultaneously with the noise data over 10 minute intervals. Wind speeds up to about 17 ms^{-1} were recorded.

Background noise data (noise/wind data pairs) during periods of rainfall and high ground-level wind speed (at the microphone location) were omitted from the data plots and criterion calculations [Ref: 4]. A total of about 2,000 synchronised data pairs were obtained at most of the sites, although some sites (only non-relevant receivers) had marginally fewer as a result of this potentially unsuitable data being omitted, which is not considered significant as the data was evenly distributed across the range of wind speeds.

The scatter plots of noise level against 10mAGL wind speed are given in [Ref : 4]. Regression curves were fitted to the plots in accordance with [Ref : 1]. The adjusted 10mAGL wind speed plots (provided by the anemometer data) vs. background noise level are shown in Appendix E. These are then consistent with the wind turbine manufacturer's sound power data at 10mAGL used in the predictions.

A recommended wind farm noise compliance level at each of the eight monitored sites and the rest of the sites has been based on the background noise levels measured. The noise criterion levels at 8ms^{-1} (10mAGL) from Appendix E are as follows:

- Luckdale (Site 1 - G2) : 41 dB(A)
- Euroka (Site 2 - G7) : 37 dB(A)
- Sunnybrook1 (Site 3 - G8) : 37 dB(A)
- The Patch (Site 5 - H15) : 40 dB(A)
- Gray Lot 7 (Site 6 - H5) : 36 dB(A)
- L'Orizon (Site 8 - E2) : 40 dB(A)
- Currandooley (Site 9 - H2) : 38 dB(A)
- Wyoming (Site 10 - E1) : 37 dB(A)

The noise criterion levels reported in the Woodlawn Wind Farm EIS are shown below.

- Torokina (G18) : 38 dB(A)
- Bonnie Doon (H25) : 40 dB(A)

The residences with wind turbines on their properties (identified in Appendix C) are not relevant receivers and the above criteria are not applicable. Predicted levels are provided for these sites and referenced to the World Health Organisation (WHO) relevant guideline level of 45 dB(A) [Ref: 7]. This applies to the Euroka, Sunnybrook1, Currandooley, Wyoming and L'Orizon residences. In the case of L'Orizon it is understood that Renewable Power Ventures (RPV) will lease these residences from the landowner.

There is another known proposed development in the area. The proposed Woodlawn Wind Farm will be located to the north east of the Capital Wind Farm and obtained Development Consent in October 2005. It will comprise 25 2MW wind turbines. The distance between the two wind farms at the closest point is greater than 5 km. The intervening area between the wind farms is sparsely settled and none of the residences in this area is located such that the combined noise impacts of the two wind farms would cause criteria to be exceeded at the residence location (see Table 4 in the next section).

6. NOISE MODEL PREDICTIONS

An accurate Predictive Noise Model has been constructed using the validated and accepted Concawe algorithm ([Ref: 2]; and section 7.3 in this report) for noise propagation in different meteorological conditions. The standard ISO9613 algorithm [Ref : 3] was used for predictions in neutral conditions (no wind). The noise model has been constructed using the widely recognised SoundPLAN proprietary software package.

The algorithms used in the model take into account the likely effects of atmospheric absorption, ground absorption/reflection, diffraction and attenuation by topographic features, screening effect of barriers and the propagation effect of wind speed and direction. The accuracy of the noise model is likely to be at least ± 2 dB(A) and up to the order of ± 5 dB(A) (see section 6.1)

The model incorporates the proposed locations and heights of the 63 WTG array (see layout in Appendix B and list in Appendix D). The model uses the manufacturer's S88 2.1MW overall sound power level data for the reference wind speed of 8ms^{-1}, distributed as per the published spectrum for that model. Predictions at other wind speeds are made using the relative difference in overall sound power level at those speeds, as measured (for wind speeds 6 to 8 ms^{-1}) and predicted (for wind speeds 4, 5 and 9+ ms^{-1}) by Suzlon, as shown in Appendix F and G.

The sound power output of the Suzlon S88 2.1MW WTG in L_{Aeq} third octave bands (from 25Hz to 10kHz), calculated for the reference wind speed of 8ms^{-1} at 10mAGL in accordance with IEC 61400-11, is provided in Appendix G.

There are no detectable tones in the sound power spectrum of the Suzlon WTGs. There are no additional significant characteristics such as impulsiveness, modulation or low frequency components. In the close vicinity of a WTG there is a slight swish-like modulation resulting from the rotor blade passing through the air and past the support tower in addition to a slight hum emanating from the WTG generator. These minor effects diminish rapidly over distance and, for an array of WTGs, are randomly mixed to form low-level background white noise.

The noise model was run for the maximum power (105.9 dB(A)) setting for all of the Suzlon WTGs. The model was run with these sound power settings for neutral and wind-affected propagation conditions. The model was individually run for the complete range of 16 wind directions for the range of wind speeds from 4 to 12 ms^{-1}, to determine which WTGs need to be removed or switched off in each situation to meet the criteria (see section 7.2).

Rated power is 14 ms^{-1}; however, Suzlon data was only provided for up to 12 ms^{-1}. However, this is not an issue as the WTG sound power level is quite constant above 10 ms^{-1} whereas the criterion continues to increase. Therefore, the gap between predicted levels and criterion increases as wind speed increases beyond 10 ms^{-1}; hence, given that the criterion is easily satisfied at 12 ms^{-1}, it therefore will be easily met at 13 and 14 ms^{-1}.

Predicted L_{Aeq} noise levels (rounded to the nearest 0.5 dB(A)) have been determined for all non relevant receivers within 2km and are tabulated in Table 2 below for the for the worst case (WNW) wind scenario at 8 ms^{-1}. The relevant World Health Organisation (WHO) guideline level of 45 dB(A) for unreasonable interference or sleep disturbance [Ref : 7] is also given in the table.

Predicted L_{Aeq} noise levels (rounded to the nearest 0.5 dB(A)) have also been determined for all relevant receivers (wind farmers) within 2km and are tabulated in Table 3 below for the worst case (WNW) wind scenario for different wind speeds from 4 to 12 ms^{-1}. The criterion level which would be applicable is also given in the table. Criterion exceedances and receivers within 1.5km of the nearest turbine are also identified in the table.

The WNW wind direction is considered the worst case wind direction for most of the receivers; however, for a few of the receivers other directions were the worst case but in these cases the

predicted noise levels were still very close (within 1 dB) to the WNW case levels. All wind directions were modelled and the wind sector management required for different wind directions and speeds in shown in section 7.2.

Non-relevant Receivers (wind farmers)			
No.	**Name**	**Predicted L_{Aeq} Level (dB(A))**	**Criterion Level* (dB(A))**
		8ms^{-1} Wind	
		WNW	
Ellenden Group			
E1	Wyoming	30	45
E2	**L'Orizon**	**59**	45
E3	**L'Orizon B**	**50**	45
E4	Ellenden A	43.5	45
E5	Ellenden B	41.5	45
E6	Vacant	39.5	45
Groses Group			
G1	Panhandle	39.5	45
G3	Kullingrah	36.5	45
G7	Euroka	42.5	45
G8	Sunnybrook 1	38	45
G9	Sunnybrook 2	39	45
Hammonds Hill Group			
H1	C'dooley cottages	36.5	45
H2	Currandooley	38.5	45
H3	Nardoo A (Willson)	38	45
H23	Nardoo B (Willson)	36	45

Table 2: Predicted L_{Aeq} noise levels for all non-relevant (wind farmer) sites for WTGs at 10mAGL (for 8ms^{-1} worst case WNW wind propagation conditions).

* Non-relevant receivers do not have specified criterion (however, the WHO guideline criterion [Ref: 7] for unreasonable interference or sleep disturbance is given, which would otherwise be applicable).

Table 3 provides the predicted noise levels for the relevant receivers closest to the wind farm (within 2km) for different wind speeds from 4 to 12 ms^{-1}, in the WNW direction (considered the equivalent worst case wind direction for the receivers). The estimated criterion levels for each wind condition are also given. Note that criterion exceedances are shown in bold and receivers within 1.5km of the nearest turbine are identified with an asterisk.

Relevant Receiver	**Wind speed ms^{-1}**								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Criterion : Luckdale (G2)									
Criterion	*35*	*36*	*38*	*39*	*41*	*42*	*43*	*44*	*46*
G2* Luckdale	**36**	**37**	**38**	38	39	39	39	39	39
G4 Lakoona	23.5	24.5	26	26	26.5	26.5	27	27	26.5
Criterion : Euroka (G7)									
Criterion	*35*	*35*	*35*	*36*	*37*	*38*	*40*	*41*	*43*
G5 Bernallah	25	26	27	27.5	27.5	27.5	28	28	27.5
G6* Widgemore	31.5	32	33.5	34	34	34	34.5	34.5	34
Criterion : Sunnybrook1 (G8)									
Criterion	*35*	*35*	*35*	*36*	*37*	*39*	*40*	*42*	*43*
G10 LaGranja	34	34.5	**36**	**36**	36.5	36.5	37	37	36.5
G11	32	33	34	34.5	35	35	35	35	35
G12 Narine Green	32	33	34	34.5	35	35	35	35	35
G13	29.5	30.5	31.5	31.5	32	32	32	32	32
G14	30	31	32	32.5	33	33	33	33	33
G15	30	30.5	32	32	32.5	32.5	32.5	32.5	32.5
G16	29	29.5	31	31	31.5	32	32	32	32
G17	29.5	30.5	32	32	32.5	32.5	33	33	32.5
Criterion: Torokina (G18) [ref: Wooodlawn Wind Farm EIS]									
Criterion	*35*	*35*	*36*	*37*	*38*	*39*	*40*	*42*	*44*
G18 Torokina	26	26.5	28	28	28.5	28.5	28.5	28.5	28.5
Criterion : The Patch (H15)									
Criterion	*36*	*37*	*38*	*39*	*40*	*41*	*42*	*43*	*44*
H13 Storey	29	29.5	31	31.5	31.5	32	32	32	32
H15 The Patch	30	30.5	32	32	33	33	33	33	33
H17 D&K Jones	25.5	26.5	28	28	28.5	29	29	29	29
H18 Fairy Meadow	24.5	25.5	26.5	27	27.5	27.5	27.5	27.5	27.5
H20 D&T Douch	28	28.5	30	30.5	30.5	30.5	30.5	30.5	30.5
H21 Page	28.5	29.5	31	31	31.5	32	32	32	32
H22	20	21	22	22	22.5	23	23	23	23
H26	28	29	30.5	30.5	31	31.5	31.5	31.5	31.5
H27	28.5	29.5	30.5	31	31.5	32	32	32	32

Relevant Receiver		Wind speed ms^{-1}								
		4	5	6	7	8	9	10	11	12
Criterion : Gray Lot 7 (H5)										
Criterion		*35*	*35*	*35*	*35*	*36*	*37*	*39*	*40*	*42*
H4	TCE	24	25	26.5	26.5	27	27.5	27.5	27.5	27.5
H5	Gray Lot 7	23.5	24	25.5	25.5	26	26.5	26.5	26.5	26.5
H6	TCE	25.5	26.5	27.5	28	28.5	29	29	29	29
H7	Clearview Lot 8	26	27	28.5	28.5	29	29.5	29.5	29.5	29.5
H8	TCE	31	31.5	33	33	33.5	34	34	34	34
H9	TCE	29	30	31	31.5	32	32	32	32	32
H10	TCE	28	29	30	30.5	31	31.5	31.5	31.5	31.5
H11	TCE	24	24.5	26	26.5	27	27	27	27	27
H12	TCE	26.5	27.5	28.5	29	29.5	29.5	29.5	29.5	29.5
H16	S Powrie	23.5	24.5	25.5	26	26.5	26.5	26.5	26.5	26.5
H19	M&E Wellford	20.5	21.5	23	23	23.5	24	24	24	24
H24*	Wroxham	31.5	32	33.5	34	34	34	34	34	34
Criterion : Bonnie Doon (H25) [ref: Woodlawn Wind Farm EIS]										
Criterion		*35*	*35*	*35*	*37*	*40*	*43*	*46*	*50*	*53*
H25	Bonnie Doon	29.5	30	31.5	31.5	32	32.5	32.5	32.5	32.5
Criterion : L'Orizon (E2)										
Criterion		*35*	*35*	*35*	*38*	*40*	*43*	*45*	*47*	*49*
(no relevant receivers)										
Criterion : Currandooley (H2)										
Criterion		*35*	*35*	*35*	*37*	*38*	*39*	*40*	*41*	*42*
E7		33.5	34	**35.5**	36	36	36.5	36.5	36.5	36.5
Criterion : Wyoming (E1)										
Criterion		*35*	*35*	*35*	*36*	*37*	*39*	*40*	*41*	*43*
(no relevant receivers)										

Table 3: Predicted Noise Levels (L_{Aeq} dB(A)) for Relevant Sites at Different Wind Speeds.

* Receivers within 1.5km of nearest turbine (levels that match or exceed criterion are shown in bold).

The predicted noise levels at most relevant receivers achieve the appropriate criteria at many (or all) wind speeds; however, predicted noise levels match or exceed criteria for some wind speeds and directions for several residences (in bold). Therefore, noise mitigation measures may be required (section 7.2).

Colour noise contour plots have been generated for the maximum power setting (for neutral and $8ms^{-1}$ worst case wind propagation scenarios), covering the surrounding area. These are shown in Appendix H.

Two receiver sites located between the Capital and Woodlawn Wind Farms (Torokina (G18) and Bonnie Doon (H25)) have been assessed for the combined effect of the two proposed wind farms as follows: (Data for the Woodlawn wind farm noise levels has been taken from the Wilkinson Murray assessment report [Ref : 6] in the Woodlawn Wind Farm EIS.)

Combined Effect of Woodlawn and Capital Wind Farms – 6ms^{-1} Wind Speed					
Residence		Criterion	Noise Level L_{Aeq} dB(A)		
			Woodlawn	Capital	Combined
G18	Torokina	36	33	28	34.5
H25	Bonnie Doon	35	27	31.5	33

Table 4: Combined effect of Woodlawn/Capital Wind Farms

6.1 Model accuracy

We acknowledge that the 95% confidence level of the Concawe model used in the SoundPLAN programme under high propagation conditions may be in the order of ± 4 to 5 dB(A). However, we note the following issues and assumptions made in the use of the Concawe model for the noise assessment of the Capital Wind Farm :

- In our experience, we have found that the Concawe model can over-predict sound pressure levels by up to approximately 3 to 4 dB(A) in some situations (compared to measurements).
- The WindPro software which would otherwise be used is oversimplistic, as it does not take into account ground absorption or the barrier effect of topographical features. The WiTuProp software is also simplistic and has been validated for nearby receivers less than 500m away; the algorithm often greatly underpredicts at distances greater than about 500m.
- The standard ISO9613 algorithm is also simplistic with limited accuracy; it should only be used to provide predictions in neutral (no wind) conditions, as we have done in this study.
- The Concawe algorithm model in combination with the capabilities of the recognised SoundPLAN software offer a far more accurate estimate of environmental noise levels and, importantly, provides estimated wind effects on noise propagation.
- In South Australia (and elsewhere to our knowledge), the use of the Concawe model has not yet been validated for its application to wind farms, as no post-construction environmental noise survey of the existing wind farms has yet been completed.
- The noise prediction model for the Capital Wind Farm has been run for the complete range of specific wind directions (and wind speeds) and allowed the associated wind propagation effect to be modelled in each case.
- The noise prediction model for the Capital Wind Farm assumes a steady or uniform wind field; however, this does not happen in reality and therefore the real noise propagation from the installed turbine array is likely to be less than that modelled, and the model is therefore likely to be slightly conservative.
- For the above reasons, the Concawe model should incorporate enough built-in conservatism to account for any possible inaccuracies.

7. NOISE IMPACT ASSESSMENT

7.1 Discussion of results

Predicted noise levels have been assessed against the criteria described in section 3, viz. the SA EPA *Environmental Noise Guidelines – Wind Farms* [Ref: 1].

Due to the absence of noise characteristics (such as tonality, impulsiveness, modulation or low frequency components) in Suzlon WTGs, no penalty adjustments are required to be applied to the predicted levels.

The predicted L_{Aeq} noise levels for neutral propagation conditions range typically between about 24 and 36 dB(A) at relevant receivers.

The predicted L_{Aeq} noise levels, for $8ms^{-1}$ wind conditions (for worst case WNW wind propagation), range between about 21 and 39 dB(A) at the relevant receivers. These predicted levels at maximum WTG power setting at $8ms^{-1}$ achieve the appropriate criteria for all relevant receivers. Noise levels at the relevant receivers are below criteria at most wind speeds, with the exception of sites G2, G10 and E7 where the criterion is just exceeded or on the criterion at wind speeds between $4ms^{-1}$ and $7ms^{-1}$. Therefore, acoustic mitigation measures may be warranted. However, it should be noted that the predictions are likely to be conservative and that the predicted exceedances are likely to occur for a small percentage of the time.

Predicted noise levels for worst case wind conditions at non-relevant receivers associated with the wind farm range between 30 and 44 dB(A), with levels up to 59 dB(A) at E2/E3. The predicted levels at these non-relevant receivers are not likely to cause significant unreasonable interference, such as sleep disturbance, due to the steady nature of the wind farm noise. However, in adverse conditions, noise levels from the Capital Wind Farm may impact on some adjacent wind farmers some of the time (potentially at night during low background noise conditions). Renewable Power Ventures (RPV) has indicated that it will lease the two closest residences to turbines sites (E2 & E3).

Even though noise levels may meet the criteria, people residing near wind farms may experience or be aware of the noise generated by the wind farm. This new type of noise source may have a character with which people may be initially unfamiliar and, even though wind farm noise is typically steady and broad-band in nature, people may notice features, usually barely or faintly, in the noise such as "swishing", "lapping" or "whistling". The psycho-acoustic response or annoyance levels to a new noise source is subjective and will vary from person to person but is unlikely to be significant with wind farm noise and particularly so with increasing separation distance between the turbines and the residences. Current wind turbine designs are not a significant source of low frequency noise or infrasound – even nearby (less than 500m), any infrasound is well below the threshold of human perception and would not cause health effects.

Formal agreements have been formulated between the wind farm developer (RPV) and potential landowner wind farmers, which include a description of the expected noise impact and the degree of interference that this may cause under the worst case range of wind conditions. The agreements satisfy the requirements of section 2.3 of the SA Guidelines [Ref 1].

The SA EPA guidelines have been written to take into account the potential influence of additional stages or wind farms; therefore the Capital Wind Farm impact should be assessed separately from the Woodlawn Wind Farm. Two residences are located between the Capital and Woodlawn Wind Farms (Torokina (G18) and Bonnie Doon (H25)). The combined effect of the two proposed wind farms is about a 1.5 dB increase over the Woodlawn-only wind farm noise exposure for Torokina (G18), and is in the order of a 1.5 dB increase over the Capital-only wind farm noise exposure for Bonnie Doon (H25). Also, these estimated combined noise levels are 1.5 to 2 dB(A) below the relevant criterion, and therefore the amenity of these residential sites is not considered to be significantly disturbed by their proximity to the two proposed wind farms.

7.2 Mitigation options

The top 5 ranked WTGs, in terms of noise contribution, for the residential sites at which the environmental noise criteria are predicted to be exceeded (for the worst case situation of 6ms^{-1}, direction WNW, for G10 and E7 and 5ms^{-1} for G2) are :

Location	Distance	Top 5 contributing WTGs
G2 Luckdale	1244m	WTG04, WTG05, WTG06, WTG07, WTG08
G10 LaGranja	1599m	WTG15, WTG14, WTG11, WTG17, WTG13
E07	1482m	WTG32, WTG31, WTG30, WTG29, WTG28

Table 5: Top 5 contributing WTGs to noise levels at relevant receivers

In order to achieve the criteria at all wind speeds and directions (for each relevant receiver listed above), turbines may need to be modified in their operation. This may include turbines being removed, relocated or "turned off" at certain wind speeds/directions (wind sector management). This has been consolidated as far as possible to minimise the total number of turbines affected. The following turbines may need to be modified at the nominated wind speeds/directions:

4 ms^{-1}:

	North	NNE	NE	ENE	East	ESE	SE	SSE
WTG #	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04
	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05

	South	SSW	SW	WSW	West	WNW	NW	NNW
WTG #	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04
	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05

5 ms^{-1}:

	North	NNE	NE	ENE	East	ESE	SE	SSE
WTG #	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04
	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05
	WTG15							

	South	SSW	SW	WSW	West	WNW	NW	NNW
WTG #	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04
	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05	WTG05
				WTG15	WTG15	WTG15	WTG15	WTG15

6 ms^{-1}:

	North	NNE	NE	ENE	East	ESE	SE	SSE
WTG #	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04
	WTG05	WTG15	WTG05	WTG05		WTG05	WTG05	WTG05
	WTG15	WTG31	WTG31	WTG32				
	WTG32	WTG32	WTG32					

	South	SSW	SW	WSW	West	WNW	NW	NNW
WTG #	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04
	WTG05	WTG05	WTG05	WTG14	WTG14	WTG14	WTG14	WTG14
			WTG15	WTG15	WTG15	WTG15	WTG15	WTG15
						WTG32	WTG32	WTG32

7 ms^{-1}:

	North	NNE	NE	ENE	East	ESE	SE	SSE
WTG #	WTG15	WTG15	WTG04	WTG04	WTG04	WTG04	WTG04	WTG04

	South	SSW	SW	WSW	West	WNW	NW	NNW
WTG #	WTG04	WTG04	WTG04	WTG15	WTG15	WTG15	WTG15	WTG15

Table 6: WTGs to be modified to achieve criteria

Therefore, it can be seen that for the noise level criteria to be achieved at all relevant receivers for all wind speeds, the following turbines need to be modified for the following specific wind speeds (and consolidating similar WTGs as much as possible):

- 4ms^{-1} : WTGs 04, 05
- 5ms^{-1} : WTGs 04, 05, 15
- 6ms^{-1} : WTGs 04, 05, 14, 15, 31, 32
- 7ms^{-1} : WTGs 04, 15

Note, however, that the predicted exceedances are likely to occur for a small percentage of time and that the modelling on which it is based is conservative. It is recommended that a management approach is implemented that includes: 1) confirmation of the actual impacts (relative to predicted impacts), 2) finalise the required turbine operation modification, and 3) apply suitable mitigation to achieve criteria compliance and agreement with affected residents.

For non-relevant receivers, a formal agreement should be established between the wind farm developer and potential landowner wind farmers, which includes a description of the expected noise impact and the degree of interference that this may cause under certain conditions.

8. ELECTRICAL SUBSTATION NOISE

An electrical substation on the wind farm site will include a 33,000V/330,000V transformer rated at 135 MVA. It will also include switchgear and circuit breakers. The overall sound power level of the substation and ancillary equipment (at full operational load) is estimated to be less than 104 dB(A) (ref: Australian Standard AS2374.6-1994, incorporating Amendment No.1). RPV have advised that the substation sound power level may be as low as 100 dB(A).

The proposed substation is around 1,200m from the nearest residential receivers (H26, H27). The predicted noise level from the substation at these receivers is likely to be around 30 dB(A) (similar to worst case wind turbine levels) and up to 33 to 34 dB(A) in certain meteorological conditions. Therefore, the combined substation and wind turbine noise is likely to be less than the 35 dB(A) criterion. Also, note that maximum loading and noise generation from the substation will occur during periods of strong winds and associated high background noise.

A significant 100Hz tone has been associated with some wind farm electrical substations, due to the specific equipment installed at those substations to service the wind farms; namely, SVC reactors. We understand that the Capital Wind Farm does not intend to utilise such equipment, rather, only an additional transformer is to be included in the existing substation.

Although it is acknowledged that the noise levels for typical standard transformers also display a strong component at 100Hz, we do not consider that this is as significant as that associated with the specific SVC reactor equipment. In addition, the nearest residential receivers (H26, H27) are of the order of 1,200m away, therefore any 100Hz tone from the substation is anticipated to be of minimal impact to residential receivers in the vicinity of the substation.

The electrical substation associated with the wind farm has also been identified as varying in line with wind speed (i.e. lower wind speed = slower turbine operation = reduced electrical substation throughput = reduced noise levels). Therefore, we anticipate that the likelihood of noise impacts from the substation are reduced as the periods of higher substation noise levels correspond to periods of higher general background noise levels.

9. CONSTRUCTION NOISE

We note that the assessment of noise from construction of the wind turbines and roads etc for associated infrastructure is not governed by the Environmental Noise Guidelines : Wind Farms; rather, the guidelines laid out in the NSW DEC's Environmental Noise Control Manual (ENCM) are applicable to construction noise.

The ENCM provides the following noise criteria :

Construction period	Criterion dB(A)
Less than 4 weeks	$L_{A10,15min}$ <= background L_{A90} + 20
4 to 26 weeks	$L_{A10,15min}$ <= background L_{A90} + 10
Greater than 26 weeks	$L_{A10,15min}$ <= background L_{A90} + 5

Table 7: Construction noise criteria

The following time restrictions also apply :

Day	Acceptable construction times
Monday to Friday	7:00 am to 6:00pm
Saturday	7:00 am to 1:00pm if inaudible
	8:00 am to 1:00pm if audible

Table 8: Construction time restrictions

The construction programme is likely to occur over an 8 month period. Due to the distributed nature of the development, noise impacts at turbine sites will progress across the wind farm site. Therefore, the extent of construction in any one area is likely to be less than 6 months (and the erection time for individual turbines being only a matter of days).

With all construction activities occurring on weekdays and only during normal working hours, the potential for sleep disturbance to occur is reduced, and the evening and night time amenity of residents in the vicinity of the construction activities being unaffected by those activities.

We anticipate that existing roads will be utilised as far as possible, minimising the time and cost of constructing additional infrastructure and reducing the impact of temporary road construction on residential locations. The short-term increase in heavy vehicle movement may be noticeable to residences along the existing roads utilised during construction. The number of Concrete Mixer Truck movements on local roads will be lower with the use of an on-site Batching Plant.

Construction activities will include: site preparation/establishment, earthworks/excavation, foundation works and structural/construction works. The following table provides indicative short-term noise levels which may be experienced at varying distances from typical items of equipment used for construction activities:

Predicted Typical Construction Noise Levels dB(A)				
Equipment	**Distance from equipment**			
	500m	**1000m**	**1500m**	**2000m**
Compactor	45-52	38-45	33-40	29-36
Concrete mixer truck	35-44	28-37	23-32	<30
Concrete pump	<30	<30	<30	<30
Crane	46-50	39-41	34-36	30-32
Batching Plant	42-46	35-39	30-34	26-30
Crushing Plant	45-52	38-45	33-40	29-36
Front End Loader/Dozer	46-50	39-41	34-36	30-32
Excavator	42-46	35-39	30-34	26-30
Grader	42-46	35-39	30-34	26-30
Piling	44-49	37-42	32-37	28-33
Roller	<30	<30	<30	<30

Table 9: Predicted Typical Construction Noise Levels dB(A)

The following average day time background (L_{A90}) noise levels were measured during the noise monitoring period, with the corresponding criteria:

Construction Noise Criteria				
Location		**Average Background Noise Level L_{A90} dB(A)**	**Construction Noise Criterion Level L_{A10} dB(A)**	**Average Daytime Ambient Noise Level L_{Aeq} dB(A)**
G2	Luckdale	36	46	48
G7	Euroka	32	42	50
G8	Sunnybrook1	31	41	43
H15	The Patch	34	44	44
H5	Gray Lot 7	32	42	39
E2	L'Orizon	31	41	43
H2	Currandooley	31	41	41
E1	Wyoming	32	42	42

Table 10: Construction Noise Criterion Levels dB(A)

As distances from the nearest turbine to each residence are mostly above 1000m, the noise criteria for construction noise is likely to be achieved at most residences, with those at distances less than approximately 1000m of the construction activities being exposed to short term noise levels which may exceed this criterion.

However, as the construction of either the appropriate infrastructure or the turbines themselves are not confined to a single location for any significant length of time, the actual exposure of any given residence to any construction noise is only for a limited time period.

We note also that construction noise levels at residences in the vicinity of the proposed Capital Wind Farm are likely to be within the general rise-and-fall of ambient noise levels experienced at the residences.

Therefore, construction noise is not anticipated to cause significant detrimental effect to the amenity of the residences in the vicinity of the wind farm during construction.

We note that it is not uncommon for exemption from environmental noise policies to be sought, and granted, for construction noise, however this should not be viewed as an evasion of responsibility to minimise the acoustic impact of construction activities.

APPENDIX A

Glossary of Acoustic Terminology.

dB(A) A unit of measurement, decibels(A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.

L_{10} The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and is used in Australia as the descriptor for intrusive noise [usually in dB(A)]. Nominal measurement period is usually 15 minutes.

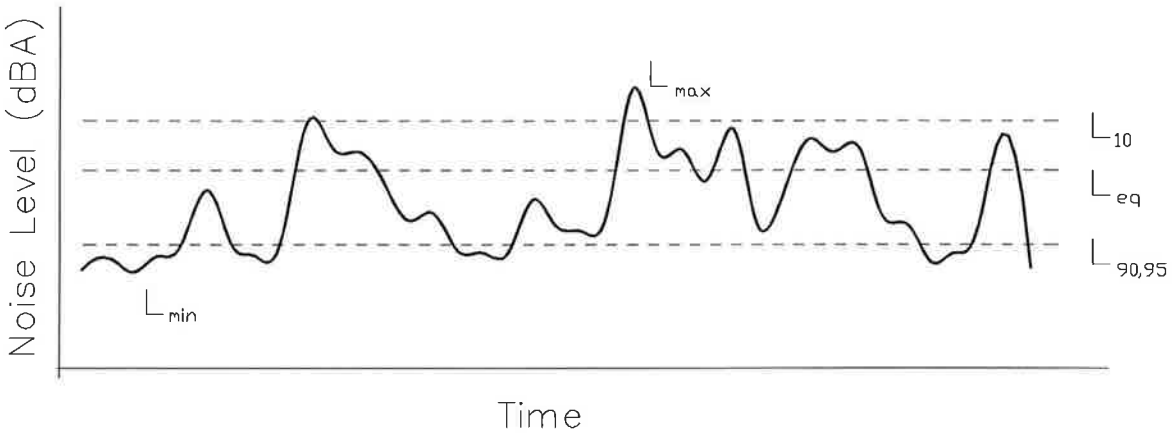
L_{90} The noise level which is equalled or exceeded for 90% of the measurement period. L_{90} or L_{95} is an indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise [usually in dB(A)].

L_{eq} The equivalent continuous noise level for the measurement period, weighted for duration and intensity. L_{eq} is an indicator of the average noise level [in dB(A)].

L_{max} The maximum noise level for the measurement period [usually in dB(A)].

L_{peak} The maximum numerical noise level, usually unweighted, attained during the measurement period [usually in dB(lin)].

SEL The single event Sound Exposure Level is the equivalent A-weighted sound level which, if it lasted for one second, would produce the same sound energy as the actual event [in dB(A)].

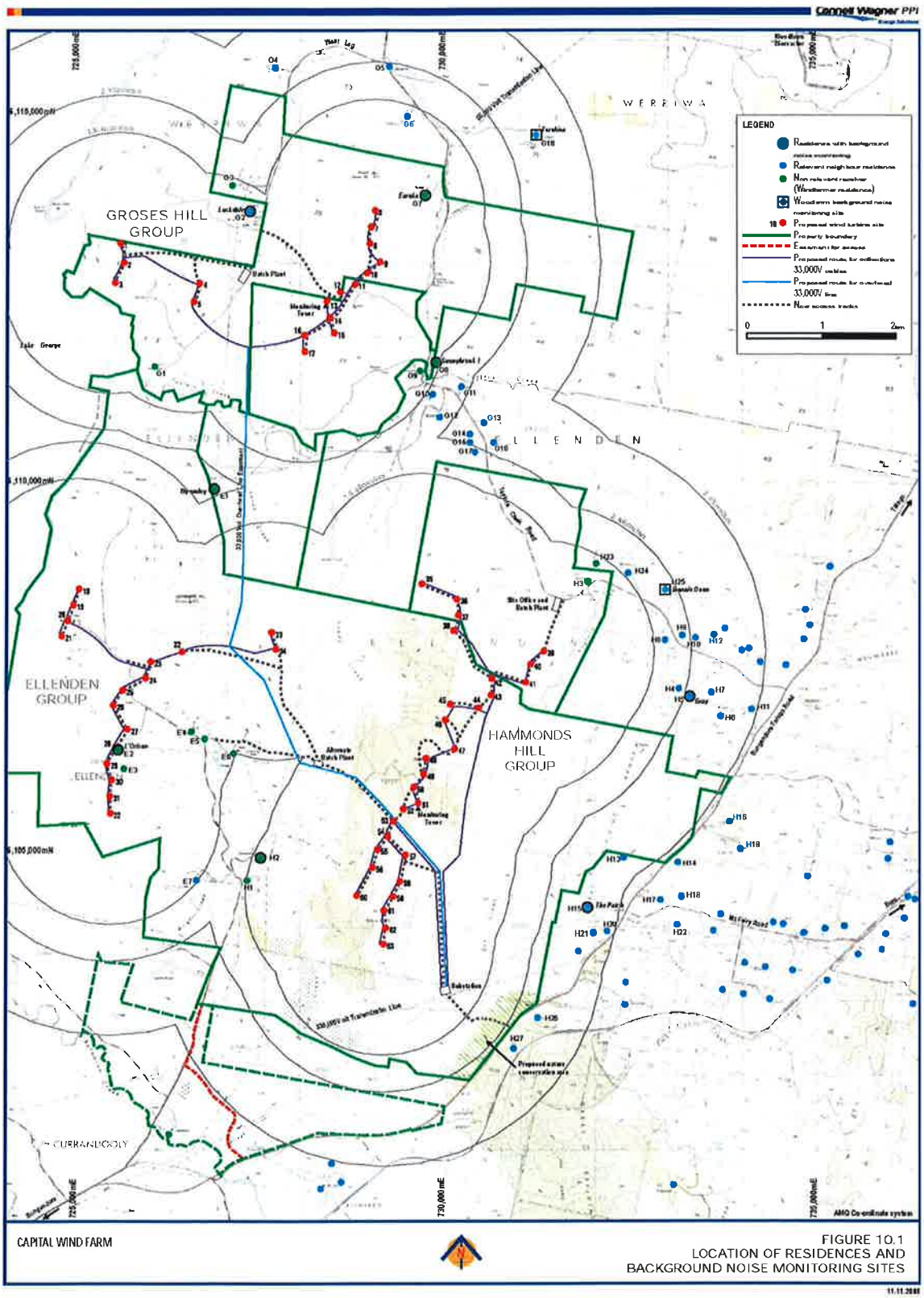


Note: *The subjective response or reaction to changes in noise levels can be described as follows:*

A 3 dB(A) change in sound pressure level is just perceptible to the average human ear; a 5 dB(A) increase is quite noticeable and a 10 dB(A) increase is typically perceived as a doubling in loudness.

APPENDIX B

Map showing Approximate WTG Layout, Residential Locations and Wind Farm Site Topography.


GROSES HILL GROUP
ELLENDEN GROUP
HAMMONDS HILL GROUP
WERRIWA
ELLENDEN
CURRANDOOLY
LEGEND
Residence with background noise monitoring
Relevant neighbour residence
Non-relevant receiver (Windfarmer assistance)
Windfarmer background noise monitoring site
Proposed wind turbine site
Property boundary
Easement for access
Proposed route for collection 33,000V cables
Proposed route for overhead 33,000V line
New access tracks
0
1
2km
CAPITAL WIND FARM
FIGURE 10.1
LOCATION OF RESIDENCES AND
BACKGROUND NOISE MONITORING SITES

APPENDIX C

List and Details of Residential Premises near Wind Farm.

Groses Hill Group					
No.	**Name**	**Easting**	**Northing**	**Dist. to nearest WTG (m)**	**Comment**
G1	Panhandle	726179	6111808	969	Non-Relevant
G2	Luckdale	727456	6113915	1244	Relevant
G3	Kullingrah	727214	6114255	1436	Wind farmer
G4	Lakoona	727801	6115830	2342	Relevant
G5	Bernallah	729333	6115864	1989	Relevant
G6	Widgemore	729586	6115177	1376	Relevant
G7	Euroka	729830	6114114	756	Wind farmer
G8	Sunnybrook 1	729977	6111854	1469	Wind farmer
G9	Sunnybrook 2	729758	6111750	1293	Wind farmer
G10	LaGranja	729938	6111422	1599	Relevant
G11		730320	6111533	1895	Relevant
G12	Narine Green	730039	6111135	1842	Relevant
G13		730635	6111045	2391	Relevant
G14		730435	6110892	2202	Relevant
G15		730442	6110783	2101	Relevant
G16		730753	6110792	2228	Relevant
G17		730502	6110650	1997	Relevant
G18	Torokina	731337	6114923	**2457**	Relevant (Woodlawn)
Ellenden Group					
No.	**Name**	**Easting**	**Northing**	**Dist. to nearest WTG (m)**	**Comment**
E1	Wyoming	726923	6110147	2125	Wind farmer
E2	L'Orizon	725688	6106628	68	Wind farmer (To be leased by RPV)
E3	L'Orizon B	725775	6106368	283	Wind farmer (To be leased by RPV)
E4	Ellenden A	726684	6106871	916	Wind farmer
E5	Ellenden B	726866	6106771	1102	Wind farmer
E6	Vacant	727251	6106575	1467	Wind farmer
E7		726745	6104869	1482	Relevant
Hammonds Hill Group					
No.	**Name**	**Easting**	**Northing**	**Dist. to nearest WTG (m)**	**Comment**
H1	C'dooley cottages	727431	6104865	1460	Wind farmer
H2	Currandooley	727612	6105163	1372	Wind farmer
H3	Nardoo A/Willson	732033	6108894	1164	Wind farmer
H4	TCE	733260	6107455	1915	Relevant
H5	TCE - Gray Lot 7	733408	6107342	2087	Relevant
H6	TCE	733826	6107080	2564	Relevant
H7	Clearview Lot 8	733702	6107396	2358	Relevant
H8	TCE	733076	6108111	1685	Relevant
H9	TCE	733312	6108171	1927	Relevant
H10	TCE	733491	6108143	2101	Relevant
H11	TCE	734234	6107174	2928	Relevant
H12	TCE	733740	6108174	2352	Relevant
H13	Storey	732516	6105130	2729	Relevant
H14	Fairy Meadow	733245	6105104	3175	Relevant
H15	The Patch	732024	6104488	2586	Relevant

No.	Name	Easting	Northing	Dist. to nearest WTG (m)	Comment
H16	S Powrie	733957	6105655	3351	Relevant
H17	D&K Jones	733010	6104595	3442	Relevant
H18	Fairy Meadow	733295	6104641	3567	Relevant
H19	M&E Wellford	734088	6105287	3670	Relevant
H20	D&T Douch	732287	6104173	2904	Relevant
H21	Page	732102	6104149	2730	Relevant
H22		733233	6104259	3814	Relevant
H23	Nardoo B/Willson	732147	6109143	1436	Wind farmer
H24	Wroxham	732577	6109014	1608	Relevant
H25	Bonnie Doon	733080	6108784	**1889**	Relevant (Woodlawn)
Southeast of substation:					
H26		731345	6102905	2367 (1,250m from substation)	Relevant
H27		730935	6102595	2186 (1,210m from substation)	Relevant

Note: Coordinate system used is MGA (equivalent to UTM WGS84).

APPENDIX D

List and Details of Proposed Wind Turbine Generators.

Proposed Wind Turbine Generators (WTGs)		
WTG No.	Easting	Northing
1	725661	6113444
2	725709	6113183
3	725590	6112912
4	726734	6112902
5	726656	6112651
6	729109	6113887
7	729059	6113668
8	729037	6113439
9	729184	6113193
10	729004	6113046
11	728840	6112886
12	728640	6112787
13	728456	6112662
14	728496	6112441
15	728557	6112228
16	728150	6112202
17	728153	6111976
18	725111	6108764
19	725035	6108549
20	724959	6108338
21	724878	6108127
22	726503	6107911
23	726081	6107782
24	726013	6107555
25	725706	6107394
26	725575	6107190
27	725768	6106864
28	725620	6106620
29	725494	6106397
30	725561	6106182
31	725531	6105955
32	725537	6105727
33	727715	6108175
34	727768	6107948
35	729766	6108794
36	730225	6108624
37	730244	6108404
38	730176	6108197
39	731402	6107916
40	731222	6107738
41	731157	6107496
42	730698	6107547
43	730685	6107322
44	730518	6107153
45	730130	6107203
46	730068	6106990
47	730195	6106598
48	729805	6106470

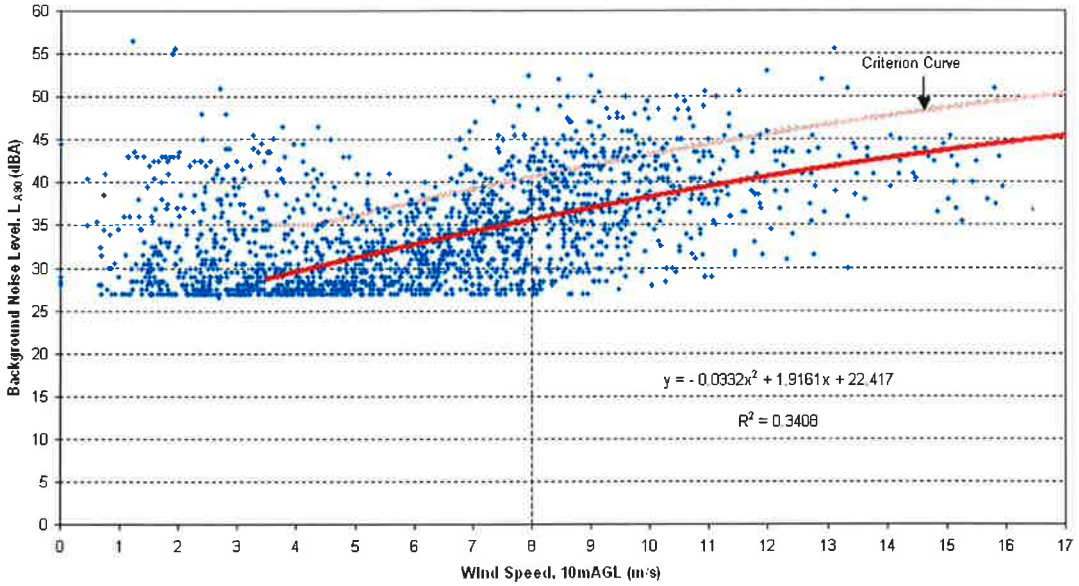
Proposed Wind Turbine Generators (WTGs) – Stage 2 (...continued)		
WTG No.	**Easting**	**Northing**
49	729775	6106250
50	729638	6106076
51	729701	6105864
52	729499	6105786
53	729360	6105616
54	729283	6105411
55	729145	6105235
56	729080	6104991
57	729528	6105166
58	729452	6104805
59	729361	6104602
60	728868	6104611
61	729231	6104414
62	729260	6104174
63	729225	6103957

Note: Coordinate system used is MGA (equivalent to UTM WGS84).

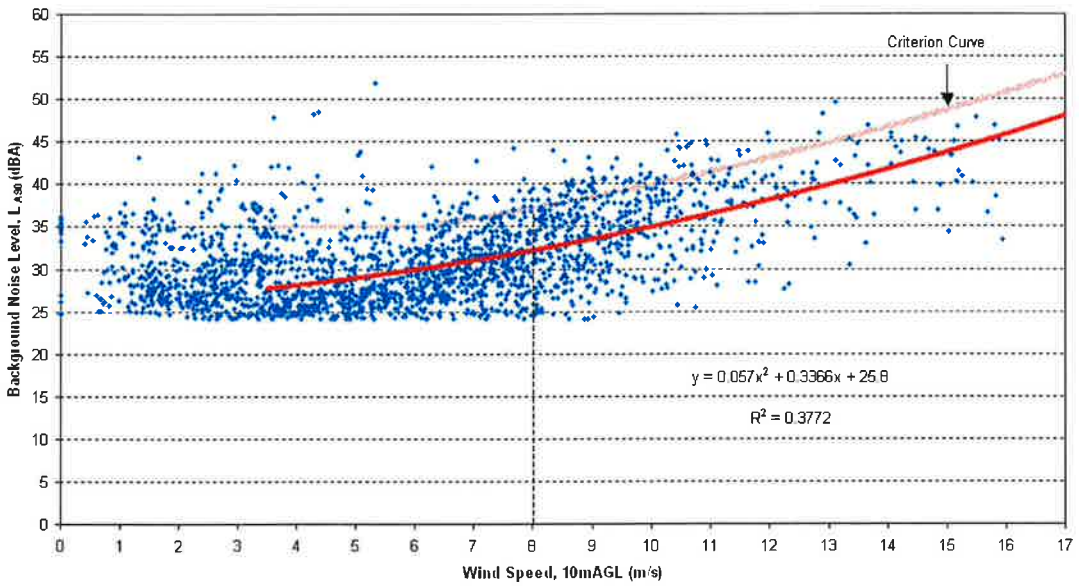
APPENDIX E

Plots of Background Noise versus Wind Speed at 10mAGL for the Eight Measured Residential Sites.

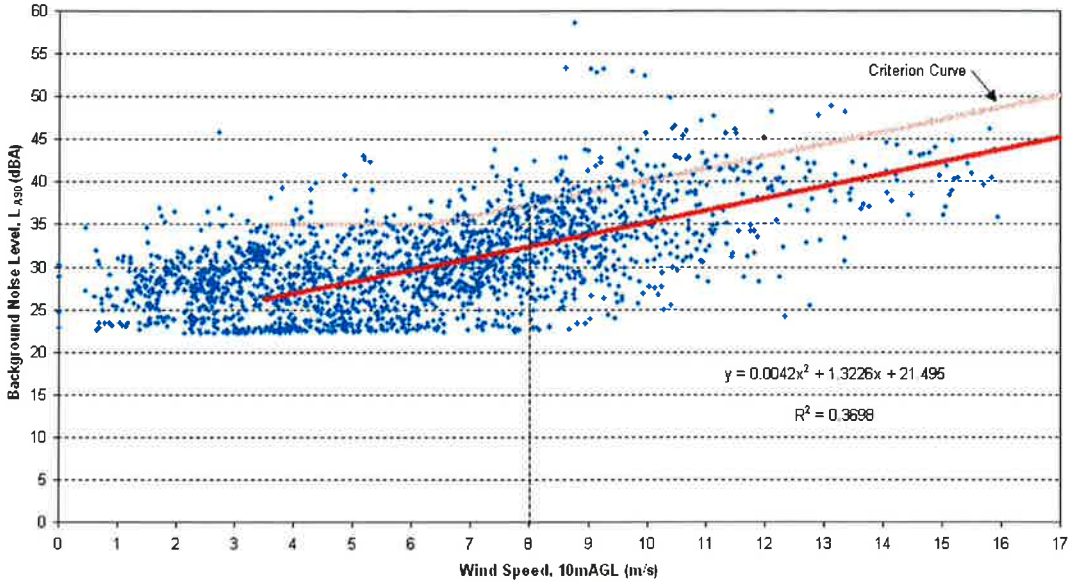
Site 1 : Background Noise at Receiver vs Wind Speed at Windfarm



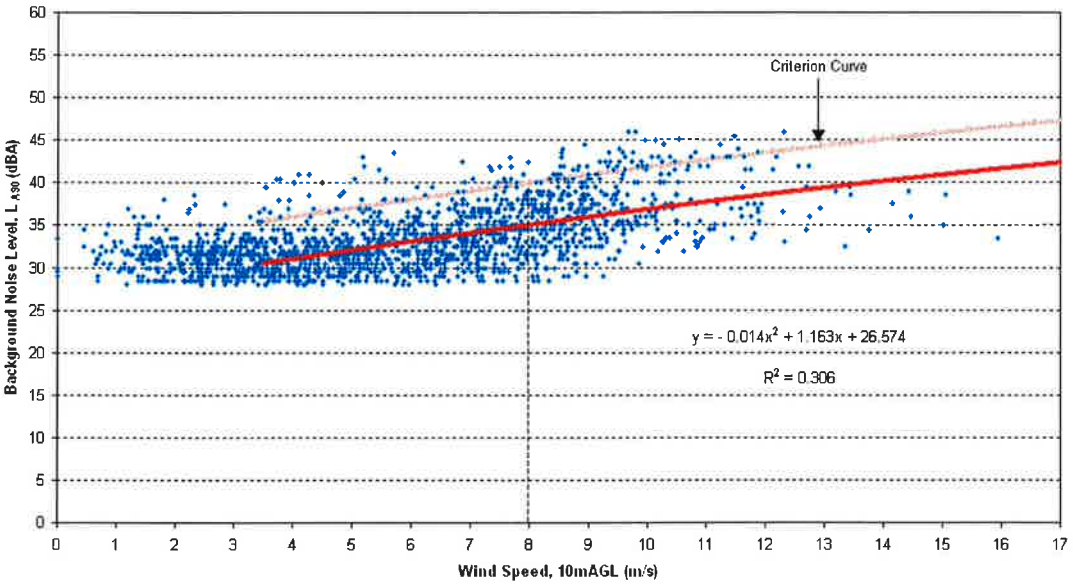
Site 2 : Background Noise at Receiver vs Wind Speed at Windfarm



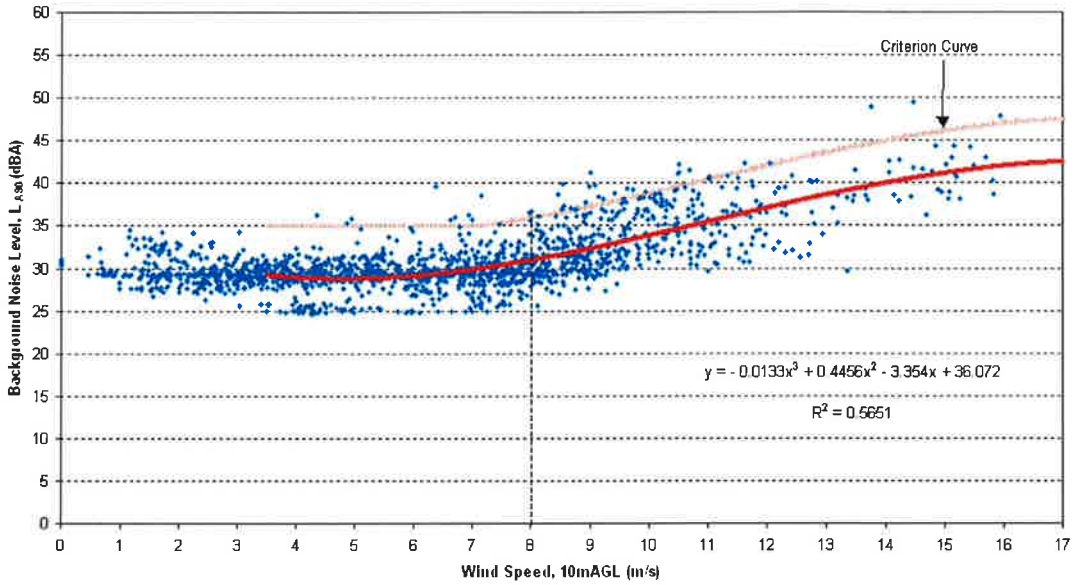
Site 3 : Background Noise at Receiver vs Wind Speed at Windfarm



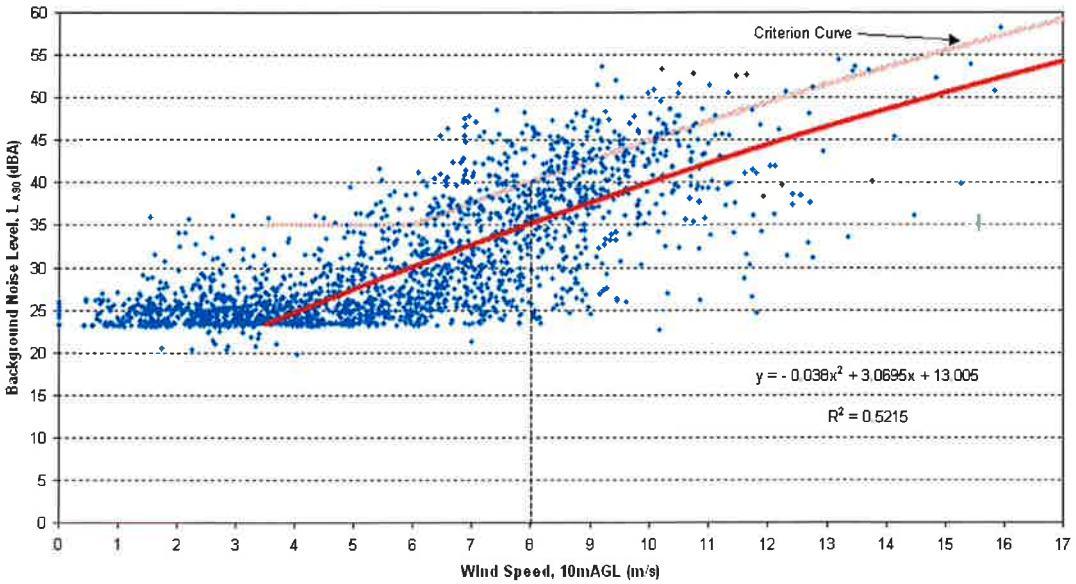
Site 5 : Background Noise at Receiver vs Wind Speed at Windfarm



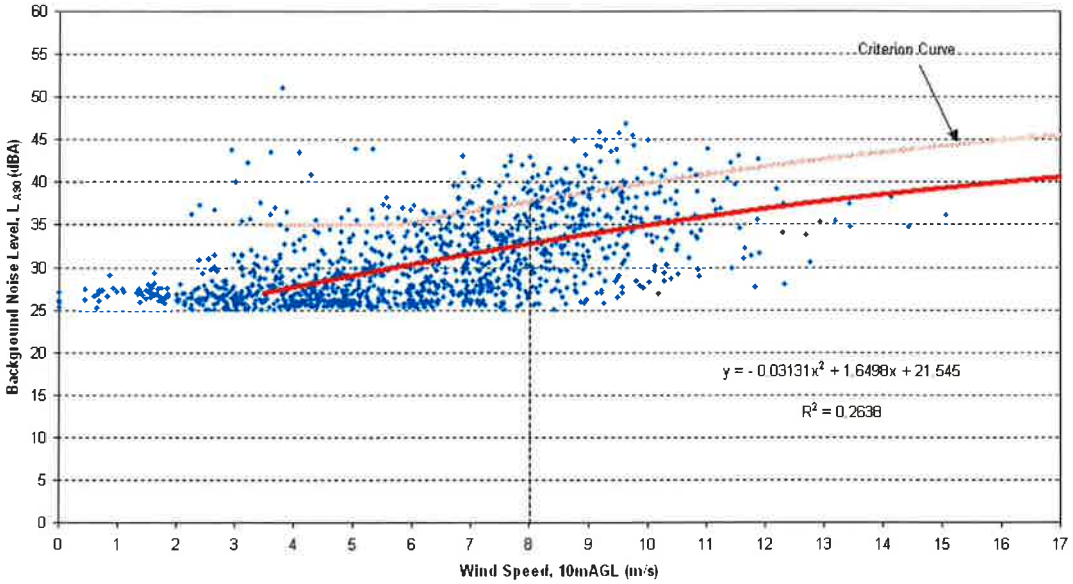
Site 6 : Background Noise at Receiver vs Wind Speed at Windfarm



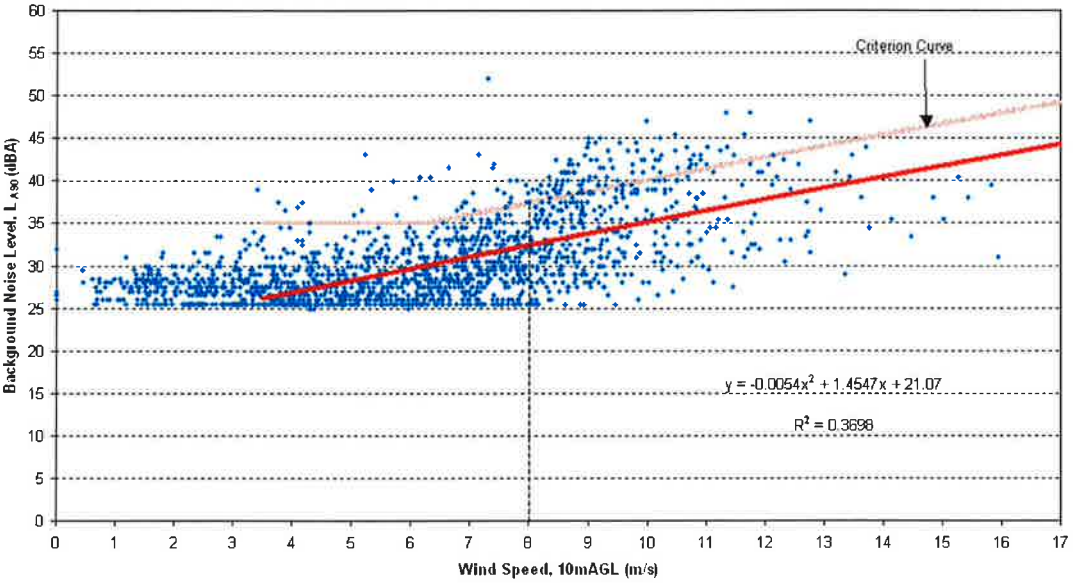
Site 8 : Background Noise at Receiver vs Wind Speed at Windfarm



Site 9 : Background Noise at Receiver vs Wind Speed at Windfarm



Site 10 : Background Noise at Receiver vs Wind Speed at Windfarm



APPENDIX F

Excerpt from Suzlon Power Curve Data for Suzlon S88 2.1 MW WTG showing Sound Power Levels (in dB(A)) for Operating Wind Speeds.

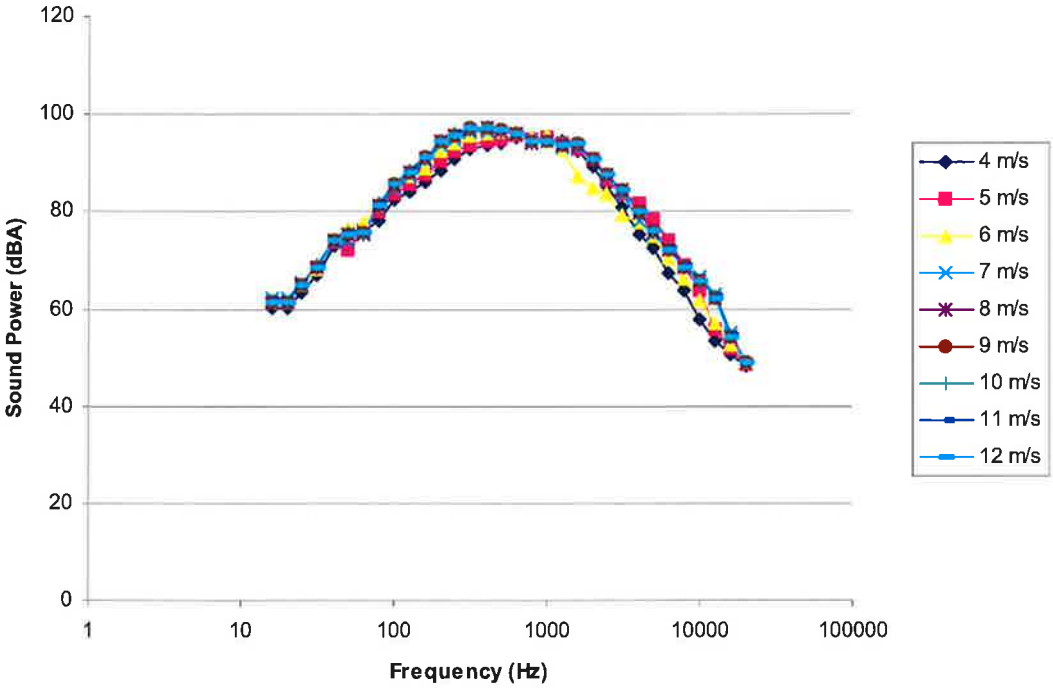
Sound Power Levels - WTG and Estimated Standard Conditions

WTG:	S88/2100	Rated Power:	2100kW	Generator:	Single Generator
Hub Height (m):	80	Power Control:	Pitch	Blade:	AE43
Rotor Diameter (m):	88	Number of Rotor Blades:	3 (upwind)		
Air Density (kg/m^3):	1.225	Tower Type:	Tubular steel		
Est. Wind Shear:	0.16	Rated RPM:	15.6		

Hub Height Wind Speed (m/s)	4.2	5.6	7.0	8.4	9.8	11.2	12.6	13.9	15.3	15.7
10m AGL Wind Speed (m/s)	3	4	5	6	7	8	9	10	11	12
A-Weighted Sound Power Level (dBA)	103.4	104.1	104.7	105.2	105.6	105.9	106.1	106.2	106.2	106.1

APPENDIX G

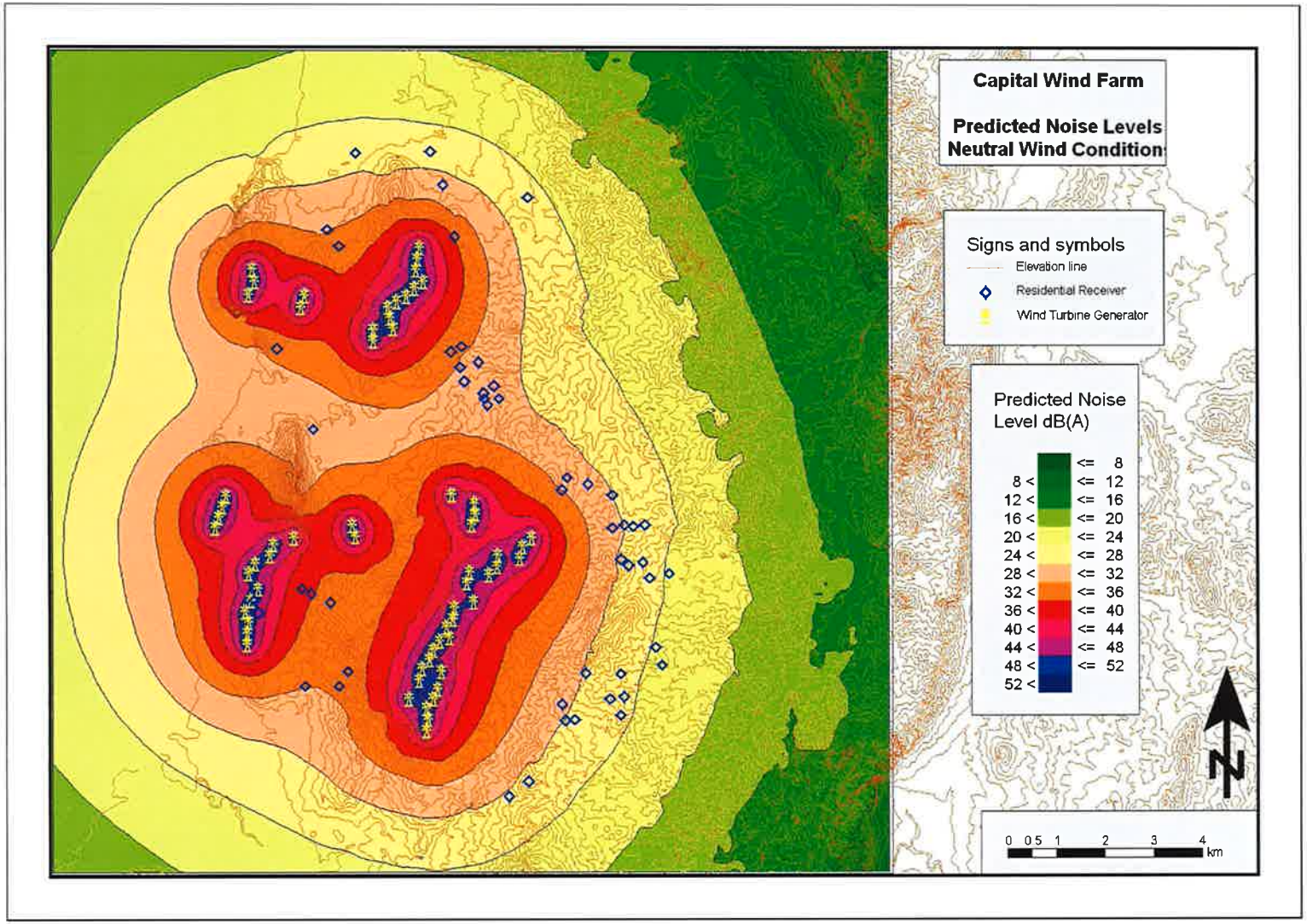
Sound Power Spectrum of the Suzlon S88 2.1MW WTG in L_{Aeq} third octave bands, measured at reference wind speed of $8ms^{-1}$ at 10mAGL.

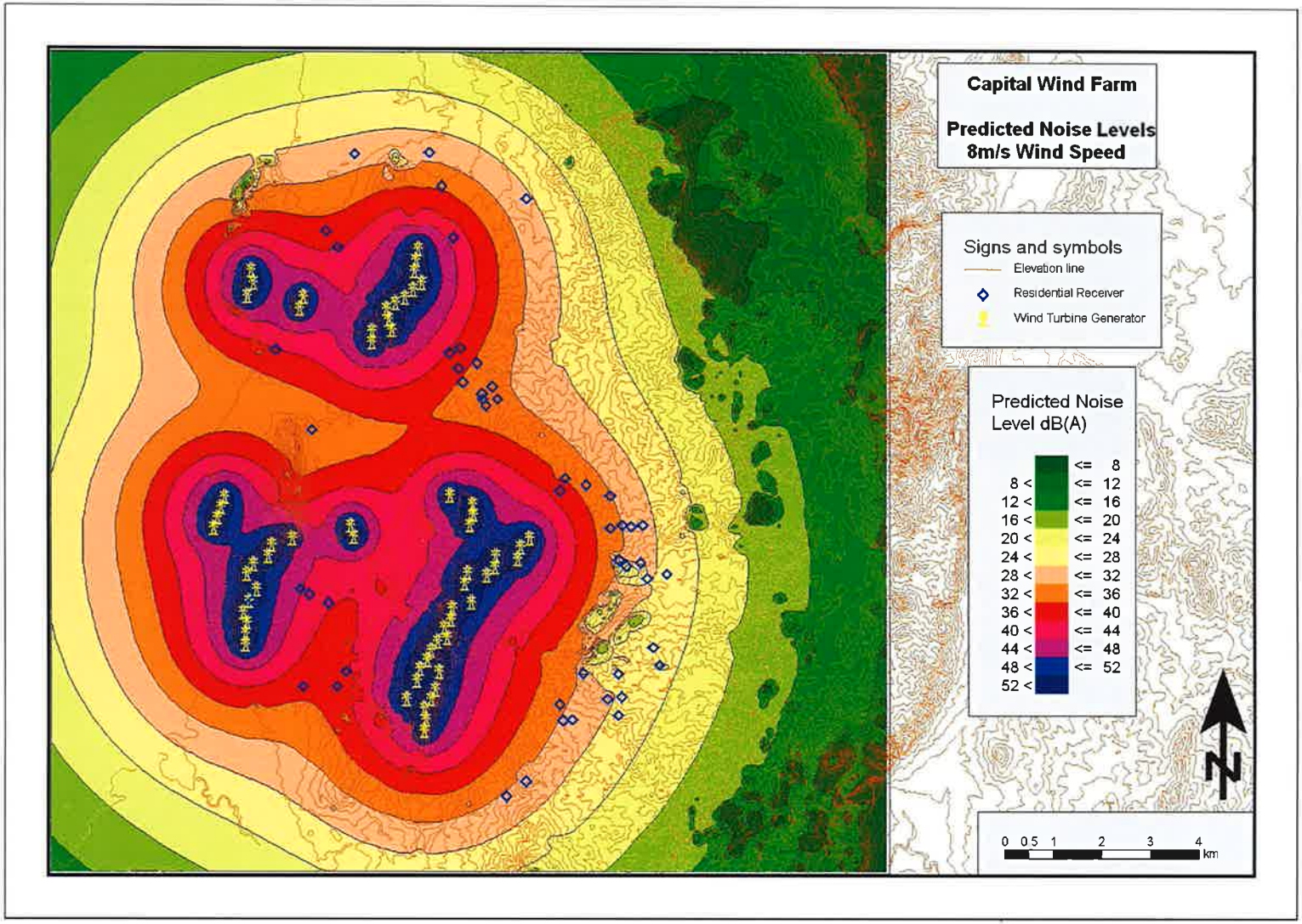


freq (Hz)	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
16	59.3	60.1	61.4	61.3	62	61.3	61.5	61.6
20	59.4	60.1	61.4	61.3	62	61.2	61.4	61.5
25	62.8	63.5	65	64.8	65.2	64.8	65	65.1
31.5	66.2	66.9	68.6	68.3	68.4	68.5	68.7	68.8
40	72.1	72.8	73.9	74.5	73.6	74	74.2	74.3
50	74.2	74.9	72.2	76.6	74.1	75.3	75.5	75.6
63	75.3	76	76.3	77.7	75.9	75.5	75.7	75.8
80	77.6	78.3	80.3	81.5	81	81.3	81.5	81.6
100	81.7	82.4	83.9	86.2	84.8	85.4	85.6	85.7
125	83.6	84.3	85.8	87.5	87.5	88.1	88.3	88.4
160	85.5	86.2	87.8	88.9	90.3	90.9	91.1	91.2
200	87.9	88.6	90.5	92.3	93.7	94.3	94.5	94.6
250	90.2	90.9	92.5	94	94.9	95.6	95.8	95.9
315	92.1	92.8	93.8	95.6	96.3	97	97.2	97.3
400	93	93.7	94.6	96.2	96.5	97.1	97.3	97.4
500	93.5	94.2	94.8	96.4	96.4	96.6	96.8	96.9
630	94.4	95.1	95.5	96.4	96	95.9	96.1	96.2
800	94.4	95.1	95	95.3	94.4	94.2	94.4	94.5
1000	94.6	95.3	95.2	95.7	94.4	94.3	94.5	94.6
1250	93.6	94.3	94.2	92.7	93.1	93.6	93.8	93.9
1600	91.7	92.4	93	87.3	93.1	93.7	93.9	94
2000	88.6	89.3	90.7	84.9	90.6	90.6	90.8	90.9
2500	84.5	85.2	86.7	83.9	87.4	87.6	87.8	87.9
3150	80.2	80.9	83.9	79.4	83.7	84.4	84.6	84.7
4000	74.7	75.4	81.8	77.7	78	79.8	80	80.1
5000	71.8	72.5	78.4	75.1	75.5	75.9	76.1	76.2
6300	66.7	67.4	74.2	70.5	72.2	72.1	72.3	72.4
8000	63	63.7	68.8	66.3	68.7	68.5	68.7	68.8
10000	57	57.7	63.8	61.8	66.5	65.6	65.8	65.9
12500	52.9	53.6	56	57.1	62.9	62.1	62.3	62.4
16000	49.9	50.6	51.8	52.6	55	54.2	54.4	54.5
20000	47.4	48.1	48.5	48.9	48.7	48.7	48.9	49
Lwa		104.0683	104.6876	105.1898	105.6026	105.9669	106.1669	106.2669

APPENDIX H

Colour Noise Contour Plots for the Maximum Power Setting for the Neutral and $8ms^{-1}$ Worst Case Wind Propagation Scenarios.


Capital Wind Farm
Predicted Noise Levels
Neutral Wind Condition
Signs and symbols
Elevation line
Residential Receiver
Wind Turbine Generator
Predicted Noise Level dB(A)
<= 8
8 < <= 12
12 < <= 16
16 < <= 20
20 < <= 24
24 < <= 28
28 < <= 32
32 < <= 36
36 < <= 40
40 < <= 44
44 < <= 48
48 < <= 52
52 <
N
0 0.5 1 2 3 4
km


Capital Wind Farm
Predicted Noise Levels
8m/s Wind Speed
Signs and symbols
Elevation line
Residential Receiver
Wind Turbine Generator
Predicted Noise Level dB(A)
<= 8
8 < <= 12
12 < <= 16
16 < <= 20
20 < <= 24
24 < <= 28
28 < <= 32
32 < <= 36
36 < <= 40
40 < <= 44
44 < <= 48
48 < <= 52
52 <
N
0 0.5 1 2 3 4
km