

**Woodlawn Wind Pty Ltd**

**David Griffin**

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# **Noise Impact Assessment**

## **Woodlawn Wind Farm Noise Assessment**

Document No.: 50B-08-0138-TRP-423683-9

22 Jul 2010

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**DOCUMENT NO:**

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### REVISION HISTORY

| Revision No. | Date Issued | Reason/Comments                    |
|--------------|-------------|------------------------------------|
| 0            | 13 Oct 2009 | Initial Issue                      |
| 1            | 13 Oct 2009 |                                    |
| 2            | 23 Dec 2009 | Expanded Section 8 – CWF influence |
| 3            | 6 Jan 2010  | Minor adjustments                  |
| 4            | 7 Jan 2010  | Minor adjustments                  |
| 5            | 9 Jan 2010  | Minor adjustments                  |
| 6            | 22 Jul 2010 | Minor adjustments                  |

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**KEYWORDS:** Wind Farm, Noise Impact Assessment, Environmental Noise

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## EXECUTIVE SUMMARY

A noise impact assessment has been performed of the proposed Woodlawn Wind Farm development near Tarago, New South Wales. This additional modelling was performed to determine the noise generated by a proposed 20 Wind Turbine Generators located at the site.

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 20 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 33 residential premises (receivers) that are between 2 and 5 km of the proposed wind farm, only four of which are relevant receivers. There are no receivers within 2km of any of the proposed turbines.

The background noise levels and criteria for the Woodlawn Wind Farm at four receiver sites have been measured (Ref [5]), as well as at the Capital Wind Farm for three sites.

The noise model was run for the maximum power WTG setting, for neutral and wind-affected propagation conditions. The model was run for the worst case wind conditions for the range of wind speeds from 4 to 12  $\text{ms}^{-1}$ .

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 all wind conditions (for worst case wind propagation), range up to 31dB(A) at the relevant receivers. These predicted levels at maximum WTG power setting achieve the appropriate criteria for all relevant receivers.

It can be noted that the noise levels at the western and south western receivers of the Woodlawn Wind Farm are dominated by noise from the Capital Wind Farm, and that they be assessed against the Capital Wind Farm noise impact assessment.



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## 1. INTRODUCTION

This report outlines a noise impact assessment of the proposed Woodlawn Wind Farm development near Tarago, New South Wales. Noise modelling was performed to determine the noise generated by a proposed 20 Wind Turbine Generators on the site.

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*” (Ref [1]).

## 2. REFERENCES

- [1] “*Wind Farms: Environmental Noise Guidelines (interim)*”, SA Environment Protection Authority, SA Government, Dec 2007 (ISBN 1 876562 43 9).
- [2] Concawe Report No. 4/81: “*The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*”, Manning C.J., 1981
- [3] International Standard ISO 9613 *Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation*, 1996
- [4] *Background Noise Monitoring Report, Capital Wind Farm*, Vipac Document No. 505608-TRP-017528-00, Vipac Engineers & Scientists, 27 April 2005
- [5] “*Woodlawn Wind Farm Noise Assessment*” Prepared by Wilkinson Murray for URS. Report Reference 04098 Version B, dated September 2004.
- [6] “*Capital Wind Farm: Noise Impact Assessment Report*” 10 February 2006. Reference: 505608-TRP-018284-02
- [7] WTG layout for Woodlawn wind farm provided by Stephen Donnelly (Babcock and Brown) 6 November 2008
- [8] “*Guidelines for Community Noise*”, World Health Organization (WHO), Geneva, Switzerland, 1999.
- [9] Transformer Noise Levels at Woodlawn Wind Farm Substation: Email from David Griffin 15<sup>th</sup> October 2009

## 3. NOISE CRITERIA GUIDELINES

The primary criteria to be used for wind farm developments in South Australia 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 : [8]].

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 6,116,000 m N, 734,000 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, New South Wales. 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 mainly rural with some agricultural industry and party industrial zoning. The land use in the area mainly comprises intermediate-sized farming properties and waste to energy activities at the Woodlawn bioreactor.

The wind farm configuration will consist of 20 Wind Turbine Generators (WTGs) distributed in an array along the crests of the Great Dividing Range.

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  $4\text{ms}^{-1}$ , the cut-out wind speed is  $25\text{ms}^{-1}$  and the rated wind speed is  $14\text{ms}^{-1}$  (equivalent to  $11.2\text{ms}^{-1}$  at hub height). The sound power output, measured at the reference wind speed of  $8\text{ms}^{-1}$  at 10mAGL (in accordance with IEC 61400-11), is 106.0 dB(A).

## 5. PREVIOUS NOISE IMPACT ASSESSMENT REVIEW

We have reviewed the previous noise impact assessment undertaken by Wilkinson Murray [5]. We note the following comments:

- Background noise levels at four receiver sites in the vicinity of the proposed wind farm have been measured (Ref [5]).
- Background noise monitoring was undertaken with noise loggers with a noise floor of approximately 25dB(A). This may influence the lower registers of the background regression curve, and may influence noise criteria at lower wind speeds.
- The report did not consider the cumulative impact from Capital Wind Farm.



## 6. 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 [5]. Additional background noise monitoring has been undertaken for the nearby Capital Wind Farm by Vipac, and is detailed in Ref [4].

There are a total of about 33 residential premises (receivers) that are between 2 and 5 km of the proposed wind farm only of which only four are relevant receivers, with no receivers within 2kms of a WTG. The receivers are listed, with details, in Appendix C. The residences associated with the wind farm ("windfarmers", with wind turbines on their properties) are also noted in Appendix C.

The background noise levels at four receiver sites in the vicinity of the proposed wind farm have been measured (Ref [5]) continuously over a period of two to three weeks in accordance with [1]:

- Torokina
- Bonnie Doon
- Kildare
- Glendale

Additionally, background noise monitoring was undertaken for the Capital Wind Farm project [6] (to the West of Woodlawn Wind Farm) and can be used as the background noise for some of the western receivers. Locations monitored. Relevant locations are listed below:

- Euroka
- Sunnybrook
- Gray

Therefore seven 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 four 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 are shown in Table 6-1:

**Table 6-1: Representative background sites with similar noise criteria**

| Background monitoring site | Sites considered to have a similar background noise characteristic     |
|----------------------------|------------------------------------------------------------------------|
| Torokina                   | Bernallah, Willeroo, Somerset                                          |
| Bonnie Doon                | Nardoo, H23, Wroxham, Rosehill Hilltop Farm, Hamptons, La Lee, Myolena |
| Kildare                    | Willandra, Ellareagh, Hollymount, Linden Park                          |
| Glendale                   | Richmond Grove, Bracken Ridge, Kandahar                                |
| Sunnybrook (G8)            | Sunnybrook (G9), La Granja (G11), Narine Green (G12)                   |



| Background monitoring site | Sites considered to have a similar background noise characteristic |
|----------------------------|--------------------------------------------------------------------|
| Gray                       | McLaughlin, Clear View, Mingary, Ugov                              |
| Kullingrah (Euroka)        | Widgemoor                                                          |

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 B.

The results of the analysis of the noise and wind monitoring are given in Refs [4], [5].

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 each wind speed (10mAGL) from Refs [4] & [5] are as follows:

**Table 6-2: Resultant noise criteria for each site**

| Monitored Site       | Wind speed ms <sup>-1</sup> |    |    |    |    |    |    |    |    |
|----------------------|-----------------------------|----|----|----|----|----|----|----|----|
|                      | 4                           | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| Torokina             | 35                          | 35 | 36 | 37 | 38 | 39 | 40 | 42 | 44 |
| Bonnie Doon          | 35                          | 35 | 35 | 37 | 40 | 43 | 46 | 50 | 53 |
| Kildare              | 35                          | 35 | 36 | 37 | 39 | 40 | 42 | 44 | 46 |
| Glendale             | 35                          | 35 | 35 | 37 | 40 | 42 | 44 | 47 | 49 |
| Sunnybrook (G8)*     | 35                          | 35 | 35 | 36 | 37 | 39 | 40 | 42 | 43 |
| Gray*                | 35                          | 35 | 35 | 35 | 36 | 37 | 39 | 40 | 42 |
| Kullingrah (Euroka)* | 35                          | 35 | 35 | 36 | 37 | 38 | 40 | 41 | 43 |

Note: The noise criterion levels reported in the Capital Wind Farm EIS [4] are noted with a \*

The residences with wind turbines on their properties (identified in Appendix B) 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: [8]]. This applies to the Woodlawn Farm, Kalva, Cowley Hills, Pylara residences.

## 7. NOISE MODEL PREDICTIONS

An accurate Predictive Noise Model has been constructed using the validated and accepted Concawe algorithm ([Ref: [2]]) 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  $\pm 2$  dB(A) and up to the order of  $\pm 5$  dB(A).

The model incorporates the proposed locations and heights of the 20 WTG array. The model uses the manufacturer's S88 2.1MW overall warranted sound power level data for the reference wind speed of  $8\text{ms}^{-1}$ , distributed as per the published spectrum for that model, as shown in Appendix E.

The data provided by the manufacturer shows that 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 (106.0 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 from 4 to  $12\text{ms}^{-1}$ .

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

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

**Table 7-1: Predicted Noise Levels ( $L_{Aeq}$  dB(A)) for Non-Relevant Sites at  $8\text{ms}^{-1}$  wind speed**

| Receiver      | Criteria, dB(A) | Neutral Meteorological Conditions - $8\text{m/s}$ , dB(A) | Worst Case Meteorological Conditions $8\text{m/s}$ , dB(A) |
|---------------|-----------------|-----------------------------------------------------------|------------------------------------------------------------|
| Woodlawn Farm | 45              | 25.5                                                      | 29.5                                                       |
| Kalva         | 45              | 24                                                        | 27                                                         |
| Cowley Hills  | 45              | 27                                                        | 31                                                         |
| Pylara        | 45              | 26.5                                                      | 30                                                         |



**Table 7-2: Predicted Noise Levels ( $L_{Aeq}$  dB(A)) for Relevant Sites at Different Wind Speeds**

| Relevant Receiver                                         | Wind speed $ms^{-1}$ |      |      |      |      |      |      |      |      |
|-----------------------------------------------------------|----------------------|------|------|------|------|------|------|------|------|
|                                                           | 4                    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   |
| <b>Criterion : Torokina</b>                               |                      |      |      |      |      |      |      |      |      |
| <i>Criterion</i>                                          | 35                   | 35   | 36   | 37   | 38   | 39   | 40   | 42   | 44   |
| Torokina                                                  | 27                   | 27.5 | 28.5 | 30   | 30   | 30.5 | 30.5 | 30.5 | 30.5 |
| Bernallah                                                 | 16                   | 17   | 18.5 | 19   | 19.5 | 19.5 | 19.5 | 19.5 | 19.5 |
| <b>Criterion : Bonnie Doon (G7)</b>                       |                      |      |      |      |      |      |      |      |      |
| <i>Criterion</i>                                          | 35                   | 35   | 35   | 37   | 40   | 43   | 46   | 50   | 53   |
| Bonnie Doon                                               | 19.5                 | 20   | 21   | 22.5 | 22.5 | 23   | 23   | 23.5 | 23.5 |
| Nardoo                                                    | 16.5                 | 17   | 18   | 19.5 | 19.5 | 20   | 20.5 | 20.5 | 20.5 |
| Wroxham                                                   | 19                   | 20   | 21   | 22   | 22.5 | 23   | 23   | 23.5 | 23.5 |
| Rosehill                                                  | 16.5                 | 17   | 18   | 19.5 | 20   | 20   | 20.5 | 20.5 | 20.5 |
| Hilltop Farm                                              | 17.5                 | 18   | 19   | 20.5 | 20.5 | 21   | 21   | 21.5 | 21.5 |
| Hamptons                                                  | 16.5                 | 17   | 18   | 19.5 | 19.5 | 20   | 20.5 | 20.5 | 20.5 |
| La Lee                                                    | —                    | —    | 0.5  | 2    | 2.5  | 3    | 3    | 3    | 3    |
| Myolena                                                   | 18                   | 19   | 20   | 21   | 21.5 | 22   | 22   | 22.5 | 22.5 |
| <b>Criterion : Kildare</b>                                |                      |      |      |      |      |      |      |      |      |
| <i>Criterion</i>                                          | 35                   | 35   | 36   | 37   | 39   | 40   | 42   | 44   | 46   |
| Kildare                                                   | 26                   | 26.5 | 27.5 | 28.5 | 29   | 29.5 | 29.5 | 29.5 | 29.5 |
| Willandra                                                 | 21                   | 22   | 22.5 | 24   | 24.5 | 25   | 25   | 25   | 25   |
| Ellareagh                                                 | 18                   | 18.5 | 19.5 | 21   | 21   | 21.5 | 22   | 22   | 22   |
| Hollymount                                                | 15                   | 15.5 | 16.5 | 18   | 18.5 | 19   | 19   | 19   | 19   |
| Linden Park                                               | 15.5                 | 16.5 | 17   | 18.5 | 19   | 19.5 | 19.5 | 19.5 | 19.5 |
| <b>Criterion: Glendale</b>                                |                      |      |      |      |      |      |      |      |      |
| <i>Criterion</i>                                          | 35                   | 35   | 35   | 37   | 40   | 42   | 44   | 47   | 49   |
| Glendale                                                  | 23                   | 23.5 | 24.5 | 26   | 26   | 26.5 | 26.5 | 27   | 27   |
| Richmond Grove                                            | 20                   | 20.5 | 21.5 | 23   | 23   | 23.5 | 23.5 | 24   | 24   |
| Bracken Ridge                                             | 17.5                 | 18   | 19   | 20.5 | 21   | 21   | 21.5 | 21.5 | 21.5 |
| Kandahar                                                  | 4.5                  | 5    | 6.5  | 8    | 8    | 8.5  | 9    | 9    | 9    |
| <b>Criterion: Sunnybrook [ref: Capital Wind Farm EIS]</b> |                      |      |      |      |      |      |      |      |      |
|                                                           | 35                   | 35   | 35   | 36   | 37   | 39   | 40   | 42   | 43   |
| G10                                                       | 16                   | 16.5 | 17.5 | 19   | 19.5 | 20   | 20   | 20   | 20   |
| G8 Sunnybrook                                             | 13.5                 | 14.5 | 15.5 | 16   | 16.5 | 16.5 | 17   | 17   | 16.5 |
| G9 Sunnybrook                                             | 11                   | 11.5 | 12.5 | 14   | 14   | 14.5 | 15   | 15   | 15   |
| G11 La Granja                                             | 16.5                 | 17.5 | 19   | 19.5 | 20   | 20   | 20   | 20   | 20   |
| G12 Narine Green                                          | 12                   | 13   | 14.5 | 15   | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 |
| G13                                                       | 18                   | 19   | 20   | 20.5 | 21   | 21   | 21.5 | 21.5 | 21   |
| G14                                                       | 16                   | 17   | 18.5 | 18.5 | 19   | 19   | 19.5 | 19.5 | 19   |
| G15                                                       | 15.5                 | 16   | 17.5 | 18   | 18.5 | 18.5 | 18.5 | 18.5 | 18.5 |
| G16                                                       | 18                   | 18.5 | 20   | 20.5 | 21   | 21   | 21   | 21   | 21   |
| G17                                                       | 15.5                 | 16.5 | 18   | 18   | 18.5 | 18.5 | 19   | 19   | 18.5 |
| <b>Criterion: Gray [ref: Capital Wind Farm EIS]</b>       |                      |      |      |      |      |      |      |      |      |
|                                                           | 35                   | 35   | 35   | 35   | 36   | 37   | 39   | 40   | 42   |
| McLaughlin                                                | 10                   | 11   | 12   | 13.5 | 13.5 | 14   | 14.5 | 14.5 | 14.5 |
| Clear View                                                | 11.5                 | 12.5 | 13.5 | 14.5 | 15   | 15.5 | 15.5 | 16   | 16   |
| Mingary                                                   | 9                    | 10   | 11   | 12.5 | 12.5 | 13   | 13.5 | 13.5 | 13.5 |
| Ugov                                                      | 14.5                 | 15.5 | 17   | 17   | 17.5 | 17.5 | 18   | 18   | 17.5 |
| Gray                                                      | 10                   | 10.5 | 11.5 | 13   | 13.5 | 14   | 14   | 14   | 14   |
| <b>Criterion: Euroka [ref: Capital Wind Farm EIS]</b>     |                      |      |      |      |      |      |      |      |      |



| Relevant Receiver   | Wind speed ms <sup>-1</sup> |      |    |    |      |    |    |    |    |
|---------------------|-----------------------------|------|----|----|------|----|----|----|----|
|                     | 4                           | 5    | 6  | 7  | 8    | 9  | 10 | 11 | 12 |
|                     | 35                          | 35   | 35 | 36 | 37   | 38 | 40 | 41 | 43 |
| Widgemoor           | 17.5                        | 18.5 | 20 | 20 | 20.5 | 21 | 21 | 21 | 21 |
| Kullingrah (Euroka) | 18.5                        | 19.5 | 21 | 21 | 21.5 | 22 | 22 | 22 | 22 |

The predicted noise levels at all relevant receivers achieve the appropriate criteria at all wind speeds. Colour noise contour plots have been generated for the maximum power setting (for neutral and 8ms<sup>-1</sup> worst case wind propagation scenarios), covering the surrounding area. These are shown in Appendix F. We note that in the table above fields indicated with a “—” are given when a residence is greater than 5km away from any WTG and likely impact from the wind farm is negligible.



## 7.1. 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  $\pm 4$  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 Woodlawn 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 minimal post-construction environmental noise survey information of the existing wind farms has yet been provided. Preliminary information suggests that the model provides reasonably accurate (and slightly conservative) predictions of wind farm noise levels.
- The noise prediction model for the Woodlawn 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.



## 8. NOISE IMPACT ASSESSMENT

### 8.1. Cumulative Impacts

#### Substation Noise

The Development Consent for Woodlawn Wind Farm allowed for a 22kV/66kV substation located at the Woodlawn Wind Farm Site. The substation was to be capable of handling the output of the proposed 50MW wind farm. The proposed modifications to the project avoid the installation of this substation and the associated 66kV overhead line for grid connection. Instead, it is proposed that grid connection is via the existing 33kV/330kV Capital Wind Farm substation that would be augmented for this purpose.

The existing 33kV/330kV Capital Wind Farm substation has two 33kV/330kV transformers rated at 80MVA. The construction of the substation included the preparation of an additional transformer bay. By installing an additional 33kV/330kV transformer at this location together with various 33kV items and a 33kV overhead line between the Woodlawn Wind Farm and the Capital Wind Farm substation it is possible to export the Woodlawn Wind Farm power via the existing 330kV TransGrid switchyard within the Capital Wind Farm substation. The additional transformer at the Capital Wind Farm substation represents an additional noise source at this location and this assessment reviews the cumulative noise impact of the existing substation augmented with an additional 33kV/330kV transformer rated at 180MVA.

The two existing 33kV/330kV (80MVA) transformers are indicated to have sound power levels of 92.6 dB(A). The proposed additional 33kV/330kV (180MVA) transformer is expected to have a conservative sound power level of 100 dB(A). Based on these figures a combined conservative sound power level of 101 dB(A) is expected for the entire augmented substation.

The Capital Wind Farm substation is about 1,200 metres from the nearest residential receivers. To date no complaints have been received from these closest neighbours in respect of noise from the operating substation. Review of potential noise levels at the closest receivers following augmentation of the substation (based on the conservative 101 dB(A) sound power level) indicates that the predicted noise level from the substation at the receivers is likely to be about 32dB(A) (similar to worst case wind turbine levels) and up to 33 to 34 dB(A) in certain meteorological conditions. The combined noise level of the substation and wind turbines at the receiver locations is estimated to be less than 35dB(A). Also, the maximum loading and noise generation from the substation will occur during periods of strong winds and associated high background noise.

Due to the distance between the substation and the receivers the 100Hz frequency component of transformer noise is not expected to be significant at the receiver locations.

#### Capital Wind Farm

We note that the Capital Wind Farm is located to the south west of the proposed Woodlawn Wind Farm. As the noise impact of the Woodlawn Wind Farm is relatively low (i.e. less than 30dB(A)) it can be assumed that the noise impact on the south west and westerly residences will be dominated by Capital Wind Farm.

**Table 8-1: Predicted Noise Levels ( $L_{Aeq}$  dB(A)) for Non-Relevant Sites at  $8ms^{-1}$  wind speed with capital wind farm impact**

| Receiver      | Worst Case Meteorological Conditions 8m/s, dB(A) |
|---------------|--------------------------------------------------|
| Woodlawn Farm | 29.5                                             |
| Kalva         | 27                                               |
| Cowley Hills  | 31                                               |
| Pylara        | 30                                               |



**Table 8-2: Predicted Noise Levels ( $L_{Aeq}$  dB(A)) for Relevant Sites at  $8\text{ms}^{-1}$  Wind Speeds with the influence of Capital Wind Farm**

| Relevant Receiver                                         | Wind speed $\text{ms}^{-1}$ |             |           |           |             |             |           |           |             |
|-----------------------------------------------------------|-----------------------------|-------------|-----------|-----------|-------------|-------------|-----------|-----------|-------------|
|                                                           | 4                           | 5           | 6         | 7         | 8           | 9           | 10        | 11        | 12          |
| <b>Criterion : Torokina</b>                               |                             |             |           |           |             |             |           |           |             |
| <i>Criterion</i>                                          | 35                          | 35          | 36        | 37        | 38          | 39          | 40        | 42        | 44          |
| Torokina                                                  | 29.5                        | 30.5        | 31.5      | 32.5      | 32.5        | 33          | 33        | 33        | 33          |
| Bernallah                                                 | 26.5                        | 27          | 28.5      | 28.5      | 29          | 29          | 29        | 29        | 29          |
| <b>Criterion : Bonnie Doon (G7)</b>                       |                             |             |           |           |             |             |           |           |             |
| <i>Criterion</i>                                          | 35                          | 35          | 35        | 37        | 40          | 43          | 46        | 50        | 53          |
| Bonnie Doon                                               | 30                          | 31          | 32        | 32.5      | 33          | 33          | 33        | 33        | 33          |
| <b>Nardoo**</b>                                           | <b>35</b>                   | <b>35.5</b> | <b>37</b> | <b>37</b> | <b>37.5</b> | <b>37.5</b> | <b>38</b> | <b>38</b> | <b>37.5</b> |
| Wroxham                                                   | 31.5                        | 32.5        | 33.5      | 34.5      | 35          | 35          | 35        | 35        | 35          |
| Rosehill                                                  | 28.5                        | 29.5        | 30.5      | 31        | 31.5        | 31.5        | 31.5      | 31.5      | 31.5        |
| Hilltop Farm                                              | 27                          | 27.5        | 29        | 29.5      | 30          | 30          | 30        | 30        | 30          |
| Hamptons                                                  | 24.5                        | 25.5        | 27        | 27.5      | 27.5        | 28          | 28.5      | 28.5      | 28.5        |
| La Lee                                                    | 23                          | 24          | 25.5      | 25.5      | 26          | 26.5        | 26.5      | 26.5      | 26.5        |
| Myolena                                                   | 26                          | 27          | 28        | 29        | 29.5        | 29.5        | 29.5      | 29.5      | 29.5        |
| <b>Criterion : Kildare</b>                                |                             |             |           |           |             |             |           |           |             |
| <i>Criterion</i>                                          | 35                          | 35          | 36        | 37        | 39          | 40          | 42        | 44        | 46          |
| Kildare                                                   | 26                          | 26.5        | 27.5      | 28.5      | 29          | 29.5        | 29.5      | 29.5      | 29.5        |
| Willandra                                                 | 21                          | 22          | 23        | 24        | 24.5        | 25          | 25        | 25        | 25          |
| Ellareagh                                                 | 18.5                        | 19          | 20        | 21.5      | 21.5        | 22          | 22.5      | 22.5      | 22.5        |
| Hollymount                                                | 16                          | 16.5        | 17.5      | 19        | 19.5        | 20          | 20        | 20        | 20          |
| Linden Park                                               | 16.5                        | 17.5        | 18.5      | 19.5      | 20          | 20.5        | 20.5      | 20.5      | 20.5        |
| Lachlan Park                                              | 10.5                        | 11.5        | 12.5      | 13        | 13.5        | 14          | 14        | 14        | 14          |
| <b>Criterion: Glendale</b>                                |                             |             |           |           |             |             |           |           |             |
| <i>Criterion</i>                                          | 35                          | 35          | 35        | 37        | 40          | 42          | 44        | 47        | 49          |
| Glendale                                                  | 24                          | 25          | 26.5      | 26.5      | 27          | 27.5        | 27.5      | 27.5      | 27.5        |
| Richmond Grove                                            | 21                          | 22          | 23.5      | 24        | 24          | 24.5        | 24.5      | 24.5      | 24.5        |
| Bracken Ridge                                             | 19.5                        | 20.5        | 22        | 22        | 22.5        | 23          | 23        | 23        | 23          |
| Kandahar                                                  | 22                          | 23          | 24        | 24.5      | 25          | 25          | 25        | 25        | 25          |
| Kalbilli                                                  | —                           | —           | —         | —         | —           | —           | —         | —         | —           |
| <b>Criterion: Sunnybrook [ref: Capital Wind Farm EIS]</b> |                             |             |           |           |             |             |           |           |             |
|                                                           | 35                          | 35          | 35        | 36        | 37          | 39          | 40        | 42        | 43          |
| G10                                                       | 32.5                        | 33          | 34.5      | 34.5      | 35          | 35.5        | 35.5      | 35.5      | 35.5        |
| <b>G8 Sunnybrook**</b>                                    | <b>36</b>                   | <b>37</b>   | <b>38</b> | <b>38</b> | <b>38.5</b> | <b>39</b>   | 39        | 39        | 39          |
| <b>G9 Sunnybrook**</b>                                    | <b>37</b>                   | <b>37.5</b> | <b>39</b> | <b>39</b> | <b>39.5</b> | <b>39.5</b> | <b>40</b> | 40        | 40          |
| G11 La Granja                                             | 32.5                        | 33          | 34.5      | 34.5      | 35          | 35.5        | 35.5      | 35.5      | 35.5        |
| G12 Narine Green                                          | 32.5                        | 33          | 34.5      | 35        | 35          | 35.5        | 35.5      | 35.5      | 35.5        |
| G13                                                       | 29.5                        | 30          | 31.5      | 31.5      | 32          | 32.5        | 32.5      | 32.5      | 32.5        |
| G14                                                       | 30                          | 30.5        | 32        | 32        | 32.5        | 33          | 33        | 33        | 33          |
| G15                                                       | 30                          | 30.5        | 32        | 32        | 32.5        | 32.5        | 33        | 33        | 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        | 32.5      | 32.5      | 32.5        |
| <b>Criterion: Gray [ref: Capital Wind Farm EIS]</b>       |                             |             |           |           |             |             |           |           |             |
|                                                           | 35                          | 35          | 35        | 35        | 36          | 37          | 39        | 40        | 42          |
| McLaughlin                                                | 18.5                        | 19.5        | 21        | 21.5      | 21.5        | 22          | 22.5      | 22.5      | 22.5        |
| Clear View                                                | 26                          | 27          | 28        | 28.5      | 29          | 29          | 29        | 29        | 29          |
| Mingary                                                   | 24.5                        | 25          | 26.5      | 26.5      | 27          | 27.5        | 27.5      | 27.5      | 27.5        |



| Relevant Receiver                                     | Wind speed ms <sup>-1</sup> |           |           |             |           |           |           |           |           |
|-------------------------------------------------------|-----------------------------|-----------|-----------|-------------|-----------|-----------|-----------|-----------|-----------|
|                                                       | 4                           | 5         | 6         | 7           | 8         | 9         | 10        | 11        | 12        |
| Ugov                                                  | 31                          | 32        | 33        | 33.5        | 34        | 34        | 34        | 34        | 34        |
| Gray                                                  | 23.5                        | 24        | 25.5      | 26          | 26        | 26.5      | 26.5      | 26.5      | 26.5      |
| <b>Criterion: Euroka [ref: Capital Wind Farm EIS]</b> |                             |           |           |             |           |           |           |           |           |
|                                                       | 35                          | 35        | 35        | 36          | 37        | 38        | 40        | 41        | 43        |
| Widgemoor                                             | 31.5                        | 32.5      | 33.5      | 34          | 34.5      | 34.5      | 34.5      | 34.5      | 34.5      |
| <b>Kullingrah (Euroka)**</b>                          | <b>39</b>                   | <b>40</b> | <b>41</b> | <b>41.5</b> | <b>42</b> | <b>42</b> | <b>42</b> | <b>42</b> | <b>42</b> |

\*\* Denotes non relevant noise receivers for Capital Wind Farm.

For the residential receivers at the western and southwestern area of the Woodlawn Wind Farm, we note that noise levels from Capital Wind Farm WTGs are dominant. Noise associated with the Capital Wind Farm project is to be assessed separately from the Woodlawn assessment, and is covered in the Capital Wind Farm Noise Impact Assessment. We note that several receivers associated with the Capital Wind Farm project (i.e. non-relevant receivers for Capital Wind Farm (CWF)) are non relevant receivers for the Woodlawn Wind Farm Project. The noise impact on these receivers (indicated by \*\* in Table 8-2) by Woodlawn Wind Farm is negligible, as the noise levels at these receivers are dominated by CWF. Any noise at these receivers due to the Capital Wind Farm is to be treated as outlined in [6]. Therefore, all noise at all relevant receiver locations for both Capital Wind Farm and Woodlawn Wind Farm meet the stipulated requirements. The receivers to the north, east and southeast of the site are unaffected by noise from Capital Wind Farm.

## 8.2. 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* [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 up to 27 dB(A) at relevant receivers.

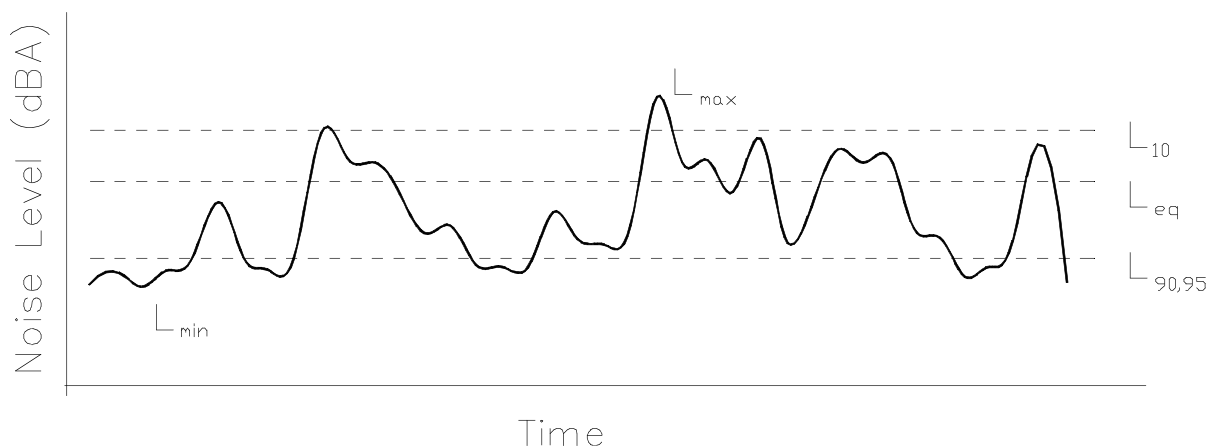
The predicted  $L_{Aeq}$  noise levels, for worst case wind conditions range up to 31 dB(A) at the relevant receivers. These predicted levels at maximum WTG power setting achieve the appropriate criteria for all relevant receivers.

We note that the expected low noise levels from the WTGs are due to the large distance between the WTGs and the residences, many of which are situated greater than 3 km away.



## 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<sub>10</sub>** The noise level which is equalled or exceeded for 10% of the measurement period. L<sub>10</sub> 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<sub>90</sub>** The noise level which is equalled or exceeded for 90% of the measurement period. L<sub>90</sub> or L<sub>95</sub> 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<sub>eq</sub>** The equivalent continuous noise level for the measurement period, weighted for duration and intensity. L<sub>eq</sub> is an indicator of the average noise level [in dB(A)].
- L<sub>max</sub>** The maximum noise level for the measurement period [usually in dB(A)].
- L<sub>peak</sub>** 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)].

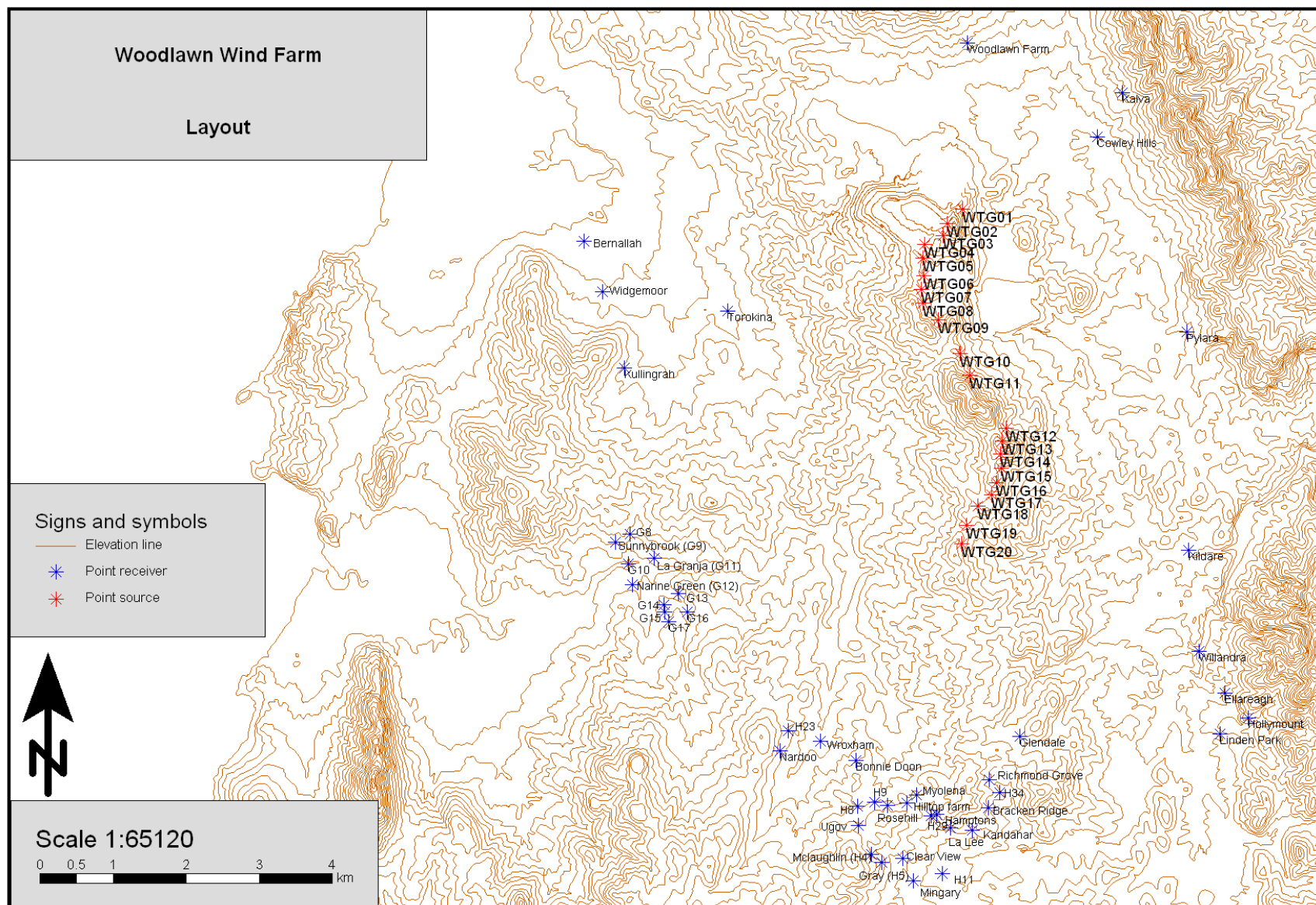


**Note:** The subjective response or reaction to changes in noise levels can be described as follows:

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    LAYOUT MAP OF WOODLAWN WIND FARM**





## **APPENDIX C      LIST AND DETAILS OF RESIDENTIAL PREMISES NEAR WIND FARM.**



| Name                  | Easting | Northing | Dist. to nearest<br>(Woodlawn) WTG (m) | Comment      |
|-----------------------|---------|----------|----------------------------------------|--------------|
| Woodlawn Farm         | 734572  | 6118602  | 2277                                   | Non-relevant |
| Kalva                 | 736694  | 6117927  | 2705                                   | Non-relevant |
| Cowley Hills          | 736355  | 6117316  | 2090                                   | Non-relevant |
| Pylara                | 737579  | 6114631  | 2803                                   | Non-relevant |
| Kildare               | 737597  | 6111634  | 2787                                   | Relevant     |
| Willandra             | 737741  | 6110252  | 3555                                   | Relevant     |
| Ellareagh             | 738098  | 6109678  | 4137                                   | Relevant     |
| Hollymount            | 738420  | 6109331  | 4590                                   | Relevant     |
| Linden Park           | 738033  | 6109115  | 4390                                   | Relevant     |
| Glendale              | 735290  | 6109075  | 2763                                   | Relevant     |
| Richmond Grove        | 734878  | 6108479  | 3266                                   | Relevant     |
| Bracken Ridge         | 734868  | 6108093  | 3648                                   | Relevant     |
| Kandahar              | 734647  | 6107790  | 3936                                   | Relevant     |
| La Lee                | 734341  | 6107822  | 3904                                   | Relevant     |
| Mingary               | 733842  | 6107089  | 4681                                   | Relevant     |
| Clear View            | 733694  | 6107400  | 4398                                   | Relevant     |
| Hamptons              | 734164  | 6108006  | 3732                                   | Relevant     |
| Myolena               | 733882  | 6108277  | 3501                                   | Relevant     |
| Hilltop farm          | 733748  | 6108165  | 3637                                   | Relevant     |
| Rosehill              | 733481  | 6108125  | 3740                                   | Relevant     |
| Bonnie Doon           | 733059  | 6108750  | 3305                                   | Relevant     |
| Wroxham               | 732568  | 6109017  | 3326                                   | Relevant     |
| Nardoo                | 732016  | 6108884  | 3774                                   | Relevant     |
| Narine Green<br>(G12) | 729998  | 6111158  | 4539                                   | Relevant     |
| La Granja (G11)       | 730301  | 6111530  | 4205                                   | Relevant     |
| Widgemoor             | 729590  | 6115188  | 5354                                   | Relevant     |
| Kullringrah           | 729893  | 6114143  | 4173                                   | Relevant     |
| Torokina              | 731308  | 6114923  | 2652                                   | Relevant     |
| Bernallah             | 729338  | 6115879  | 3633                                   | Relevant     |
| Gray (H5)             | 733413  | 6107346  | 4510                                   | Relevant     |
| Mclaughlin (H4)       | 733261  | 6107458  | 4442                                   | Relevant     |
| Ugov                  | 733090  | 6107859  | 4114                                   | Relevant     |



| Name            | Easting | Northing | Dist. to nearest<br>(Woodlawn) WTG (m) | Comment  |
|-----------------|---------|----------|----------------------------------------|----------|
| Sunnybrook (G8) | 729972  | 6111860  | 4532                                   | Relevant |
| Sunnybrook (G9) | 729767  | 6111746  | 4735                                   | Relevant |
| G10             | 729947  | 6111450  | 4563                                   | Relevant |
| G13             | 730635  | 6111045  | 3926                                   | Relevant |
| G14             | 730435  | 6110892  | 4151                                   | Relevant |
| G15             | 730442  | 6110783  | 4167                                   | Relevant |
| G16             | 730753  | 6110792  | 3863                                   | Relevant |
| G17             | 730502  | 6110650  | 4141                                   | Relevant |
| H8              | 733077  | 6108115  | 3879                                   | Relevant |
| H9              | 733308  | 6108179  | 3740                                   | Relevant |
| H11             | 734231  | 6107192  | 4540                                   | Relevant |
| H23             | 732128  | 6109154  | 3498                                   | Relevant |
| H29             | 734077  | 6107987  | 3760                                   | Relevant |
| H34             | 735013  | 6108307  | 3454                                   | Relevant |



## **APPENDIX D     LIST AND DETAILS OF PROPOSED WIND TURBINE GENERATORS**



| <b>Proposed Wind Turbine Generators (WTGs)</b> |                |                 |
|------------------------------------------------|----------------|-----------------|
| <b>WTG No.</b>                                 | <b>Easting</b> | <b>Northing</b> |
| WTG01                                          | 734514         | 6116326         |
| WTG02                                          | 734307         | 6116126         |
| WTG03                                          | 734248         | 6115958         |
| WTG04                                          | 733992         | 6115838         |
| WTG05                                          | 733966         | 6115656         |
| WTG06                                          | 733977         | 6115412         |
| WTG07                                          | 733944         | 6115218         |
| WTG08                                          | 733969         | 6115036         |
| WTG09                                          | 734178         | 6114806         |
| WTG10                                          | 734481         | 6114335         |
| WTG11                                          | 734615         | 6114043         |
| WTG12                                          | 735106         | 6113311         |
| WTG13                                          | 735057         | 6113136         |
| WTG14                                          | 735028         | 6112956         |
| WTG15                                          | 735041         | 6112762         |
| WTG16                                          | 734969         | 6112563         |
| WTG17                                          | 734906         | 6112397         |
| WTG18                                          | 734724         | 6112248         |
| WTG19                                          | 734571         | 6111984         |
| WTG20                                          | 734502         | 6111723         |



**APPENDIX E    SOUND POWER SPECTRUM OF THE SUZLON S88  
2.1MW WTG IN  $L_{AEQ}$  THIRD OCTAVE BANDS, MEASURED  
AT REFERENCE WIND SPEED OF  $8\text{MS}^{-1}$  AT 10MAGL**



### 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 <sup>3</sup> ): | 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  | 16.7  |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 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 |

| 1/3 Octave Band Data - A-Weighted Sound Power Level (dBA) |                          |      |      |      |      |      |      |      |      |      |
|-----------------------------------------------------------|--------------------------|------|------|------|------|------|------|------|------|------|
| Freq (Hz) Bin                                             | 10m agl Wind Speed (m/s) |      |      |      |      |      |      |      |      |      |
|                                                           | 3                        | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   |
| 16                                                        | 59.3                     | 60.1 | 61.4 | 61.3 | 62.0 | 61.3 | 61.5 | 61.6 | 61.6 | 61.5 |
| 20                                                        | 59.4                     | 60.1 | 61.4 | 61.3 | 62.0 | 61.2 | 61.4 | 61.5 | 61.5 | 61.4 |
| 25                                                        | 62.8                     | 63.5 | 65.0 | 64.8 | 65.2 | 64.8 | 65.0 | 65.1 | 65.1 | 65.0 |
| 31.5                                                      | 66.2                     | 66.9 | 68.6 | 68.3 | 68.4 | 68.5 | 68.7 | 68.8 | 68.8 | 68.7 |
| 40                                                        | 72.1                     | 72.8 | 73.9 | 74.5 | 73.6 | 74.0 | 74.2 | 74.3 | 74.3 | 74.2 |
| 50                                                        | 74.2                     | 74.9 | 72.2 | 76.6 | 74.1 | 75.3 | 75.5 | 75.6 | 75.6 | 75.5 |
| 63                                                        | 75.3                     | 76.0 | 76.3 | 77.7 | 75.9 | 75.5 | 75.7 | 75.8 | 75.8 | 75.7 |
| 80                                                        | 77.6                     | 78.3 | 80.3 | 81.5 | 81.0 | 81.3 | 81.5 | 81.6 | 81.6 | 81.5 |
| 100                                                       | 81.7                     | 82.4 | 83.9 | 86.2 | 84.8 | 85.4 | 85.6 | 85.7 | 85.7 | 85.6 |
| 125                                                       | 83.6                     | 84.3 | 85.8 | 87.5 | 87.5 | 88.1 | 88.3 | 88.4 | 88.4 | 88.3 |
| 160                                                       | 85.5                     | 86.2 | 87.8 | 88.9 | 90.3 | 90.9 | 91.1 | 91.2 | 91.2 | 91.1 |
| 200                                                       | 87.9                     | 88.6 | 90.6 | 92.3 | 93.7 | 94.3 | 94.5 | 94.6 | 94.6 | 94.5 |
| 250                                                       | 90.2                     | 90.9 | 92.5 | 94.0 | 94.9 | 95.8 | 95.8 | 95.9 | 95.9 | 95.8 |
| 315                                                       | 92.1                     | 92.8 | 93.8 | 95.6 | 96.3 | 97.0 | 97.2 | 97.3 | 97.3 | 97.2 |
| 400                                                       | 93.0                     | 93.7 | 94.6 | 96.2 | 96.5 | 97.1 | 97.3 | 97.4 | 97.4 | 97.3 |
| 500                                                       | 93.5                     | 94.2 | 94.8 | 96.4 | 96.4 | 96.6 | 96.8 | 96.9 | 96.9 | 96.8 |
| 630                                                       | 94.4                     | 95.1 | 95.5 | 96.4 | 96.0 | 95.9 | 96.1 | 96.2 | 96.2 | 96.1 |
| 800                                                       | 94.4                     | 95.1 | 95.0 | 95.3 | 94.4 | 94.2 | 94.4 | 94.5 | 94.5 | 94.4 |
| 1000                                                      | 94.6                     | 95.3 | 95.2 | 95.7 | 94.4 | 94.3 | 94.5 | 94.6 | 94.6 | 94.5 |
| 1250                                                      | 93.6                     | 94.3 | 94.2 | 92.7 | 93.1 | 93.6 | 93.8 | 93.9 | 93.9 | 93.8 |
| 1600                                                      | 91.7                     | 92.4 | 93.0 | 87.3 | 93.1 | 93.7 | 93.9 | 94.0 | 94.0 | 93.9 |
| 2000                                                      | 88.6                     | 89.3 | 90.7 | 84.9 | 90.6 | 90.6 | 90.8 | 90.9 | 90.9 | 90.8 |
| 2500                                                      | 84.5                     | 85.2 | 86.7 | 83.9 | 87.4 | 87.6 | 87.8 | 87.9 | 87.9 | 87.8 |
| 3150                                                      | 80.2                     | 80.9 | 83.9 | 79.4 | 83.7 | 84.4 | 84.6 | 84.7 | 84.7 | 84.6 |
| 4000                                                      | 74.7                     | 75.4 | 81.8 | 77.7 | 78.0 | 79.8 | 80.0 | 80.1 | 80.1 | 80.0 |
| 5000                                                      | 71.8                     | 72.5 | 78.4 | 75.1 | 75.5 | 75.9 | 76.1 | 76.2 | 76.2 | 76.1 |
| 6300                                                      | 68.7                     | 67.4 | 74.2 | 70.5 | 72.2 | 72.1 | 72.3 | 72.4 | 72.4 | 72.3 |
| 8000                                                      | 63.0                     | 63.7 | 68.8 | 66.3 | 66.7 | 68.5 | 68.7 | 68.8 | 68.8 | 68.7 |
| 10000                                                     | 57.0                     | 57.7 | 63.8 | 61.8 | 66.5 | 65.6 | 65.8 | 65.9 | 65.9 | 65.8 |
| 12500                                                     | 52.9                     | 53.6 | 58.0 | 57.1 | 62.9 | 62.1 | 62.3 | 62.4 | 62.4 | 62.3 |
| 16000                                                     | 49.9                     | 50.6 | 51.8 | 52.6 | 55.0 | 54.2 | 54.4 | 54.5 | 54.5 | 54.4 |
| 20000                                                     | 47.4                     | 48.1 | 48.5 | 48.9 | 48.7 | 48.7 | 48.9 | 49.0 | 49.0 | 48.9 |

| 1 Octave Band Data - A-Weighted Sound Power Level (dBA) |                          |      |      |       |       |       |       |       |       |       |
|---------------------------------------------------------|--------------------------|------|------|-------|-------|-------|-------|-------|-------|-------|
| Freq (Hz) Bin                                           | 10m agl Wind Speed (m/s) |      |      |       |       |       |       |       |       |       |
|                                                         | 3                        | 4    | 5    | 6     | 7     | 8     | 9     | 10    | 11    | 12    |
| 62.5                                                    | 81.5                     | 82.2 | 83.1 | 84.6  | 83.6  | 83.8  | 84.0  | 84.1  | 84.1  | 84.0  |
| 125                                                     | 88.6                     | 89.3 | 90.9 | 92.4  | 92.9  | 93.5  | 93.7  | 93.8  | 93.8  | 93.7  |
| 250                                                     | 95.2                     | 95.9 | 97.2 | 98.9  | 99.9  | 100.5 | 100.7 | 100.8 | 100.8 | 100.7 |
| 500                                                     | 98.4                     | 99.1 | 99.8 | 101.1 | 101.1 | 101.3 | 101.6 | 101.6 | 101.6 | 101.5 |
| 1000                                                    | 99.0                     | 99.7 | 99.6 | 99.5  | 98.8  | 98.8  | 99.0  | 99.1  | 99.1  | 99.0  |
| 2000                                                    | 94.0                     | 94.7 | 95.6 | 90.4  | 95.7  | 96.1  | 96.3  | 96.4  | 96.4  | 96.3  |
| 4000                                                    | 81.7                     | 82.4 | 86.7 | 82.5  | 85.2  | 86.1  | 86.3  | 86.4  | 86.4  | 86.3  |
| 8000                                                    | 68.8                     | 69.5 | 75.7 | 72.5  | 74.9  | 74.6  | 74.8  | 74.9  | 74.9  | 74.8  |

Sound Power Data: Commercial Warranty Value at 12/7/2005. Calculated from initial S88 noise measurements.  
Test conditions -wind shear coeff. estimate of 0.16, standard air density, 10% site turbulence, Clean Blades, No Ice/Snow on blades,  
No Damage to Leading Edge, Terrain to IEC 61400-12, Inflow Angle: 0+/-2 Deg. Should site conditions vary substantially  
from these values the actual sound power level output may also vary.



## **APPENDIX F COLOUR NOISE CONTOUR PLOTS FOR THE MAXIMUM POWER SETTING FOR THE NEUTRAL AND 8MS<sup>-1</sup> WORST CASE WIND PROPAGATION SCENARIOS**

