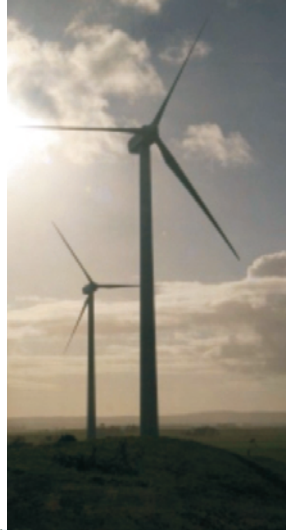


Woodlawn Wind Farm



Noise

7

7. Noise

7.1 Introduction

This chapter of the SEE reviews the proposed project variations and the associated noise issues arising for the amended project. Table 7.1 lists the proposed variations to the project together with the noise related issues to be considered for the respective variations.

Table 7.1 – Project variations and noise related issues arising for the variations

Project variation	Associated noise issues to be considered
Installation of 12 kilometres of 33 kV overhead transmission line	<ul style="list-style-type: none"> • Short term noise during construction of the line • No noise impact once the 33 kV line is installed
Variations to the wind farm array <ul style="list-style-type: none"> • lesser number of turbines • different turbine model variation in turbine dimensions and noise specification	<ul style="list-style-type: none"> • lesser amount of construction works • operational noise for each turbine marginally increased but lesser number of turbines • review of predicted operational noise levels associated with revised array and comparison with permissible levels for the existing consent
Removal of the 22 kV/66 kV substation from the wind farm site	<ul style="list-style-type: none"> • less construction activity at the wind farm site • removal of transformer noise source at wind farm site
Augmentation of the Capital Wind Farm substation with an additional 33 kV/330 kV transformer	<ul style="list-style-type: none"> • short term construction activity at substation site • extra noise source once Woodlawn Wind Farm operational

The Director-General's requirements of 10 July 2009 identified specific aspects to be addressed by the SEE including the following in respect of noise issues:

- a revised noise assessment demonstrating that the proposed modification to the development would be capable of achieving the noise limits set under the conditions of consent for Woodlawn, dated 4 October 2005
- a revised noise assessment demonstrating that the proposed modification to the development would be capable of achieving the noise limits set under the conditions of consent for Capital Wind Farm, dated 7 November 2006
- details of any further mitigation and management measures, where necessary, to ensure compliance with the noise limits

The SEE provides a summary of the revised noise assessment conducted by Vipac Noise Consultants (Vipac 2010) in respect of the proposed variations. The Vipac assessment report is attached as Appendix D and provides updated details of predicted noise impacts from the amended project in relation to the relevant noise amenity criteria.

The above noise issues are addressed in this chapter that describes the noise assessments undertaken relative to the approved and amended Woodlawn Wind Farm projects and, as relevant, taking into account the Capital Wind Farm noise impact.

7.2 Existing Development Consent

The 2004 EIS prepared by URS contained a noise assessment report prepared by Wilkinson Murray (September 2004). This report detailed the methodology, noise criteria determination and project and site description for the approved 25 turbine project. It did not take into account the cumulative impact of the Woodlawn and Capital Wind Farms as the details of the Capital Wind Farm were not available at that time. The maximum turbine noise rating used by Wilkinson Murray was 105 dB(A). An updated assessment was provided in January 2005 to the then DEC in response to various issues by the

DEC. Subsequently, the development consent for the Woodlawn Wind Farm Project (DA 250-10-204-i) was granted on 4 October 2005 and included the following conditions of consent relating to noise impact.

Table 7.2 – Woodlawn Wind Farm Consent Conditions relevant to noise impact

Condition	Summary details of condition
19	Construction hours
20 – 22	Blasting and vibration requirements
28 (d)	Traffic and Transport Management Plan
42 (c)	Communication and Consultation - information on the development
48	Construction noise management sub plan required as part of the CEMP
49 – 52	Operational noise criteria
53 – 55	Noise compliance monitoring during operation including compliance assessment plan
56	Noise mitigation for vacant lots in respect of a future dwelling

As required by Condition 48, a construction noise management plan is to be prepared by the project contractor and will form part of the project Construction Environmental Management Plan (CEMP). In addition, traffic movements are subject to a traffic management plan that will include consideration of timing of vehicle movements on local roads. Operational noise impacts are addressed by Conditions 49 to 56.

7.3 2010 noise assessment

A further noise assessment to take into account the proposed variations to the approved project was undertaken by Vipac Engineers & Scientists (Vipac, 2010) and is provided as Appendix D of this SEE. The project variations relevant to the 2010 noise assessment included:

- the reduction of wind turbines from 25 to 20
- minor relocation of four wind turbines of between 100 metres and 250 metres from the previously approved turbine locations
- different turbine model and increased power rating from 2 MW to 2.1 MW
- changes in turbine dimensions as indicated below
 - increase in hub height of all wind turbines to 80 metres
 - increase in blade length from 40 metres to 44 metres
- increase from two to three transformers at Capital Wind Farm substation

To identify the variation to the potential noise impacts of the wind farm due to variations listed above, the 2010 Vipac noise assessment report addresses the following aspects:

- noise source locations were identified
- noise characteristics of proposed turbines established (106 dB(A) in place of 105 dB(A))
- residential receiver locations were reviewed in relation to the amended project
- background sound level data at representative residence locations was reviewed
- noise objectives based on existing background sound levels were developed
- sound levels at selected residential receiver locations resulting from the wind farm were predicted using a noise model
- Comparison of predicted sound levels and noise amenity criteria

- Assessment of noise impact of the proposed project variations and identification of any potential exceedances

The South Australian EPA's (SA EPA) Guideline entitled "*Environmental Noise Guidelines: Wind Farms February 2003*" was used in the assessment as this was the reference for the available background monitoring and the 2004 assessment on which the existing consent is based.

In addition to the 2004 Wilkinson Murray noise assessment for Woodlawn Wind Farm, Vipac has also prepared noise assessments for Capital Wind Farm in 2005, 2008 and 2009 as well as the 2010 Vipac noise assessment for the amended Woodlawn Wind Farm.

7.4 Residential receivers

For the purpose of noise impact assessment, residences are classified as follows:

- **Non-relevant receivers (or "wind farmers"):** These are residences on the properties on which the wind farm is located ie properties where the landowners have leases or easements for the construction and operation of the wind farm and associated facilities.
- **Relevant receivers (or "non-wind farmers"):** These are residences on the neighbouring properties.

Vipac identified 33 relevant receivers located between two and five kilometres from the proposed wind turbine locations. There are no relevant or non-relevant receivers located within 2.5 kilometres of a wind turbine and only three relevant receiver residences are within three kilometres of the Woodlawn Wind Farm. The locations of relevant and non-relevant receiver residences are shown in Figure 7.1.

Four non-relevant (wind-farmer) residence locations (Woodlawn Farm, Kalua, Cowley Hills and Pylara) have been identified at distances of two to three kilometres from Woodlawn Wind Farm. It is also noted that lands within the Goulburn Mulwaree Shire close to and including part of the Woodlawn Wind Farm site are zoned industrial and the four residences are within the area subject to industrial zoning.

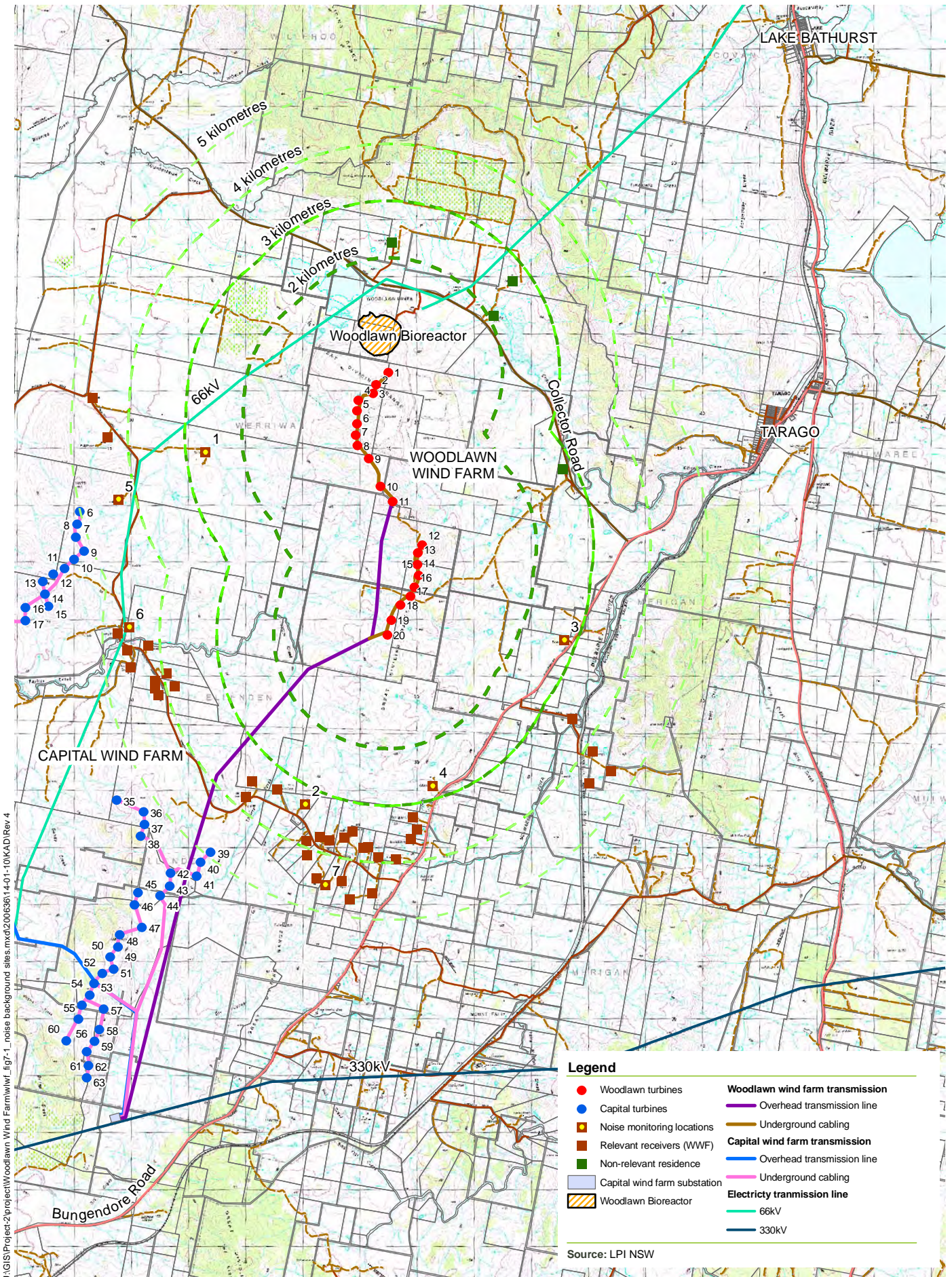
7.5 Background noise levels

7.5.1 Background noise monitoring sites

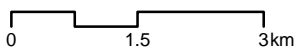
Sound levels at four representative residential receiver locations were previously measured by Wilkinson Murray (September 2004) for the Woodlawn Wind Farm noise assessment. Continuous monitoring was carried out over a period of two weeks with wind speed reference data obtained from the Woodlawn Wind Farm site at a former wind monitoring site adjacent to the Turbine 5 site of the original array.

Background noise monitoring was undertaken for Capital Wind Farm by Vipac Engineers & Scientists in April 2005. Three receiver sites from the Capital Wind Farm investigations were identified as being relevant for assessing noise impacts at receiver locations to the south and west of the Woodlawn Wind Farm. For the purpose of any future compliance assessment these three sites that are closer to Capital Wind Farm are referenced to wind speed measurements at 10 metres height at Groses Hill.

The seven sites from the 2004 Woodlawn Wind Farm and 2005 Capital Wind Farm noise assessments were considered by Vipac as being suitable for the 2010 assessment of noise impacts relating to the proposed variations to the Woodlawn Wind Farm and in respect of residences that may have a cumulative noise impact from the two wind farms. The representative receiver sites are described in Table 7.3 and shown in Figure 7.1.



SCALE 1:90,000 @ A4



Projection: MGA

Woodlawn Wind Farm **Statement of Environmental Effects**

FIGURE 7.1: Receiver locations and representative background sites

Monitoring of the background sound levels and development of noise amenity criteria are described fully in the 2004 EIS prepared by URS and in the Capital Wind Farm EA (CW PPI, 2006).

Table 7.3 – Location of background noise monitoring sites

Receiver site	Ref no. (Fig 7.1)	Location	Distance to wind turbines
Torokina ⁽¹⁾	1	west / north-west	2.7 – 4.6 km
Bonnie Doon ⁽¹⁾	2	south / south-west	3.3 – 7.7 km
Kildare ⁽¹⁾	3	east / south-east	2.8 – 7.4 km
Glendale ⁽¹⁾	4	south / south-east	2.9 – 5.8 km
Kullingrah (Euroka) ⁽²⁾	5	west	4.5 km
Sunnybrook (G8) ⁽²⁾	6	west / south west	4.7 km
Gray (H5) ⁽²⁾	7	south	4.5 km

Note: ⁽¹⁾ Wilkinson Murray (2004) – Reference 10 metre height wind speed at Woodlawn Wind Farm site

⁽²⁾ Vipac (2005) – Reference 10 metre height wind speed from Sunnybrook mast on Grose Hill

Based on characteristics of residence locations, degree of exposure, prevailing meteorological conditions and similarities in ambient noise characteristics, Vipac has indicated that the noise levels and associated criteria for the seven representative sites can be applied to the other residences. Table 7.4 that shows the representative background sites for the current assessment and residences with similar background noise characteristics.

Table 7.4 – Representative background sites and sites with similar characteristics

Background site	Sites with similar background noise characteristics
Torokina	Bernallah, Willeroo, Somerset
Bonnie Doon	Nardoo, Wroxham, Rosehill, Hilltop Farm, Hamptons, La Lee, Myolena
Kildare	Willandra, Ellareagh, Hollymount, Linden Park
Glendale	Richmond Grove, Bracken Ridge Kandahar, Kalbilli
Sunnybrook (G8)	Sunnybrook (G9), G10, La Granja (G11), Narine Green (G12), G13 to G17
Gray (H5)	McLaughlin, Clear View, Mingary, Ugov
Kullingrah (G7)	Widgemoor

7.5.2 Noise amenity criteria

The noise amenity criteria at each of the monitored sites and all other remaining sites have been developed based on background noise levels measured and assessed in accordance with the South Australia “*Wind Farms Environmental Noise Guidelines*” 2003. Consideration of wind turbine noise impacts also considers the Industrial Noise Policy (INP) issued by the NSW EPA (DECCW).

The development of noise criteria using regression analysis of the background monitoring data according to SA EPA guidelines showed that the criterion range from 35 dB(A) at 4 m/s (the cut-in wind speed of the turbine) to over 40 dB(A) at 12 m/s). The criterion for each of the integer wind speeds at the seven relevant representative background monitoring sites is shown in Table 7.5.

Table 7.5 – Noise amenity criteria in dB(A) for each representative background site (SA EPA Guideline 2003)

Wind speed (m/s)	4	5	6	7	8	9	10	11	12
Torokina ⁽¹⁾	35	35	35	36	37	39	40	42	44
Bonnie Doon ⁽¹⁾	35	35	35	37	40	43	46	50	53
Kildare ⁽¹⁾	35	35	35	36	38	40	42	45	47
Glendale ⁽¹⁾	35	35	35	37	39	42	44	47	50
Sunnybrook (G8) ⁽²⁾	35	35	35	36	37	39	40	42	43
Gray (H5) ⁽²⁾	35	35	35	35	36	37	39	40	42
Kullingrah (G7) ⁽²⁾	35	35	35	36	37	38	40	41	43

Note: ⁽¹⁾ Wilkinson Murray (2005) – Reference 10 metre height wind speed at Woodlawn Wind Farm site

⁽²⁾ Vipac (2005) – Reference 10 metre height wind speed from Sunnybrook mast on Grose Hill

The data in Table 7.5 shows that criterion values for the seven background noise sites for the reference wind speed of 8 m/s (10 metre height) vary from 36 dB(A) to 40 dB(A). The lowest value of 36 dB(A) is for a very sheltered site while the higher values are for more exposed sites or where traffic on Tarago-Bungendore Road may have contributed to the developed criterion.

7.6 Noise model predictions

7.6.1 Source sound characteristics

The wind turbine generators that will be used for the wind farm and which have been referenced for the Vipac noise assessment are the Suzlon S88 2.1 MW units. A maximum power setting of 106.0 dB(A) measured according to the standard IEC 612400-11 at the reference condition of 8 m/s wind speed at 10 metres above ground level (AGL) has been used for the modelling.

The sound power levels and measured noise spectra of this type of turbine have been supplied by Suzlon Energy. This information shows that the sound power levels increase with increasing wind speed (Appendix D).


The data provided by Suzlon Energy shows that there are no detectable tones in the sound power spectrum of the Suzlon wind turbine generators. Current wind turbine designs are not a significant source of low frequency noise impulsiveness or modulation. In the near vicinity of the turbines there is a 'swoosh' like modulation when the blade passes the tower in addition to a slight hum from the wind turbine generator. Vipac indicates that these noise effects diminish rapidly over distance and for an array of wind turbines are at distance randomly mixed to form a low level background white noise.

7.6.2 Methodology

The noise prediction model was set up taking into account the proposed variations, ie lesser number of turbines, revised locations of the 20 turbines and changes in the proposed wind turbine performance and noise specifications (height and rotor diameter). The operating wind farm's noise impacts have been assessed for Suzlon S88 2.1 MW wind turbines with a three bladed rotor, a diameter of 88 metres and a hub height of 80 metres.

Vipac indicated that the predictive noise model was constructed using the validated and accepted Concawe algorithm for noise propagation in different meteorological conditions. The standard ISO9613 algorithm was used for noise prediction in neutral conditions and for a reference wind speed of 8 m/s. The model was constructed using SoundPLAN.

The sound power level spectra and the sound power levels for the Suzlon S88 2.1 MW turbine used in the assessment are shown in Appendix D. No noise characteristics (ie tonality, impulsiveness, modulation or low frequency components) have been identified by Vipac and no penalty adjustments



were required to be applied to predicted levels. Predictions of sound levels were made for all receiver locations between two and five kilometres. Vipac did however note that the accuracy of the noise model is likely to be at least ± 2 dB(A) and up to the order of +5 dB(A).

Noise level contours for neutral conditions and worse case conditions using a reference wind speed of 8 m/s are provided in Appendix D and in Figure 7.2. Details of predicted noise levels from the Woodlawn Wind Farm only at the respective receiver locations for a range of wind speeds from 4 m/s to 12 m/s are shown in Table 7.6.

It should be noted that although the rated power is 14 m/s, sound power levels remains quite constant over 10 m/s, whereas the noise amenity criterion continues to increase at higher wind speeds. The gap between the predicted levels and the criterion increases as wind speed increases beyond 10 m/s, such that the noise amenity criterion is easily satisfied at wind speeds of 12 m/s and greater for the setback distances applicable for residences surrounding the Woodlawn Wind Farm (See Table 7.6).

A summary review of the predicted noise impacts at relevant and non relevant receivers is provided in the following sections and the full Vipac 2010 noise assessment is provided in Appendix D.

7.6.3 Relevant receivers

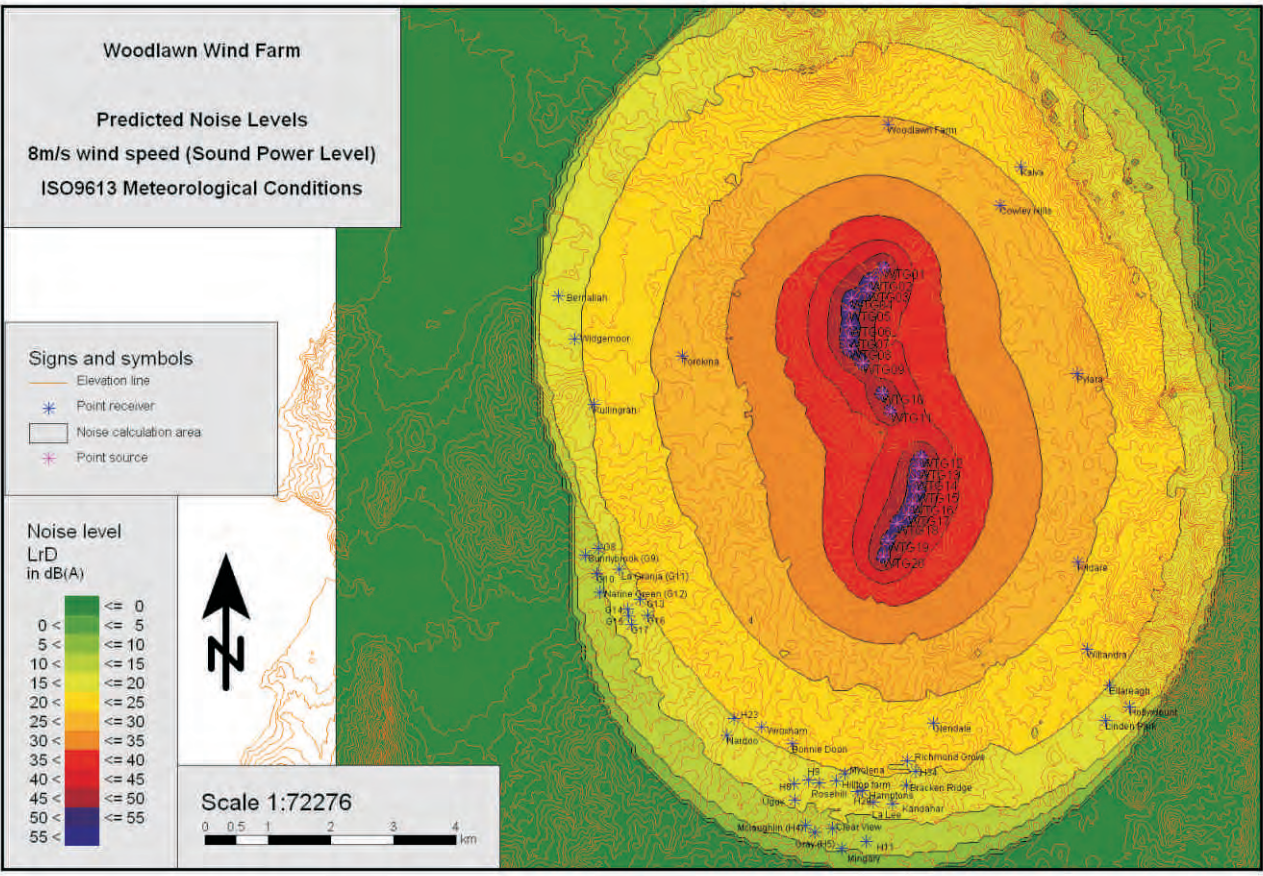
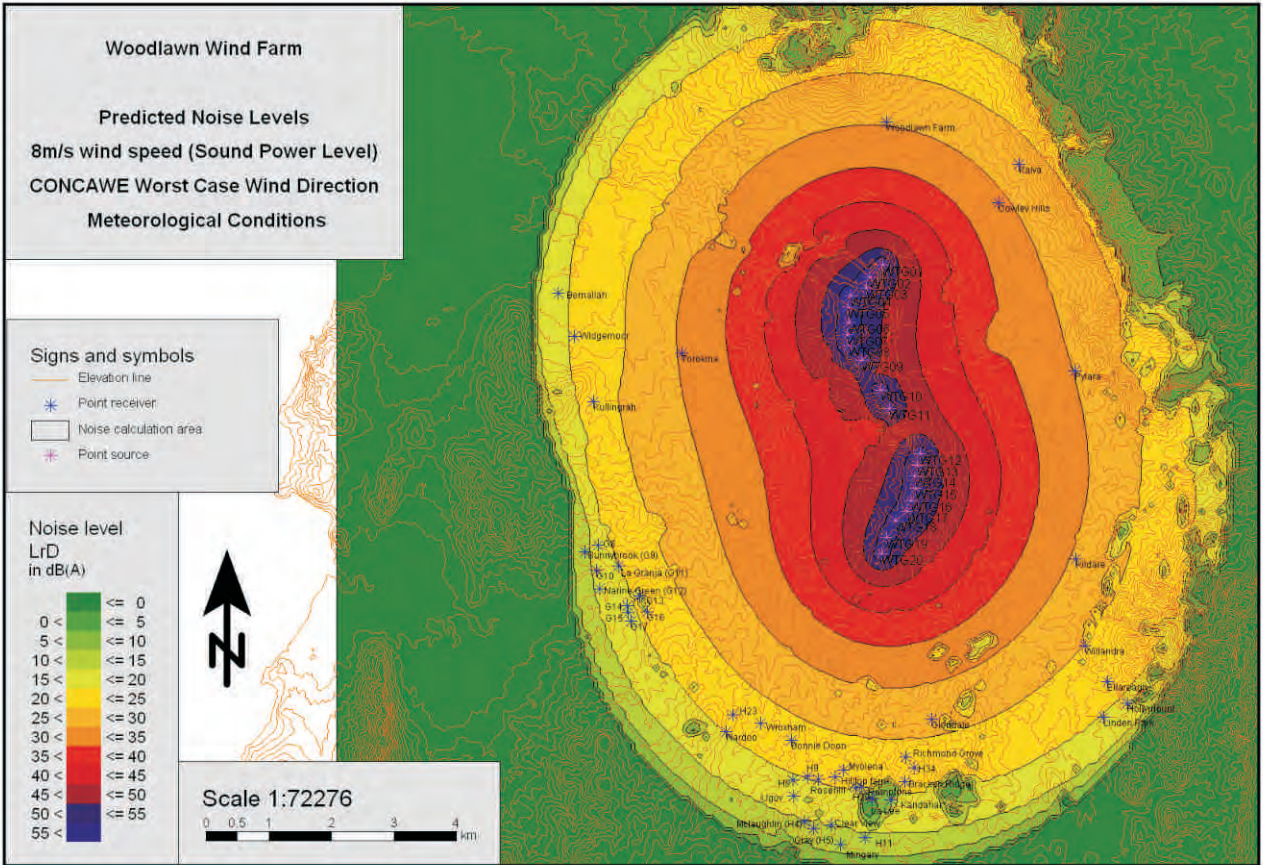
The predicted noise levels for the residences located between two and five kilometres of Woodlawn Wind Farm have been assessed by Vipac (2010). It is expected that all residences on neighbouring properties more than 2.5 kilometres from the nearest turbines will have low levels of wind farm noise, in many cases below average background levels. There are no relevant receivers at distances less than 2.5 kilometres from the nearest wind turbine.

Table 7.6 provides the predicted noise levels and noise amenity criteria for the receiver locations less than five kilometres from the closest turbine. The predicted noise levels have been computed based on the noise source of the Woodlawn Wind Farm only.

The results shown in Table 7.6 indicate that the predicted noise levels for Woodlawn Wind Farm at surrounding receiver locations are less than the SA EPA criteria at all winds speeds.

The currently predicted noise levels at 6 m/s and 8 m/s appear to be lower than those predicted in 2004 by between 3 dB(A) and 6 dB(A), indicating that the reduction in the number of wind turbines from 25 to 20 and the marginal increase in hub height and blade diameter results in a lower overall wind farm noise impact for receiver locations. Variations in predicted wind farm noise levels are shown in Figure 7.2 for neutral and worse case meteorological conditions.

The predicted noise levels due to the Woodlawn Wind Farm at the relevant receivers are all less than the relevant noise amenity criteria.



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Table 7.6 – Predicted noise levels (L_{Aeq}) for the receiver locations at integral wind speeds (m/s) (Vipac, 2010)

Receiver locations	Predicted noise levels (L _{Aeq}) - Woodlawn Wind Farm only *								
	4	5	6	7	8	9	10	11	12
Criteria dB(A) Torokina ⁽¹⁾	35	35	35	36	37	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
Criteria dB(A) Bonnie Doon ⁽¹⁾	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
Myolena	18	19	20	21	21.5	22	22	22.5	22.5
Criteria dB(A) Kildare ⁽¹⁾	35	35	35	36	38	40	42	45	47
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
Criteria dB(A) Glendale ⁽¹⁾	35	35	35	37	39	42	44	47	50
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
Criteria dB(A) Sunnybrook (G8) ⁽²⁾	35	35	35	36	37	39	40	42	43
Sunnybrook (G8)	13.5	14.5	15.5	16	16.5	16.5	17	17	16.5
Sunnybrook (G9)	11	11.5	12.5	14	14	14.5	15	15	15
G10	16	16.5	17.5	19	19.5	20	20	20	20
G11 – La Granja	12.5	13.5	15	15	15.5	15.5	16	16	15.5
G12 – Narine Green	11.5	12	13	14.5	15	15.5	15.5	15.5	15.5
G13	10.5	11.5	13	13	13.5	13.5	14	14	13.5
G14	11	12	13.5	13.5	14	14	14.5	14.5	14
G15	11	12	13.5	13.5	14	14	14.5	14.5	14
G16	10.5	11.5	12.5	13	13.5	13.5	13.5	13.5	13.5
G17	11	12	13.5	13.5	14	14.5	14.5	14.5	14.5
Criteria dB(A) Gray ⁽²⁾	35	35	35	35	36	37	39	40	42
Gray	10	10.5	11.5	13	13.5	14	14	14	14
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
Criteria dB(A) Kullingrah ⁽²⁾	35	35	35	36	37	38	40	41	43
Kullingrah	18.5	19.5	21	21	21.5	22	22	22	22
Widgemoor	17.5	18.5	20	20	20.5	21	21	21	21

Note: criteria source ⁽¹⁾ Wilkinson Murray (2004) ⁽²⁾ Vipac (2005)

* predicted noise levels have accuracy as indicated in Section 7.6.2




Table 7.7 shows predicted noise levels taking into account both the Woodlawn and Capital Wind Farms. The extra noise source of Capital Wind Farm means that many of the residences between the two wind farms have higher predicted noise levels than when only considering impacts from the Woodlawn Wind Farm.

As the residences between the two wind farms are mostly closer to Capital Wind Farm (eg G10 to G17) noise levels are more affected by the noise from Capital Wind Farm than from Woodlawn Wind Farm eg G10 predicted noise level at 8 m/s is 19.5 dB(A) for Woodlawn Wind Farm only and 35 dB(A) when both Capital and Woodlawn Wind Farms are considered.

Nardoo, Sunnybrook and Kullingrah have predicted noise levels that are above the criteria derived in accordance with the SA EPA Guideline. As these exceedances are attributed primarily to the Capital Wind Farm and these residences are non relevant receivers in respect of Capital Wind Farm the exceedances are addressed by the existing noise agreements with the respective landowners.

The Director Generals' requirements for the SEE also require that a revised noise assessment demonstrate that the proposed modification to the Woodlawn Wind Farm development would be capable of achieving the noise limits set under the conditions of consent for Capital Wind Farm, dated 7 November 2006. Condition 53 of the Capital Wind Farm Approval Conditions lists compliance criteria for six locations, of which three (Widgemoor (G6), G10 and Wroxham (H24)) are located between Capital Wind Farm and Woodlawn Wind Farm and are relevant to this assessment.

Table 7.8 shows predicted noise levels for these three locations compared to the Capital Wind Farm Condition 53 criteria and the SA EPA Guide 2003. All three locations (G6, G10 and H24) have cumulative predicted noise levels from the two wind farms below the criteria defined in Condition 53. The criteria defined under Condition 53 are applicable only to the noise from Capital Wind Farm.

Table 7.7 – Cumulative predicted noise levels (L_{Aeq}) for the receiver locations at integral wind speeds (m/s) (Vipac, 2010)

Receiver locations	Predicted noise levels (L _{Aeq}) – Woodlawn and Capital Wind Farm *								
	4	5	6	7	8	9	10	11	12
Criteria dB(A) Torokina ⁽¹⁾	35	35	35	36	37	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
Criteria dB(A) Bonnie Doon ⁽¹⁾	35	35	35	37	40	43	46	50	53
Bonnie Doon	30	31	32	32.5	33	33	33	33	33
Nardoo (non-relevant - CWF)	35	35.5	37	37	37.5	37.5	38	38	37.5
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
Myolena	26	27	28	29	29.5	29.5	29.5	29.5	29.5
Criteria dB(A) Kildare ⁽¹⁾	35	35	35	36	38	40	42	45	47
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
Criteria dB(A) Glendale ⁽¹⁾	35	35	35	37	39	42	44	47	50
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
Criteria dB(A) Sunnybrook (G8) ⁽²⁾	35	35	35	36	37	39	40	42	43
Sunnybrook G8 (non-relevant CWF)	36	37	38	38	38.5	39	39	39	39
Sunnybrook G9 (non-relevant CWF)	37	37.5	39	39	39.5	39.5	40	40	39.5
G10	32.5	33	34.5	34.5	35	35.5	35.5	35.5	35.5
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	34.5	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	32	31	31.5	32	32	32	32
G17	29.5	30.5	32	32	32.5	32.5	32.5	32.5	32.5
Criteria dB(A) Gray ⁽²⁾	35	35	35	35	36	37	39	40	42
Gray	23.5	24	25.5	26	26	26.5	26.5	26.5	26.5
McLaughlin ⁽²⁾	24	25	26.5	26.5	27	27.5	27.5	27.5	27.5
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
Ugov	31	32	33	33.5	34	34	34	34	34
Criteria dB(A) Kullingrah ⁽²⁾	35	35	35	36	37	38	40	41	43
Kullingrah (non-relevant - CWF)	39	40	41	41.5	42	42	42	42	42
Widgemoor	31.5	32.5	33.5	34	34.5	34.5	34.5	34.5	34.5

Note: criteria source ⁽¹⁾ Wilkinson Murray (2004) ⁽²⁾ Vipac (2005)

* predicted noise levels have accuracy as indicated in Section 7.6.2

Table 7.8 – Capital Wind Farm Operational Noise Criteria

Receiver locations	Predicted noise levels for Capital and Woodlawn Wind Farms (dB(A) for integer wind speed (m/s) at 10 metres height)								
	4	5	6	7	8	9	10	11	12
1. Widge Moor									
Criteria (SA EPA Guide 2003)	35	35	36	37	38	39	40	42	44
Criteria (CWF Condition 53)	35	35	35	35	35	35	35	35	35
Predicted noise levels *	31.5	32.5	33.5	34	34.5	34.5	34.5	34.5	34.5
2. Residence G10 (Source of Criteria – SA EPA values for Sunnybrook – Condition 53, G10 but not La Granja)									
Criteria (SA EPA Guide 2003)	35	35	35	36	37	39	40	42	43
Criteria (CWF Condition 53)	35	35	35	36	37	37	37	37	37
Predicted noise levels *	32.5	33	34.5	34.5	35	35.5	35.5	35.5	35.5
3. Wroxham (Criteria developed via SA EPA guideline relate to Bonnie Doon that is adjacent Wroxham)									
Criteria (SA EPA Guide 2003)	35	35	35	37	40	43	46	50	53
Criteria (CWF Condition 53)	35	35	35	35	35	35	35	35	35
Predicted noise levels *	31.5	32.5	33.5	34.5	35	35	35	35	35

Note: * - predicted noise levels are based on Vipac modelling with accuracy as indicated in Section 7.6.2

7.6.4 Wind farmers

In the case where wind farmers may experience wind farm noise levels above relevant criteria, the SA EPA Noise Assessment Guideline provides for agreements to be reached between the proponent and the owner of an affected wind farmer residence. The agreement must document the nature of the impact likely to occur at the wind farmer residence and the owner's acceptance of the predicted noise levels. Such agreements should nevertheless address World Health Organisation (WHO) noise amenity guidelines.

Agreements for wind farmer residences are not applicable in the case of the Woodlawn Wind Farm as predicted noise levels at the wind farmer residences are below SA EPA derived criteria.

Table 7.9 provides the predicted noise levels (rounded to the nearest 0.5 dB(A)) of the wind farmers for the Woodlawn Wind Farm (at 8 m/s) and Figure 7.2 shows the predicted noise level contours for neutral and worse case meteorological conditions.

The noise amenity criteria (at 8 m/s) derived according to the SA EPA Guideline for nearby relevant receivers of Kildare and Glendale are 39 dB(A) and 40 dB(A) respectively. Table 7.9 indicates that the predicted noise levels at 8 m/s for both neutral and worse case meteorological conditions for Woodlawn wind farmer residences are well within the SA EPA criteria and all predicted values are 30 dB(A) or less. As such it would not be necessary to establish noise agreements for these locations.

Table 7.9 – Predicted noise levels (L_{Aeq}) at 8 m/s wind speed for wind farmers (non-relevant receivers)

Receiver	Distance to nearest turbine	Predicted L _{Aeq} level dB(A) at 8 m/s	
		Neutral conditions	Worse case conditions
Woodlawn Farm	2.28	25.5	29.5
Kalua	2.71	24.0	27.0
Cowley Hills	2.09	27.0	31.0
Pylara	2.80	26.5	30.0

7.7 Cumulative noise impact assessment

At the time of the 2004 Woodlawn Wind Farm EIS, the potential noise impacts of the following developments were not included in the noise assessment:

- Operational Capital Wind Farm
- Additional transformer at Capital Wind Farm substation
- Woodlawn Bioreactor

The lack of consideration of the above developments related to the relative planning status of the projects at the time. This section describes the circumstances relating to developments that have occurred or are proposed since the 2004 EIS and the implications of potential noise impacts for these additional noise sources.

7.7.1 Capital Wind Farm

Capital Wind Farm was not considered at the time the 2004 Woodlawn Wind Farm EIS was prepared. The Capital Wind Farm EA was not publicly exhibited until 2006, two years after the Woodlawn Wind Farm EIS. Construction and commissioning of Capital Wind Farm is now complete and the cumulative impacts of both wind farms on local residents can be taken into account.

Capital Wind Farm is located to the south and west of Woodlawn Wind Farm comprising 67 approved wind turbines located in three distinct groups (Table 7.10).

Table 7.10 – Capital Wind Farm layout relative to Woodlawn Wind Farm


Turbine Group	Number of Turbines	General Location and proximity to Woodlawn Wind Farm
Substation	Not applicable. Two 33 kV/330 kV transformers	South east of Hammonds Hill and approximately 10 kilometres south of Woodlawn Wind Farm – Additional transformer to be installed
Hammonds Hill	29	Between Ellenden Group and Tarago Road and five to 10 kilometres south-west of Woodlawn Wind Farm
Ellenden	15	Southwestern Group adjacent Lake George and 10 kilometres or more south-south-west of Woodlawn Wind Farm
Groses Hill	23	North-west Group adjacent Lake George and approximately six kilometres west / south-west of Woodlawn Wind Farm

The residences with most potential to experience some cumulative noise impact from both the Capital Wind Farm and Woodlawn Wind Farm are:

- those located to the west and south-west of Woodlawn Wind Farm and mostly closer to Capital Wind Farm. It is expected that for these residences the noise impact from Woodlawn Wind Farm will be less than from the Capital Wind Farm.
- those south of Woodlawn Wind Farm and closer to Capital Wind Farm. These will also be likely to have a lesser impact from Woodlawn Wind Farm than from the Capital Wind Farm.

Table 7.7 shows the cumulative predicted noise impacts of the operational Capital and Woodlawn Wind Farms (worse case meteorological conditions) for relevant receiver locations. Noise assessments for Capital Wind Farm have been reported by Vipac in 2005, 2006 and 2008. Table 7.11 provides a comparison of relevant noise criteria and predicted noise levels as follows:

- criteria for relevant receiver locations (Woodlawn Wind Farm) incl. non-relevant for Capital WF
- criteria determined in accordance with SA EPA 2003 Guideline
- predicted noise levels from Woodlawn Wind Farm, Capital Wind Farm and both wind farms



The predicted noise levels shown as 'Bold' in Table 7.11 exceed the criteria developed in accordance with the SA EPA 2003 guidelines. These residence locations, Kullingrah (G7) and the two Sunnybrook residences (G8) and G9) are all wind farmer residences for the Capital Wind Farm and have existing noise agreements with Woodlawn Wind's parent company. In each case the noise impact from Woodlawn Wind Farm is minor and not significant.

Torokina mid way between the two wind farms has similar predicted noise levels (29 and 30) from each of the two wind farms that combine to increase the overall predicted noise level by 3.5dB(A). The level is still below the applicable criteria.

The other residences generally have greater differences between the predicted noise levels from the respective wind farms and have a lesser increase in the overall predicted noise level when the impacts of the two are combined.

The receivers to the north, east and south-east of Woodlawn Wind Farm are expected to be relatively unaffected by Capital Wind Farm and any wind farm noise impact would be attributed to the Woodlawn Wind Farm. The distance to these residences is such that the noise impacts will be below relevant criteria.

Table 7.11 – Comparison of criteria and predicted L_{Aeq} level dB(A) at 8 m/s for relevant receivers

Note: shaded rows are representative receiver residences

Relevant Receiver	Criteria at 8 m/s wind speed (10 metres)		Predicted noise levels at 8 m/s wind speed (10 metres)		
	CWF PA and WLWF DC conditions	SA EPA 2003 Criteria	Woodlawn WF only	Capital WF only	Capital and Woodlawn
			Vipac (2010)	Vipac (06 or 08)	Vipac (2010)
Torokina (G18)	37	37	30	29	32.5
Bernallah (G5)		38	19.5	28.5	29
Bonnie Doon (H25)	35	40	22.5	32	33
Nardoo (H3)		40	19.5	38	37.5
Wroxham (H24)	35	40	22.5	34	35
Rosehill		40	20.0	32	31.5
Hill Top Farm		40	20.5	31	30
Hamptons		40	19.5	29.5	27.5
La Lee		40	2.5	Not assessed	26
Myolena		40	21.5	Not assessed	29.5
Kildare	36	38	29	Not assessed	29
Willandra		32	24.5	Not assessed	24.5
Ellareagh		32	21.0	Not assessed	21.5
Hollymount		32	18.5	Not assessed	19.5
Linden Park		32	19.0	Not assessed	20
Glendale	35	39	26.0	Not assessed	27
Richmond Grove		40	23.0	Not assessed	24
Bracken Ridge		40	21.0	Not assessed	22.5
Kandahar		40	8.0	Not assessed	25
Kullingrah (G7)		37	21.5	42.5	42
Widgemoor (G6)	35	37	20.5	34.5	34.5
G8 – Sunnybrook		37	16.5	38	38.5
G9 – Sunnybrook		37	14	39	39.5
G10	37	37	19.5	36.5	35
G11 – La Granja		37	15.5	35	35
G12 – Narine Green		37	15.0	35	35
G13		37	13.5	32	32
G14		37	14.0	32.5	32.5
G15		37	14.0	32	32.5
G16		37	13.5	31	31.5
G17		37	14.0	32	32.5
Gray (H5)		36	13.5	26	24
McLaughlin (H4)		36	13.5	27	23
Clearview		36	15.0	29	29
Mingary		36	12.5	27	27
Ugov		36	17.5	Not assessed	34

Note: PA – Project Approval (Capital Wind Farm) and DC – Development Consent (Woodlawn Wind Farm)

7.7.2 Substation noise

The Development Consent for Woodlawn Wind Farm allowed for a 22 kV/66 kV substation located at the Woodlawn Wind Farm Site between wind turbines 14 and 15. The substation was to be capable of handling the output of the proposed 50 MW wind farm. The proposed modifications to the project avoid the installation of this substation and the associated 66 kV overhead line for grid connection. Instead, it is proposed that grid connection is via the existing 33 kV/330 kV Capital Wind Farm substation that would be augmented for this purpose.

The existing 33 kV/330 kV Capital Wind Farm substation has two 33 kV/330 kV transformers rated at 80 MVA. The construction of the substation included the preparation of an additional transformer bay. By installing an additional 33 kV/330 kV transformer at this location together with various 33 kV items (such as additional switchgear and circuit breakers) and a 33 kV 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 330 kV 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 the Vipac assessment reviewed the cumulative noise impact of the existing substation augmented with an additional 33 kV/330 kV transformer rated at 180 MVA.

Vipac's assessment indicated that the two existing 33 kV/330 kV (80 MVA) transformers have sound power levels of 92.6 dB(A). The proposed additional 33 kV/330 kV (180 MVA) 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 (Table 7.12).

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. The Vipac 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 32 dB(A) (similar to worst case wind turbine levels) and up to 33 dB(A) to 34 dB(A) in certain meteorological conditions). The combined noise level of the substation and wind turbines at the receiver locations was estimated by Vipac to be less than 35 dB(A). Also, the maximum loading and noise generation from the substation will occur during periods of strong winds and associated high background noise that is likely to mask any substation noise.

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

Table 7.12 – Predicted noise levels for the substation and closest receiver locations (Source: Vipac 2010)

Aspect	Noise levels
Augmented sub station (3 transformers)	101 dB(A) (Vipac 2010 – conservative)
Residential receivers	
Predicted noise from substation	32 dB(A) ⁽¹⁾
Predicted in certain meteorological conditions	33 – 34 dB(A)
Combined noise levels from turbines and substation	35 dB(A)

Note: ⁽¹⁾ – similar to worse case turbine levels

7.7.3 Woodlawn Bioreactor and alternative waste facility

Heggies Australia (Pty) Ltd undertook a noise impact assessment in 2006 of the proposed Woodlawn Alternative Waste Technology Facility to be located at the Woodlawn Eco-precinct. The assessment included consideration of construction, road traffic and operational noise for the proposed waste facility development. A cumulative impact assessment taking into account the operation of the Bioreactor, the Woodlawn Wind Farm (with 25 turbines) and the alternative waste facility under calm and adverse conditions was also undertaken.

The report indicates that the cumulative impacts would comply with the relevant amenity criteria at residential receivers surrounding the site which were set in accordance with the INP. The residential receivers included Cowley Hills, Woodlawn Farm, Pylara, Torokina, Willeroo and Bernallah. Predicted intrusive noise levels for the Woodlawn Wind Farm were sourced from Wilkinson Murray (2004) and noise data for the Bioreactor was sourced from the Bioreactor EIS (Umwelt, February 1999) and the report investigating the bioreactor acoustic enclosures (Umwelt, August 2006).

7.7.4 Future mining activities

It is understood that Tri Origin has proposed future mining may involve reworking material in the tailings dams as well as some underground mining. The underground mining is indicated to be directed away from the area of the proposed wind farm but surface facilities and ore treatment processing plant could be located in proximity to the wind farm.

7.8 Construction noise

Construction noise has been covered in detail in the 2004 Woodlawn Wind Farm EIS. The construction activities are expected to be similar to those identified in the 2004 assessment. In respect of the Capital Wind Farm substation, construction noise was addressed by the 2006 environmental assessment undertaken for Capital Wind Farm. As the substation construction included the preparation of a bay for a third transformer there are limited construction activities to be undertaken, with the main one being delivery and lifting of the 33 kV/330 kV transformer into its position in the transformer yard. Auxiliary activities will include installation of the 33 kV equipment and other items for 330 kV connection to the TransGrid switchyard.

7.8.1 Working hours

Construction of the wind farm is expected to occur over a 12 month period, as indicated in the 2004 EIS. The Woodlawn Wind Farm Project Consent (DA 250-10-204-i), issued in October 2005, specifies activities are to be restricted to normal working hours.

Monday to Friday:	7:00 am to 6:00 pm
Saturday:	7:00 am to 1:00 pm if inaudible at residences, otherwise 8:00 am to 1:00 pm
Sunday:	No construction activities

Some activities may be carried out in association with construction outside of these hours; including works not causing noise emissions which would be audible at any nearby residences not located on the Premises.

Due to the significant setback of the neighbouring rural residences from the wind turbine sites (all over 2.5 kilometres) and the degree of mitigation of construction noise with distance it is considered that erection of the turbines during suitable weather conditions is able to be undertaken out of hours without risk of significant noise impact for neighbours. Such activity would only occur infrequently and where suitable conditions are not available during approved working hours. The ability to erect turbines out of hours will also assist in compressing the overall construction time, therefore reducing the overall period when any impact may occur for neighbouring properties.

7.8.2 Construction activities

Construction activities for the installation of the 20 wind turbines are expected to be similar to those described in the 2004 EIS. In addition the construction of the 12 kilometres 33 kV overhead line will involve minor earthworks, installation of poles and stringing of conductors.

The key site activities during construction include:

- site preparation, site entry, site offices facilities and laydown areas.
- site establishment
- upgrading and construction of access tracks
- excavation and construction of turbine footings
- excavation and construction of cable trenches
- erection of turbines
- construction of the new 33 kV overhead line to Capital Wind Farm substation

Construction noise levels were predicted in the 2004 EIS for earthworks, foundation works and construction of superstructures (ie turbines, substation and transmission lines). The assessment indicated that the predicted construction noise would comfortably meet the 35-36 dB(A) criteria from the various activities..

Applicability to proposed variations

- The proposed variations include a reduction in the number of turbines from 25 to 20, potentially reducing the period of construction activities associated with foundations and earthworks.
- The size and volume of the footings is less than previously indicated and will reduce the time for excavations.
- Earthworks associated with construction of trenches and access roads are likely to remain very similar to that indicated in 2004 EIS.
- Works associated with the construction of the substation on the Woodlawn site will no longer be required. As the Capital Wind Farm substation has been constructed, no significant amount of additional earthworks will be required.
- The construction noise associated with the overhead transmission line from Woodlawn to the Capital Wind Farm substation is not likely to significantly differ from the predicted noise levels for the 66 kV line estimated in the 2004 EIS, but could involve slightly smaller pole footings. The line route is well away from neighbouring residence locations and this activity is not expected to result in any noise impacts for relevant residence locations.

The contractor has identified that the adherence to the normal construction hours for the turbine erection activities could significantly affect progress of construction activities, increase construction costs and may indirectly adversely affect the safe and efficient conduct of construction. Due to the significant set back of neighbouring relevant receivers from the turbine site, the proponent seeks a relaxation of the normal construction hours in respect of turbine erection.

7.9 Mitigation measures

The potential noise impacts of the operation of the amended wind farm with the proposed variations from the approved project have been considered by the recent Vipac noise assessment. All residences within five kilometres of the amended Woodlawn Wind Farm turbine locations were reviewed. Four residences are identified as non-relevant receivers or “wind-farmers” and are located within two and 2.8 kilometres of the closest turbines (Table 7.9). All relevant receivers are at least 2.7 kilometres from the nearest Woodlawn turbine site.

Predicted noise levels (L_{Aeq}) for the relevant receiver sites at integer wind speeds (Table 7.6) indicate that no exceedances of SA EPA noise criteria will occur for neutral or worse case meteorological conditions.

If a noise nuisance is reported by a relevant receiver after the wind farm is commissioned, Woodlawn Wind Pty Ltd will review the nature of the noise impact and assess the potential sources. If necessary, the equipment supplier will be required to perform testing to confirm that equipment performance is in accordance with the required noise specification.

If any noise exceedance is shown to be occurring at a relevant receiver due to the turbine operation, Woodlawn Wind Pty Ltd can vary operation of the relevant turbine(s) to achieve noise compliance. In addition, Woodlawn Wind Pty Ltd may consult with any affected landowner in regard to other measures such as installation of double glazing or other forms of sound insulation.

As mentioned above, a Construction Noise Management Plan will be implemented as part of the project Environmental Management Plan for the construction stage of the project to mitigate any potential adverse noise impacts that could affect nearby residents.

Slight increase in wind farm noise levels for some residences surrounding Capital Wind Farm is indicated. In three instances this applies to wind farmer residences for the Capital Wind Farm and the proponent has in place noise agreements with these landowners regarding exceedance of SA EPA noise criteria.

7.10 Conclusions

The amended Woodlawn Wind Farm is able to operate with acceptable noise impacts at surrounding relevant receiver locations. The variations to the wind farm were assessed and operational noise levels are slightly less than those which were applicable to the existing consent.

The predicted noise levels for the operating wind farm indicate no exceedance of the SA EPA criteria and the overall noise levels (at 8 m/s) appear to be lower than those previously predicted (URS, 2004). This is likely due to the reduction in the number of turbines from 25 to 20.

It is also expected that the noise impacts on neighbours located to the west and south west of Woodlawn will be dominated by noise levels from Capital Wind Farm. The predicted noise levels for relevant receivers are still indicated to fall within the relevant criteria.

The proposal to install and operate an additional 180 MVA transformer at the Capital Wind Farm substation as part of the project variation has been assessed. As there will be limited construction activities undertaken at the substation during installation of the transformer, the temporary noise impact is expected to be minimal and controlled through the Construction Noise Management Plan. The combined noise levels of the additional 33 kV/330 kV transformer and the existing transformers has been predicted to be less than the relevant criteria for the nearest relevant receiver locations.

