Appendix 2 NOISE ASSESSMENTS

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REPORT No.: 2008237 001

PROJECT: YASS VALLEY WIND FARM – COPPABELLA HILLS
NOISE IMPACT ASSESSMENT

CLIENT: EPURON Pty Ltd
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ATTENTION: Julian Kasby

DATE: 22 April 2009

MARSHALL DAY ACOUSTICS

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Consultant

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DOCUMENT STATUS

Revision	Purpose	Date delivered	Reviewed by
-	Incomplete draft issued to client	18 February 2009	JBB
-	Draft issued to client	2 April 2009	RCL
-	Report issued to client	22 April 2009	RCL

EXECUTIVE SUMMARY

Marshall Day Acoustics Pty Ltd has carried out a noise impact assessment of the proposed Coppabella Hills section of the Yass Valley Wind Farm.

A proposed layout of 86 turbines has been assessed in accordance with the South Australian EPA's *Environmental Noise Guidelines: Wind Farms (2003)*, the World Health Organisation's *Guidelines for Community Noise*, the DECC's *Environmental Criteria for Road Traffic Noise*, *Environmental Noise Control Manual* and *Assessing Vibration: A Technical Guide*.

Background noise monitoring was conducted over a four week period from 4 July and 4 August 2008 at eleven (11) relevant receiver locations. Data from monitoring has been used to set noise limits in accordance with the procedures set out in the wind farm guidelines.

Noise level predictions have been modelled in SoundPLAN noise modelling software using *ISO9613-2: 1996- Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* standard.

Two turbine types have been considered. The predicted noise levels for the representative turbine (MM92E) indicate full compliance with the relevant noise criteria. Furthermore, the predicted noise levels for the worst-case turbine (V90 3MW) in terms of sound power level, generating capacity and physical dimensions, indicate mitigation measures or a layout redesign would be required.

The assessment considers the cumulative noise impact of all neighbouring wind farms. It is noted that Conroys Gap Wind Farm receivers in close proximity to the Yass Valley Wind Farm may experience an increase in noise level. It is further noted that compliance with noise criteria is still achieved at these receiver locations.

Substation noise levels are predicted to be below the existing background noise at most receiver locations. Some receiver locations may experience audibility however compliance with relevant noise criteria is achieved.

MDA has been provided with test reports for each turbine stating each does not exhibit audible tonality. Therefore, no penalty has been applied to predicted results for either turbine type.

The predicted construction noise levels have been found to comply with ENCM criteria at all receiver locations.

The predicted construction blasting noise and vibration levels have been found to comply with ANZEC guidelines. A maximum instantaneous charge (MIC) of approximately 30kg is recommended.

The predicted construction vibration levels have been found to comply with DECC guidelines at all receiver locations.

The predicted construction traffic noise levels have been found to comply with ECRTN criteria at all assessed locations. It is noted that the predicted levels at some receiver locations exceed +2dB increase.

1.0 INTRODUCTION

Marshall Day Acoustics Pty Ltd (MDA) has been requested by EPURON Pty Ltd to provide acoustical consultancy services in relation to the proposed Coppabella Hills site to be located approximately 30km west of Yass, New South Wales (NSW). This report has been prepared for inclusion in the environmental impact statement submission to the NSW Department of Planning.

This report details the methodology and findings of our noise assessment on the impact to the amenity of dwellings located within approximately 5km of up to 86 wind turbine generators that are proposed for the Coppabella site. It should be noted that the cumulative impact of the nearby proposed Marilba Hills and Conroys Gap wind farms has been considered.

The assessment has been performed in accordance with the South Australia EPA's *Environmental Noise Guidelines: Wind Farms (2003)* (referred to herein as the Guideline), which is currently the applicable guideline in the state of New South Wales for the assessment of the wind farm noise on non-involved landowners. Dwellings that have been assessed in accordance with the Guideline are termed *relevant receivers* within this report.

The European Working Group on Noise from Wind Turbines document *ETSU-R-97* as well as the World Health Organisation's *Guidelines for Community Noise* have been reviewed for guidance where landowners have entered into an agreement with EPURON. Involved landowners that have been assessed within this report are termed *involved relevant receivers.*

In addition to assessing the noise impact of the operational wind farm, an assessment of construction noise has also been undertaken in accordance with relevant guidelines.

Table 1 summarises test reports and documents received from EPURON that have been used as the basis for this assessment.

Table 1

Document Name	Document Number
MM92E – Windtest report	SE06010B2A1
MM92E - Sound Power Level	SD-2.9-WT.SL-1-B
V90 3MW Windtest report	WT4245/05
Traffic Impact Study – Proposed Yass Valley Wind Farm	-

Acoustic terminology used throughout this report is defined in Appendix A.

2.0 SITE DESCRIPTION

The Coppabella Hills site (Coppabella) forms part of the proposed Yass Valley Wind Farm project and is located in the Coppabella Hills Precinct, 30km west of Yass, NSW.

Coppabella is bounded to the west by Berremangra Settlement Road, to the south by Whitefields Road (followed by the Hume Highway), to the east by Bookham Illalong Road and to the north by Cumbamurra, Coppabella and Garryowen Roads. The township of Binalong is located some 10km to the north-east.

The site is characterised by numerous hills including Jerusalem, Bushrangers and Dales Hills in addition to a distinct ridgeline running continuously for approximately 8km in a south-east direction. It is proposed that the site will contain up to 86 wind turbine generators (turbines) in the 1.65-3.6MW class.

Located approximately 4.5km to the east is the proposed Marilba-1 wind farm, with the proposed Marilba-2 wind farm located approximately 10km east of the site.

The Conroys Gap wind farm is located approximately 12km to the south-east. It should be noted that the Conroys Gap site has been granted planning approval for the construction of up to 15 turbines in the 2MW class.

The proposed Carrolls Ridge Wind Farm is located approximately 15km to the south of the site.

Refer to Appendix B for an indicative turbine layout for Coppabella.

2.1 Proposed Wind Farm Layout

It is proposed that up to 86 wind turbine generators (WTG) will be installed at the Coppabella site. Turbine locations and receiver locations surrounding the site are detailed in Appendices C & D respectively.

At the time of finalising this report, a decision with respect to final turbine type had not been made. It is noted that the environmental impact assessment seeks approval for a wide range of turbines; therefore this noise assessment considers representative impacts as well as worst case impacts in terms of sound power level and physical dimensions (blade tip height).

Accordingly, the REpower MM92E (MM92E) and Vestas V90 3MW (V90) turbines have been selected as being representative of the range of turbines being considered. In addition, a comparison is made between these two turbines and a hypothetical worst case turbine (V90 3MW with 100m hub) to clearly demonstrate that noise emission only marginally increases with a change in hub height of this magnitude.

Both turbines run three upwind rotor blades and use active blade pitch and rotor speed to control power generation. The rotor diameters measure 92.5m and 90m for the MM92E and V90 respectively.

The one-third octave band sound power level data for each unit is shown in Appendix E. These values have been determined by independent tests conducted in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* and are sourced from documents received from EPURON Pty Ltd.

Table 2 summarises the relevant specifications of the two representative turbines considered for the development.

Table 2
WTG manufacturer specifications

Description	Turbine 1	Turbine 2
Make and Model	REpower MM92E 2MW	Vestas V90 3MW
Particulars	Evolution	Mode 0
Rotor Diameter (m)	92.5	90
Hub Height (m)	80	78.8
Rotor speed (rpm)	7.8 – 15.0	8.6-18.4
Cut-in Wind Speed (ms^{-1})	3.0	4.0
Rated Wind Speed (ms^{-1})	11.2	15.5
Cut-out Wind Speed (ms^{-1})	24.0	25.0
Sound Power L_{WA} at $9ms^{-1}$ (dB)	105.0	109.4
Tonality audibility	No	No

If at any stage after the finalisation of this report, a modification is made to any aspect of the layout, EPURON understands that a reassessment of noise impacts will be required. Additionally, where a change is made to the specification of a turbine, data measured in accordance with IEC-61400-11 will be required in order to re-access noise levels and tonality.

3.0 NOISE ASSESSMENT GUIDELINES

In 2003 the NSW EPA was incorporated into the Department of Environment Conservation NSW (DEC). In April 2007 the DEC became the Department of Environment and Climate Change (DECC).

Currently the NSW Department of Environment and Climate Change (DECC) has no specific guidelines relating to wind farm development within New South Wales. The DECC has acknowledged that the NSW Industrial Noise Policy (INP) is not appropriate for new wind farm developments.

The NSW Government Department of Planning requires in their letter to EPURON (S08/01553) that the noise impact for the proposed Yass Valley Wind Farm be undertaken in accordance with the South Australia Environmental Protection Authority document *Environmental Noise Guidelines: Wind Farms (2003)* (the Guideline).

With respect to the applicability of the criteria to landowners, Section 2.3 of the Guideline states:

> *The criteria have been developed to minimise the impact on the amenity of premises that do not have an agreement with wind farm developers.*

Premises that have not entered into an agreement with the developer are termed *non-involved relevant receivers* within this report.

Where on the other hand, a landowner is involved with the project, we have referred to the European Working Group on Noise from Wind Turbines document *ETSU-R-97 - The Assessment and Rating of Noise from Wind Farms*, and the World Health Organisation document *Guidelines for Community Noise* for guidance on setting limits.

Additionally, noise associated with the construction of the wind farm has been assessed in accordance with the NSW EPA *Environmental Noise Control Manual*.

Blasting has been assessed in accordance with ANZEC guidelines.

3.1 SA EPA Environmental Noise Guidelines: Wind Farms (2003)

In determining the operational noise criteria for each non-involved relevant receiver for the Coppabella wind farm, the Guideline states that:

> *The predicted equivalent noise level ($L_{Aeq,10min}$), adjusted for tonality in accordance with these guidelines, should not exceed 35dBA, or the background noise ($L_{A90,\ 10\ min}$) by more than 5dBA, whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.*

The Guideline has been developed with the inherent characteristics of noise from wind farms taken into account. These include aerodynamic noise from passing blades, referred to as "swish" and infrequent braking noise. Where wind farms display characteristics which are considered to be atypical then rectification should be undertaken.

The Guideline proposes a 5dBA penalty for characteristics of turbine operation that would be deemed annoying, such as tonality. Additionally, it should be noted that the Guideline accepts that modern-day "upwind" turbine designs do not exhibit significant levels of infrasound.

SA EPA Environmental Noise Guidelines: Wind Farms 2007 (Interim)

It should be noted that the South Australia EPA's guideline *Wind farms: Environmental noise guidelines (interim) – December 2007* has not been considered within this assessment because it has not been formally recognised by the DECC.

3.2 ETSU-R-97 and World Health Organisation Guidelines

With respect to involved landowners, the Guideline criteria have been developed to minimise the impact on the amenity of those not involved with the project. It is recognised however that where financial agreements exist, developers cannot absolve themselves of the responsibility of ensuring that an adverse effect on an area's amenity does not occur as a result of the operation of the wind farm.

In light of the aforementioned requirement, we have referred to the European Working Group on Noise from Wind Turbines document *ETSU-R-97* in determining noise criteria for involved landowners. It states:

> *The Noise Working Group recommends that both day- and night-time lower fixed limits can be increased to 45dBA and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.*

It should be noted that the Noise Working Group limit of 45dBA is in agreement with the World Health Organisation (WHO) criteria for protection of amenity and avoidance of sleep disturbance as published in the document *Guidelines for Community Noise*.

The criteria for involved landowners, termed *involved relevant receivers*, recognise the changed attitudinal response to noise from wind farms for those financially involved with the project. Furthermore, we understand that EPURON has discussed the implications of wind turbine noise with each of the involved landowners in relation to their property. Each of the involved landowners has been or will be provided with noise agreements that outline the noise criteria applied to them as outlined within this report.

We have therefore adopted a night-time limit of 45dBA in conjunction with limits stipulated by the Guideline. This effectively makes the limit 45dBA *or* background L_{A90} + 5dBA; whichever is the greater; at all involved relevant receivers for each integer wind speed from cut-in to rated power of the wind farm.

3.3 Construction Noise Guidelines

In NSW, there is no current guidance in relation to appropriate construction noise criteria. In the absence of a current standard, the DECC advises that the now out-of-date *Environmental Noise Control Manual* should be used to determine the allowable level of construction noise at residential receivers. The noise level restrictions are as follows:

- Construction period 4 weeks and under

  The L_{10} level measured over a period of not less than 15-minutes when the construction site is in operation must not exceed the background level by more than 20 dB.

- Construction period greater than 4 weeks and not exceeding 26 weeks

> The L_{10} level measured over a period of not less than 15-minutes when the construction site is in operation must not exceed the background level by more than 10 dB.

The construction duration associated with the proposed development is estimated to take 12-24 months in total. However, due to the large coverage area of the wind farm and up to 86 individual turbine sites, intensive works will be located in any one location for only a short period of time relative to the overall duration.

We therefore consider it appropriate to allow construction (L_{A10}) noise levels to exceed background (L_{A90}) noise levels for short and intermittent periods by up to 10dB.

The DECC sets time restrictions for noise generated during construction work as follows:

- Monday to Friday, 0700-1800hrs
- Saturday, 0700-1300hrs if audible on residential premises, otherwise 0800-1300hrs *[sic]*
- No construction work is to take place on Sundays or Public Holidays.

3.4 ANZEC Blasting Noise Guidelines

Noise control in relation to blasting is guided by the Australian and New Zealand Environment Council (ANZEC) guidelines – *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (1990). Times of day, air-blast over-pressure level and ground vibration peak particle velocity limits are all considered. Table 3 summarises the criteria limits in order to minimise annoyance due to blasting overpressure and ground vibration at nearby residences.

Table 3
ANZEC blasting guidelines

Time of Blasting	Blast Over-pressure Level (dB Lin Peak)	Ground Vibration Peak Particle Velocity (mm/sec)
Monday – Saturday: 9am – 5pm	115	5
Sunday & public holidays:		
No blasting to take place	-	-

The NSW DECC accepts that on infrequent occasions the overpressure limit of 115 dB (Lin Peak) may be exceeded. This should be limited to not more than 5% of the total number of blasts over a 12-month period and should not exceed 120dB (Lin Peak) at any time whatsoever.

Additionally, ground vibration peak particle velocity may also exceed the 5mm/sec limit on infrequent occasions. This should be limited to not more than 5% of the total number of blasts over a 12-month period and should not exceed 10mm/sec at any time whatsoever.

Blasting should generally take place no more than once per day. Additionally, the restrictions referred to above do not apply at premises where the effects of the blasting are not perceived to be noise sensitive.

3.5 Vibration Assessment Guidelines

Human Response to Vibration

The NSW DECC document *Assessing Vibration: a technical guide* (DEC2006/43, February 2006) presents preferred and maximum vibration criteria for use in assessing human response to vibration.

It is noted that acceptable values of human exposure to vibration are dependent on, amongst other things, the time of day. This assessment will only consider the period during which construction can take place i.e. 0700-1800 Monday to Friday and 0700-1300 (or 0800-1300 if audible at receiver) on Saturday.

The following tables summarise the preferred and maximum values for acceptable human exposure to continuous, impulsive and intermittent vibration.

Table 4
Preferred and maximum values for vibration during daytime (mm/s) 1-80Hz

Location	Preferred Values	Maximum Values
Continuous		
Residences	0.28	0.56
Impulsive		
Residences	8.6	17

Table 5
Vibration dose values for intermittent vibration during daytime ($m/s^{1.75}$) 1-80Hz

Location	Preferred Values	Maximum Values
Residences	0.2	0.4

It should be noted that based on the operational characteristics of the construction equipment considered within this assessment, only impulsive and intermittent vibration will be emitted.

Evaluation of Vibration in Buildings

Table 1 of British standard *BS 7385 Part 2: 1993 Evaluation and measurement for vibration in buildings Part 2. Guide to damage levels from ground-borne vibration*, has been referenced to determine acceptable values of ground-borne vibration which will not cause cosmetic damage to neighbouring buildings.

Table 6 summarises acceptable ground-borne vibration levels.

Table 6
Transient vibration guide values to prevent cosmetic damage

Type of building	Guide value peak particle velocity
Unreinforced or light framed structures, residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz. 20mm/s at 15Hz increasing to 50mm/s at 40Hz and above.

It should be noted that BS7385 recommends that guide values for continuous vibration may need to be reduced to 50% of the values listed in Table 3 (based on common practice) however it is not envisaged that construction equipment generating vibration of a continuous nature will be used for this development.

3.6 NSW DECC Environmental Criteria For Road Traffic Noise

The noise level criteria for increased traffic flow as a result of land-use development with the potential to create additional traffic are set by the NSW DECC's *Environmental Criteria for Road Traffic Noise (ECRTN)*. Table 7 presents the traffic noise criteria for this development.

Table 7
Road traffic noise criteria

Type of Development	Criteria Day 0700-2200hrs
Land use developments with potential to create additional traffic on local roads	$L_{eq(1hr)}$ 55 dBA
Land use developments with potential to create additional traffic on existing freeways/collector roads	$L_{eq(1hr)}$ 60 dBA

Source: Table 1 NSW EPA – Environmental Criteria for road traffic noise

Furthermore, the guidance states:

> *Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads, regulating times of use, using clustering, using 'quiet' vehicles, and using barriers and acoustic treatments.*
>
> *In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2dB.*

4.0 ASSESSMENT METHODOLOGY

Predictions and Relevant Receiver Assessment

Preliminary predictions of wind farm noise levels have been modelled for each receiver within approximately 5km of the development using the algorithm detailed in *ISO9613-2: 1996- Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO9613-2:1996) as implemented in the noise modeling software SoundPlan. ISO9613-2:1996 is recognised as being acceptable for use in calculating wind farm noise. Our predictions use sound power data determined in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques.*

Potentially affected residential properties in the vicinity of the wind farm have been determined in accordance with Section 3.1 of the Guideline. In excess of 50 residential properties have been identified. Background noise monitoring is required to be carried out at locations, termed relevant receivers, which are relevant for assessing the impact of wind farm noise on nearby premises. Where a cluster of dwellings occurred, one receiver was selected as being a *worst-case* representation of the cluster as a whole. Eleven (11) relevant receivers were shortlisted for background noise monitoring based on predicted levels, site photographs and topography.

Background Noise Monitoring

Long-term background noise monitoring was carried out in accordance with Section 3.1 of the Guideline at these eleven (11) locations. The data gathered from each site was then analysed, in accordance with Section 3.4 of the Guideline, together with wind speed data collected within the proposed site in accordance with Section 3.2 of the Guideline.

Establishment of Noise Limits

Noise criteria for the development have been determined in accordance with Section 2.2 of the Guideline. Specifically, the Guideline requires that the predicted wind farm noise level should not exceed 35dBA or background noise $L_{A90,10\text{-}min}$ by more than 5dBA, whichever is the greater, at all relevant receivers for the operating wind speed range of the wind farm from cut-in to rated power. Noise limits determined at the eleven (11) noise monitoring locations have been applied to all residential properties initially identified.

Assessment of Acceptability of Wind Farm Noise

Noise predictions were undertaken at each identified receiver in accordance with Section 3.3 of the Guideline using the algorithm detailed in ISO9613-2:1996. Predicted noise levels were then compared with the relevant noise limits for each relevant receiver in order to establish compliance with the Guideline.

5.0 RELEVANT RECEIVER ASSESSMENT

5.1 Selection of Relevant Receivers

In total, over 50 dwellings have been considered within the Coppabella assessment. There are small clusters of dwellings located to the north-west, north, east and south-east of the proposed site, with additional dwellings located along the Hume Highway.

The Guideline states that background noise monitoring should be carried out at locations that are relevant for assessing the impact of wind farm noise on nearby premises. These locations, termed *relevant receivers,* are defined within the Guideline as premises at which:

- someone resides or has development approval to build a residential dwelling on and;
- the predicted noise level exceeds the relevant base noise level for wind velocities (V10m) of 10ms-1 or less and;
- is representative of the worst-case situation for a cluster of similarly located dwellings.

It should be noted that dwellings located between the Coppabella Hills and Marilba Hills sites have been assessed as part of the Marilba Hills noise impact assessment due to closer proximity. In addition, all dwellings considered within this assessment have been assessed in terms of the cumulative noise impact from the nearby proposed Marilba Hills site and Conroys Gap wind farm.

Dwellings located further than approximately 5km distance from a turbine have not been considered within this assessment because at greater distances, existing ambient noise levels will dominate.

Dwellings with predicted noise levels of 35dBA or greater were included for further assessment. From this shortlist, eleven (11) relevant receiver locations were selected.

Where a cluster of dwellings occurred in one location, a worst-case determination was made that involved selecting a single dwelling as being representative of the cluster. Factors that were used in this determination included elevation, foliage coverage, topography of surrounding land, proximity to the nearest turbine and overall predicted level.

Table 8 details all relevant receiver locations where background noise monitoring was undertaken.

Table 8
Relevant receiver locations

Location	Easting (m)	Northing (m)	Elevation above sea level (m)	Distance to closest WTG (km)	Distance to mast (km)	Indicative of cluster
C01*	634541	6152998	450	1.0	7.9	
C02*	636010	6153231	479	1.6	6.5	
C03*	637354	6151270	414	1.8	6.3	
C04*[W]	641149	6150592	487	1.8	4.9	
C05*	644196	6148247	553	1.9	7.5	C23, C06, C08, C41
C07*	631744	6154014	328	1.8	10.4	
C29	645491	6156830	402	3.7	3.7	
C30*	643944	6159581	464	4.2	4.6	C31-C34
C35*	639640	6159615	364	3.5	4.9	C36
C38	632048	6157837	315	3.8	10.3	C39, C40
C42	649145	6147576	462	3.7	10.5	C46-C49

* Involved landowner. [W] Weather station location.

5.2 Background Noise Monitoring

Background noise monitoring was undertaken at relevant receiver locations over 2-week periods from 4 July to 4 August 2008. The monitoring was conducted during winter in order to establish worst case, lowest, background noise curves.

Noise monitoring loggers were generally placed within 20m of a house and no closer than 5m to any reflective surface other than the ground. The microphone was positioned at a height of 1.2m above ground level (AGL) for all locations and fitted with a manufacturer-supplied 9cm windshield in order to protect against wind-induced noise across the microphone diaphragm.

The microphone windshields used provide approximately 26dBA of wind noise attenuation up to 20ms^{-1}.

Loggers were placed on each property near the dwelling façade that was on-axis to the nearest proposed turbine location.

Logging was conducted using Acoustic Research Laboratories (ARL) EL316 environmental noise loggers. These are Type-1 measurement devices, certified in accordance with AS1259-1990 or IEC-61672 (*International Electrotechnical Commission 2002*).

Calibration and time drift was checked for each monitoring installation, in addition to collecting site photographs and detailed notations of the immediate surroundings. Factors that could affect the measurements including potential noise sources and unusual topography were noted. Pre and post-measurement calibrations were conducted using a Rion NC-74 Class-1 calibrator complying with IEC60942:1997.

5.3 Weather Station Monitoring

The Guideline requires that any data affected by rainfall or extraneous noise events must be excluded from the assessment. In order to determine rainfall events, a WeatherPro-Plus weather station was installed at dwelling C04 for the duration of the monitoring programme.

Weather data recorded at C04 captured real-time weather events local to the area. The nearest Bureau of Meteorology weather station with sufficiently detailed climate records (Canberra) was deemed too far away, and would not provide sufficient indication of localised conditions. The onsite weather station recorded local atmospheric pressure, wind velocity and direction, rainfall, temperature and humidity.

The onsite weather station data confirmed that for the entire monitoring period, very little rainfall occurred. The general meteorological conditions for the assessment period were dry and cool.

5.4 Reference Mast Data

Reference mast wind speeds were measured at 10m AGL and in 10-minute intervals corresponding to the background noise measurement period. See Appendix B for mast location in relation to the overall site.

5.5 Data Analysis

Approximately 2000 intervals of measured background noise level $L_{A90,\ 10min}$ data were collected for each relevant receiver. A review of the data was then undertaken in order to determine the occurrence of extraneous noise events (e.g. noise due to rainfall, lawn mowing etc). After excluding all data affected by extraneous noise events, the remaining data were plotted as an XY scatter as a function of the wind velocity at 10m AGL.

A regression analysis was performed for each relevant receiver data set in order to determine the background noise line of best fit. Table 9 summarises the data statistics for each relevant receiver location. The 'R^2' value, also called the coefficient of determination, describes the degree of variability of a set a data. The 'R' value on the other hand, describes the strength of relationship between variables.

Table 9
Relevant Receiver Noise Logger Statistics

Location	Measurement Period	Logger Serial No.	Total Data points	Valid Data points	Correlation R	Correlation R^2
C01*	04/07/08 to 21/07/08	16-707-020	2113	2010	0.36	0.17
C02*	04/07/08 to 21/07/08	16-707-019	2098	2029	0.64	0.43
C03*	04/07/08 to 21/07/08	16-707-018	1833	1808	0.57	0.35
C04*	04/07/08 to 21/07/08	16-207-029	1984	1949	0.54	0.32
C05*	04/07/08 to 21/07/08	16-707-022	2068	2011	0.20	0.11
C07*	21/07/08 to 04/08/08	16-707-018	1994	1981	0.66	0.45
C29	21/07/08 to 04/08/08	16-707-021	2117	2078	0.42	0.24
C30*	21/07/08 to 04/08/08	16-707-019	1742	1735	0.75	0.64
C35*	21/07/08 to 04/08/08	16-707-020	1755	1610	0.66	0.48
C38	21/07/08 to 04/08/08	16-207-029	1876	1860	0.63	0.46
C42	21/07/08 to 04/08/08	16-707-021	1786	1767	0.59	0.36

* Involved landowner.

It should be noted that data were excluded from each dataset where:

- extraneous noise was indicated (e.g. where low wind speed recorded but elevated background $L_{A90, 10min}$ level compared to surrounding data points)
- any measurement coincided with recorded rainfall

Extraneous noise events are defined as any measurement that is 5dB or greater above surrounding measurements.

5.6 Relevant Receiver Noise Assessments

This section describes each monitoring location and the results obtained in terms of the noise criteria assessment conducted in accordance with the Guideline. Photographs of each logger location relative to the dwelling can be found in Appendix F. Refer to Appendix G for measured L_{90} background noise level and wind speed vs. time graphs for each location.

Relevant Receiver C01

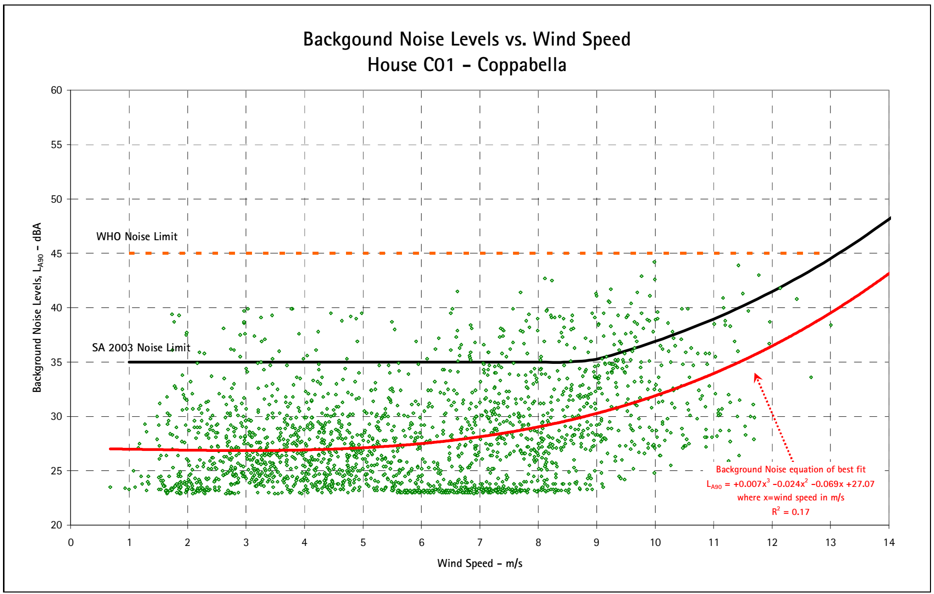
Background noise monitoring was carried out at "Hill View" located approximately 5.5km north of the Hume Highway on Hill View Road, Berremangra, from 4 July to 21 July 2008 using ARL logger EL316 serial no. 16-707-020.

C01 was selected as a monitoring location based on its potential sensitivity to noise limit criteria and its proximity to a small cluster of turbines headed by COP_76, approximately 1km away.

The environment surrounding the measurement location consisted of various deciduous trees and to the south of the dwelling, other small vegetation. A shelter belt of trees was located 200m to the south-west, with Berremangra Settlement Road approximately 1.2km to the south.

A total of 103 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 1 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 1
C01 derived noise limits



Relevant Receiver C02

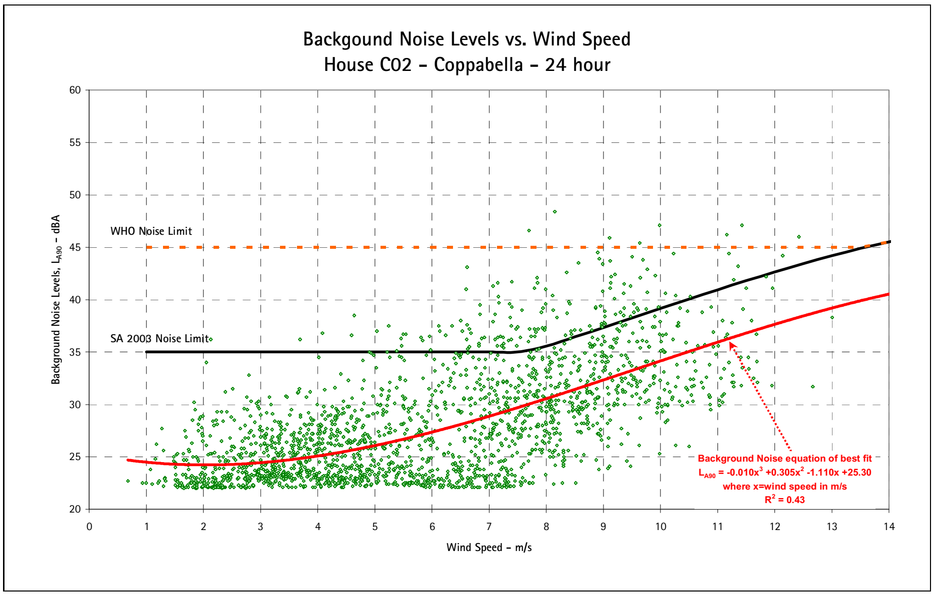
Background noise monitoring was carried out at “Coppa Canyon” located on Coppabella Road, Bookham, from 4 July to 21 July 2008 using ARL logger EL316 serial no. 16-707-019.

C02 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The closest turbine is COP_40 which is located approximately 1.6km to the east.

The environment surrounding the measurement location was characterised by a combination of small to medium-sized trees forming a shelter belt along the north, east and south property boundaries. The dwelling is nestled at the bottom of a small rocky hill, which affords shelter from the prevailing westerly.

A total of 69 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 2 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 2
C02 derived noise limits



Relevant Receiver C03

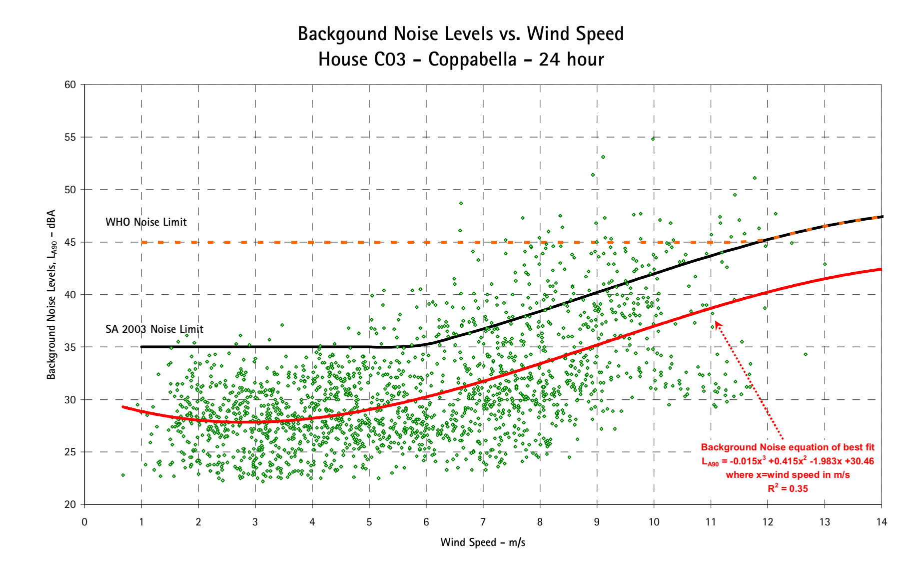
Background noise monitoring was carried out at "Kooryanga" located on Berremangra Settlement Road, Berremangra, from 4 July to 21 July 2008 using ARL logger EL316 serial no. 16-707-018.

C03 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The closest turbine is COP_34 which is located approximately 1.8km to the north.

The environment surrounding the measurement location was characterised by a combination of small to medium-sized trees in the vicinity of the dwelling. The location of the dwelling affords direct line-of-sight toward the Coppabella Hills, located to the north and north-east. The Hume Highway is located some 3.3km to the south.

A total of 26 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 3 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 3
C03 derived noise limits



Relevant Receiver C04

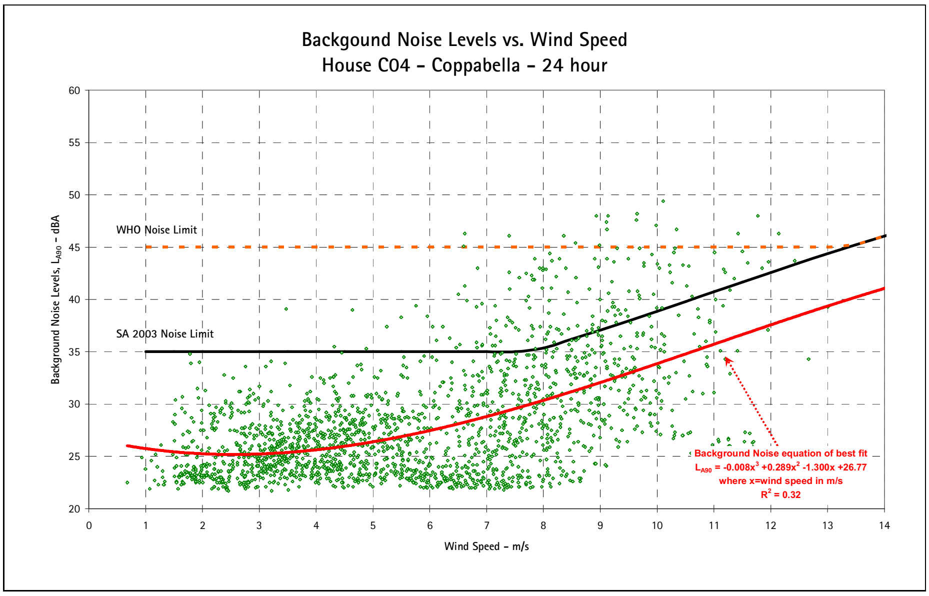
Background noise monitoring was carried out at "Whitefields" located on Whitefields Road, Bookham, from 4 July to 21 July 2008 using ARL logger EL316 serial no. 16-207-029.

C04 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The closest turbine is COP_59 which is located approximately 1.8km to the north.

The environment surrounding the measurement location was characterised by a combination of small to medium-sized trees in the vicinity of the dwelling, with a contiguous shelter belt of trees lining the length of Whitefields Road. The location of the dwelling affords direct line-of-sight toward the Coppabella Hills, located to the north and north-west. The Hume Highway is located some 2.7km to the south.

A total of 35 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 4 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 4
C04 derived noise limits



Relevant Receiver C05

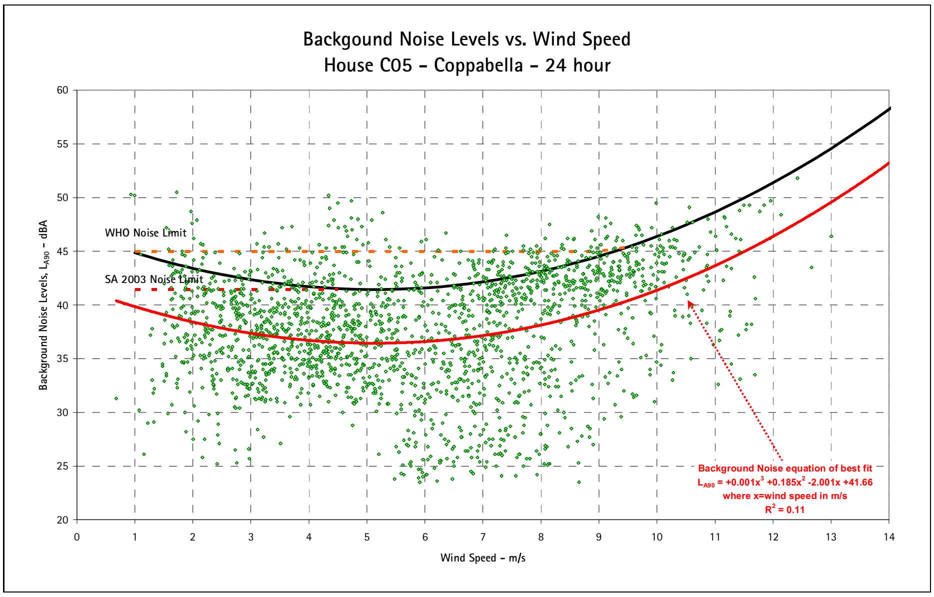
Background noise monitoring was carried out at "Shalom" located on Whitefields Road, Bookham, from 4 July to 21 July 2008 using ARL logger EL316 serial no. 16-707-022.

C05 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The closest turbine is COP_68 which is located approximately 1.8km to the north-east. Additionally, it was determined that this location was indicative of worst-case amongst other dwellings in the area (C23, C06, C08 & C41) due to having a greater set-back from the Hume Highway (900m). It is noted that the Hume Highway has an influence on the measured background noise levels at this location.

The environment surrounding the measurement location was sparsely vegetated with an exposed easterly and southerly outlook. An outcrop of trees was located 50m to the west, with the terrain of the property steeply rising toward the north.

A total of 58 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 5 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 5
C05 derived noise limits



Relevant Receiver C07

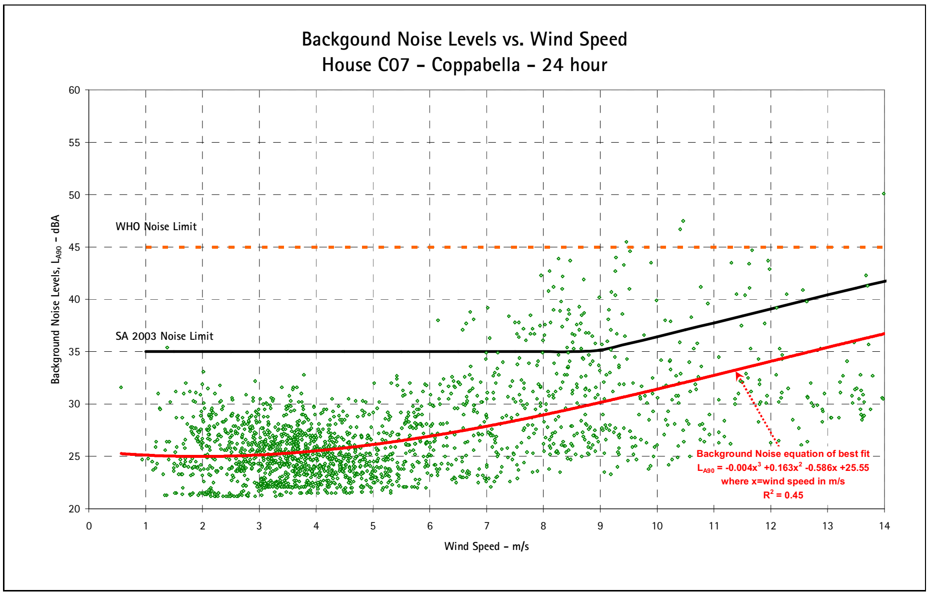
Background noise monitoring was carried out at "Dawn" located on Berremangra Settlement Road, Berremangra, from 21 July to 4 August 2008 using ARL logger EL316 serial no. 16-707-018.

C07 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The closest turbine is COP_74 which is located approximately 1.8km to the east.

The environment surrounding the measurement location was characterised by undulating topography, with some sparse, medium-to-tall trees surrounding the dwelling. The dwelling has a relatively exposed easterly outlook, back towards the closest proposed turbines.

A total of 14 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 6 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 6
C07 derived noise limits



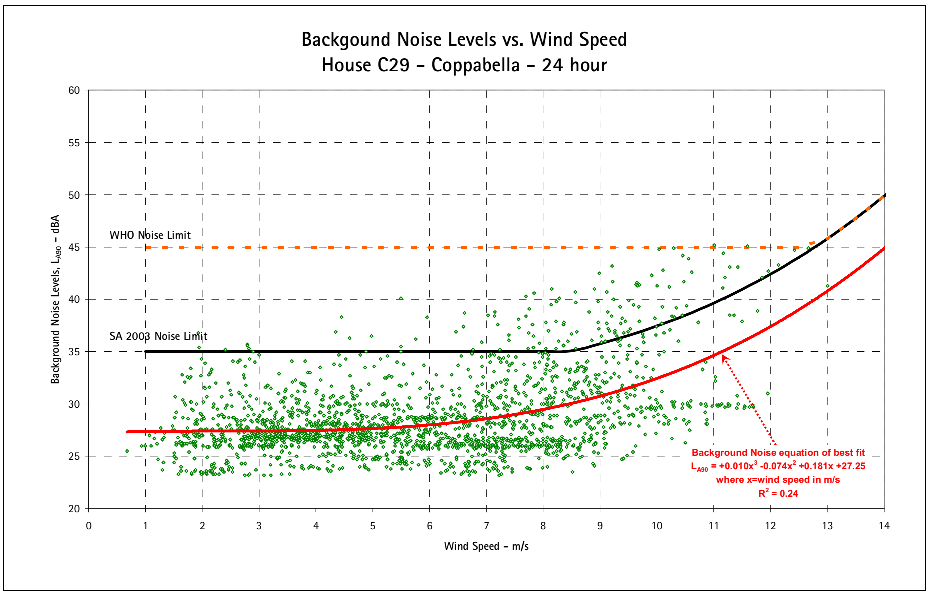
Relevant Receiver C29

Background noise monitoring was carried out at "Glendalyn" located at 620 Sykes Road, Binalong, from 4 to 21 July 2008 using ARL logger EL316 serial no. 16-707-021.

C29 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The environment surrounding the measurement location was characterised by dense shelter belts of trees; the main ridgeline of the proposed site was visible through a break in the tree line to the west. An additional occupied dwelling is located 50m to the north-west of the main homestead.

A total of 40 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 7 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 7
C29 derived noise limits



Relevant Receiver C30

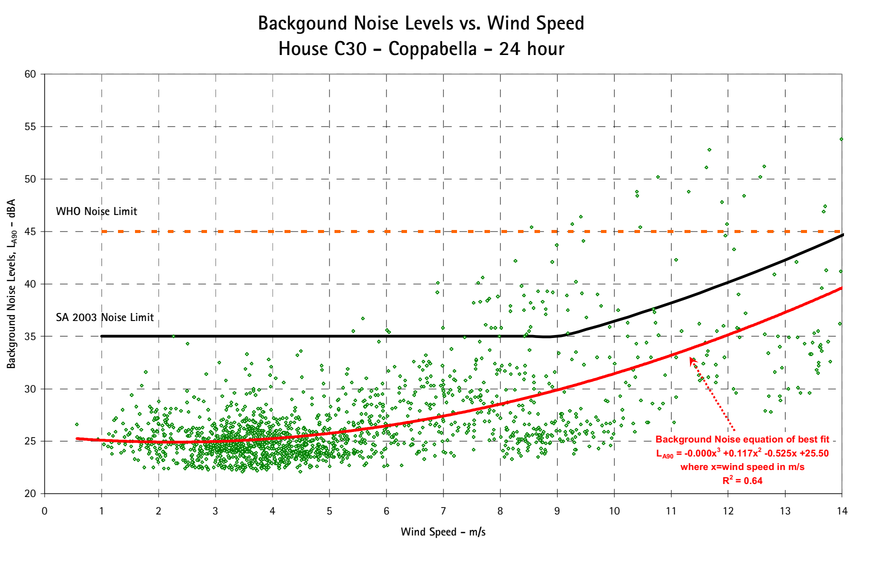
Background noise monitoring was carried out at "Montana" located on Garryowen Road, Binalong, from 22 July to 4 August 2008 using ARL logger EL316 serial no. 16-707-019.

C30 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. Additionally, it was determined that this location was indicative of worst-case amongst other dwellings in the area (C31 to C34) due to having a greater set-back from Garryowen Road (1.2km).

The environment surrounding the monitoring location was characterised by open farmland with minimal vegetation. The dwelling is located on a hill with unobstructed line of sight in all directions.

A total of 8 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 8 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 8
C30 derived noise limits



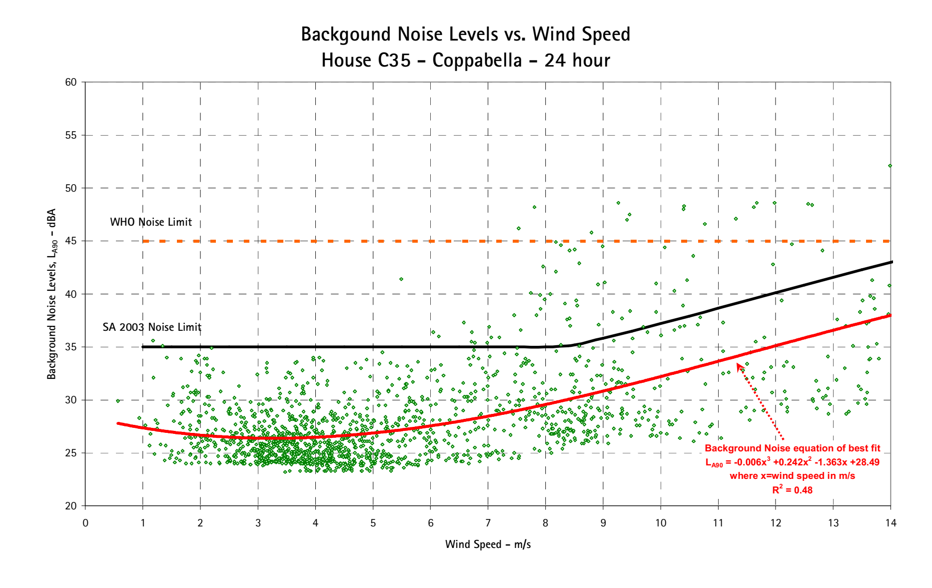
Relevant Receiver C35

Background noise monitoring was carried out at "Cumbarmurra" located on Coppabella Road, Berremangra, from 22 July to 4 August 2008 using ARL logger EL316 serial no. 16-707-020.

C35 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The environment surrounding the measurement location was characterised by a combination of small to medium-sized trees, with a hill located to the south and south-west which displayed a gentle gradient. The location of the dwelling affords direct line of sight to the proposed wind farm site.

A total of 145 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 9 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 9
C35 derived noise limits



Relevant Receiver C38

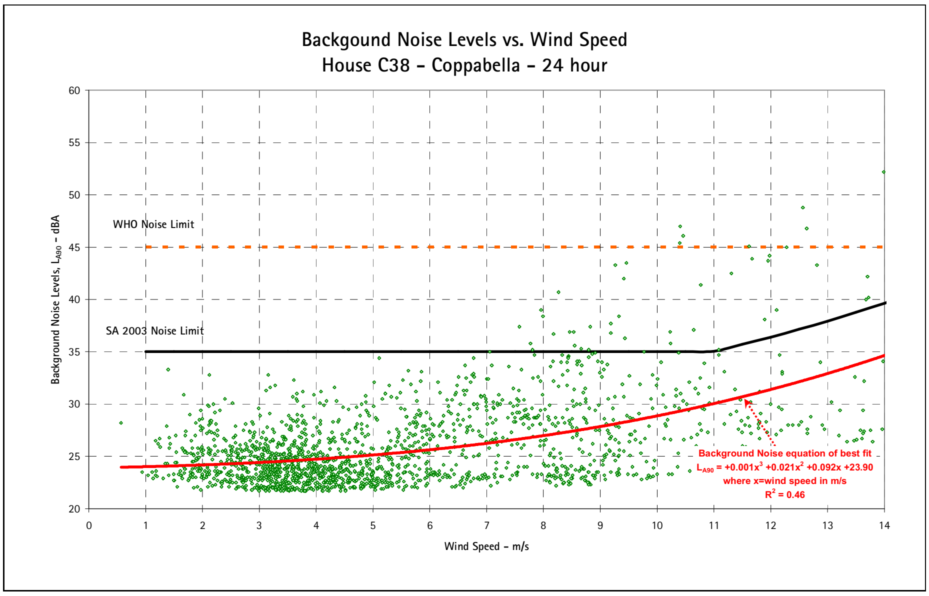
Background noise monitoring was carried out at "Ykicamoocow" located on Berremangra Road, Berremangra, from 21 July to 5 August 2008 using ARL logger EL316 serial no. 16-207-029.

C38 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. Additionally, it was determined that this location was indicative of worst-case amongst other dwellings in the area (C39 and C40) due to being substantially closer to a cluster of turbines headed by COP_72.

The environment surrounding the measurement location was characterised by undulating topography, with medium sized trees located 30-50m away to the north and north-east. The location of the dwelling affords direct line of sight to the proposed wind farm site located toward the south-east.

A total of 16 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 10 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 10
C38 derived noise limits



Relevant Receiver C42

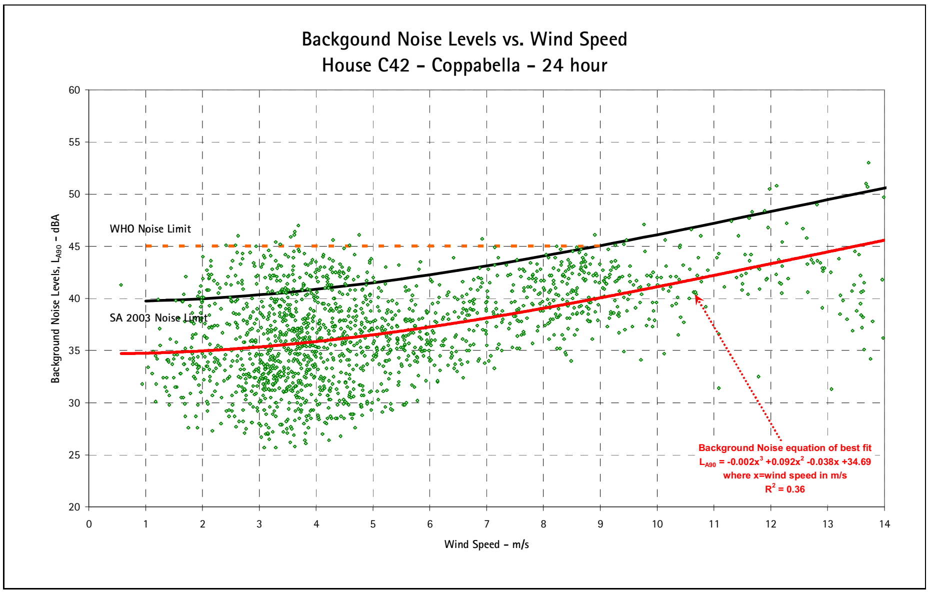
Background noise monitoring was carried out at this dwelling located at 12 Bookham Illalong Road, Bookham, from 22 July to 5 August 2008 using ARL logger EL316 serial no. 16-707-021.

C42 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. Additionally, it was determined that this location was indicative of worst-case amongst other dwellings in the area (C46 to C49) due to having a greater set-back from the Hume Highway (580m). It is noted that the Hume Highway has an influence on the measured background noise levels at this location.

The environment surrounding the measurement location was characterised by undulating topography, with medium sized trees located 30m to the south. The dwelling has line of sight to both the proposed Coppabella and Marilba wind farm sites, located approximately 3.7km and 4.4km north-west and east respectively.

A total of 19 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 11 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners is shown.

Figure 11
C42 derived noise limits



6.0 NOISE LEVEL PREDICTIONS

6.1 Selection of Prediction Model

It has been empirically shown that where the distance between source and receiver is significant, and the intermediate ground displays significant topographic features, ISO9613 predictions are more accurate than CONCAWE and NZS6808[1]. This however requires the use of high quality terrain information, such as can be provided by a digital terrain file. It should be noted that a digital terrain model has been used as one of the input parameters in our modelling.

A study by Bass, Bullmore and Sloth[2] compared three prediction models, IEA Part 4, ISO9613-2 and ENM implementing CONCAWE and found that for flat, rolling and complex terrain sites ISO9613 predicted noise levels to within 1.5dBA accuracy of levels measured under conditions of an $8ms^{-1}$ positive wind vector. Furthermore, they noted that the output of ISO9613 was not unduly sensitive to meteorological input parameters when compared to ENM (CONCAWE).

Furthermore, a study conducted by Hoare Lea Consulting Engineers[3] compared predicted levels using ISO9613 to measured levels at four receiver locations between 100 – 800m from an operational UK wind farm.

The downwind measurements used in the comparison were between +/- 15 to 45 degrees, with hub height wind speeds of 8-14 ms^{-1}. Two ground assumptions were modelled, a hard ground assumption (G=0) and a mixed ground assumption (G=0.5). The report concluded that using ISO9613 with a single wind speed reference offered a robust representation of wind farm noise levels.

It should be noted that ISO9613-2 has been used for wind farm noise level predictions in this report.

6.2 ISO9613-2:1996 Standard

Operational wind farm noise levels were predicted to all residential dwellings considered within this assessment using a three-dimensional computer noise model generated in SoundPLAN.

The model was implemented in SoundPLAN version 6.5, which is produced by Braunstein & Berndt GmbH. The SoundPLAN implementation of ISO9613 has been tested in-house by SoundPLAN developers to ensure calculated results are within 0.2dB of the standard. See Appendix H for a description of the attenuation factors used in our calculations.

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[1] Stakeholder Review & Technical Comments – NZS6808:1998 Acoustics- Assessment and measurement of sound from wind turbine generators; 22.0001.06.04(CC,) May 2007.

[2] Bass, Bullmore and Sloth - Development of a wind farm noise propagation prediction model; Contract JOR3-CT95-0051, Final Report, January 1996 to May 1998.

[3] Bullmore, Adcock, Jiggins & Cand – Wind Farm Noise Predictions: The Risks of Conservatism; Presented at the Second International Meeting on Wind Turbine Noise in Lyon, September 2007.

Noise levels were calculated for $9ms^{-1}$ at all receiver locations previous defined.

6.3 Predicted Results

Results of the predicted wind farm noise levels calculated in accordance with ISO9613-2:1996 are presented in Table 10 for the MM92E and V90 3MW.

Table 10
Relevant receiver predicted levels (L_{eq}) in dBA re $2x10^{-5}$ Pa at $9ms^{-1}$

Receiver	MM92E	V90 3MW (78.8m hub)	V90 3MW (100m hub)	Criteria Limit at $9ms^{-1}$	Comply?
C01*	39	42	42	45	Yes
C02*	39	42	43	45	Yes
C03*	38	42	41	45	Yes
C04*	38	42	42	45	Yes
C05*	30	34	34	45	Yes
C07*	34	37	37	45	Yes
C29	33	37	37	35	Yes/Marginal
C30*	31	35	34	45	Yes
C35*	33	37	37	45	Yes
C38	29	33	33	35	Yes
C42	32	37	36	44	Yes

* Involved landowner.

The results in Table 10 show that the representative turbine (MM92E) complies with noise limit criterion at $9ms^{-1}$ at all receiver locations. The results for the worst-case turbine (V90 3MW) indicate a marginally compliant layout. If this turbine is selected for the project, mitigation measures or a layout redesign would be considered.

Furthermore, it can be seen that an increase in hub height from 80m to 100m does not significantly affect receiver noise levels in this instance. It should be noted that the Vestas V90 3MW is the turbine with the greatest sound power level for which data exists and therefore serves as a worst case assessment in terms of sound power level, generating capacity and physical dimensions.

MDA recommends that wind farm noise level predictions be reviewed once warranted sound power levels for the selected turbine have been received from the contracted turbine manufacturer.

Please refer to Appendix I for predicted noise level versus noise limit plots for all relevant receiver locations. Appendix J summarises the predicted levels at each receiver in addition to predicted levels relative to the associated compliance limits. The predicted noise contour plots for Coppabella Hills are presented in Appendix K.

Table 11 summarises the compliance status for each turbine type.

Table 11
Compliance status

Turbine Model	No. of turbines	Compliance at all receiver locations	Marginal Receivers
MM92E	86	Yes	
V90 3MW (80m hub)	86	Marginally compliant	C13, C29, C36
V90 3MW (100m hub)	86	Marginally compliant	C13, C29, C36

6.4 Cumulative Effect of Other Wind Farm Developments

Separate wind farm developments that are in close proximity to each other have the potential to impact on the same receiver. Therefore it is important to assess the cumulative impact on receivers where such circumstances exist. There are currently no active wind farms in the Yass area however there are a number of sites that are seeking development approval or have gained approval. Figure 12 indicates the locations of these relative to the Coppabella Hills site.

Figure 12
Southern Tablelands wind farm sites

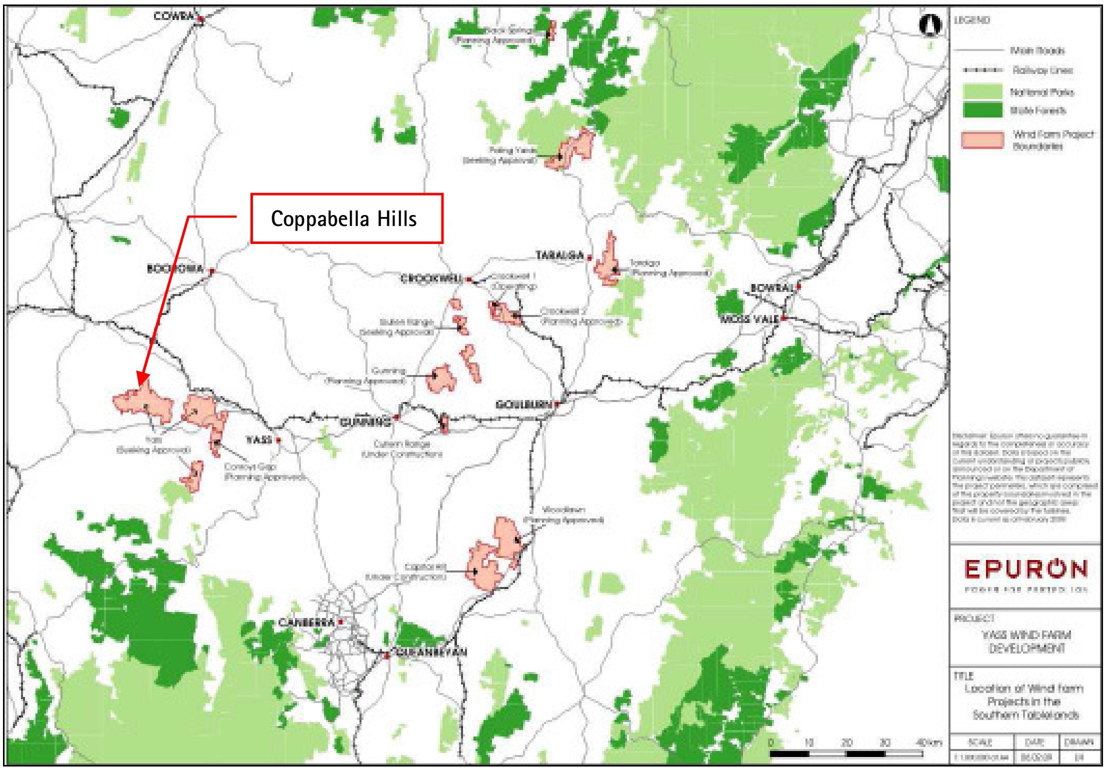

Image courtesy of EPURON

The surrounding sites are as follows:

- Conroys Gap (planning approved)– located approximately 11km to the south-east
- Carrolls Ridge (seeking approval)– located approximately 15km to the south
- Marilba Hills-1 (seeking approval) – located approximately 4.5km to the east
- Marilba Hills-2 (seeking approval) – located approximately 10km to the east

It should be noted that the cumulative noise emission from Conroys Gap and Marilba Hills wind farms has been included in the Coppabella Hills noise impact assessment. In addition, the Carrolls Ridge wind farm will not impact receivers around Coppabella Hills due to the large separation distance involved.

The cumulative effect of multiple wind farms on total noise level for those receivers previously assessed as part of the Conroys Gap wind farm has also been considered. The Guideline states that any new wind farm should meet the criteria using the background noise levels as they existed before the original wind farm site development. It is noted that our assessment uses the original criteria for Conroys Gap receivers in this instance.

The following table compares the relevant receiver noise levels predicted by Heggies Australia for the Conroys Gap Wind Farm against the cumulative noise level based on all three wind farms operating.

Table 12
Conroys Gap receivers cumulative level comparison in dBA re $2x10^{-5}$ Pa at $8ms^{-1}$

Receiver	Conroys Gap Prediction*	Cumulative Noise Levels			Noise Criteria at $8ms^{-1}$	Comply?
		MM92E	V90 3MW (80m hub)	V90 3MW (100m hub)		
G01	37	37	37	37	42	Yes
G02	35	35	35	35	39	Yes
G04**	38	40	40	40	45	Yes
G10**	41	41	42	42	45	Yes
G11	28	37	40	40	40	Yes
G17	35	36	37	37	37	Yes
G24	35	35	35	35	38	Yes

* Based on REpower MM82 2MW – Heggies report 40-1143-R2 26 July 2006 ** Involved limits apply

From the information summarised in Table 12, it is noted that the cumulative noise emission from the Yass Valley Wind Farm are likely to increase noise levels for Conroys Gap receivers that are in close proximity to the site. This effect is typified by the cumulative noise level at G11, which indicates that an increase of approximately 9-12dB is likely to result.

It is noted that compliance is achieved for both turbine types when considering noise limits based on Heggies' report 40-1143-R2 dated 26 July 2006.

6.5 WTG Tonality Assessment

Where tonality is a characteristic of a turbines frequency spectrum, the Guideline states that a 5dBA penalty should be added to the cumulative predicted level at each receiver location. Tests for tonality have been independently conducted in accordance with *IEC-61400-11*, the results of which have been supplied to MDA by EPURON.

For the wind speed range considered within this assessment, we understand that tonality is not an audible component of either the MM92E or V90 3MW sound power spectra; therefore no penalty has been applied to the predicted results.

MDA recommends that tonality is assessed as part of the wind farm commissioning process.

6.6 WTG Annoying Characteristics

The Guideline has been developed with the inherent noise characteristic from turbines already taken into account. This includes aerodynamic noise from the blades passing through the air commonly referred to as "swish" or "swoosh".

It should be clarified that infrasound and "swoosh" are two separate characteristics. Infrasound is defined as soundwaves having frequency below the human audible range (below 20Hz).

Historically, turbine design located the rotating blades downwind of the tower, with the turbulence created by the tower being cut through by the blades, resulting in increased low frequency noise. Modern turbine designs have located the blades upwind of the tower and as such exhibit infrasound levels significantly lower than the old downwind design, with measured levels in fact below the threshold of human hearing[4]. In addition, the South Australia EPA has completed an extensive literature search and is not aware of infrasound being present at any modern wind farm site.

In light of these previous findings, no additional penalty has been applied to the predicted equivalent noise level at each receiver due to WTG annoying characteristics including infrasound.

[4] A McKenzie – Infra-sound, Low Frequency Noise & Vibration from Wind Turbines; AUSWIND 2004

6.7 Health Effects Due To WTG Operation

At receiver locations, any modern wind turbine generator system does not emit sufficient sound power to cause health effects such as have been claimed to be associated with them, including Vibro-Acoustic Disease (VAD). Calculations have shown that to be exposed to conditions similar to those referred to in papers on VAD[5], a receiver would have to be located within several metres of the blade tip of a turbine, and that the exposure would need to be continuous for ten years. Furthermore, no reputable published studies have shown any causal link between ill health effects and infrasound emitted by turbines. It should be noted that there have been no health-related complaints in South Australia due to wind farm operation.

6.8 Meteorological Effects On Noise Propagation

Meteorological factors such as wind direction, air pressure, temperature and humidity have an effect on the propagation of sound from a noise source. Our noise predictions have been modelled based on air absorption values at 10 degrees Celsius and 70% humidity. Additionally, it is noted that ISO9613-2:1996 predicts noise levels to receivers based on down wind conditions in all directions. In light of this, our meteorological discussion will focus on the effect of atmospheric stability and temperature effects on noise emission from the wind farm.

Atmospheric Stability and Wind Profile

The vertical wind velocity profile (or shear exponent) describes a change in wind velocity as a function of height. Wind velocity is generally at a minimum at ground level and follows an isotropic increase with altitude up to the jet stream. The primary factors that determine the wind velocity profile are ground surface roughness, topography and atmospheric stability.

Atmospheric stability is a measure of the degree to which the atmosphere resists turbulence and vertical motion. It is determined by the net heat flux to the ground, which is the sum of incoming solar and outgoing thermal radiation in addition to thermal exchange with the air and subsoil.

The concept of atmospheric stability can be further explained by considering the daily thermal exchange that occurs due to solar activity. During clear days the net flux is dominated by incoming solar radiation, heating the ground. Air is heated from below and rises, causing thermal turbulence and vertical air movement. As a result of this turbulence, the atmosphere is unstable, preventing significant changes in the vertical wind velocity profile over short distances.

At night the net flux is dominated by outgoing thermal radiation, resulting in cooling of the ground; the air is cooled from below. Vertical thermal turbulence reduces or stops, leading to a decoupling of horizontal layers of the air mass and thus creating greater changes in vertical wind profile over short distances.

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[5] Aviat Space Environ Med. 1999 Mar;70(3 Pt 2):A46-53.Related Articles, Links Echocardiographic evaluation in 485 aeronautical workers exposed to different noise environments

The relevance of atmospheric stability to wind farms is that a change in the stability of the atmosphere leads to a change in wind profile and therefore a change in the relationship between background noise level at receiver locations and wind speeds measured at the site of the wind farm.

It is noted that our assessment takes into account the wind profile of the area and it would be expected that mast wind speed measurements made during long-term background noise monitoring would cover all stability conditions.

van den Berg Effect

In 2003, Dr G.P. van den Berg undertook a study of the effect of stable air on wind farm noise emissions at the Rhede Wind Park located in northwest Germany near the Dutch border. He conjectured that during periods where the air was highly stable (mostly at night) noise emissions from the wind farm increased significantly[6].

Dr van den Berg undertook his study at only one particular site with very specific topographical characteristics. The potential increase of noise levels due to stable air has become known as the eponymous "van den Berg effect" and has been raised on many other wind farm projects where the sites have very different characteristics from the wind farm studied by Dr van den Berg.

The issue of the van den Berg Effect was explored during the Taralga wind farm appeal heard by the Land and Environment Court of NSW[7] (LEC 2006). The judgement handed down by the court noted that the SA Guidelines adopted a very cautious approach to accommodate the impacts of any and all noise effects caused by wind farms by using a lower 35dBA limit instead of 40dBA, as adopted by New Zealand (NZS6808:1998).

A further observation was that if the van den Berg Effect did occur, it would be at night when people were unlikely to be outside their dwellings and the façade effect (estimated at 10dBA) would reduce the transmission of noise to the interior of the house.

The commissioner concluded:

> *I am satisfied that the combination of the low probability of occurrence of the van den Berg Effect, the small number of houses which would be impacted and the infrequent occasions when it did occur (if it did occur), does not warrant the extensive monitoring proposed.*

It was noted in the judgement that a precautionary approach to the possible (albeit low probability) occurrence of the van den Berg Effect would be to consider building remediation to those dwellings proven to be impacted by the phenomenon.

Marshall Day Acoustics has not observed the effect investigated by van den Berg, nor is aware of the phenomenon being reported at any operational Australian wind farm.

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[6] G P van den Berg – *Effects of the wind profile at night on wind turbine sound*, Journal of Sound and Vibration, 2003.09.050

[7] Taralga Landscape Guardians Inc vs Minister for Planning and RES Southern Cross Pty Ltd(2007) NSWLEC59

Temperature Inversions

As previously discussed, the SA EPA Guideline has been adopted as the sole basis for this noise impact assessment. It is noted that the Guideline does not specify the inclusion of temperature inversion effects in the assessment. However, in light of the potential for inversions to increase noise levels generally, the phenomenon has been considered in the context of wind farm noise.

In a temperature inversion, the vertical motion in the atmosphere is suppressed due to mild atmospheric conditions (calm and cool conditions that are generally experienced in winter time). Temperature inversions reverse the normal atmospheric temperature gradient i.e. temperature increases with height, rather than decreases. The resulting colder layer of air (in contact with the ground) is trapped beneath a warmer layer of air and can cause sound waves propagating from a sound source below the inversion layer to be refracted downwards. It should be noted that this phenomenon has the most pronounced effect for ground based sources which are below the inversion layer.

The NSW INP has been referenced for guidance when considering temperature inversion effects. Table E3 from the INP indicates that for a moderate Class F inversion to occur, the wind speed required (2-3ms^{-1}) is below the cut-in wind speed for the assessed turbines (3-4ms^{-1}). It should be further noted that at cut-in wind speeds, the assessed turbines are emitting sound power levels between 10-12dB below the levels emitted at rated power.

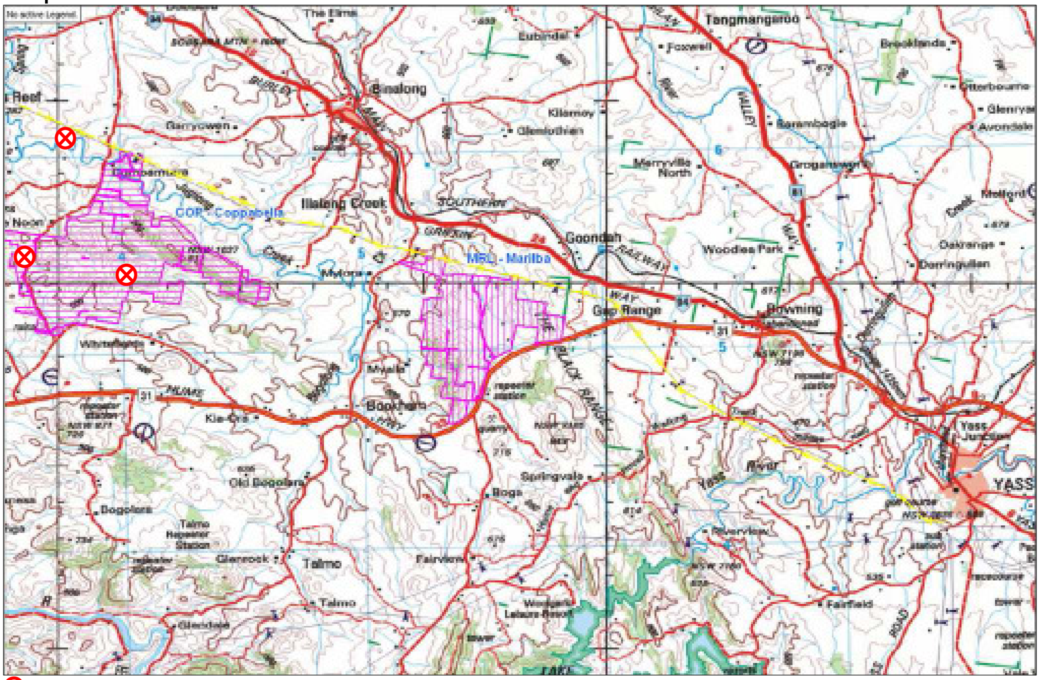
It is noted that ISO9613-2:1996 allows for downwind propagation of sound in all directions, which is analogous to moderate temperature inversion conditions.

Notwithstanding the above, if it is found that elevated wind farm noise levels are occurring as a result of temperature inversion effects then an adaptive management approach could be implemented.

6.9 Transformer Noise Levels

A total of three substations have been proposed for the Coppabella Hills site. Each substation is comprised of dual 100MVA transformers which will be used to step-up the incoming voltage from the wind farm to match the 132kV requirement of the transmission line. Figure 13 indicates the proposed locations.

Figure 13
Proposed location of substations



⊗ Denotes approximate substation locations. Image courtesy of EPURON

MDA has estimated the sound power level of each transformer as 102dBA. This level has been estimated from Figure AA1 from Australian Standard AS2374.6-1994 -*Power transformers – Determination of transformer and reactor sound levels.* It is noted that transformers of this nature may display strong tonality at 100Hz, therefore we have applied a +5dB correction to predicted results.

Background noise levels for the night period have been determined in accordance with the procedure detailed in Table 3.1 *Methods for determining background noise* from the *NSW Industrial Noise Policy*. Termed the rating background level (RBL), it is an overall single-figure background level representing the entire night-time period. The RBL is the level used for assessment purposes. Where it is found to be less than 30dBA, then it is set to 30dBA.

Noise levels have been predicted for each dual transformer installation to the nearest dwelling. Predicted noise levels, adjusted for tonality in accordance with Table 4.1 of the NSW Industrial Noise Policy, are detailed in Table 13.

Table 13
Predicted transformer noise levels (L_{eq}) in dBA re $2x10^{-5}$ Pa

Dwelling	Distance to Substation (km)	Predicted Transformer Level L_{eq}, dBA	Night-time RBL dBA	INP Intrusiveness Criteria (L_{90} + 5dB)	Comply?
C02	2.8	<10	30	35	Y
C04	3.6	<10	30	35	Y
C35	1.3	30	30	35	Y

The predicted levels summarised in Table 13 indicate that noise emission from the closest substation to receivers C02 and C04 will be substantially below existing background noise levels. It is noted that the predicted level for receiver C35 will be similar to the existing ambient noise level and therefore may be audible at times. However, it is further noted that the level at C35, an involved landowner, complies with the INP night-time intrusiveness criteria.

MDA recommends that transformer noise level predictions be reviewed once the actual transformer has been selected for the development.

7.0 SITE CONSTRUCTION NOISE IMPACT ASSESSMENT

7.1 Construction Site Noise Sources

Construction tasks associated with the project include the following:

- Access road construction
- Turbine tower foundation construction
- Trench digging to accommodate underground cabling
- Assembly of turbine tower, nacelle and rotor blades.

It should be noted that some rock blasting may be required during the early part of the construction phase. This is covered in Section 7.4.

Equipment required to complete the tasks outlined above include:

- Bulldozer, grader, excavator, dump trucks, roller, concrete trucks, front end loader, crane, blasting dynamite, pneumatic jack hammer etc
- Concrete batching plant (located approximately 850m from the Hume Highway)
- All wheel drive vehicles and flat-bed delivery trucks.

In order to predict noise levels associated with the construction phase, we have used noise level data from previous projects of a similar nature in addition to data obtained from our noise source database. See Appendix L for equipment sound power levels used within this assessment.

7.2 Construction Site Noise Limits

Background noise levels for the day period have been determined in accordance with the procedure detailed in Table 3.1 *Methods for determining background noise* from the *NSW Industrial Noise Policy*. Section 7.3 Table 14 summarises the daytime background noise level for each site.

As detailed in Section 3.3, it is considered appropriate to allow the construction noise level when measured over a 15-minute period ($L_{A10,\ 15min}$) to exceed the background level (L_{A90}) by up to 10dB.

It will be a requirement that all construction companies and construction sub-contractors comply with the noise limits outlined in Section 7.3 Table 14.

7.3 Construction Noise Assessment

Noise levels associated with the construction of each turbine installation have been predicted based on the sound power levels summarised in Appendix L.

We have predicted noise levels at each relevant receiver location based on a 15-minute assessment period, which is in line with the monitoring period outlined within the *NSW Industrial Noise Policy.*

Table 14 summarises the predicted noise levels at each relevant receiver location.

Table 14
Predicted construction noise level (L_{10}) at each relevant receiver location

			Predicted Noise Level in dBA				
Location	Background Noise Level	Limit L_{90}+ 10 dBA	Access Road Construction	Turbine Foundation Construction	Cable Trench Digging	WTG Assembly	Concrete Batching
C01*	41	51	43	43	39	31	-
C02*	35	45	17	17	15	<10	-
C03*	38	48	13	12	10	<10	-
C04*	36	46	17	17	13	<10	-
C05*	39	49	12	12	10	<10	-
C07*	33	43	29	29	28	21	-
C29	33	43	<10	<10	<10	<10	-
C30*	30	40	<10	<10	<10	<10	-
C35*	36	46	<10	<10	<10	<10	-
C38	31	41	11	11	<10	<10	-
C42	42	52	<10	<10	<10	<10	10

* Involved landowner

From the results summarised in Table 14, it can be seen that noise levels associated with the construction of the wind farm are expected to comply with noise limits set in accordance with the DECC *Environmental Noise Control Manual.*

We understand that provision has been made for onsite concrete batching. Should this scenario eventuate, MDA recommends that construction noise level predictions be reviewed. In addition, we recommend that predictions be reviewed once actual construction equipment has been selected for the development.

7.4 Construction Noise Control Measures

With regard to construction activities, reference should be made to *AS2436 – 1981: Guide to noise control on construction, maintenance and demolition sites*, which offers detailed guidance on the control of noise and vibration from demolition and construction activities. In particular, it is proposed that various practices be adopted during construction, including:

- Limiting the hours during which site activities are likely to create high levels of noise or vibration
- Establishing channels of communication between the contractor/developer, Local Authority and residents
- Appointing a site representative responsible for matters relating to noise and vibration
- Monitoring typical levels of noise and vibration during critical periods and at sensitive locations.

All site access roads should be kept even so as to mitigate the potential for vibration from trucks.

Furthermore, it is envisaged that a variety of practicable noise control measures will be employed. These may include:

- Selection of machinery with low inherent potential for generation of noise and/or vibration
- Erection of barriers as necessary around items such as generators or high duty compressors
- Siting of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints and the use of vibration isolated support structures where necessary.

7.5 Blasting Assessment

Should bedrock be encountered during foundation excavation, it is possible that blasting may be required. No details are available at this stage however we understand that the minimum distance between blasting and residences is likely to be approximately 700m. At this distance a blast with a maximum instantaneous charge (MIC) of 30kg is unlikely to exceed the limits detailed in Section 3.4 in relation to air blast overpressure and impulsive vibration.

7.6 Vibration Assessment

The following table summarises the typical vibration levels of construction plant items in addition to the applicable vibration limit criteria.

Table 15
Typical construction plant vibration levels

Equipment	Predicted Peak Particle Velocity (mm/s) at 10m*	Predicted Peak Particle Velocity (mm/s) at 700m	Building Conservation Limit (mm/s) **	Impulsive Vibration Limit (mm/s)
Piling	12-30	0.2-0.5	15-50	8.6-17
Loader – breaking kerbs	6-8	0.1-0.13	15-50	8.6-17
15 tonne roller	7-8	0.1-0.13	15-50	8.6-17
7 tonne compactor	5-7	0.08-0.1	15-50	8.6-17
Roller	5-6	0.08-0.09	15-50	8.6-17
Pavement breaker	4.5-6	0.07-0.09	15-50	8.6-17
Bulldozer	2.5-4	0.04-0.06	15-50	8.6-17
Backhoe	1	0.02	15-50	8.6-17
Jackhammer	0.5	0.01	15-50	8.6-17

*Source: *RTA Environmental Noise Management Manual* (2001) ** Frequency dependent

As can be seen from Table 15, the vibration levels for typical construction and demolition plant will comply with building conservation and human exposure to vibration limits at the nearest receiver located 700m away. It should be noted that these vibration levels are indicative only and would be subject to determining the vibration spectra of each source. However, based on the large separation distance, vibration levels are expected to comply.

With respect to vibration dose values from construction activity, MDA has measured a value of $0.22m/s^{1.75}$ at a distance of 10m over the course of a typical day period for general construction. Activities associated with this measurement include impact piling, excavation, crane operation, roller, truck deliveries, jackhammer, vehicle movements and backhoe activity. It should be noted that this is within the range of acceptable vibration dose values for intermittent vibration ($0.2\text{-}0.4m/s^{1.75}$) resulting in a low probability of adverse comment.

7.7 Construction Traffic

The following table summarises the predicted daily rates of traffic during construction of up to 86 turbines. These values have been sourced from the report titled *Traffic Impact Study: Proposed Yass Valley Wind Farm – Coppabella Hills, Marilba Hills & Carrolls Ridge Precints* (December 2008) prepared by Bega Duo Designs.

MARSHALL DAY Acoustics

Table 16
Estimated daily construction traffic volumes

Description	Trips per day
Construction and management staff*	54
Precinct setup*	10
Road construction	30
Foundation construction	102
Dust suppression	4
Substation & powerline construction	26
Internal cabling	6
Turbine erection	58

* Light vehicles only

It is understood that design of roads and intersections will be based around the Austroads single unit truck/bus (12.2m in length) however for substation and turbine erection oversize and over-mass B-doubles will be used.

7.8 Construction Traffic Noise Levels

MDA has estimated the current traffic noise levels on the surrounding road network. We have also predicted the increase to traffic noise levels based on the movement of vehicles associated with turbine construction for the Coppabella Hills site. See Appendix M for a site overview map of the surrounding road network.

Table 17 summarises the current and estimated traffic counts on the surrounding road network, including percentage of heavy vehicles.

Table 17
Current and estimated traffic volumes in both directions

	Current		Estimated	
Road	AADT	Heavy Vehicle %	AADT	Heavy Vehicle %
Hume Highway at Bowning	7223	38	7463	39
Burley Griffin Way	1661	16	1901	24
Bookham Illalong Road	70	<10*	310	64
Berramangra Settlement Rd	<50	<10*	170	42
Garry Owen Rd	<50	<10*	170	42
Paynes Road	<200	<10*	320	27
Cumbamurra, Coppabella, Coppa Creek, Whitefields Roads	<30	<10*	150	46

* Based on estimates provided by Bega Duo Designs

Within the defined heavy vehicle routes detailed in Appendix M, it is uncertain as to the precise route that each heavy vehicle will take to gain access to the site. Therefore, we have estimated the increase to traffic noise levels based on all heavy vehicles and staff cars using each major road, that is, the Hume Highway, Burley Griffin Way and Bookham Illalong Road. For smaller roads such as Garry Owen, we have assumed that up to 50% of traffic may use the same route.

MDA has estimated traffic noise levels using the Calculation of Road Traffic Noise (CRTN) algorithm. We have based our estimations on the available traffic count data and site heavy vehicle volumes as summarised in Tables 16 & 17.

Table 18 summarises the current and future estimated traffic noise levels at the nearest receivers.

Table 18
Estimated current and future traffic noise levels ($L_{eq\ 1\text{-}hour}$) dBA re $2x10^{-5}$ Pa

Receiver	Current traffic noise level	Future traffic noise level	Change in dB	ECRTN Criterion 7am-10pm ($L_{Aeq\ 1\text{-}hour}$)	Comply?
C01*	12	14	+2	55	Yes
C02*	18	28	+10	55	Yes
C03*	17	18	+1	55	Yes
C04*	18	19	+1	55	Yes
C05*	23	23	-	55	Yes
C07*	1	8	+7	55	Yes
C29	4	6	+2	55	Yes
C30*	2	7	+5	55	Yes
C35*	1	11	+10	55	Yes
C38	3	11	+8	55	Yes
C42	23	24	+1	55	Yes

* Involved landowner

The levels summarised in Table 18 indicate that at some receiver locations, the increase in traffic noise level is greater than 2dB however it should be noted that the estimated levels comply with ECRTN criterion.

8.0 COMPLIANCE MONITORING

MDA recommends that compliance monitoring be undertaken at regular intervals in order to ensure that the operation of the wind farm complies with noise limits. This monitoring is in addition to the compliance monitoring detailed in the Guideline and should cover all prevailing wind conditions and be conducted at positions representative of the nearest non-involved noise sensitive receivers.

MDA recommends that a monitoring strategy be developed prior to wind farm commissioning.

9.0 CONTINGENCY STRATEGY

Where it is determined that the operational wind farm exceeds noise limits set in the development approval conditions, the following noise mitigation measures may be considered:

- Using active noise control functions of turbines
- Acoustic treatment of receiver dwellings

In the first instance, all reasonable and feasible measures should be undertaken to reduce noise emission from the wind farm to the identified receiver location(s) where non-compliance occurs. The use of active noise control features of each turbine should be used as the primary control function to achieve compliance. If, after implementation of a control strategy, it is determined that excesses still occur then remedial measures should be considered for affected dwellings such as acoustically treating the windows with double glazing.

10.0 CONCLUSION

Noise emission from the Coppabella Hills site has been predicted to over 50 dwellings located in the Coppabella Hills precinct near Yass, NSW.

One turbine layout has been assessed, with the predicted noise levels at all receiver locations found to fully comply with noise criteria set in accordance with SA EPA Guidelines and World Health Organisation guidelines.

Worst case turbine noise impacts have been modelled and indicate a marginally compliant layout. MDA recommends mitigation measures or a layout redesign would be required.

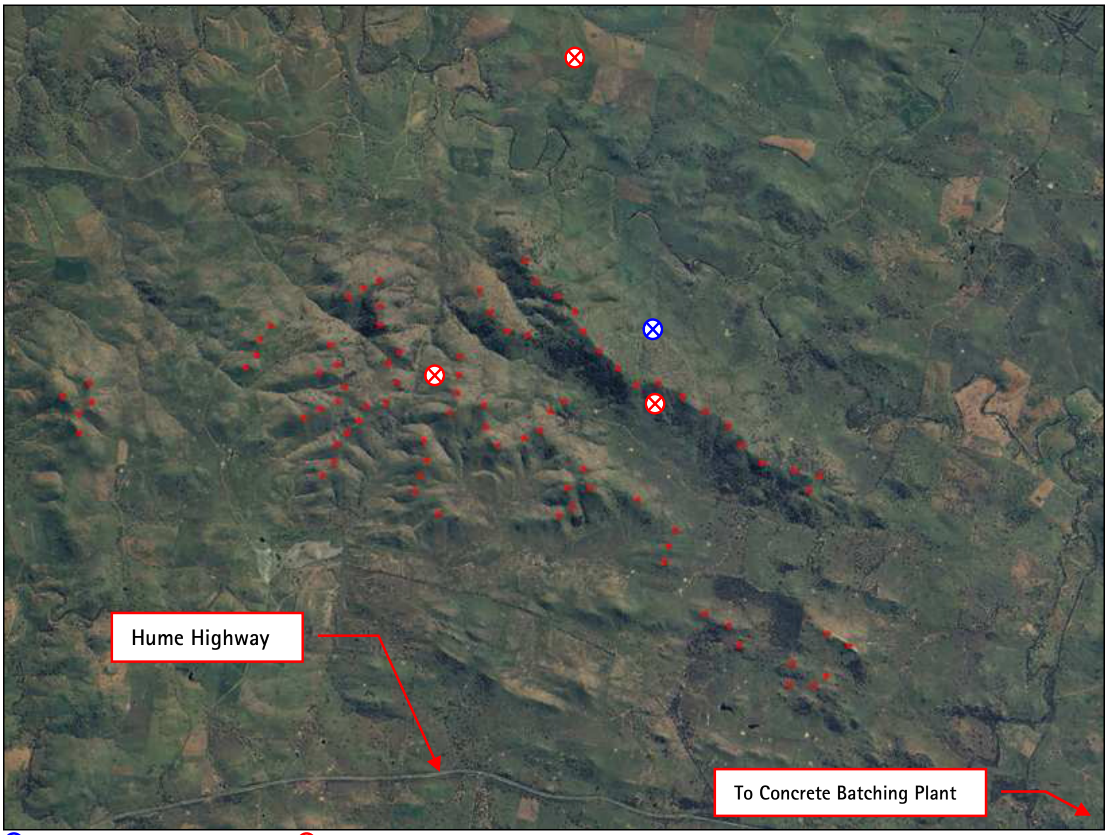
Construction noise and vibration has been assessed and has been found to comply with relevant guidelines. In addition, traffic noise associated with the construction of the wind farm will comply with ECRTN criteria.

Noise and vibration from blasting activities has been assessed and found to comply with ANZEC guidelines. A maximum instantaneous charge (MIC) of approximately 30kg is recommended.

APPENDIX A
ACOUSTIC TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
AGL	Above Ground Level.
dBA	Unit of overall noise level, in A-weighted decibels. The A-weighting approximates the average human response over the entire frequency range.
L_w	Sound power level is the measure of acoustic power radiated by a sound source.
L_{10}	Non-continuous noise levels are described in terms of the level exceeded for 10% of the measurement period (L_{10}). This is commonly referred to as the typical maximum level and is generally measured in dBA.
L_{90}	Background noise levels are described in terms of the level exceeded for 90% of the measurement period (L_{90}). This is commonly referred to as the typical minimum level and is generally measured in dBA.
L_{eq}	Continuous or semi-continuous noise levels are described in terms of the equivalent continuous sound level (L_{eq}). This is the constant sound level over a stated time period which is equivalent in total sound energy to the time-varying sound level measured over the same time period. This is commonly referred to as the average noise level and is generally measured in dBA.
L_{Aeq}	The "A" weighted equivalent continuous sound level.
Octave band	The noise level at a range of individual frequencies can be determined by dividing the frequency range (usually 63Hz to 4kHz) into 7 frequency bands called octave bands, with centre frequencies of 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz and 4kHz.

APPENDIX B
INDICATIVE SITE LAYOUT



⊗ Monitoring mast location ⊗ Proposed substation locations. Image courtesy of EPURON

Table B1

Location	Easting (m)	Northing (m)
Coppabella Mast	642097	6155410
Substations:		
COP A	642160	6154059
COP B	638431	6154628
COP C	640839	6159996

APPENDIX C
PROPOSED TURBINE LOCATIONS

Turbine	Easting	Northing	Turbine	Easting	Northing
Coppabella Hills					
COP_01	641141.84	6156569.77	COP_35	637734.71	6154728.57
COP_02	641328.80	6156230.56	COP_36	638034.40	6154843.44
COP_03	641680.85	6155979.76	COP_37	638166.21	6154479.94
COP_04	641967.31	6155722.98	COP_38	638037.58	6154243.37
COP_05	642099.72	6155401.79	COP_39	637761.77	6154114.28
COP_06	642361.55	6155082.24	COP_40	637485.25	6153973.88
COP_07	642670.90	6154792.69	COP_41	640060.51	6154985.99
COP_08	642980.24	6154509.78	COP_42	640049.35	6154673.89
COP_09	643736.42	6154321.18	COP_43	640014.63	6154384.33
COP_10	644120.75	6154082.09	COP_44	639888.78	6154038.25
COP_11	644496.90	6153842.12	COP_45	639464.04	6153587.56
COP_12	644712.42	6153513.92	COP_46	639516.45	6153264.17
COP_13	645051.25	6153228.09	COP_47	639400.40	6153013.34
COP_14	645590.39	6153096.38	COP_48	639307.90	6152751.07
COP_15	646003.79	6153010.05	COP_49	639700.29	6152377.48
COP_16	645833.87	6152763.14	COP_50	640458.28	6154179.56
COP_17	640381.72	6156076.65	COP_51	640492.14	6153813.19
COP_18	640567.82	6155715.39	COP_52	641783.30	6154241.99
COP_19	640848.12	6155409.05	COP_53	640693.44	6153510.48
COP_20	641174.72	6155345.02	COP_54	641113.93	6153632.62
COP_21	638470.99	6156113.57	COP_55	641397.68	6153769.25
COP_22	638226.99	6155966.60	COP_56	641555.84	6154081.20
COP_23	638733.49	6155811.44	COP_57	642115.30	6153126.21
COP_24	638730.79	6155516.30	COP_58	641848.55	6152808.95
COP_25	639063.96	6155074.42	COP_59	641695.34	6152353.95
COP_26	638886.10	6154872.44	COP_60	641924.31	6152502.84
COP_27	639022.16	6154555.90	COP_61	642214.01	6152812.85
COP_28	638845.28	6154224.79	COP_62	642992.32	6152607.21
COP_29	638504.44	6154174.13	COP_63	643511.38	6151853.65
COP_30	638392.83	6153925.33	COP_64	643442.43	6151582.49
COP_31	638212.64	6153718.37	COP_65	644492.82	6150530.25
COP_32	638011.95	6153523.93	COP_66	644669.92	6150208.74
COP_33	637973.18	6153233.88	COP_67	645540.03	6149909.53
COP_34	637788.04	6153025.88	COP_68	645506.95	6149548.71

Turbine	Easting	Northing	Turbine	Easting	Northing
COP_69	645912.85	6149537.68	Marilba Hills		
COP_70	646130.59	6150400.73	MRL 01	652382	6154635
COP_71	646492.43	6150200.28	MRL 02	652405	6154327
COP_72	633941.45	6154540.30	MRL 03	652379	6153987
COP_73	633979.79	6154224.49	MRL 04	652443	6153673
COP_74	633501.18	6154330.61	MRL 05	653312	6154603
COP_75	633765.44	6154029.05	MRL 06	653407	6154294
COP_76	633779.71	6153719.79	MRL 07	653429	6153999
COP_77	636938.39	6155490.12	MRL 08	653792	6154253
COP_78	636766.22	6155273.81	MRL 09	653997	6153919
COP_79	636525.48	6154799.73	MRL 10	654050	6153041
COP_80	636701.69	6155005.33	MRL 11	653921	6152861
COP_81	637922.76	6155172.35	MRL 12	653839	6152630
COP_82	638731.17	6156246.21	MRL 13	653842	6152346
COP_83	643622.85	6152121.02	MRL 14	653825	6152055
COP_84	643344.47	6154542.50	MRL 15	653835	6151755
COP_85	644107.15	6150725.34	MRL 16	650966	6152351
COP_86	646109.89	6149703.50	MRL 17	650970	6152060
Conroys Gap			MRL 18	651030	6151737
V01	657797	6146725	MRL 19	652880	6151508
V02	657750	6146448	MRL 20	653261	6150880
V03	658205	6146051	MRL 21	653187	6150629
V04	658089	6145805	MRL 22	653201	6150375
V05	658526	6145702	MRL 23	653360	6150101
V06	658125	6145510	MRL 24	653220	6149898
V07	658150	6145224	MRL 25	653181	6149617
V08	658079	6144965	MRL 26	653766	6150044
V09	657796	6143224	MRL 27	653709	6149738
V10	657776	6142954	MRL 28	654107	6150500
V11	657225	6142566	MRL 29	654155	6150037
V12	657148	6142128	MRL 30	654059	6149791
V13	658451	6140700	MRL 31	654126	6149499
V14	658500	6140304	MRL 32	654271	6149176
V15	658400	6140026	MRL 33	654138	6148935
			MRL 34	653938	6148738
			MRL 35	653374	6148775
			MRL 36	653868	6148187

Turbine	Easting	Northing	Turbine	Easting	Northing
MRL 38	653909	6147881			
MRL 39	653845	6147629			
MRL 43	657772	6152855			
MRL 44	657680	6152601			
MRL 45	657519	6152393			
MRL 46	656462	6152313			
MRL 47	656351	6152106			
MRL 48	656548	6151827			
MRL 49	657628	6151652			
MRL 50	657647	6151369			
MRL 51	657475	6151155			
MRL 52	657804	6150859			
MRL 53	658275	6150211			
MRL 54	658270	6149928			
MRL 55	658118	6149706			
MRL 56	658265	6149274			
MRL 57	658027	6149116			
MRL 58	658103	6148797			
MRL 59	658095	6148516			
MRL 60	658049	6148242			
MRL 61	658137	6147895			
MRL 62	658582	6147857			
MRL 63	658436	6147613			
MRL 64	658828	6147521			
MRL 65	659501	6147765			
MRL 66	659407	6147513			
MRL 67	658958	6147197			
MRL 68	659195	6146888			
MRL 69	658964	6146742			
MRL 70	658870	6146506			

APPENDIX D
RECEIVER LOCATIONS

Dwelling	Easting	Northing	Dwelling	Easting	Northing
Coppabella Hills					
C01	634541.63	6152997.75	C36	639230.73	6160371.38
C02	636009.92	6153231.28	C37	635457.4	6159657.3
C03	637353.94	6151270.03	C38	632047.61	6157837.01
C04	641149.01	6150591.98	C39	631508.27	6158554.66
C05	644196.28	6148246.55	C40	630864.01	6158341.98
C06	645147.61	6147452.9	C41	646822.55	6146838.75
C07	631743.84	6154014.29	C42	649145.52	6147576.19
C08	645783.29	6147090.28	C43	652333.09	6149876.1
C09	630848.62	6153136.44	C44	651694.45	6149353.94
C10	632778.32	6150353	C45	652108.76	6146650.6
C11	632017.69	6148189.78	C46	649022.6	6147320.81
C12	634113.98	6149264.93	C47	649751.62	6146653.97
C13	634466.26	6150956.32	C48	649388.38	6146698.94
C14	635386.67	6148215.38	C49	649010.21	6146839.33
C15	634548.03	6147184.98	C50	650453.02	6153370.45
C16	634452.17	6146886.87	C51	648216.03	6159649
C17	636266.59	6146244.22	C52	649583.93	6157887.98
C18	638491.13	6147769.73	Marilba Hills		
C19	639048.75	6148338.14	M01	658885	6154626
C20	639041.86	6147883.43	M02	658967	6154884
C21	640134.02	6147862.72	M03	658590	6154878
C22	641631.69	6147822.54	M04	658557	6154944
C23	643338.44	6147617.67	M05	661995	6152897
C24	650322.43	6151487.97	M06	661362	6152923
C25	650904.9	6151073.18	M07	662307	6152429
C26	650347.2	6153680.92	M08	660245	6151580
C27	651322.47	6154525.59	M09	650218	6146568
C28	648493.38	6156982.64	M10	650154	6146278
C29	645491.2	6156830.33	M11	650177	6146370
C30	643944.43	6159581.14	M12	650051	6146376
C31	645555.86	6160564.77	M13	650548	6145967
C32	644891.64	6161453.05	M14	650095	6146256
C33	644012.22	6160671.31	M15	650134	6146219
C34	643485.25	6160766.39	M16	650156	6146155
C35	639639.84	6159615.3	M17	650120	6146322

Dwelling	Easting	Northing	Dwelling	Easting	Northing
M18	652333	6149876			
M20	658743	6154508			
M21	651854	6155574			
M22	654105	6156790			
M23	651792	6156534			
Conroys Gap					
G01	656955	6140691	G33	655949	6150369
G02	655830	6142160	G34	660167	6151635
G02a	656066	6141866	G35	662856	6150456
G03	654913	6142552	G36	662352	6150964
G04	658616	6142092	G37	662944	6151152
G04a	659368	6143377	G38	662678	6148142
G04b	658267	6142549	G39	663628	6149297
G05	660294	6142075	G41	662272	6147338
G06	661339	6142115	G42	658195	6138491
G07	659736	6143497	G43	656469	6137652
G08	659548	6143435	G44	655423	6136237
G09	660108	6143295	G45	655567	6135982
G10	657463	6144500	G46	659015	6137292
G11	661209	6147630	G47	658669	6137052
G12	660201	6149381	G48	658809	6137051
G13	659983	6150849	G49	658608	6136920
G14	659548	6150659	G50	658702	6136982
G15	655374	6149637			
G16	655027	6147494			
G17	659823	6143216			
G18	662442	6150000			
G19	662932	6149397			
G20	661622	6145660			
G22	663768	6144604			
G23	661185	6144412			
G24	660294	6144222			
G26	654589	6142433			
G27	654358	6139578			
G29	654689	6144675			
G30	652109	6146651			
G31	651694	6149354			
G32	655766	6149602			

APPENDIX E
WIND TURBINE GENERATOR SOUND POWER DATA

Figure E1

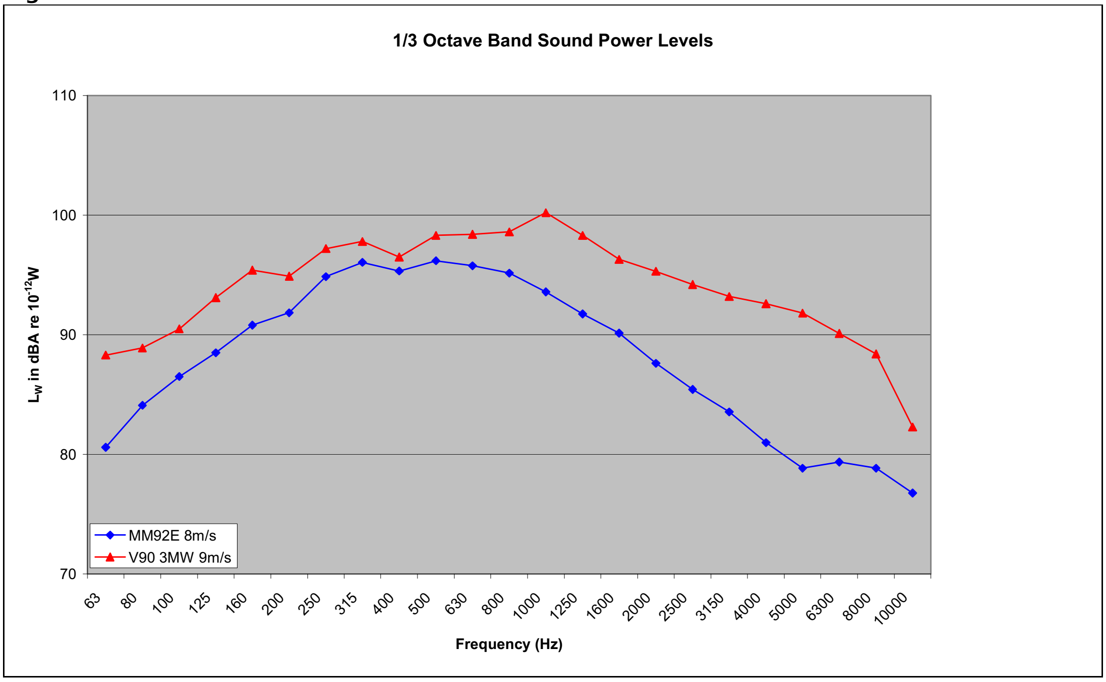


Table E1
Turbine sound power (L_W) in dBA re 10^{-12} W as a function of wind speed

	V_{10} ms^{-1}										
Turbine Type	3	4	5	6	7	8	9	10	11	12	13-15
REpower MM92E	95*	99*	101.6	103.6	104.4	105	105	105	105	105	
Vestas V90 3MW		97*	101.5	105.2	107.6	109	109.4	108.7	109.4	109.4	109.4

* Value extrapolated based on 2nd order polynomial.

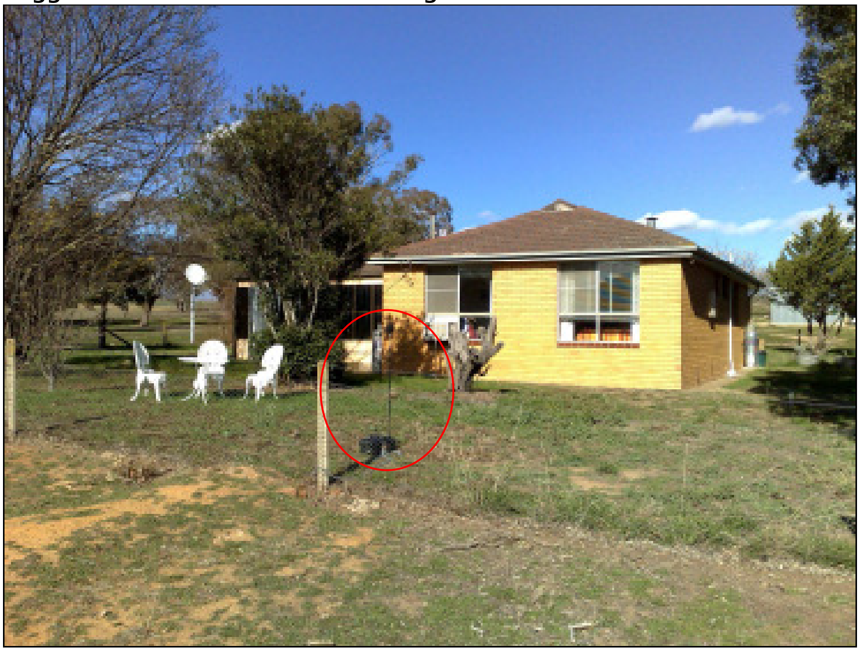
It should be noted that test data was not available for the V90 3MW from 11ms^{-1} up to rated power of 15.5ms^{-1}. We have therefore used the maximum sound power level of 109.4dBA at 9ms^{-1} for this wind speed bin range.

APPENDIX F
RELEVANT RECEIVER SITE PHOTOS

Logger location relative to dwelling C01

Logger location relative to dwelling C02

Logger location relative to dwelling C03



Logger location relative to dwelling C04

Logger location relative to dwelling C05

Logger location relative to dwelling C07

Logger location relative to dwelling C29

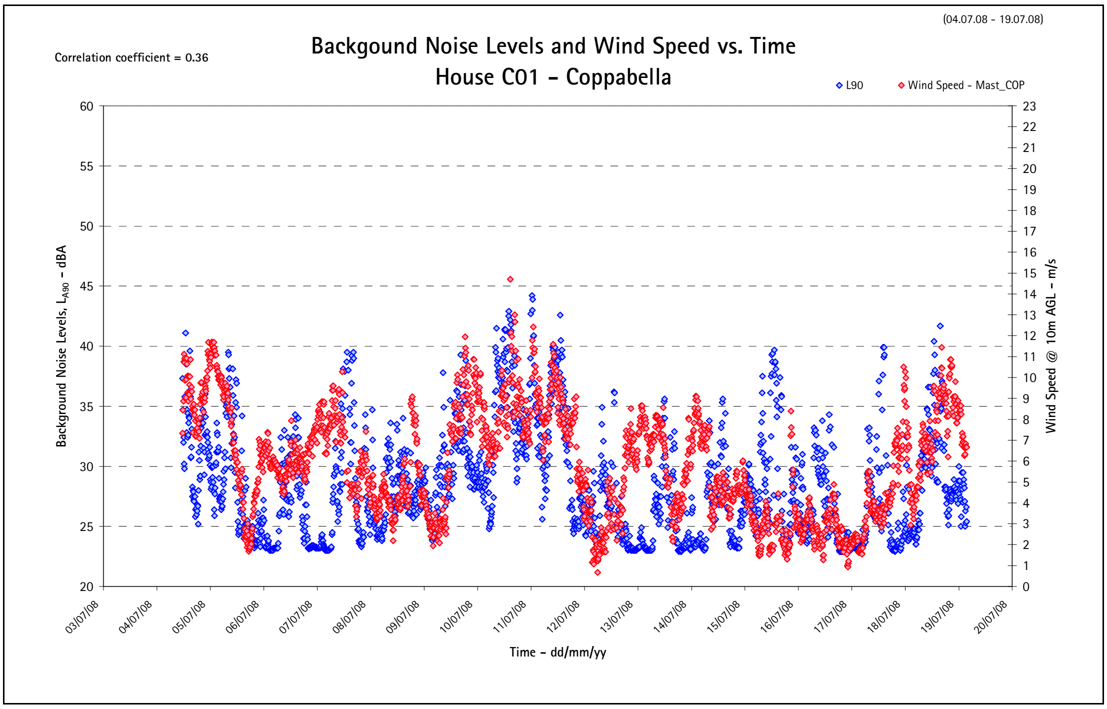
Logger location relative to dwelling C30

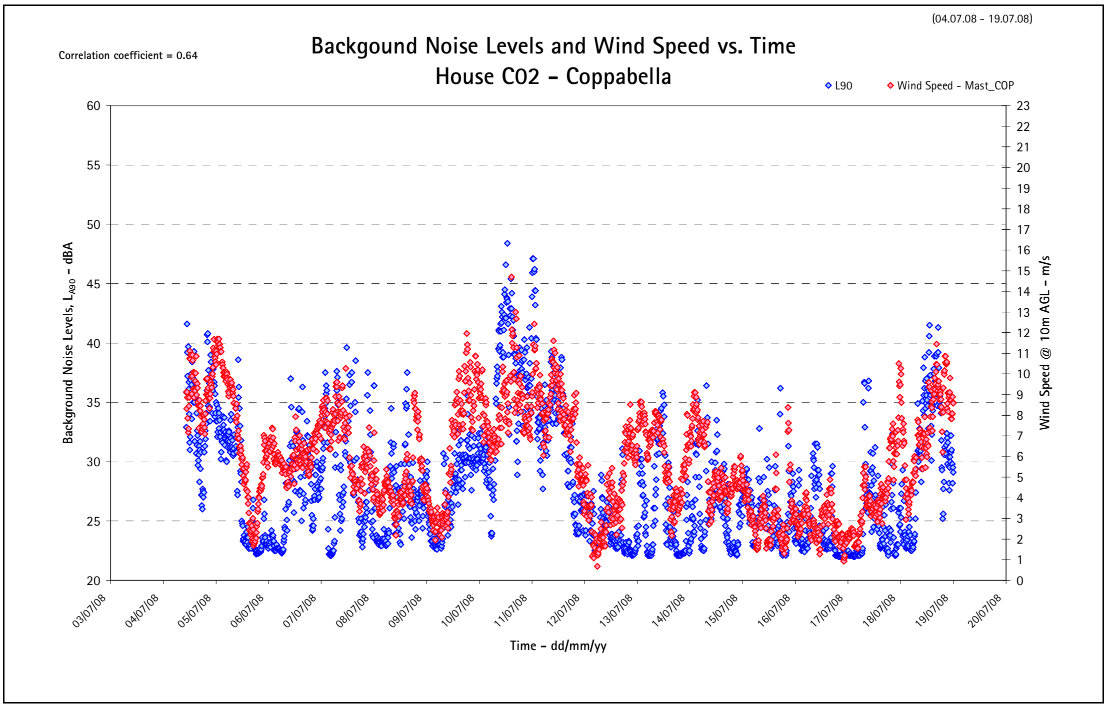
Logger location relative to dwelling C35

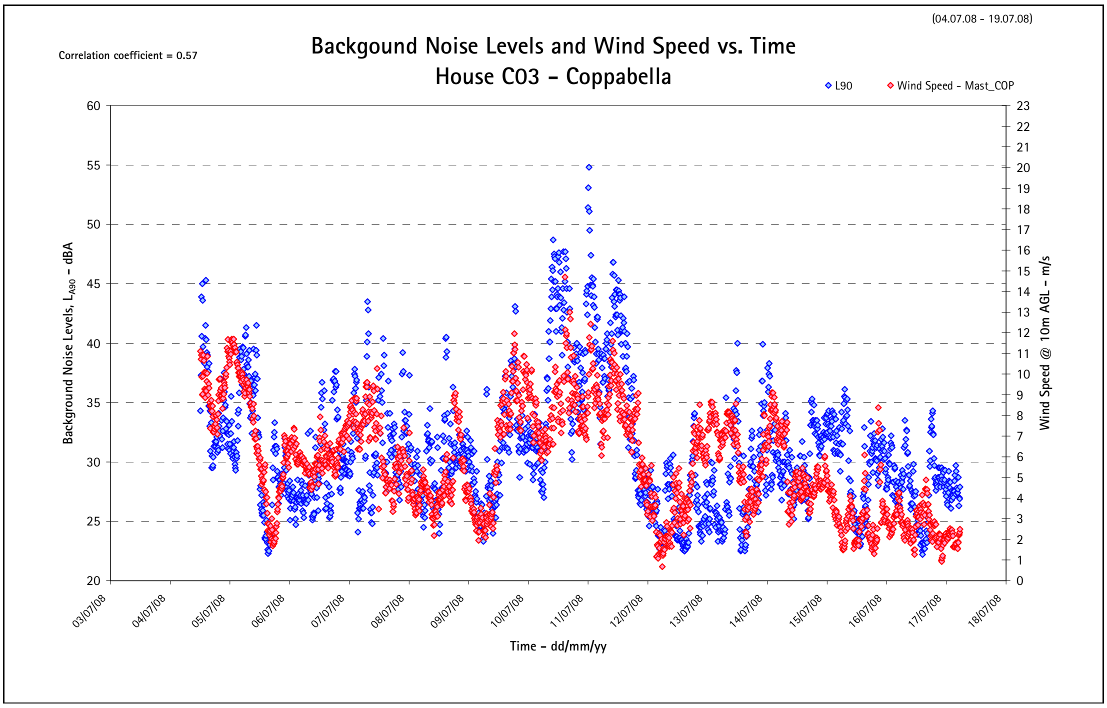
Logger location relative to dwelling C38

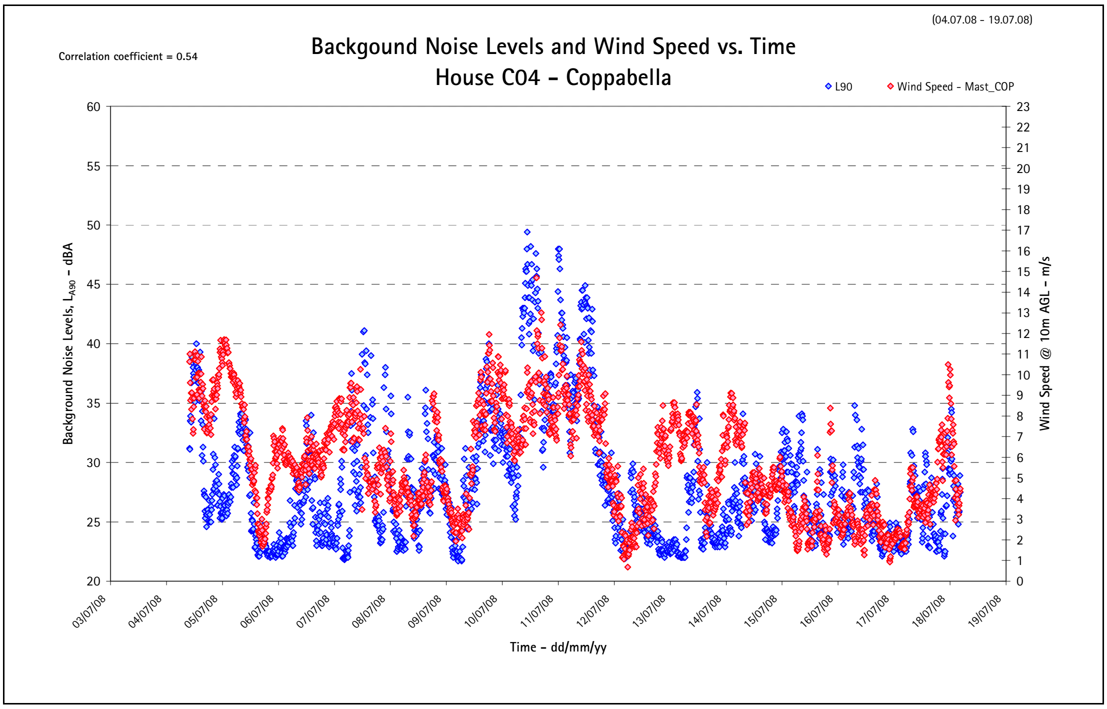
Logger location relative to dwelling C42

APPENDIX G
RELEVANT RECEIVER MEASURED L_{90} & MAST V_{10} WIND SPEED vs. TIME






(04.07.08 - 19.07.08)
Correlation coefficient = 0.57
Backgound Noise Levels and Wind Speed vs. Time
House C03 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy
03/07/08
04/07/08
05/07/08
06/07/08
07/07/08
08/07/08
09/07/08
10/07/08
11/07/08
12/07/08
13/07/08
14/07/08
15/07/08
16/07/08
17/07/08
18/07/08


(04.07.08 - 19.07.08)
Correlation coefficient = 0.54
Backgound Noise Levels and Wind Speed vs. Time
House C04 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy
03/07/08
04/07/08
05/07/08
06/07/08
07/07/08
08/07/08
09/07/08
10/07/08
11/07/08
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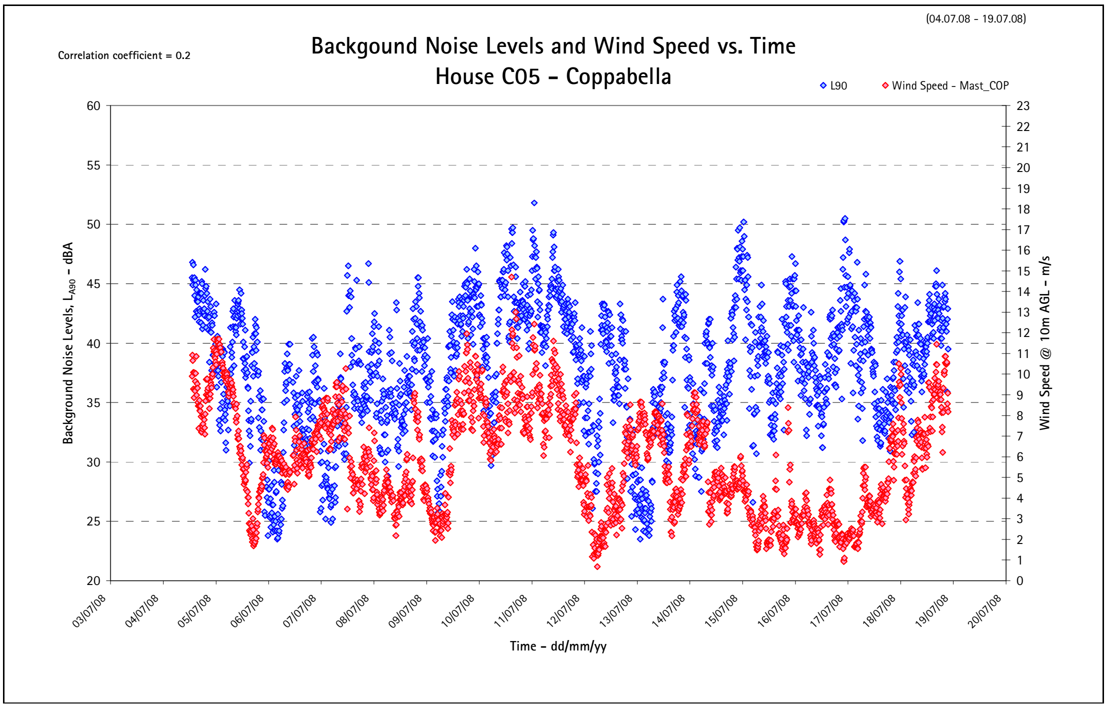
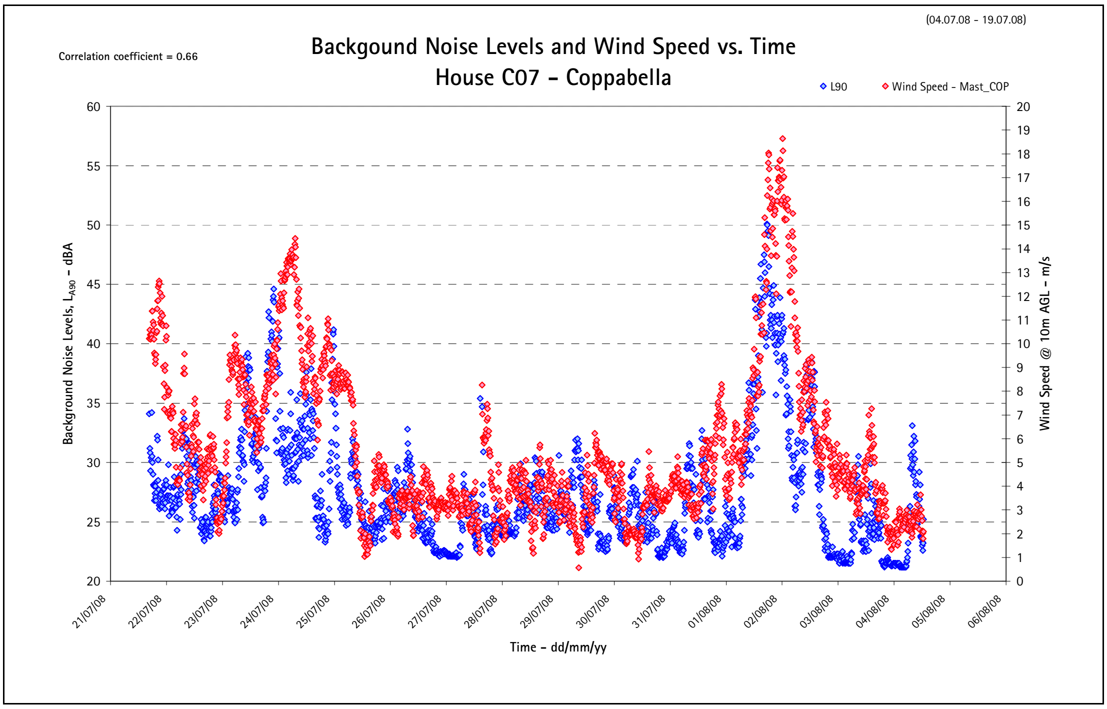
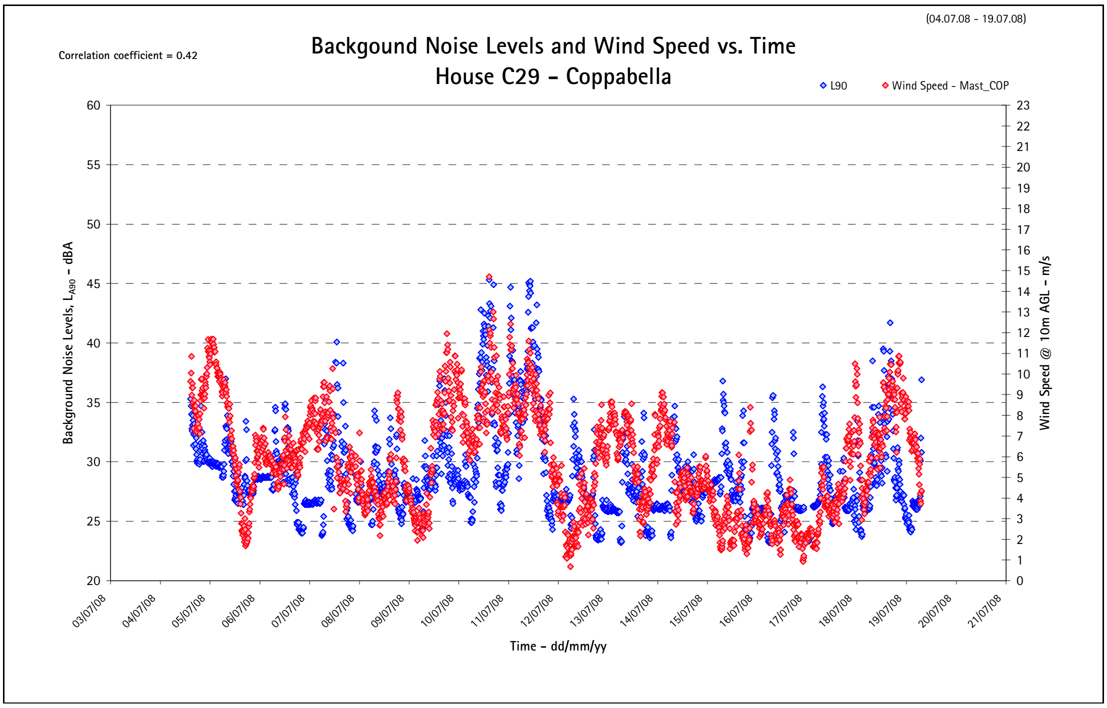
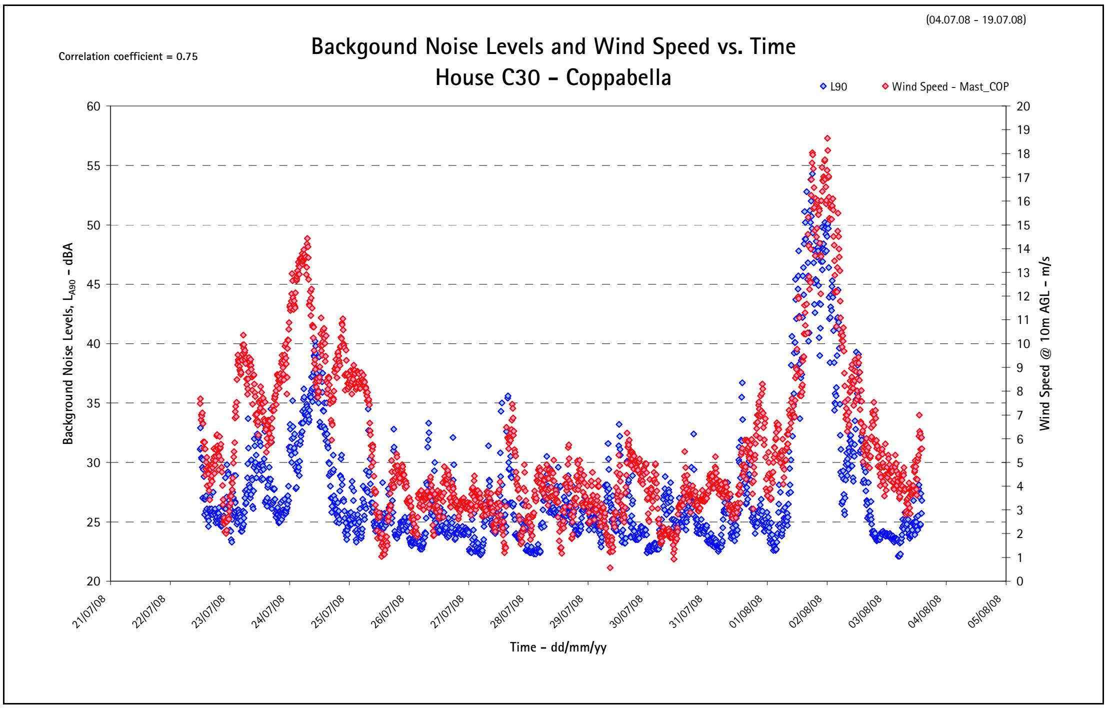
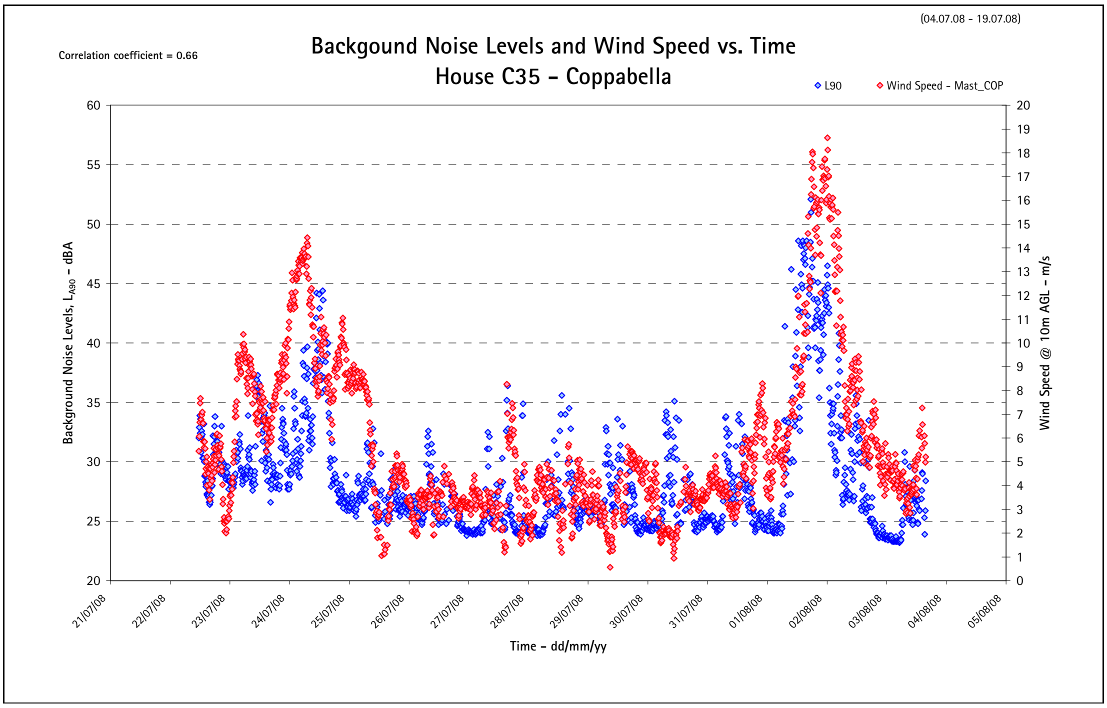
17/07/08
18/07/08
19/07/08

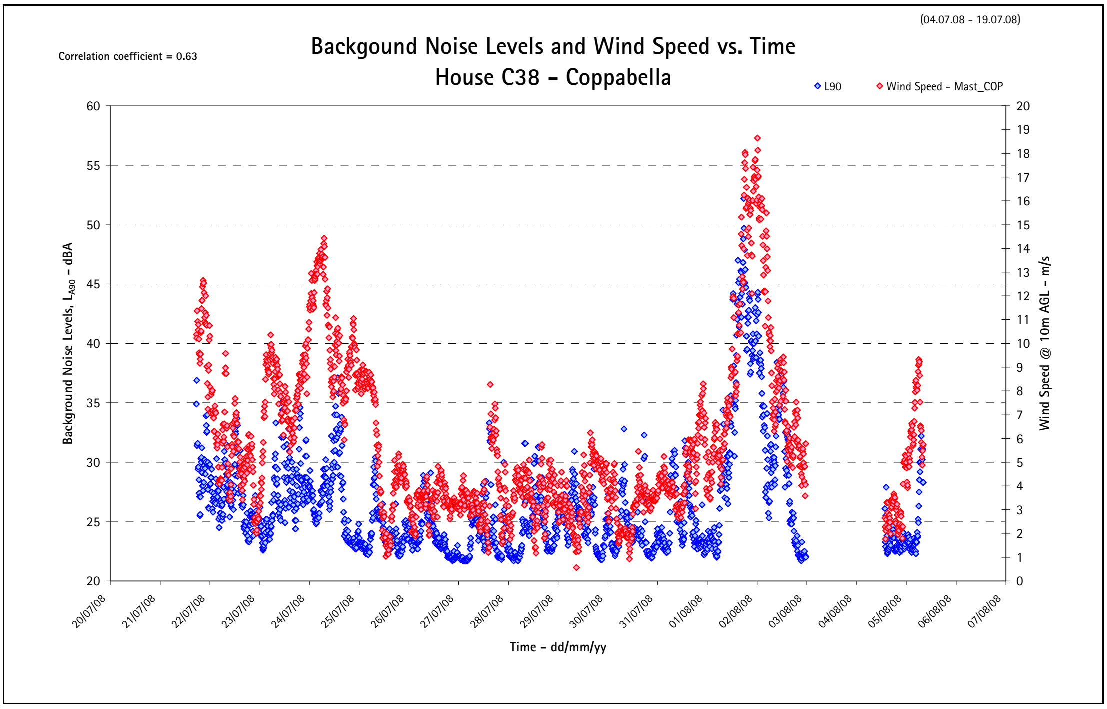

(04.07.08 - 19.07.08)
Correlation coefficient = 0.2
Backgound Noise Levels and Wind Speed vs. Time
House C05 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy

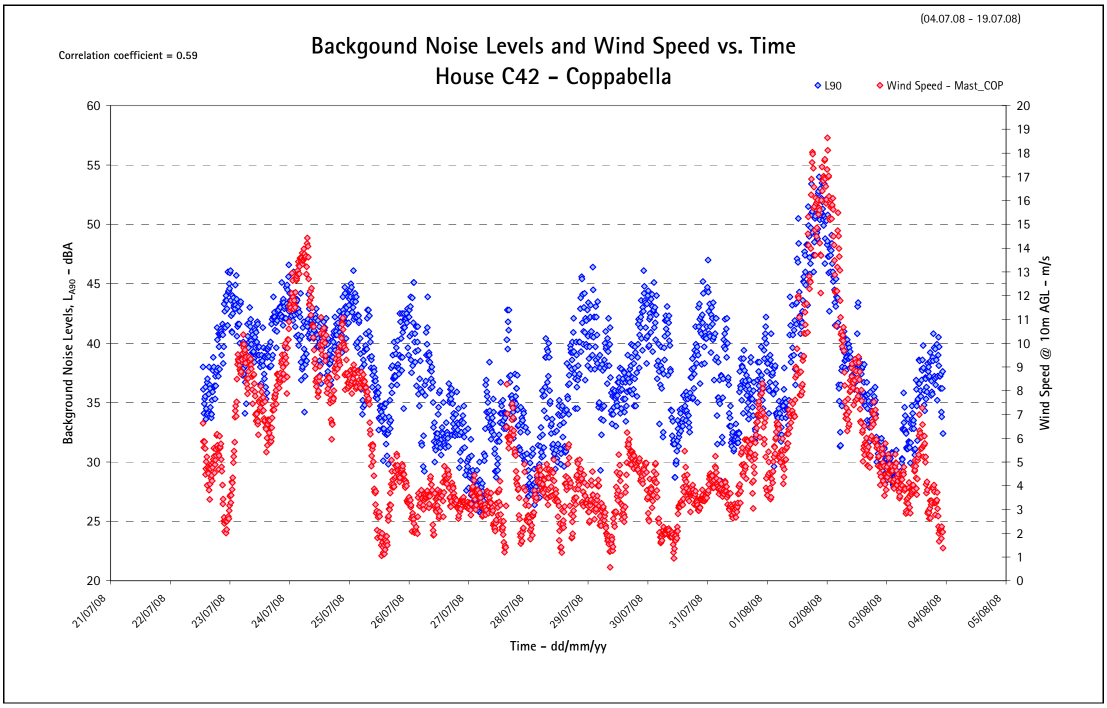

(04.07.08 - 19.07.08)
Correlation coefficient = 0.66
Backgound Noise Levels and Wind Speed vs. Time
House C07 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(04.07.08 - 19.07.08)
Correlation coefficient = 0.42
Backgound Noise Levels and Wind Speed vs. Time
House C29 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(04.07.08 - 19.07.08)
Correlation coefficient = 0.75
Backgound Noise Levels and Wind Speed vs. Time
House C30 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(04.07.08 - 19.07.08)
Correlation coefficient = 0.66
Backgound Noise Levels and Wind Speed vs. Time
House C35 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(04.07.08 - 19.07.08)
Correlation coefficient = 0.63
Backgound Noise Levels and Wind Speed vs. Time
House C38 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(04.07.08 - 19.07.08)
Correlation coefficient = 0.59
Backgound Noise Levels and Wind Speed vs. Time
House C42 - Coppabella
L90
Wind Speed - Mast_COP
Background Noise Levels, LA90 - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy
21/07/08
22/07/08
23/07/08
24/07/08
25/07/08
26/07/08
27/07/08
28/07/08
29/07/08
30/07/08
31/07/08
01/08/08
02/08/08
03/08/08
04/08/08
05/08/08

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APPENDIX H
ISO 9613-2:1996 ATTENUATION FACTORS

The ISO9613-2: 1996 propagation model predicts sound pressure level at a field point using equation [1]:

$$L_p = L_{Wpoint} + D - A_{div} - A_{atm} - A_{ground} - A_{screen} - A_{misc} \qquad [1]$$

where:

L_p is the sound pressure level at a field point, L_{wpoint} is the sound power level of a point source, D is the directivity index of the source in dB, A_n are the attenuation allowances for geometrical divergence, atmospheric absorption, ground hardness, screening and miscellaneous effects.

L_{Wpoint} – Point Source Sound Power Level

The sound power level data for each assessed turbine can be found in Appendix E. The sound power data provided by EPURON has been calculated in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* and is expressed in terms of A-weighted decibels (dBA), for each integer multiple of the wind speed range of interest in addition to linear 1/3 octave values from 50Hz to 10kHz.

It should be noted that for the wind speed bins where manufacturer-supplied data were not provided (3-4ms^{-1}), we have extrapolated sound power levels based on a 2nd order polynomial.

D – Directivity Factor

The directivity factor (D) allows for an adjustment to be made to the radiated sound power level where the source is understood to radiate higher levels of sound in the direction of interest. It is a convention of the IEC-61400-11 standard that sound power levels are derived from downwind sound pressure level measurements and as such, implies worst-case sound propagation conditions in all directions. As such, no directivity correction has been used in our model.

A_{div} – Unidirectional Spherical Divergence

A WTG is considered to be a point sound source radiating sound energy in a free-field. As such, sound energy propagating distance (r) will be attenuated according to equation [2]:

$$A_{div} = 20\log(r) + 11dB \qquad [2]$$

A_{atm} – Atmospheric Absorption

Sound propagation through the atmosphere is considered to be a diabatic process in that as the wave front propagates outwards from the source, energy is converted to heat. The attenuation provided by this process is largely dependant on the relative humidity and temperature of the air through which the sound propagates.

Atmospheric attenuation is also frequency dependent, with attenuation increasing as a function of frequency. Table H1 summarises the octave band attenuation values used in our predictions.

Table H1
Octave band atmospheric attenuation coefficients

	Octave band mid frequency (Hz)							
Description	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Atmospheric attenuation (dB/km)	0.1	0.4	1.0	1.9	3.7	9.7	33.1	118.4

The attenuation coefficients summarised above have been calculated based on 70% humidity, 10 degrees Celsius temperature and an atmospheric pressure of 101.325kPa.

A_{ground} – Ground Effect

The ISO9613-2:1996 standard describes three distinct ground surface types, namely hard, porous and mixed ground. The ground effect parameter input into the model uses a hard ground assumption, that is, 100% acoustically hard ground at the source and receiver positions.

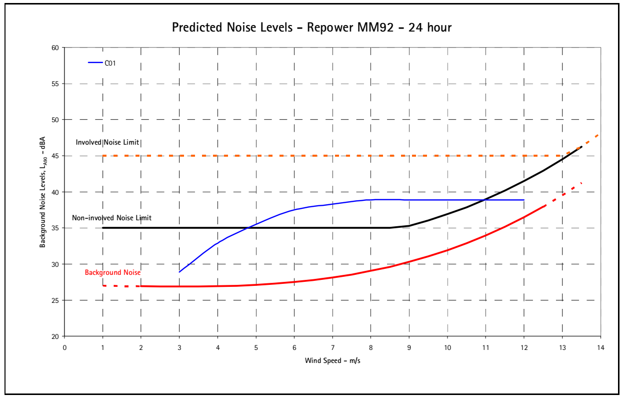
A_{screen} – Acoustic Screening

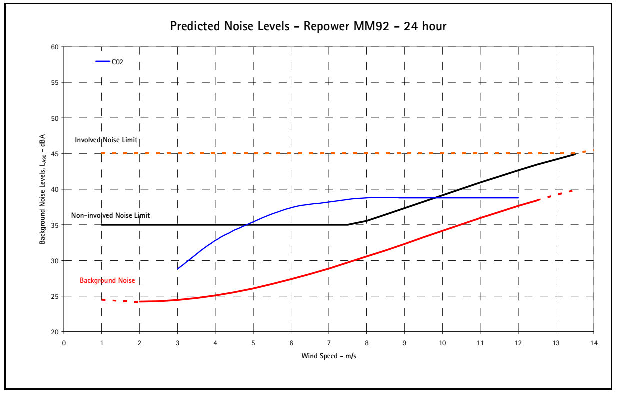
No barrier attenuation assumptions have been used within this model. It should be noted that attenuation due to topographic screening is inherently calculated by SoundPLAN from the digital terrain file.

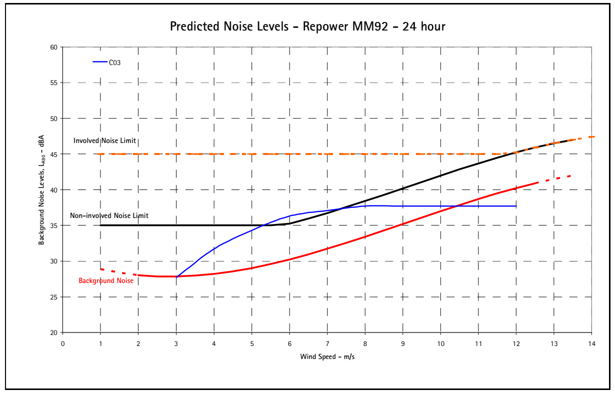
A_{misc} – Miscellaneous Effects

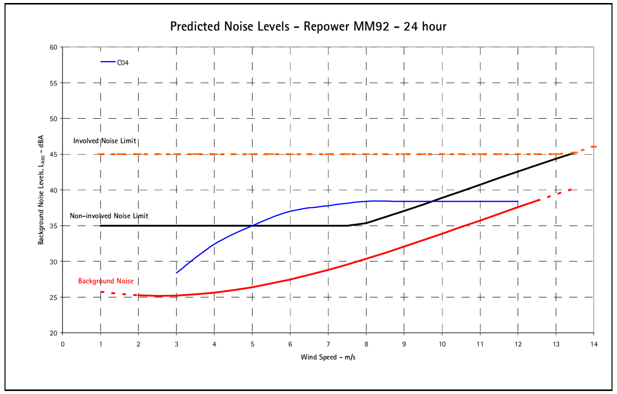
No miscellaneous attenuation affects have been used within this model.

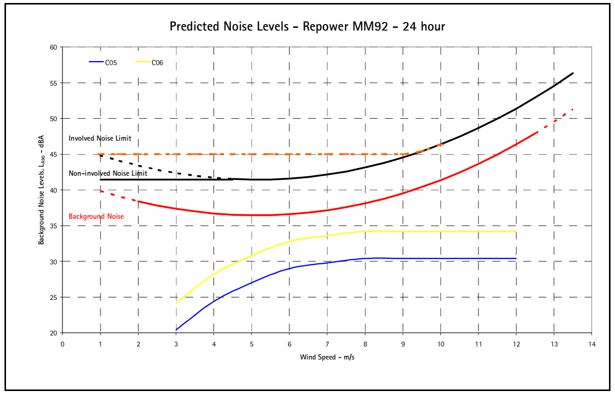
APPENDIX I
RELEVANT RECEIVER PREDICTED NOISE LEVELS

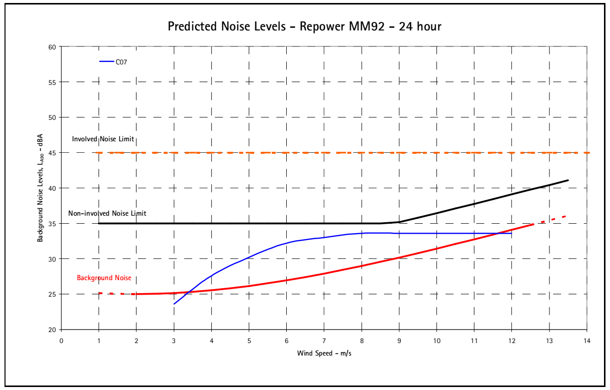


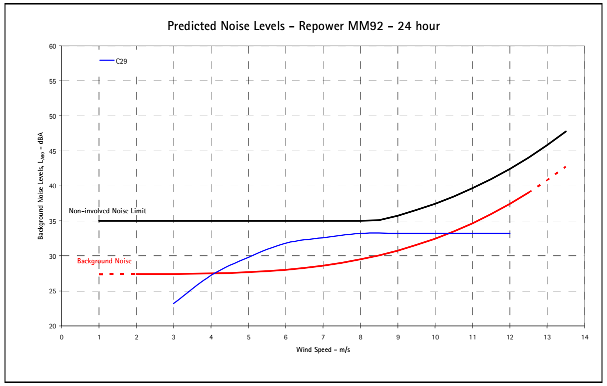


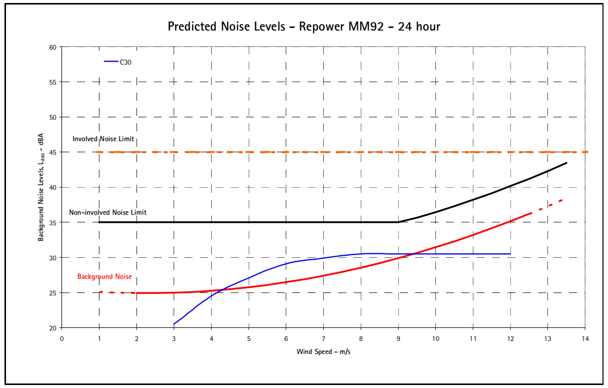


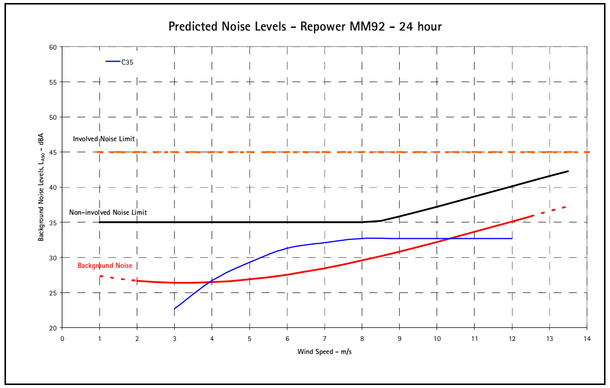


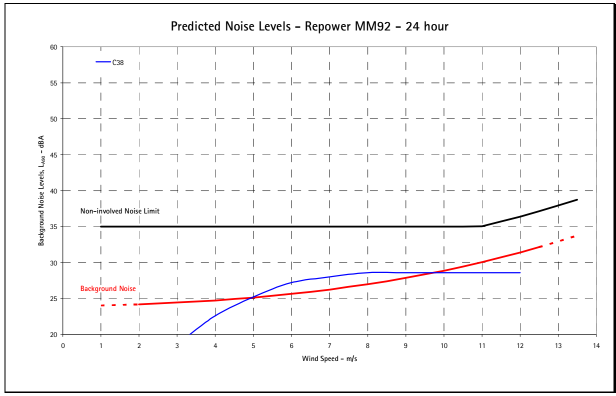


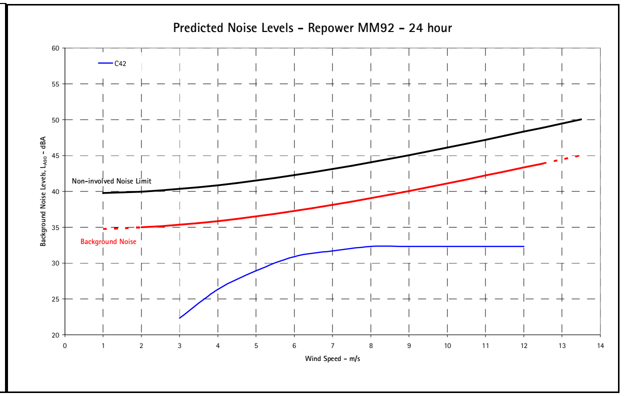


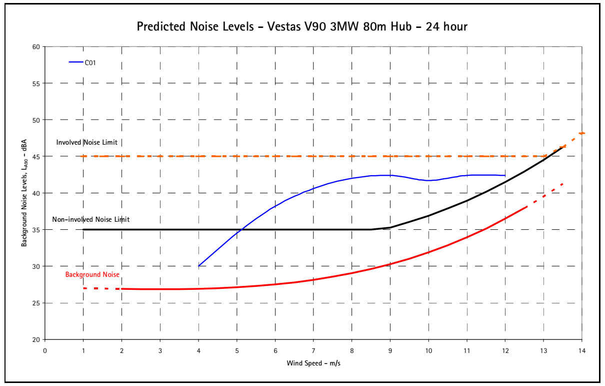

Predicted Noise Levels - Repower MM92 - 24 hour
C29
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

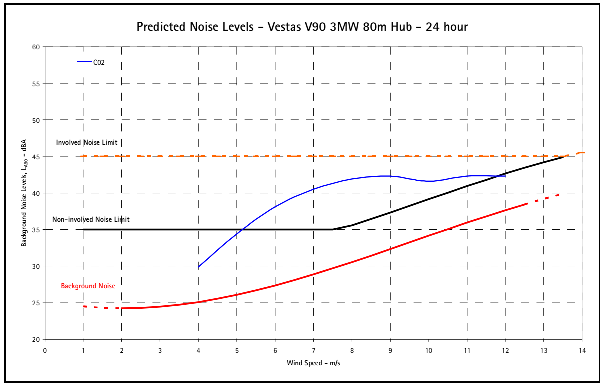

Predicted Noise Levels - Repower MM92 - 24 hour
C30
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

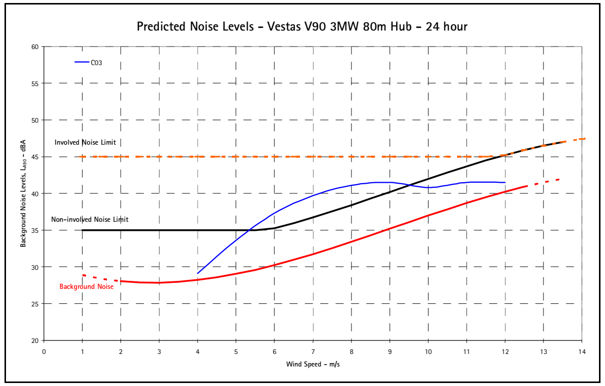

Predicted Noise Levels - Repower MM92 - 24 hour
C35
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

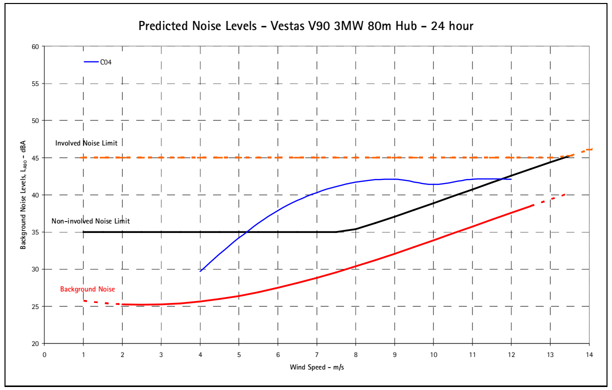

Predicted Noise Levels - Repower MM92 - 24 hour
C38
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

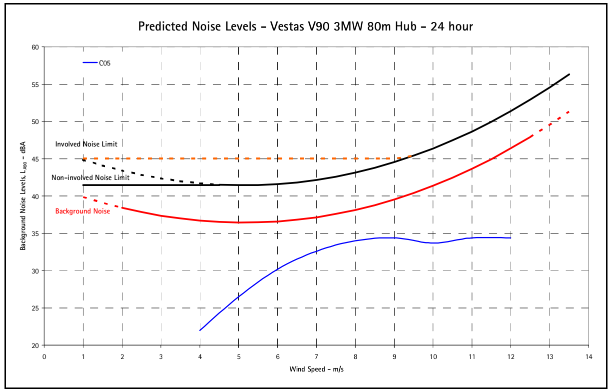

Predicted Noise Levels - Repower MM92 - 24 hour
C42
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

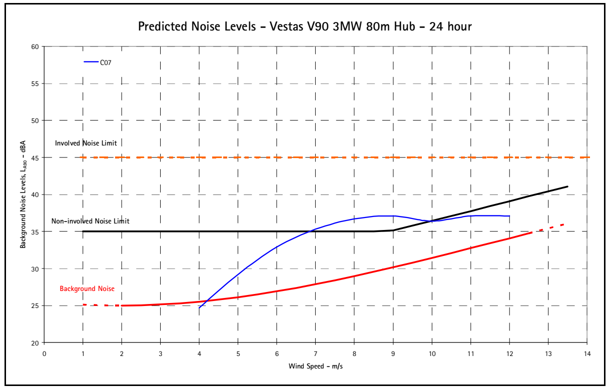

Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C01
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

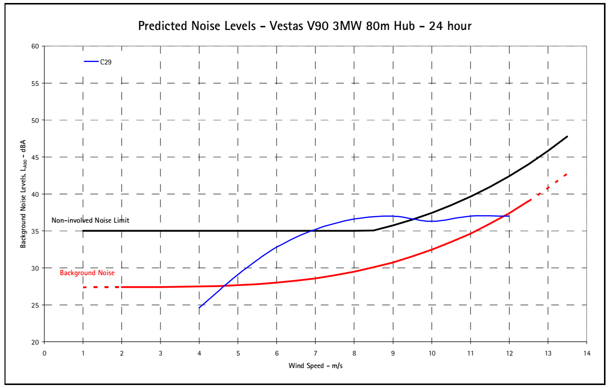

Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C02
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C03
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

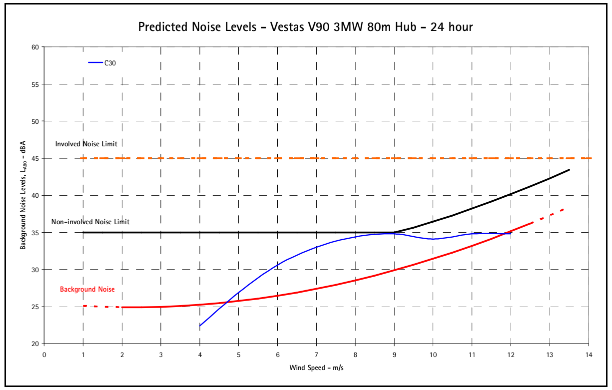

Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C04
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C05
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s

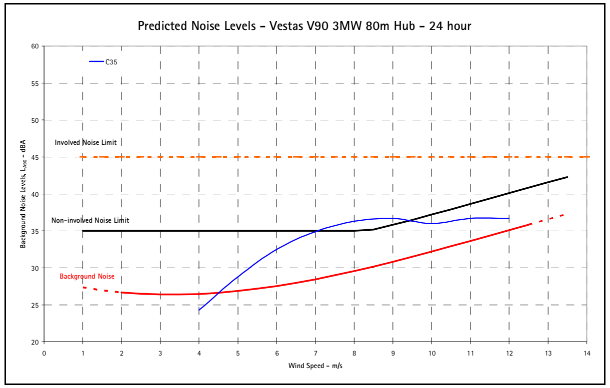

Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C07
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, LA90 - dBA
Wind Speed - m/s



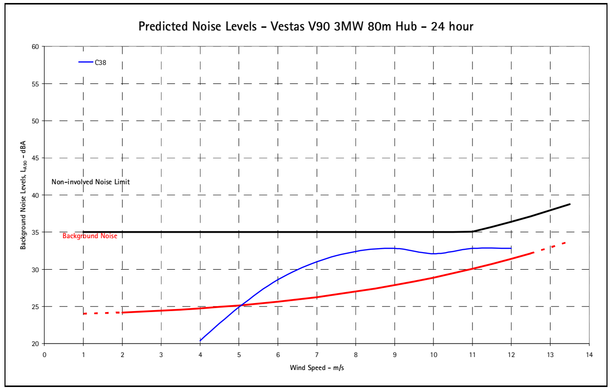
Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C29
Non-involved Noise Limit
Background Noise
Wind Speed - m/s



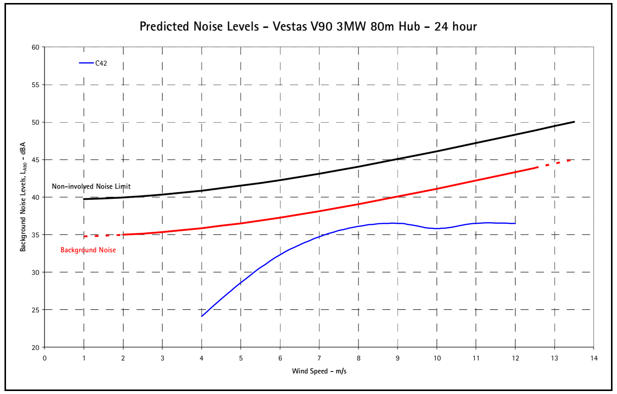
Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C30
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Wind Speed - m/s



Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C35
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Wind Speed - m/s



Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C38
Non-involved Noise Limit
Background Noise
Wind Speed - m/s



Predicted Noise Levels - Vestas V90 3MW 80m Hub - 24 hour
C42
Non-involved Noise Limit
Background Noise
Wind Speed - m/s

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APPENDIX J
RECEIVER PREDICTED NOISE LEVELS RELATIVE TO COMPLIANCE LIMITS

Receiver	Associated Compliance	Prediction @ 9m/s	Difference Between Compliance Limits and Predicted Noise Levels - MM92 80m Hub									
			3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
C01*	C01	38.9	-16.1	-12.1	-9.5	-7.5	-6.7	-6.1	-6.1	-6.1	-6.1	-6.1
C02*	C02	38.8	-16.2	-12.2	-9.6	-7.6	-6.8	-6.2	-6.2	-6.2	-6.2	-6.2
C03*	C03	37.7	-17.3	-13.3	-10.7	-8.7	-7.9	-7.3	-7.3	-7.3	-7.3	-7.3
C04*	C04	38.4	-16.6	-12.6	-10.0	-8.0	-7.2	-6.6	-6.6	-6.6	-6.6	-6.6
C05*	C05	30.4	-24.6	-20.6	-18.0	-16.0	-15.2	-14.6	-14.6	-16.0	-18.3	-21.0
C06	C05	34.2	-17.3	-13.3	-10.6	-8.8	-8.6	-8.9	-10.3	-12.2	-14.5	-17.2
C07*	C07	33.6	-21.4	-17.4	-14.8	-12.8	-12.0	-11.4	-11.4	-11.4	-11.4	-11.4
C08	C05	32.6	-18.9	-14.9	-12.2	-10.4	-10.2	-10.5	-11.9	-13.8	-16.1	-18.8
C09	C07	29.1	-15.9	-11.9	-9.3	-7.3	-6.5	-5.9	-6.1	-7.3	-8.6	-10.0
C10	C01	27.8	-17.2	-13.2	-10.6	-8.6	-7.8	-7.2	-7.5	-9.1	-11.2	-13.7
C11	C05	20.7	-30.8	-26.8	-24.1	-22.3	-22.1	-22.4	-23.8	-25.7	-28.0	-30.7
C12	C01	28.7	-16.3	-12.3	-9.7	-7.7	-6.9	-6.3	-6.6	-8.2	-10.3	-12.8
C13	C01	33.2	-11.8	-7.8	-5.2	-3.2	-2.4	-1.8	-2.1	-3.7	-5.8	-8.3
C14	C05	27.3	-24.2	-20.2	-17.5	-15.7	-15.5	-15.8	-17.2	-19.1	-21.4	-24.1
C15	C05	8.8	-42.7	-38.7	-36.0	-34.2	-34.0	-34.3	-35.7	-37.6	-39.9	-42.6
C16	C05	15.2	-36.3	-32.3	-29.6	-27.8	-27.6	-27.9	-29.3	-31.2	-33.5	-36.2
C17	C05	2.4	-49.1	-45.1	-42.4	-40.6	-40.4	-40.7	-42.1	-44.0	-46.3	-49.0
C18	C05	29.4	-22.1	-18.1	-15.4	-13.6	-13.4	-13.7	-15.1	-17.0	-19.3	-22.0
C19	C05	30.7	-20.8	-16.8	-14.1	-12.3	-12.1	-12.4	-13.8	-15.7	-18.0	-20.7
C20	C05	29.8	-21.7	-17.7	-15.0	-13.2	-13.0	-13.3	-14.7	-16.6	-18.9	-21.6
C21	C05	29.9	-21.6	-17.6	-14.9	-13.1	-12.9	-13.2	-14.6	-16.5	-18.8	-21.5
C22	C05	27.9	-23.6	-19.6	-16.9	-15.1	-14.9	-15.2	-16.6	-18.5	-20.8	-23.5
C23	C05	28.3	-23.2	-19.2	-16.5	-14.7	-14.5	-14.8	-16.2	-18.1	-20.4	-23.1
C28	C29	29.9	-15.1	-11.1	-8.5	-6.5	-5.7	-5.1	-5.9	-7.6	-9.7	-12.5
C29	C29	33.2	-11.8	-7.8	-5.2	-3.2	-2.4	-1.8	-2.6	-4.3	-6.4	-9.2
C30*	C30	30.5	-24.5	-20.5	-17.9	-15.9	-15.1	-14.5	-14.5	-14.5	-14.5	-14.5
C31	C30	24.5	-20.5	-16.5	-13.9	-11.9	-11.1	-10.5	-10.5	-11.9	-13.7	-15.6
C32	C30	21	-24.0	-20.0	-17.4	-15.4	-14.6	-14.0	-14.0	-15.4	-17.2	-19.1
C33	C30	26.8	-18.2	-14.2	-11.6	-9.6	-8.8	-8.2	-8.2	-9.6	-11.4	-13.3
C34	C30	27.4	-17.6	-13.6	-11.0	-9.0	-8.2	-7.6	-7.6	-9.0	-10.8	-12.7
C35*	C35	32.7	-22.3	-18.3	-15.7	-13.7	-12.9	-12.3	-12.3	-12.3	-12.3	-12.3
C36	C35	31.5	-13.5	-9.5	-6.9	-4.9	-4.1	-3.5	-4.3	-5.7	-7.1	-8.6
C37	C38	23.5	-21.5	-17.5	-14.9	-12.9	-12.1	-11.5	-11.5	-11.5	-11.6	-12.9
C38	C38	28.6	-16.4	-12.4	-9.8	-7.8	-7.0	-6.4	-6.4	-6.4	-6.5	-7.8
C39	C38	25.1	-19.9	-15.9	-13.3	-11.3	-10.5	-9.9	-9.9	-9.9	-10.0	-11.3
C40	C38	24.1	-20.9	-16.9	-14.3	-12.3	-11.5	-10.9	-10.9	-10.9	-11.0	-12.3
C41	C05	30.9	-20.6	-16.6	-13.9	-12.1	-11.9	-12.2	-13.6	-15.5	-17.8	-20.5
C42	C42	32.3	-22.7	-18.7	-16.1	-14.1	-13.3	-12.7	-12.8	-13.8	-14.9	-16.0
C46	C42	30.6	-19.7	-16.3	-14.3	-13.1	-13.1	-13.5	-14.5	-15.5	-16.6	-17.7
C47	C42	30.2	-20.1	-16.7	-14.7	-13.5	-13.5	-13.9	-14.9	-15.9	-17.0	-18.1
C48	C42	29	-21.3	-17.9	-15.9	-14.7	-14.7	-15.1	-16.1	-17.1	-18.2	-19.3
C49	C42	29.9	-20.4	-17.0	-15.0	-13.8	-13.8	-14.2	-15.2	-16.2	-17.3	-18.4
C51	C29	18.4	-26.6	-22.6	-20.0	-18.0	-17.2	-16.6	-17.4	-19.1	-21.2	-24.0
C52	C29	27.8	-17.2	-13.2	-10.6	-8.6	-7.8	-7.2	-8.0	-9.7	-11.8	-14.6

* Involved land owner limits apply

Receiver	Associated Compliance	Prediction @ 9m/s	Predicted Noise Levels - MM92 80m Hub 3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
C01*	C01	38.9	28.9	32.9	35.5	37.5	38.3	38.9	38.9	38.9	38.9	38.9
C02*	C02	38.8	28.8	32.8	35.4	37.4	38.2	38.8	38.8	38.8	38.8	38.8
C03*	C03	37.7	27.7	31.7	34.3	36.3	37.1	37.7	37.7	37.7	37.7	37.7
C04*	C04	38.4	28.4	32.4	35.0	37.0	37.8	38.4	38.4	38.4	38.4	38.4
C05*	C05	30.4	20.4	24.4	27.0	29.0	29.8	30.4	30.4	30.4	30.4	30.4
C06	C05	34.2	24.2	28.2	30.8	32.8	33.6	34.2	34.2	34.2	34.2	34.2
C07*	C07	33.6	23.6	27.6	30.2	32.2	33.0	33.6	33.6	33.6	33.6	33.6
C08	C05	32.6	22.6	26.6	29.2	31.2	32.0	32.6	32.6	32.6	32.6	32.6
C09	C07	29.1	19.1	23.1	25.7	27.7	28.5	29.1	29.1	29.1	29.1	29.1
C10	C01	27.8	17.8	21.8	24.4	26.4	27.2	27.8	27.8	27.8	27.8	27.8
C11	C05	20.7	10.7	14.7	17.3	19.3	20.1	20.7	20.7	20.7	20.7	20.7
C12	C01	28.7	18.7	22.7	25.3	27.3	28.1	28.7	28.7	28.7	28.7	28.7
C13	C01	33.2	23.2	27.2	29.8	31.8	32.6	33.2	33.2	33.2	33.2	33.2
C14	C05	27.3	17.3	21.3	23.9	25.9	26.7	27.3	27.3	27.3	27.3	27.3
C15	C05	8.8	0.0	2.8	5.4	7.4	8.2	8.8	8.8	8.8	8.8	8.8
C16	C05	15.2	5.2	9.2	11.8	13.8	14.6	15.2	15.2	15.2	15.2	15.2
C17	C05	2.4	0.0	0.0	0.0	1.0	1.8	2.4	2.4	2.4	2.4	2.4
C18	C05	29.4	19.4	23.4	26.0	28.0	28.8	29.4	29.4	29.4	29.4	29.4
C19	C05	30.7	20.7	24.7	27.3	29.3	30.1	30.7	30.7	30.7	30.7	30.7
C20	C05	29.8	19.8	23.8	26.4	28.4	29.2	29.8	29.8	29.8	29.8	29.8
C21	C05	29.9	19.9	23.9	26.5	28.5	29.3	29.9	29.9	29.9	29.9	29.9
C22	C05	27.9	17.9	21.9	24.5	26.5	27.3	27.9	27.9	27.9	27.9	27.9
C23	C05	28.3	18.3	22.3	24.9	26.9	27.7	28.3	28.3	28.3	28.3	28.3
C28	C29	29.9	19.9	23.9	26.5	28.5	29.3	29.9	29.9	29.9	29.9	29.9
C29	C29	33.2	23.2	27.2	29.8	31.8	32.6	33.2	33.2	33.2	33.2	33.2
C30*	C30	30.5	20.5	24.5	27.1	29.1	29.9	30.5	30.5	30.5	30.5	30.5
C31	C30	24.5	14.5	18.5	21.1	23.1	23.9	24.5	24.5	24.5	24.5	24.5
C32	C30	21	11.0	15.0	17.6	19.6	20.4	21.0	21.0	21.0	21.0	21.0
C33	C30	26.8	16.8	20.8	23.4	25.4	26.2	26.8	26.8	26.8	26.8	26.8
C34	C30	27.4	17.4	21.4	24.0	26.0	26.8	27.4	27.4	27.4	27.4	27.4
C35*	C35	32.7	22.7	26.7	29.3	31.3	32.1	32.7	32.7	32.7	32.7	32.7
C36	C35	31.5	21.5	25.5	28.1	30.1	30.9	31.5	31.5	31.5	31.5	31.5
C37	C38	23.5	13.5	17.5	20.1	22.1	22.9	23.5	23.5	23.5	23.5	23.5
C38	C38	28.6	18.6	22.6	25.2	27.2	28.0	28.6	28.6	28.6	28.6	28.6
C39	C38	25.1	15.1	19.1	21.7	23.7	24.5	25.1	25.1	25.1	25.1	25.1
C40	C38	24.1	14.1	18.1	20.7	22.7	23.5	24.1	24.1	24.1	24.1	24.1
C41	C05	30.9	20.9	24.9	27.5	29.5	30.3	30.9	30.9	30.9	30.9	30.9
C42	C42	32.3	22.3	26.3	28.9	30.9	31.7	32.3	32.3	32.3	32.3	32.3
C46	C42	30.6	20.6	24.6	27.2	29.2	30.0	30.6	30.6	30.6	30.6	30.6
C47	C42	30.2	20.2	24.2	26.8	28.8	29.6	30.2	30.2	30.2	30.2	30.2
C48	C42	29	19.0	23.0	25.6	27.6	28.4	29.0	29.0	29.0	29.0	29.0
C49	C42	29.9	19.9	23.9	26.5	28.5	29.3	29.9	29.9	29.9	29.9	29.9
C51	C29	18.4	8.4	12.4	15.0	17.0	17.8	18.4	18.4	18.4	18.4	18.4
C52	C29	27.8	17.8	21.8	24.4	26.4	27.2	27.8	27.8	27.8	27.8	27.8

* Involved land owner limits apply

Difference Between Compliance Limits and Predicted Noise Levels - V90 3MW 78.8m Hub

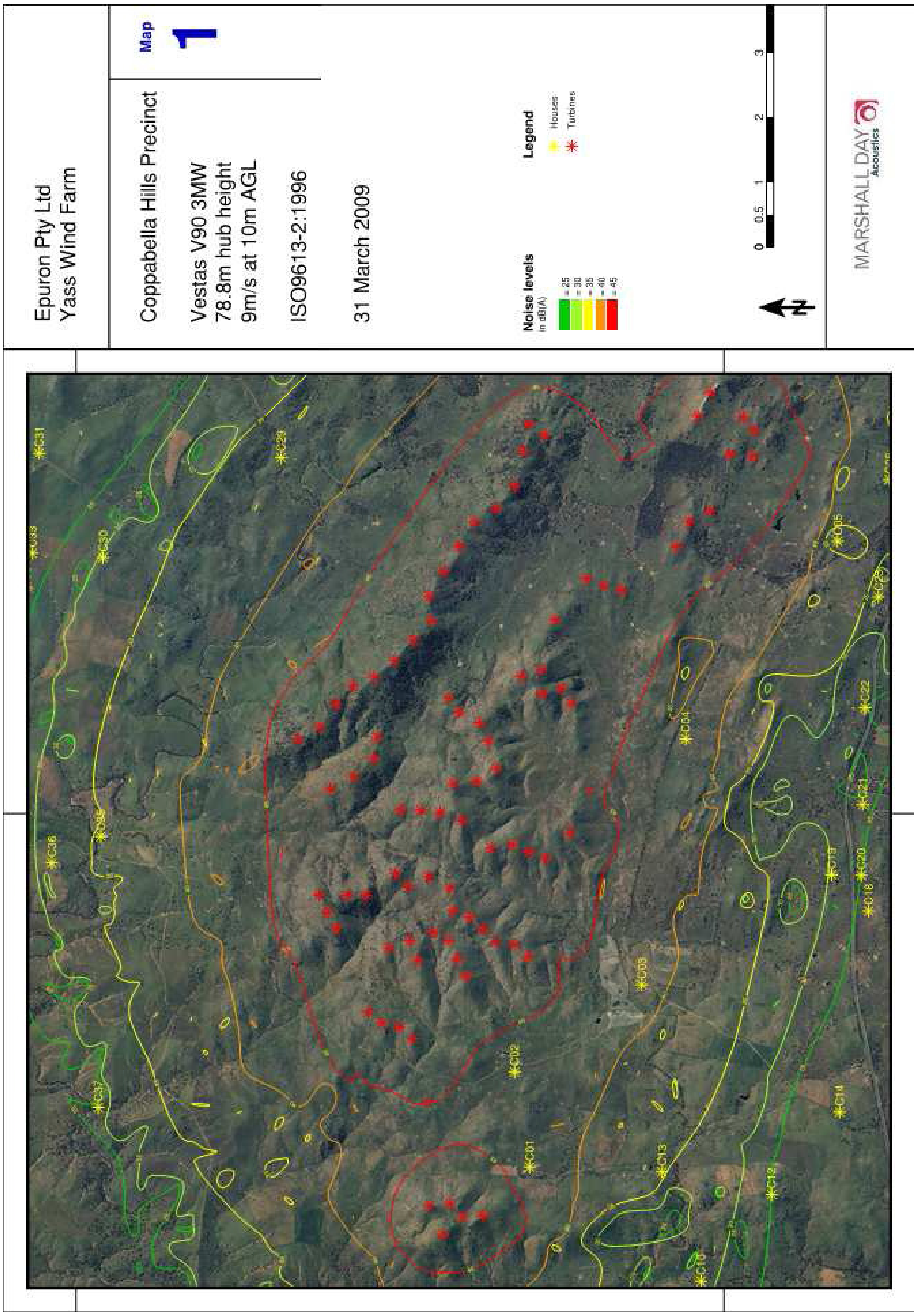
Receiver	Associated Compliance	Prediction @ 9m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s	14m/s	15m/s
C01*	C01	42.4	-15.0	-10.5	-6.8	-4.4	-3.0	-2.6	-3.3	-2.6	-2.6	-2.6	-5.7	-10.0
C02*	C02	42.3	-15.1	-10.6	-6.9	-4.5	-3.1	-2.7	-3.4	-2.7	-2.7	-2.7	-3.2	-4.3
C03*	C03	41.5	-15.9	-11.4	-7.7	-5.3	-3.9	-3.5	-4.2	-3.5	-3.7	-5.0	-5.9	-6.4
C04*	C04	42.1	-15.3	-10.8	-7.1	-4.7	-3.3	-2.9	-3.6	-2.9	-2.9	-2.9	-4.0	-5.5
C05*	C05	34.4	-23.0	-18.5	-14.8	-12.4	-11.0	-10.6	-12.7	-14.3	-17.0	-20.2	-23.8	-27.9
C06	C05	37.9	-16.0	-11.4	-7.9	-6.1	-5.6	-6.6	-9.2	-10.8	-13.5	-16.7	-20.3	-24.4
C07*	C07	37.1	-20.3	-15.8	-12.1	-9.7	-8.3	-7.9	-8.6	-7.9	-7.9	-7.9	-7.9	-7.9
C08	C05	36.3	-17.6	-13.0	-9.5	-7.7	-7.2	-8.2	-10.8	-12.4	-15.1	-18.3	-21.9	-26.0
C09	C07	32.8	-14.6	-10.1	-6.4	-4.0	-2.6	-2.4	-4.3	-4.9	-6.3	-7.6	-8.9	-10.2
C10	C01	31.9	-15.5	-11.0	-7.3	-4.9	-3.5	-3.4	-5.7	-7.1	-9.6	-12.6	-16.2	-20.5
C11	C05	25.2	-28.7	-24.1	-20.6	-18.8	-18.3	-19.3	-21.9	-23.5	-26.2	-29.4	-33.0	-37.1
C12	C01	33.2	-14.2	-9.7	-6.0	-3.6	-2.2	-2.1	-4.4	-5.8	-8.3	-11.3	-14.9	-19.2
C13	C01	37.2	-10.2	-5.7	-2.0	**0.4**	**1.8**	**1.9**	-0.4	-1.8	-4.3	-7.3	-10.9	-15.2
C14	C05	31.9	-22.0	-17.4	-13.9	-12.1	-11.6	-12.6	-15.2	-16.8	-19.5	-22.7	-26.3	-30.4
C15	C05	13.6	-40.3	-35.7	-32.2	-30.4	-29.9	-30.9	-33.5	-35.1	-37.8	-41.0	-44.6	-48.7
C16	C05	20	-33.9	-29.3	-25.8	-24.0	-23.5	-24.5	-27.1	-28.7	-31.4	-34.6	-38.2	-42.3
C17	C05	7.2	-46.7	-42.1	-38.6	-36.8	-36.3	-37.3	-39.9	-41.5	-44.2	-47.4	-51.0	-55.1
C18	C05	34	-19.9	-15.3	-11.8	-10.0	-9.5	-10.5	-13.1	-14.7	-17.4	-20.6	-24.2	-28.3
C19	C05	35	-18.9	-14.3	-10.8	-9.0	-8.5	-9.5	-12.1	-13.7	-16.4	-19.6	-23.2	-27.3
C20	C05	34.2	-19.7	-15.1	-11.6	-9.8	-9.3	-10.3	-12.9	-14.5	-17.2	-20.4	-24.0	-28.1
C21	C05	34.1	-19.8	-15.2	-11.7	-9.9	-9.4	-10.4	-13.0	-14.6	-17.3	-20.5	-24.1	-28.2
C22	C05	32.3	-21.6	-17.0	-13.5	-11.7	-11.2	-12.2	-14.8	-16.4	-19.1	-22.3	-25.9	-30.0
C23	C05	32.1	-21.8	-17.2	-13.7	-11.9	-11.4	-12.4	-15.0	-16.6	-19.3	-22.5	-26.1	-30.2
C28	C29	34.2	-13.2	-8.7	-5.0	-2.6	-1.2	-1.6	-4.0	-5.4	-8.2	-11.6	-15.7	-20.5
C29	C29	37	-10.4	-5.9	-2.2	**0.2**	**1.6**	**1.2**	-1.2	-2.6	-5.4	-8.8	-12.9	-17.7
C30*	C30	34.8	-22.6	-18.1	-14.4	-12.0	-10.6	-10.2	-10.9	-10.2	-10.2	-10.2	-10.2	-12.3
C31	C30	29.2	-18.2	-13.7	-10.0	-7.6	-6.2	-5.8	-7.9	-9.0	-10.9	-13.1	-15.4	-17.9
C32	C30	25.6	-21.8	-17.3	-13.6	-11.2	-9.8	-9.4	-11.5	-12.6	-14.5	-16.7	-19.0	-21.5
C33	C30	31.2	-16.2	-11.7	-8.0	-5.6	-4.2	-3.8	-5.9	-7.0	-8.9	-11.1	-13.4	-15.9
C34	C30	31.9	-15.5	-11.0	-7.3	-4.9	-3.5	-3.1	-5.2	-6.3	-8.2	-10.4	-12.7	-15.2
C35*	C35	36.7	-20.7	-16.2	-12.5	-10.1	-8.7	-8.3	-9.0	-8.3	-8.3	-8.3	-8.3	-8.3
C36	C35	35.8	-11.6	-7.1	-3.4	-1.0	**0.4**	0.0	-2.1	-2.8	-4.3	-5.8	-7.2	-8.5
C37	C38	27.9	-19.5	-15.0	-11.3	-8.9	-7.5	-7.1	-7.8	-7.2	-8.5	-10.0	-11.8	-13.7
C38	C38	32.8	-14.6	-10.1	-6.4	-4.0	-2.6	-2.2	-2.9	-2.3	-3.6	-5.1	-6.9	-8.8
C39	C38	29.4	-18.0	-13.5	-9.8	-7.4	-6.0	-5.6	-6.3	-5.7	-7.0	-8.5	-10.3	-12.2
C40	C38	28.5	-18.9	-14.4	-10.7	-8.3	-6.9	-6.5	-7.2	-6.6	-7.9	-9.4	-11.2	-13.1
C41	C05	34.6	-19.3	-14.7	-11.2	-9.4	-8.9	-9.9	-12.5	-14.1	-16.8	-20.0	-23.6	-27.7
C42	C42	36.5	-16.8	-12.9	-10.0	-8.4	-8.0	-8.6	-10.3	-10.7	-11.8	-13.0	-14.1	-15.2
C46	C42	34.8	-18.5	-14.6	-11.7	-10.1	-9.7	-10.3	-12.0	-12.4	-13.5	-14.7	-15.8	-16.9
C47	C42	34.4	-18.9	-15.0	-12.1	-10.5	-10.1	-10.7	-12.4	-12.8	-13.9	-15.1	-16.2	-17.3
C48	C42	33.2	-20.1	-16.2	-13.3	-11.7	-11.3	-11.9	-13.6	-14.0	-15.1	-16.3	-17.4	-18.5
C49	C42	33.9	-19.4	-15.5	-12.6	-11.0	-10.6	-11.2	-12.9	-13.3	-14.4	-15.6	-16.7	-17.8
C51	C29	23.2	-24.2	-19.7	-16.0	-13.6	-12.2	-12.6	-15.0	-16.4	-19.2	-22.6	-26.7	-31.5
C52	C29	32.2	-15.2	-10.7	-7.0	-4.6	-3.2	-3.6	-6.0	-7.4	-10.2	-13.6	-17.7	-22.5

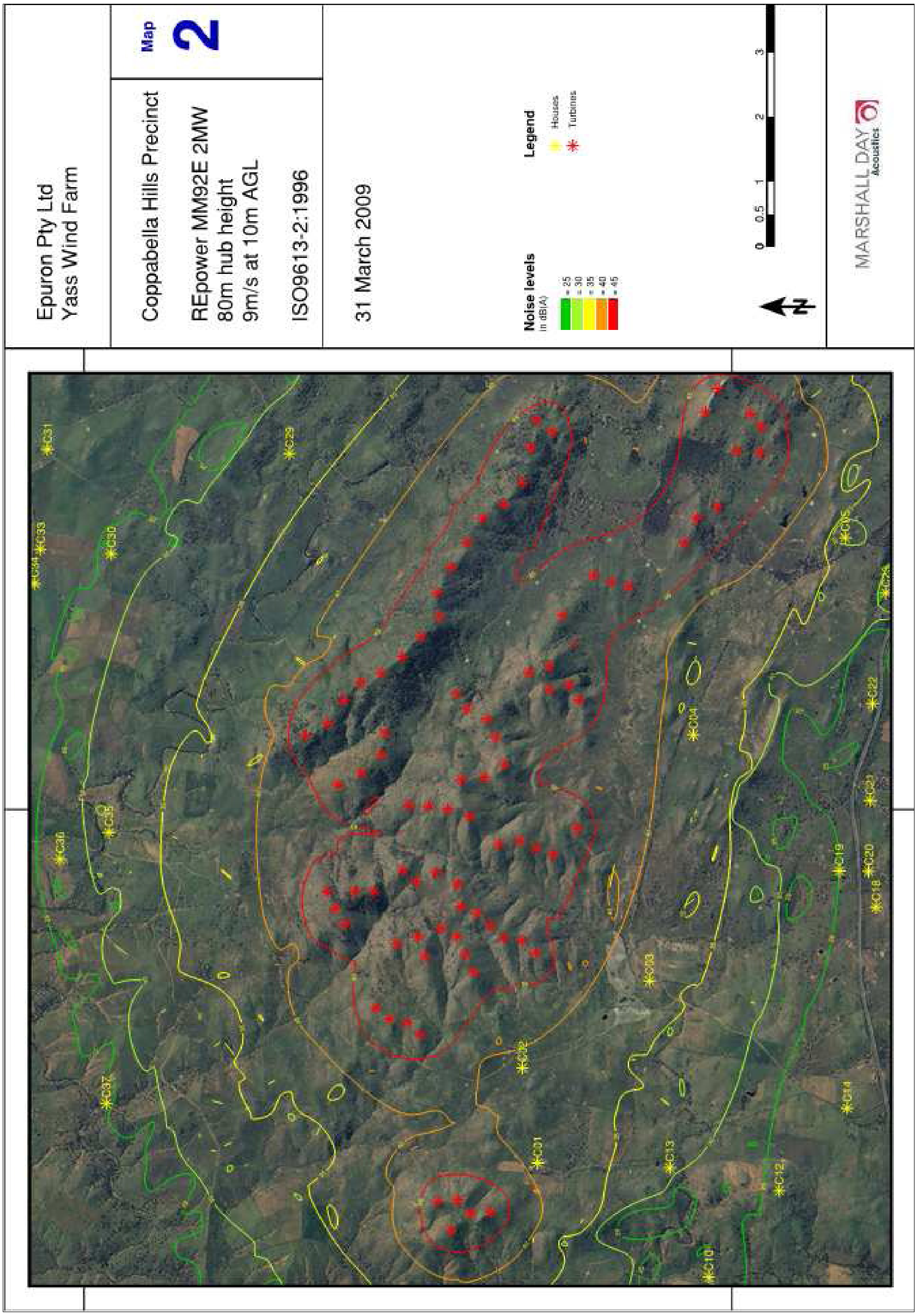
* Involved land owner limits apply

Predicted Noise Levels - V90 3MW 78.8m Hub														
Receiver	Associated Compliance	Prediction @ 9m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s	14m/s	15m/s
C01*	C01	42.4	30.0	34.5	38.2	40.6	42.0	42.4	41.7	42.4	42.4	42.4	42.4	42.4
C02*	C02	42.3	29.9	34.4	38.1	40.5	41.9	42.3	41.6	42.3	42.3	42.3	42.3	42.3
C03*	C03	41.5	29.1	33.6	37.3	39.7	41.1	41.5	40.8	41.5	41.5	41.5	41.5	41.5
C04*	C04	42.1	29.7	34.2	37.9	40.3	41.7	42.1	41.4	42.1	42.1	42.1	42.1	42.1
C05*	C05	34.4	22.0	26.5	30.2	32.6	34.0	34.4	33.7	34.4	34.4	34.4	34.4	34.4
C06	C05	37.9	25.5	30.0	33.7	36.1	37.5	37.9	37.2	37.9	37.9	37.9	37.9	37.9
C07*	C07	37.1	24.7	29.2	32.9	35.3	36.7	37.1	36.4	37.1	37.1	37.1	37.1	37.1
C08	C05	36.3	23.9	28.4	32.1	34.5	35.9	36.3	35.6	36.3	36.3	36.3	36.3	36.3
C09	C07	32.8	20.4	24.9	28.6	31.0	32.4	32.8	32.1	32.8	32.8	32.8	32.8	32.8
C10	C01	31.9	19.5	24.0	27.7	30.1	31.5	31.9	31.2	31.9	31.9	31.9	31.9	31.9
C11	C05	25.2	12.8	17.3	21.0	23.4	24.8	25.2	24.5	25.2	25.2	25.2	25.2	25.2
C12	C01	33.2	20.8	25.3	29.0	31.4	32.8	33.2	32.5	33.2	33.2	33.2	33.2	33.2
C13	C01	37.2	24.8	29.3	33.0	35.4	36.8	37.2	36.5	37.2	37.2	37.2	37.2	37.2
C14	C05	31.9	19.5	24.0	27.7	30.1	31.5	31.9	31.2	31.9	31.9	31.9	31.9	31.9
C15	C05	13.6	1.2	5.7	9.4	11.8	13.2	13.6	12.9	13.6	13.6	13.6	13.6	13.6
C16	C05	20	7.6	12.1	15.8	18.2	19.6	20.0	19.3	20.0	20.0	20.0	20.0	20.0
C17	C05	7.2	0.0	0.0	3.0	5.4	6.8	7.2	6.5	7.2	7.2	7.2	7.2	7.2
C18	C05	34	21.6	26.1	29.8	32.2	33.6	34.0	33.3	34.0	34.0	34.0	34.0	34.0
C19	C05	35	22.6	27.1	30.8	33.2	34.6	35.0	34.3	35.0	35.0	35.0	35.0	35.0
C20	C05	34.2	21.8	26.3	30.0	32.4	33.8	34.2	33.5	34.2	34.2	34.2	34.2	34.2
C21	C05	34.1	21.7	26.2	29.9	32.3	33.7	34.1	33.4	34.1	34.1	34.1	34.1	34.1
C22	C05	32.3	19.9	24.4	28.1	30.5	31.9	32.3	31.6	32.3	32.3	32.3	32.3	32.3
C23	C05	32.1	19.7	24.2	27.9	30.3	31.7	32.1	31.4	32.1	32.1	32.1	32.1	32.1
C28	C29	34.2	21.8	26.3	30.0	32.4	33.8	34.2	33.5	34.2	34.2	34.2	34.2	34.2
C29	C29	37	24.6	29.1	32.8	35.2	36.6	37.0	36.3	37.0	37.0	37.0	37.0	37.0
C30*	C30	34.8	22.4	26.9	30.6	33.0	34.4	34.8	34.1	34.8	34.8	34.8	34.8	34.8
C31	C30	29.2	16.8	21.3	25.0	27.4	28.8	29.2	28.5	29.2	29.2	29.2	29.2	29.2
C32	C30	25.6	13.2	17.7	21.4	23.8	25.2	25.6	24.9	25.6	25.6	25.6	25.6	25.6
C33	C30	31.2	18.8	23.3	27.0	29.4	30.8	31.2	30.5	31.2	31.2	31.2	31.2	31.2
C34	C30	31.9	19.5	24.0	27.7	30.1	31.5	31.9	31.2	31.9	31.9	31.9	31.9	31.9
C35*	C35	36.7	24.3	28.8	32.5	34.9	36.3	36.7	36.0	36.7	36.7	36.7	36.7	36.7
C36	C35	35.8	23.4	27.9	31.6	34.0	35.4	35.8	35.1	35.8	35.8	35.8	35.8	35.8
C37	C38	27.9	15.5	20.0	23.7	26.1	27.5	27.9	27.2	27.9	27.9	27.9	27.9	27.9
C38	C38	32.8	20.4	24.9	28.6	31.0	32.4	32.8	32.1	32.8	32.8	32.8	32.8	32.8
C39	C38	29.4	17.0	21.5	25.2	27.6	29.0	29.4	28.7	29.4	29.4	29.4	29.4	29.4
C40	C38	28.5	16.1	20.6	24.3	26.7	28.1	28.5	27.8	28.5	28.5	28.5	28.5	28.5
C41	C05	34.6	22.2	26.7	30.4	32.8	34.2	34.6	33.9	34.6	34.6	34.6	34.6	34.6
C42	C42	36.5	24.1	28.6	32.3	34.7	36.1	36.5	35.8	36.5	36.5	36.5	36.5	36.5
C46	C42	34.8	22.4	26.9	30.6	33.0	34.4	34.8	34.1	34.8	34.8	34.8	34.8	34.8
C47	C42	34.4	22.0	26.5	30.2	32.6	34.0	34.4	33.7	34.4	34.4	34.4	34.4	34.4
C48	C42	33.2	20.8	25.3	29.0	31.4	32.8	33.2	32.5	33.2	33.2	33.2	33.2	33.2
C49	C42	33.9	21.5	26.0	29.7	32.1	33.5	33.9	33.2	33.9	33.9	33.9	33.9	33.9
C51	C29	23.2	10.8	15.3	19.0	21.4	22.8	23.2	22.5	23.2	23.2	23.2	23.2	23.2
C52	C29	32.2	19.8	24.3	28.0	30.4	31.8	32.2	31.5	32.2	32.2	32.2	32.2	32.2

* Involved land owner limits apply

APPENDIX K
SOUNDPLAN NOISE CONTOUR PLOTS



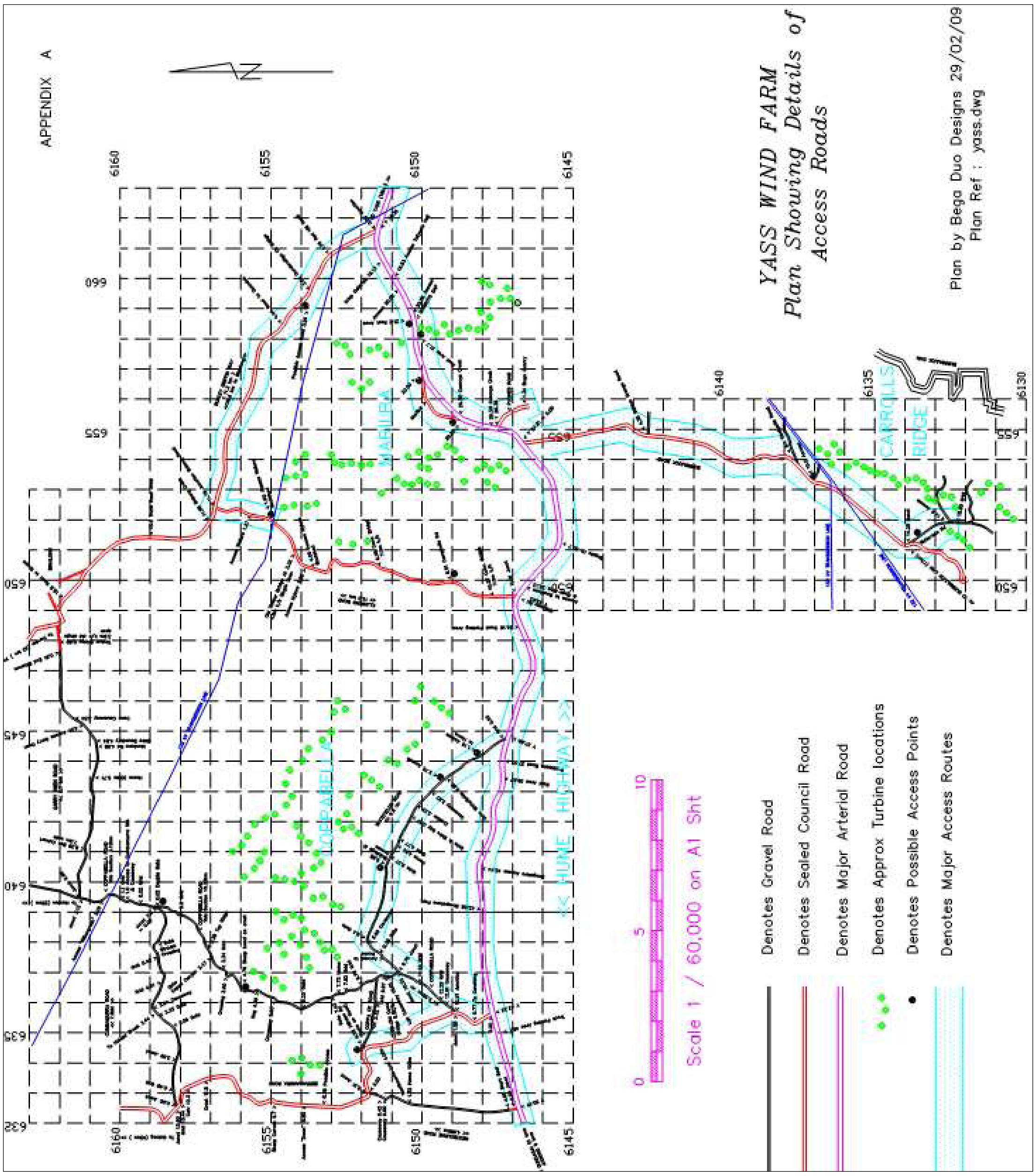

Epuron Pty Ltd
Yass Wind Farm
Map 2
Coppabella Hills Precinct
REpower MM92E 2MW
80m hub height
9m/s at 10m AGL
ISO9613-2:1996
31 March 2009
Noise levels
in dB(A)
Legend
Houses
Turbines
MARSHALL DAY Acoustics

APPENDIX L
CONSTRUCTION EQUIPMENT SOUND POWER LEVELS

Table L1
Construction equipment (L_{10}) sound power levels in dB, re 10^{-12} W

	Octave band mid frequency							
Description	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**dBA**
Excavator	121	126	111	107	106	101	96	113
Grader	118	124	115	114	115	114	113	120
Dump truck	111	105	108	106	107	104	99	111
Rock breaking	113	115	117	122	121	120	118	126
Concrete truck	104	101	96	95	94	93	91	100
Front end loader	120	117	101	101	92	88	88	104
Crane	108	105	109	107	111	105	97	113
Bulldozer	113	119	110	109	110	109	108	115
Concrete batching	118	115	110	109	108	107	105	114
Delivery trucks	118	110	99	104	99	95	91	105
4WD vehicles	96	92	88	84	84	80	75	88

APPENDIX M
SURROUNDING ROAD NETWORK



Source: Bega Duo Designs

MARSHALL DAY Acoustics

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REPORT No.: 2008237 002

PROJECT: YASS VALLEY WIND FARM - MARILBA HILLS
NOISE IMPACT ASSESSMENT

CLIENT: EPURON Pty Ltd
Level 11, 75 Miller Street
NORTH SYDNEY, NSW 2060

ATTENTION: Julian Kasby

DATE: 22 April 2009

MARSHALL DAY ACOUSTICS

Mat Cottle
Consultant

TABLE OF CONTENTS

Page No.

DOCUMENT STATUS

Revision	Purpose	Date delivered	Reviewed by
-	Draft issued to client	2 April 2009	RCL
-	Report issued to client	22 April 2009	RCL

MARSHALL DAY Acoustics

EXECUTIVE SUMMARY

Marshall Day Acoustics Pty Ltd has completed a noise impact assessment of the proposed Marilba Hills section of the Yass Valley Wind Farm.

A proposed layout of 66 turbines has been assessed in accordance with the South Australian EPA's *Environmental Noise Guidelines: Wind Farms (2003)*, the World Health Organisation's *Guidelines for Community Noise*, the DECC's *Environmental Criteria for Road Traffic Noise*, *Environmental Noise Control Manual* and *Assessing Vibration: A Technical Guide*.

Background noise monitoring was conducted over a three week period from 5 August to 28 August 2008 at seven (7) relevant receiver locations. Data from monitoring has been used to set noise limits in accordance with the procedures set out in the wind farm guideline.

Noise level predictions have been modelled in SoundPLAN noise modelling software using *ISO9613-2: 1996- Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* standard.

Two turbine types have been considered. The predicted noise levels for the representative turbine (MM92E) indicate full compliance with the relevant noise criteria. Furthermore, the predicted noise levels for the worst-case turbine (V90 3MW) in terms of sound power level, generating capacity and physical dimensions, indicate mitigation measures or a layout redesign would be required.

The assessment considers the cumulative noise impact of all neighbouring wind farms. It is noted that Conroys Gap wind farm receivers in close proximity to the Yass Valley Wind Farm may experience an increase in noise level. It is further noted that compliance with noise criteria is still achieved at these receiver locations.

Substation noise levels are predicted to be below the existing background noise at all receiver locations.

MDA has been provided with test reports for each turbine stating that each does not exhibit audible tonality. Therefore, no penalty has been applied to predicted results for either turbine type.

The predicted construction noise levels have been found to comply with ENCM criteria at all receiver locations.

The predicted construction blasting noise and vibration levels have been found to comply with ANZEC guidelines. A maximum instantaneous charge (MIC) of approximately 30kg is recommended.

The predicted construction vibration levels have been found to comply with DECC guidelines at all receiver locations.

The predicted construction traffic noise levels have been found to comply with ECRTN criteria at all assessed locations. It is noted that the predicted levels at some receiver locations exceed +2dB increase.

1.0 INTRODUCTION

Marshall Day Acoustics Pty Ltd (MDA) has been requested by EPURON Pty Ltd to provide acoustical consultancy services in relation to the proposed Marilba Wind Farm to be located approximately 15km west of Yass, New South Wales (NSW). This report has been prepared for inclusion in the environmental impact statement submission to the NSW Department of Planning.

This report details the methodology and findings of our noise assessment on the impact to the amenity of dwellings located within approximately 5km of up to 66 turbines proposed for the Marilba site. It should be noted that the cumulative impact of the nearby proposed Coppabella Hills and Conroys Gap wind farms has been considered.

The assessment has been performed in accordance with the South Australia EPA's *Environmental Noise Guidelines: Wind Farms (2003)* (referred to herein as the Guideline), which is currently the applicable guideline in the state of New South Wales for the assessment of the wind farm noise on non-involved landowners. Dwellings that have been assessed in accordance with the Guideline are termed *relevant receivers* within this report.

The European Working Group on Noise from Wind Turbines document *ETSU-R-97* and the World Health Organisation's *Guidelines for Community Noise* have been reviewed for guidance where landowners have entered into an agreement with EPURON. Involved landowners that have been assessed within this report are termed *involved landowners.*

In addition to assessing the impact of the operational wind farm, an assessment of construction noise has also been undertaken in accordance with relevant guidelines.

Table 1 summarises test reports, documents and files received from EPURON that have been used as the basis for this assessment.

Table 1

Document Name	Document Number
MM92E – Windtest report	SE06010B2A1
MM92E - Sound Power Level	SD-2.9-WT.SL-1-B
V90 3MW Windtest report	WT4245/05
Traffic Impact Study – Proposed Yass Valley Wind Farm	-

Acoustic terminology used throughout this report is defined in Appendix A.

2.0 SITE DESCRIPTION

The Marilba Hills site (Marilba) is proposed to be located along two adjacent ridgelines separated by approximately 4km of farmland. The site forms part of the proposed Yass Valley Wind Farm project and is located in the Marilba Hills Precinct, approximately 15km west of Yass, NSW.

Marilba is bounded to the north and east by open farmland and Burley Griffin Way (B94) and to the west by farmland and the Bookham Illalong Road.

Marilba-1 is the western-most ridgeline and will contain approximately 38 wind turbine generators (turbines). The site is approximately 8km south south-east of the township of Binalong.

Marilba-2 is located approximately 4km east of Marilba-1 and will contain approximately 28 turbines. The site is approximately 12.5km south-east of the township of Binalong. It is noted that the Marilba-2 site is divided by the Hume Highway at Conroys Gap.

Located approximately 4km to the west of Marilba-1 is the proposed Coppabella Hills Wind Farm; the Conroys Gap Wind Farm is located along the same ridgeline as Marilba-2, approximately 800m south-west.

Please see Appendix B for an indicative turbine layout for Marilba.

2.1 Proposed Wind Farm Layout

It is proposed that up to 66 turbines will be installed at the Marilba site. Turbine locations and receiver locations surrounding the site are detailed in Appendices C & D respectively.

At the time of finalising this report, a decision with respect to final turbine type had not been made. It is noted that the environmental impact assessment seeks approval for a wide range of turbines; therefore this noise assessment considers representative impacts as well as worst case impacts in terms of sound power level and physical dimensions (blade tip height).

Accordingly, the REpower MM92E (MM92E) and Vestas V90 3MW (V90) turbines have been selected as being representative of the range of turbines being considered. In addition, a comparison is made between these two turbines and a hypothetical worst case turbine, the V90 3MW with 100m hub, to clearly demonstrate that noise emission only marginally increases with a change in hub height of this magnitude.

Both turbines run three upwind rotor blades and use active blade pitch and rotor speed to control power generation. The rotor diameters measure 92.5m and 90m for the MM92E and V90 respectively.

The one-third octave band sound power level data for each unit is shown in Appendix E. These values have been determined by independent tests conducted in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* and are sourced from documents received from EPURON Pty Ltd.

Table 2 summarises the relevant specifications of the two representative turbines considered for the development.

Table 2
WTG manufacturer specifications

Description	Turbine 1	Turbine 2
Make and Model	REpower MM92E 2MW	Vestas V90 3MW
Particulars	Evolution	Mode 0
Rotor Diameter (m)	92.5	90
Hub Height (m)	80	78.8
Rotor speed (rpm)	7.8 – 15.0	8.6-18.4
Cut-in Wind Speed (ms^{-1})	3.0	4.0
Rated Wind Speed (ms^{-1})	11.2	15.5
Cut-out Wind Speed (ms^{-1})	24.0	25.0
Sound Power L_{WA} at $9ms^{-1}$ (dB)	105.0	109.4
Tonality audibility	No	No

If at any stage after the finalisation of this report, a modification is made to any aspect of the layout, EPURON understands that a reassessment of noise impacts will be required. Additionally, where a change is made to the specification of a turbine, data measured in accordance with IEC-61400-11 will be required in order to re-access noise levels and tonality.

3.0 NOISE ASSESSMENT GUIDELINES

In 2003 the NSW EPA was incorporated into the Department of Environment Conservation NSW (DEC). In April 2007 the DEC became the Department of Environment and Climate Change (DECC).

Currently the NSW Department of Environment and Climate Change (DECC) has no specific guidelines relating to wind farm development within New South Wales. The DECC has acknowledged that the NSW Industrial Noise Policy (INP) is not appropriate for new wind farm developments.

The NSW Government Department of Planning requires in their letter to EPURON (S08/01553) that the noise impact for the proposed Yass Valley Wind Farm be undertaken in accordance with the South Australia Environmental Protection Authority document *Environmental Noise Guidelines: Wind Farms (2003)* (the Guideline).

With respect to the applicability of the criteria to landowners, Section 2.3 of the Guideline states:

> *The criteria have been developed to minimise the impact on the amenity of premises that do not have an agreement with wind farm developers.*

Premises that have not entered into an agreement with the developer are termed *non-involved relevant receivers* within this report.

Where on the other hand, a landowner is involved with the project, we have referred to the European Working Group on Noise from Wind Turbines document *ETSU-R-97 - The Assessment and Rating of Noise from Wind Farms*, and the World Health Organisation document *Guidelines for Community Noise* for guidance on setting limits.

Additionally, noise associated with the construction of the wind farm has been assessed in accordance with the NSW EPA *Environmental Noise Control Manual*.

Blasting has been assessed in accordance with ANZEC guidelines.

3.1 SA EPA Environmental Noise Guidelines: Wind Farms (2003)

In determining the operational noise criteria for each non-involved relevant receiver for Marilba, the Guideline states that:

> *The predicted equivalent noise level ($L_{Aeq,10min}$), adjusted for tonality in accordance with these guidelines, should not exceed 35dBA, or the background noise ($L_{A90,\ 10\ min}$) by more than 5dBA, whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.*

The Guideline has been developed with the inherent characteristics of noise from wind farms taken into account. These include aerodynamic noise from passing blades, referred to as “swish” and infrequent braking noise. Where wind farms display characteristics which are considered to be atypical then rectification should be undertaken.

The Guideline proposes a 5dBA penalty for characteristics of turbine operation that would be deemed annoying, such as tonality. Additionally, it should be noted that the Guideline accepts that modern-day “upwind” turbine designs do not exhibit significant levels of infrasound.

SA EPA Environmental Noise Guidelines: Wind Farms 2007 (Interim)

It should be noted that the South Australia EPA's guideline *Wind farms: Environmental noise guidelines (interim) – December 2007* has not been considered within this assessment because it has not been formally recognised by the DECC.

3.2 ETSU-R-97 and World Health Organisation Guidelines

With respect to involved landowners, the Guideline criteria have been developed to minimise the impact on the amenity of those not involved with the project. It is recognised however that where financial agreements exist, developers cannot absolve themselves of the responsibility of ensuring that an adverse effect on an area's amenity does not occur as a result of the operation of the wind farm.

In light of the aforementioned requirement, we have referred to the European Working Group on Noise from Wind Turbines document *ETSU-R-97* in determining noise criteria for involved landowners. It states:

> *The Noise Working Group recommends that both day- and night-time lower fixed limits can be increased to 45dBA and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.*

It should be noted that the Noise Working Group limit of 45dBA is in agreement to the World Health Organisation (WHO) criteria for protection of amenity and avoidance of sleep disturbance as published in the document *Guidelines for Community Noise*.

The criterion for involved landowners within this assessment recognises the changed attitudinal response to noise from wind farms for those financially involved with the project. Furthermore, we understand that EPURON has discussed the implications of wind turbine noise with each of the involved landowners in relation to their property. Each of the involved landowners has been or will be provided with noise agreements that outline the noise criteria applied to them as outlined within this report.

We have therefore adopted a night-time limit of 45dBA in conjunction with limits stipulated by the Guideline. This effectively makes the limit 45dBA *or* background L_{A90} + 5dBA; whichever is the greater; at all involved relevant receivers for each integer wind speed from cut-in to rated power of the wind farm.

3.3 Construction Noise Guidelines

In NSW, there is no current guidance in relation to appropriate construction noise criteria. In the absence of a current standard, the DECC advises that the now out-of-date *Environmental Noise Control Manual* should be used to determine the allowable level of construction noise at residential receivers. The noise level restrictions are as follows:

- Construction period 4 weeks and under

The L_{10} level measured over a period of not less than 15-minutes when the construction site is in operation must not exceed the background level by more than 20 dB.

- Construction period greater than 4 weeks and not exceeding 26 weeks

  The L_{10} level measured over a period of not less than 15-minutes when the construction site is in operation must not exceed the background level by more than 10 dB.

The construction duration associated with the proposed development is estimated to take 12-24 months in total. However, due to the large coverage area of the wind farm and up to 66 individual turbine sites, intensive works will be located in any one location for only a short period of time relative to the overall duration.

We therefore consider it appropriate to allow construction (L_{10}) noise levels to exceed background (L_{90}) noise levels for short and intermittent periods by up to 10dB.

The DECC sets time restrictions for noise generated during construction work as follows:

- Monday to Friday, 0700-1800hrs
- Saturday, 0700-1300hrs if audible on residential premises, otherwise 0800-1300hrs *[sic]*
- No construction work is to take place on Sundays or Public Holidays.

3.4 AZEC Blasting Noise Guidelines

Noise control in relation to blasting is guided by the Australian and New Zealand Environment Council (ANZEC) guidelines – *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (1990). Times of day, air-blast overpressure level and ground vibration peak particle velocity limits are all considered. Table 3 summarises the criteria limits in order to minimise annoyance due to blasting overpressure and ground vibration at nearby residences.

Table 3

Time of Blasting	Blast Over-pressure Level (dB Lin Peak)	Ground Vibration Peak Particle Velocity (mm/sec)
Monday – Saturday: 9am – 5pm	115	5
Sunday & public holidays:		
No blasting to take place	-	-

The NSW DECC accepts that on infrequent occasions the overpressure limit of 115 dB (Lin Peak) may be exceeded. This should be limited to not more than 5% of the total number of blasts over a 12-month period and should not exceed 120dB (Lin Peak) at any time whatsoever.

Additionally, ground vibration peak particle velocity may also exceed the 5mm/sec limit on infrequent occasions. This should be limited to not more than 5% of the total number of blasts over a 12-month period and should not exceed 10mm/sec at any time whatsoever.

Blasting should generally take place no more than once per day. Additionally, the restrictions referred to above do not apply at premises where the effects of the blasting are not perceived to be noise sensitive.

3.5 Vibration Assessment Guidelines

Human Response to Vibration

The NSW DECC document *Assessing Vibration: a technical guide* (DEC2006/43, February 2006) presents preferred and maximum vibration criteria for use in assessing human response to vibration.

It is noted that acceptable values of human exposure to vibration are dependent on, amongst other things, the time of day. This assessment will only consider the period during which construction can take place i.e. 0700-1800 Monday to Friday and 0700-1300 (or 0800-1300 if audible at receiver) on Saturday.

The following tables summarise the preferred and maximum values for acceptable human exposure to continuous, impulsive and intermittent vibration.

Table 4
Preferred and maximum values for vibration during daytime (mm/s) 1-80Hz

Location	Preferred Values	Maximum Values
Continuous		
Residences	0.28	0.56
Impulsive		
Residences	8.6	17

Table 5
Vibration dose values for intermittent vibration during daytime ($m/s^{1.75}$) 1-80Hz

Location	Preferred Values	Maximum Values
Residences	0.2	0.4

It should be noted that based on the operational characteristics of the construction equipment considered within this assessment, only impulsive and intermittent vibration will be emitted.

Evaluation of Vibration in Buildings

Table 1 of British standard *BS 7385 Part 2: 1993 Evaluation and measurement for vibration in buildings Part 2. Guide to damage levels from ground-borne vibration*, has been referenced to determine acceptable values of ground-borne vibration which will not cause cosmetic damage to neighbouring buildings.

Table 6 summarises acceptable ground-borne vibration levels.

Table 6
Transient vibration guide values to prevent cosmetic damage

Type of building	Guide value peak particle velocity
Unreinforced or light framed structures, residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz. 20mm/s at 15Hz increasing to 50mm/s at 40Hz and above.

It should be noted that BS7385 recommends that guide values for continuous vibration may need to be reduced to 50% of the values listed in Table 3 (based on common practice) however it is not envisaged that construction equipment generating vibration of a continuous nature will be used for this development.

3.6 NSW DECC Environmental Criteria For Road Traffic Noise

The noise level criteria for increased traffic flow as a result of land-use development with the potential to create additional traffic are set by the NSW DECC's *Environmental Criteria for Road Traffic Noise (ECRTN).* Table 7 presents the traffic noise criteria for this development.

Table 7
Road traffic noise criteria

Type of Development	Criteria Day 0700-2200hrs
Land use developments with potential to create additional traffic on local roads	$L_{eq(1hr)}$ 55 dBA
Land use developments with potential to create additional traffic on existing freeways/collector roads	$L_{eq(1hr)}$ 60 dBA

Source: Table 1 NSW EPA – Environmental Criteria for road traffic noise

Furthermore, the guidance states:

Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads, regulating times of use, using clustering, using 'quiet' vehicles, and using barriers and acoustic treatments.

In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2dB.

4.0 ASSESSMENT METHODOLOGY

Predictions and Relevant Receiver Assessment

Preliminary predictions of wind farm noise levels have been modelled for each receiver within approximately 5km of the development using the algorithm detailed in *ISO9613-2: 1996- Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO9613-2:1996) as implemented in the noise modeling software SoundPLAN. ISO9613-2:1996 is recognised as being acceptable for use in calculating wind farm noise. Our predictions use sound power data determined in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques.*

Potentially affected residential properties in the vicinity of the wind farm have been determined in accordance with Section 3.1 of the Guideline. In excess of 70 residential properties have been identified. Background noise monitoring is required to be carried out at locations, termed relevant receivers, which are relevant for assessing the impact of wind farm noise on nearby premises. Where a cluster of dwellings occurred, one receiver was selected as being a *worst-case* representation of the cluster as a whole. Seven (7) relevant receivers were shortlisted for background noise monitoring based on predicted levels, site photographs and topography.

Background Noise Monitoring

Long-term background noise monitoring was carried out in accordance with Section 3.1 of the Guideline at these seven (7) locations. The data gathered from each site was then analysed, in accordance with Section 3.4 of the Guideline, together with wind speed data collected within the proposed site in accordance with Section 3.2 of the Guideline.

Establishment of Noise Limits

Noise criteria for the development have been determined in accordance with Section 2.2 of the Guideline. Specifically, the Guideline requires that the predicted wind farm noise level should not exceed 35dBA or background noise $L_{A90,10-min}$ by more than 5dBA, whichever is the greater, at all relevant receivers for the operating wind speed range of the wind farm from cut-in to rated power. Noise limits determined at the seven (7) noise monitoring locations have been applied to all residential properties initially identified.

Assessment of Acceptability of Wind Farm Noise

Noise predictions were undertaken at each identified receiver in accordance with Section 3.3 of the Guideline using the algorithm detailed in ISO9613-2:1996. Predicted noise levels were then compared with the relevant noise limits for each relevant receiver in order to establish compliance with the Guideline.

5.0 RELEVANT RECEIVER ASSESSMENT

5.1 Selection of Relevant Receivers

In total, over 70 dwellings have been considered within the Marilba assessment. Small clusters of dwellings are located to the north, east, south and west, with a somewhat contiguous belt of dwellings, following a north-south line, located further to the east.

The Guideline states that background noise monitoring should be carried out at locations that are relevant for assessing the impact of WTG noise on nearby premises. These locations, termed relevant receivers, are defined within the Guideline as premises at which:

- someone resides or has development approval to build a residential dwelling on and
- the predicted noise level exceeds the relevant base noise level for wind velocities (V_{10m}) of $10ms^{-1}$ or less and
- is representative of the worst-case situation for a cluster of similarly located dwellings.

It should be noted that dwellings located between the Coppabella Hills and Marilba Hills sites have been assessed as part of the Marilba Hills noise impact assessment due to closer proximity. In addition, all dwellings considered within this assessment have been assessed in terms of the cumulative noise impact from the nearby proposed Coppabella Hills and Conroys Gap wind farms.

Dwellings located further than approximately 5km distance from a turbine have not been considered within this assessment because at greater distances, existing ambient noise levels will dominate.

Dwellings with predicted noise levels of 35dB or greater were included for further assessment. From this shortlist, seven (7) relevant receiver locations were selected.

Where a cluster of dwellings occurred in one location, a worst-case determination was made that involved selecting a single dwelling as being representative of the cluster. Factors that were used in this determination included elevation, foliage coverage, topography of surrounding land, proximity to the nearest turbine and of course, overall predicted level.

Table 8 lists all relevant receiver locations where background noise monitoring was undertaken.

Table 8
Relevant receiver locations

Location	Easting (m)	Northing (m)	Elevation above sea level (m)	Distance to closest WTG (km)	Distance to mast (km)	Indicative of cluster
C26*	650347	6153681	427	1.4	4.4	C25, C27, M21
M04	658557	6154944	550	2.2	7.0	M01-03, M20
G14	659547	6150658	597	1.4	6.4	G13, G34, M08
G12*	660201	6149381	590	1.9	7.1	G11, G41
G15*	655374	6149637	550	1.1	2.3	G32-33
G30[W]	652108	6146650	483	2.0	3.9	G16
M18*	652333	6149876	486	1.0	1.0	G31

* Involved landowner. [W] Weather station location.

5.2 Background Noise Monitoring

Background noise monitoring was undertaken at relevant receiver locations over 2-week periods from 5 August to 28 August 2008. The exception to this was at location G14, where an additional week's worth of monitoring was undertaken. The monitoring was conducted during winter in order to establish worst case, lowest, background noise curves.

Noise monitoring loggers were generally placed within 20m of a house and no closer than 5m to any reflective surface (other than the ground). The microphone was positioned at a height of 1.2m above ground level (AGL) for all locations and fitted with a manufacturer-supplied 9cm windshield in order to protect against wind-induced noise across the microphone diaphragm.

The microphone windshields used provide approximately 26dBA of wind noise attenuation up to 20ms^{-1}.

Loggers were placed on each property near the dwelling façade that was on-axis to the nearest proposed turbine location.

Logging was conducted using Acoustic Research Laboratories (ARL) EL316 environmental noise loggers. These are Type-1 measurement devices, certified in accordance with AS1259-1990 or IEC-61672 (*International Electrotechnical Commission 2002*).

Calibration and time drift was checked for each monitoring installation, in addition to collecting site photographs and detailed notations of the immediate surroundings. Factors that could affect the measurements including potential noise sources and unusual topography were noted. Pre and post-measurement calibrations were conducted using a Rion NC-74 Class-1 calibrator complying with IEC60942:1997.

5.3 Weather Station Monitoring

The Guideline requires that any data affected by rainfall or extraneous noise events must be excluded from the assessment. In order to determine rainfall events, a WeatherPro-Plus weather station was installed at dwelling G30 for the duration of the monitoring programme.

Weather data recorded at dwelling G30 captured real-time weather events local to the area. The nearest Bureau of Meteorology weather station with sufficiently detailed climate records (Canberra) was deemed too far away, and would not provide sufficient indication of localised conditions. The onsite weather station recorded local atmospheric pressure, wind velocity and direction, rainfall, temperature and humidity.

The onsite weather station data confirmed that for the entire monitoring period, very little rainfall occurred. The general meteorological conditions for the assessment period were dry and cool.

5.4 Reference Mast Data

Reference mast wind speeds were measured at 10m AGL and in 10-minute intervals corresponding to the background noise measurement period. See Appendix B for mast location in relation to the overall site.

5.5 Data Analysis

Approximately 2000 intervals of measured background noise level $L_{A90,\ 10min}$ data were collected for each relevant receiver. A review of the data was then undertaken in order to determine the occurrence of extraneous noise events (e.g. noise due to rainfall, lawn mowing etc). After excluding all data affected by extraneous noise events, the remaining data were plotted as an XY scatter as a function of the wind velocity at 10m AGL.

A regression analysis was performed for each relevant receiver data set in order to determine the background noise line of best fit. Table 9 summarises the data statistics for each relevant receiver location. The 'R^2' value, also called the coefficient of determination, describes the degree of variability of a set a data. The 'R' value on the other hand, describes the strength of relationship between variables.

Table 9
Relevant Receiver Noise Logger Statistics

Location	Measurement Period	Logger Serial No.	Total Data points	Valid Data points	Correlation R	Correlation R^2
C26*	05/08/08 to 19/08/08	16-707-020	1884	1815	0.62	0.41
M04	05/08/08 to 19/08/08	16-707-021	1775	1718	0.69	0.49
G14	05/08/08 to 19/08/08	16-306-034				
	19/08/08 to 28/08/08	16-707-020	2608	2554	0.34	0.12
G12*	05/08/08 to 19/08/08	16-707-018	1691	1638	0.70	0.50
G15*	05/08/08 to 19/08/08	16-707-019	1654	1615	0.50	0.28
G30*[W]	05/08/08 to 19/08/08	16-707-022	1721	1697	0.57	0.35
M18*	05/08/08 to 19/08/08	16-207-029	1798	1726	0.46	0.24

* Involved landowner [W] Weather station location

It should be noted that data were excluded from each dataset where:

- extraneous noise was indicated (e.g. where low wind speed recorded but elevated background $L_{A90,\ 10min}$ level compared to surrounding data points)
- any measurement coincided with recorded rainfall

Extraneous noise events are defined as any measurement that is 5dB or greater above surrounding measurements.

5.6 Relevant Receiver Noise Assessments

This section describes each monitoring location and the results obtained in terms of the noise criteria assessment conducted in accordance with the Guideline. Photographs of each logger location relative to the dwelling can be found in Appendix F. Please refer to Appendix G for measured L_{90} background noise level and wind speed vs. time graphs for each location.

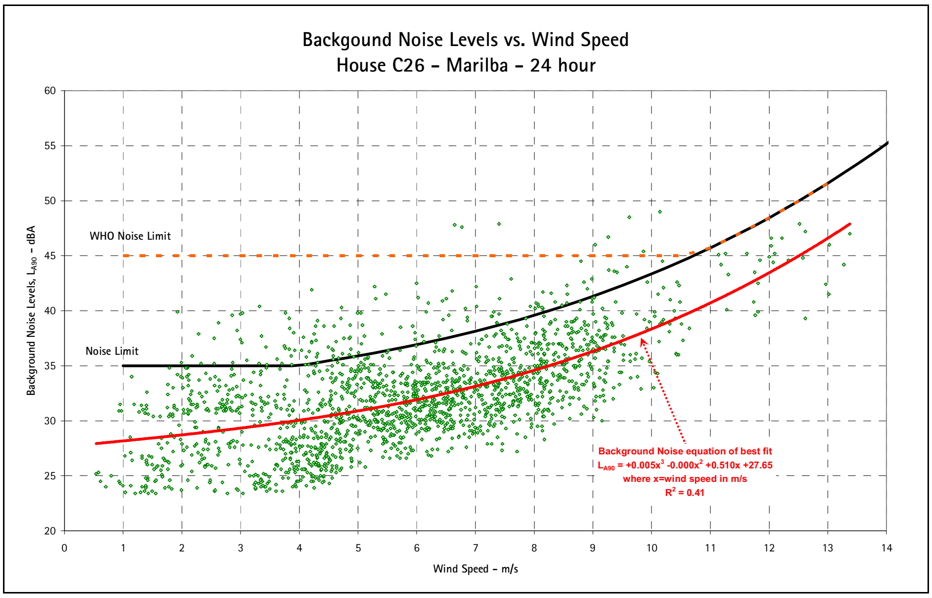
Relevant Receiver C26

Background noise monitoring was carried out at "Mylora" located approximately 7km north of the Hume Highway on Bookham Illalong Road, Bookham, from 5 August to 19 August 2008 using ARL logger EL316 serial no. 16-707-020.

C26 was selected as a monitoring location based on its potential sensitivity to noise limit criteria and its proximity to a small cluster of turbines headed by MRL_16 (approximately 1.4km distance). The environment surrounding the measurement location consisted of tall shelter belts of trees to the west and east, with the location bounded to the east by Bookham Illalong Road. A large pond is located to the south of the dwelling.

A total of 69 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 1 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners are shown.

Figure 1
C26 derived noise limits



Relevant Receiver M04

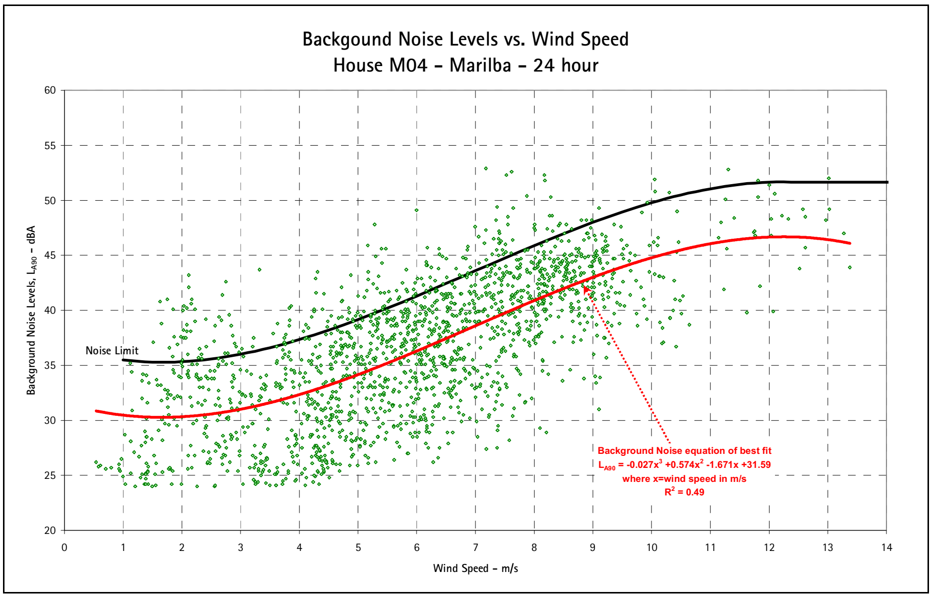
Background noise monitoring was carried out at "The Pines" on George Street, Goondah, from 5 August to 19 August 2008 using ARL logger EL316 serial no. 16-707-021.

M04 was selected as a monitoring location based on its exposed westerly outlook and potential sensitivity to noise limit criteria. Additionally, it was determined that this location was indicative of being worst-case amongst other houses in the cluster (M01-03 & M20) due to its relatively exposed nature and minimal vegetation.

The environment surrounding the measurement location consisted of some sparse but tall trees and smaller plants. The dwelling is bounded to the east by George Street, with the Main South Line (rail) located a further 130m east. Located to the west is Burley Griffin Way, approximately 420m distance from the dwelling.

A total of 57 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 2 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners are shown.

Figure 2
M04 derived noise limits



Relevant Receiver G14

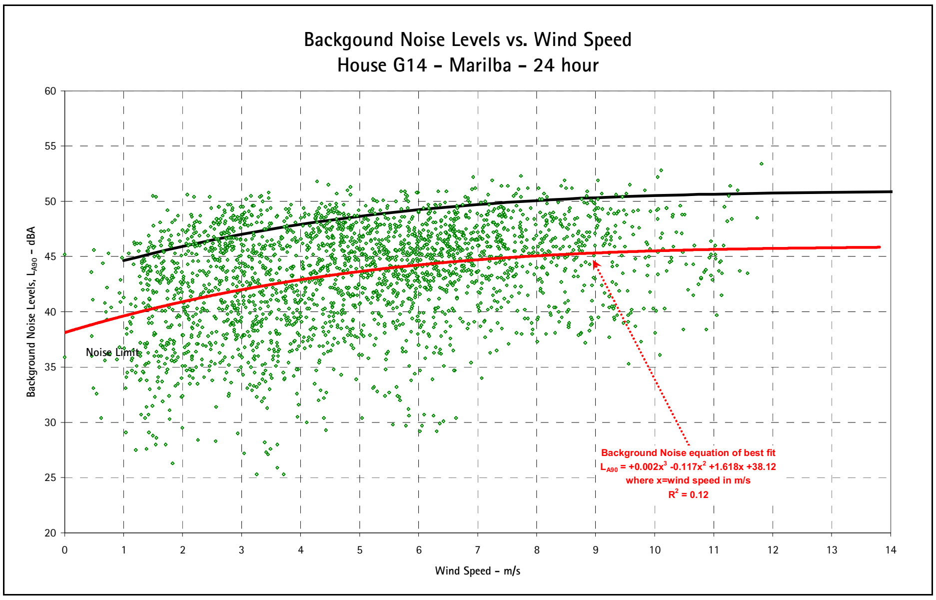
Background noise monitoring was carried out at "Tullyvale Hall" 28327 Hume Highway, Bowning, from 5 August to 19 August 2008 using ARL logger EL316 serial no. 16-306-034.

G14 was selected as a monitoring location based on its potential sensitivity to noise limit criteria and its proximity to a small cluster of turbines headed by MRL_53 (approximately 1.4km distance). Additionally, it was determined that this location was indicative of being worst-case amongst other houses in the cluster (G13, G34 & M08) due to higher predicted noise levels and less surrounding vegetation.

The environment surrounding the measurement location consisted of some sparse but tall trees to the west and south, with an exposed northerly outlook to the north. The dwelling is bounded to the north by the Hume Highway, approximately 200m to the north. The logger was placed on the western façade of the dwelling, with the Marilba-2 ridgeline visible in the distance.

A total of 54 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 3 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners are shown.

Figure 3
G14 derived noise limits



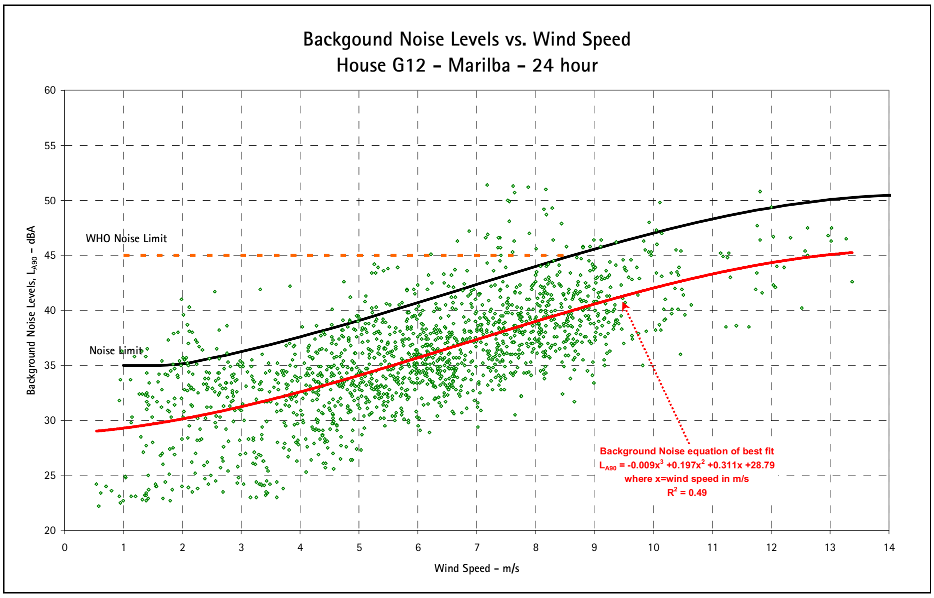
Relevant Receiver G12

Background noise monitoring was carried out at "Ryalda" Graces Flat Road, Bowning, from 5 August to 19 August 2008 using ARL logger EL316 serial no. 16-707-018.

G12 was selected as a monitoring location based on its potential sensitivity to noise limit criteria. The environment surrounding the measurement location consisted of flat, open farmland with shelter belt trees approximately 100m in each direction. The Hume Highway is located 1.6km to the north of the dwelling, with the closest proposed turbine located approximately 1.9km to the west.

A total of 53 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 4 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners are shown.

Figure 4
G12 derived noise limits



Relevant Receiver G15

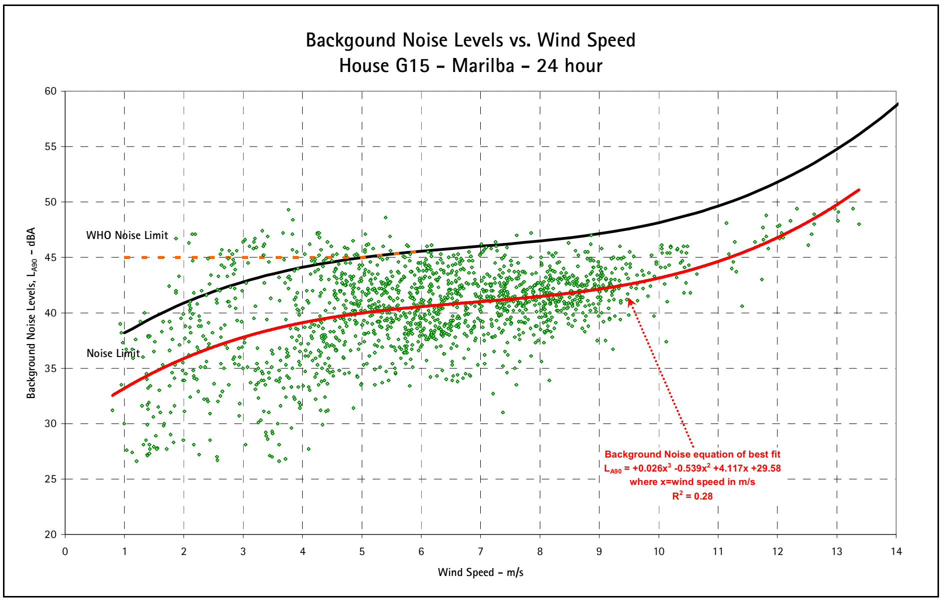
Background noise monitoring was carried out at "Marilba" 28628 Hume Highway, Bowning, from 5 August to 19 August 2008 using ARL logger EL316 serial no. 16-707-019.

G15 was selected as a monitoring location based on its potential sensitivity to noise limit criteria and its proximity to turbines headed by MRL_31 (approximately 1.1km distance). Additionally, it was determined that this location was indicative of worst-case amongst other houses in the cluster (G32 & G33) due to having higher predicted noise levels and exposed south-westerly outlook.

The environment surrounding the measurement location consisted of some sparse but tall trees and smaller plants to the north and east of the dwelling. The Hume Highway is located to the south, approximately 490m distance.

A total of 39 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 5 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners are shown.

Figure 5
G15 derived noise limits



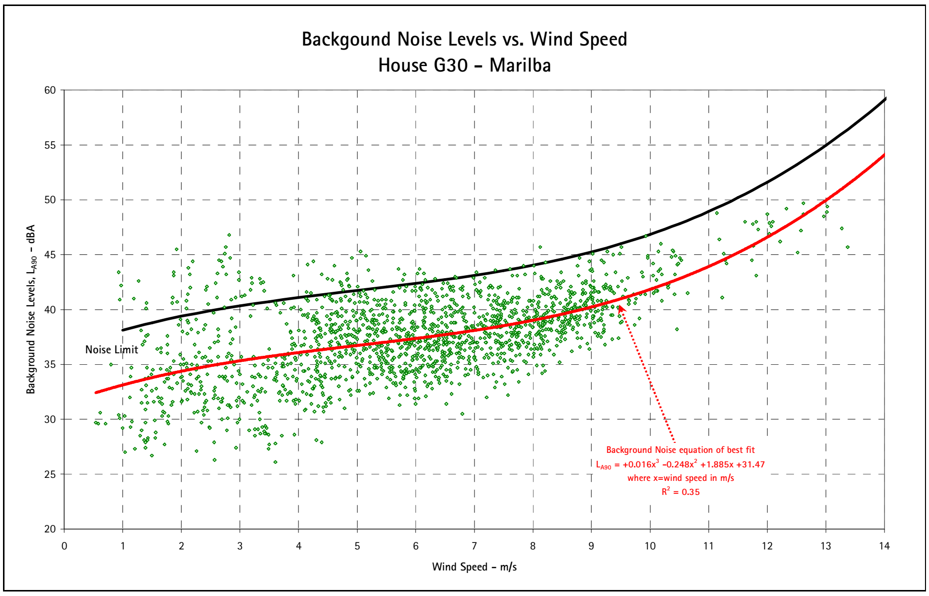
Relevant Receiver G30

Background noise monitoring was carried out at “Bogolong” Hume Highway, Bowning, from 5 August to 19 August 2008 using ARL logger EL316 serial no. 16-707-022.

G30 was selected as a monitoring location based on its potential sensitivity to noise limit criteria and its proximity to turbines headed by MRL_41 (approximately 2km distance). The environment surrounding the measurement location consisted of some sparse but tall trees to the west and south. The Hume Highway is located approximately 1km to the south, with the southern ridgeline of Marilba-1 visible to the east.

A total of 24 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 6 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners are shown.

Figure 6
G30 derived noise limits



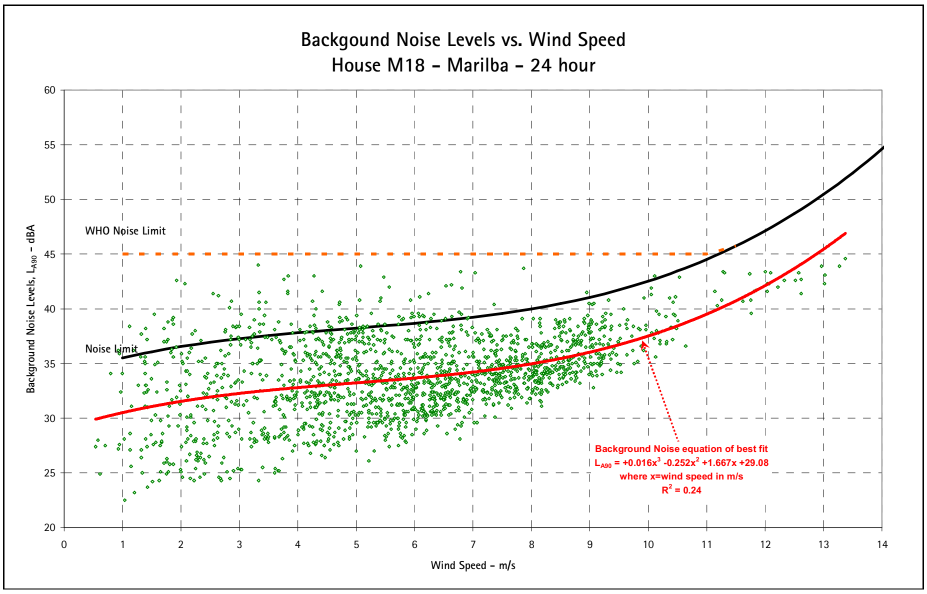
Relevant Receiver M18

Background noise monitoring was carried out at M18, access off Campbells Road, Bookham, from 5 August to 19 August 2008 using ARL logger EL316 serial no. 16-207-029.

M18 was selected as a monitoring location based on its potential sensitivity to noise limit criteria and its proximity to turbines headed by MRL_24 (approximately 1km distance). The dwelling is located at the base of the hill that rises up to the Marilba-1 site. The surrounding area is characterised by flat open pastureland, with the Bookham Illalong Road located approximately 2.3km to the west.

A total of 72 data points were excluded from the analysis due to rain and extraneous noise events. The results of baseline noise monitoring ($L_{A90,10min}$) are shown in Figure 7 below, including the data scatter and regression line of best fit. In addition, guideline noise criteria for non-involved landowners and WHO guideline noise criteria for involved landowners are shown.

Figure 7
M18 derived noise limits



6.0 NOISE LEVEL PREDICTIONS

6.1 Selection of Prediction Model

It has been empirically shown that where the distance between source and receiver is significant, and the intermediate ground displays significant topographic features, ISO9613 predictions are more accurate than CONCAWE and NZS6808[1]. This however requires the use of high quality terrain information, such as can be provided by a digital terrain file. It should be noted that a digital terrain model has been used as one of the input parameters in our modelling.

A study by Bass, Bullmore and Sloth[2] compared three prediction models, IEA Part 4, ISO9613-2 and ENM implementing CONCAWE and found that for flat, rolling and complex terrain sites ISO9613 predicted noise levels to within 1.5dBA accuracy of levels measured under conditions of an $8ms^{-1}$ positive wind vector. Furthermore, they noted that the output of ISO9613 was not unduly sensitive to meteorological input parameters when compared to ENM (CONCAWE).

Furthermore, a study conducted by Hoare Lea Consulting Engineers[3] compared predicted levels using ISO9613 to measured levels at four receiver locations between 100 – 800m from an operational UK wind farm.

The downwind measurements used in the comparison were between +/- 15 to 45 degrees, with hub height wind speeds of 8-14 ms^{-1}. Two ground assumptions were modelled, a hard ground assumption (G=0) and a mixed ground assumption (G=0.5). The report concluded that using ISO9613 with a single wind speed reference offered a robust representation of wind farm noise levels.

It should be noted that ISO9613-2 has been used for wind farm noise level predictions in this report.

6.2 ISO9613-2:1996 Model

Operational wind farm noise levels were predicted to all residential dwellings considered within this assessment using a three-dimensional computer noise model generated in SoundPLAN.

The model was implemented in SoundPLAN version 6.5, which is produced by Braunstein & Berndt GmbH. The SoundPLAN implementation of ISO9613 has been tested in-house by SoundPLAN developers to ensure calculated results are within 0.2dB of the standard. See Appendix H for a description of the attenuation factors used in our calculations.

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[1] Stakeholder Review & Technical Comments – NZS6808:1998 Acoustics- Assessment and measurement of sound from wind turbine generators; 22.0001.06.04(CC,) May 2007.

[2] Bass, Bullmore and Sloth - Development of a wind farm noise propagation prediction model; Contract JOR3-CT95-0051, Final Report, January 1996 to May 1998.

[3] Bullmore, Adcock, Jiggins & Cand – Wind Farm Noise Predictions: The Risks of Conservatism; Presented at the Second International Meeting on Wind Turbine Noise in Lyon, September 2007.

Noise levels were calculated for $9ms^{-1}$ at all receiver locations previously defined.

6.3 Predicted Results

Results of the predicted wind farm noise levels calculated in accordance with ISO9613-2:1996 are presented in Table 10 for the MM92E and V90 3MW.

Table 10
Relevant receiver predicted levels (L_{eq}) in dBA re $2x10^{-5}$ Pa at $9ms^{-1}$

Receiver	MM92E	V90 3MW (80m hub)	V90 3MW (100m hub)	Criteria Limit at $9ms^{-1}$	Comply?
C26*	38	42	42	45	Yes
M04	31	34	35	45	Yes
G14	40	43	43	50	Yes
G12*	39	42	42	45	Yes
G15*	43	46	46	46	Yes
G30	35	39	39	44	Yes
M18*	43	47	47	45	Yes/Marginal

* Involved landowner.

The results in Table 10 show that the representative turbine (MM92E) complies with noise limit criterion at $9ms^{-1}$ at all receiver locations. The results for the worst-case turbine (V90 3MW) indicate a marginally compliant layout. If this turbine is selected for the project, mitigation measures or a layout redesign would be considered.

Furthermore, it can be seen that an increase in hub height from 80m to 100m does not significantly affect receiver noise levels in this instance. It should be noted that the Vestas V90 3MW is the turbine with the greatest sound power level for which data exists and therefore serves as a worst case assessment in terms of sound power level, generating capacity and physical dimensions.

MDA recommends that wind farm noise level predictions be reviewed once warranted sound power levels for the selected turbine have been received from the contracted turbine manufacturer.

Please refer to Appendix I for predicted noise level versus noise limit plots for all relevant receiver locations. Appendix J summarises the predicted levels at each receiver in addition to predicted levels relative to the associated compliance limits. The predicted noise contour plots for Coppabella Hills are presented in Appendix K.

Table 11 summarises the compliance status for each turbine type.

Table 11
Compliance status

Turbine Model	No. of Turbines	Compliance at all receiver locations	Marginal Receivers
MM92E	66	Yes	
V90 3MW (80m hub)	66	Marginally compliant	G11, G31, M18, C25
V90 3MW (100m hub)	66	Marginally compliant	G11, G31, M18, C25

6.4 Cumulative Effect of Other Wind Farm Developments

Separate wind farm developments that are in close proximity to each other have the potential to impact on the same receiver. Therefore it is important to assess the cumulative impact on receivers where such circumstances exist. There are currently no active wind farms in the Yass area however there are a number of sites that are seeking development approval or have gained approval. Figure 12 indicates the locations of these relative to the Marilba Hills site.

Figure 12
Southern Tablelands wind farm sites

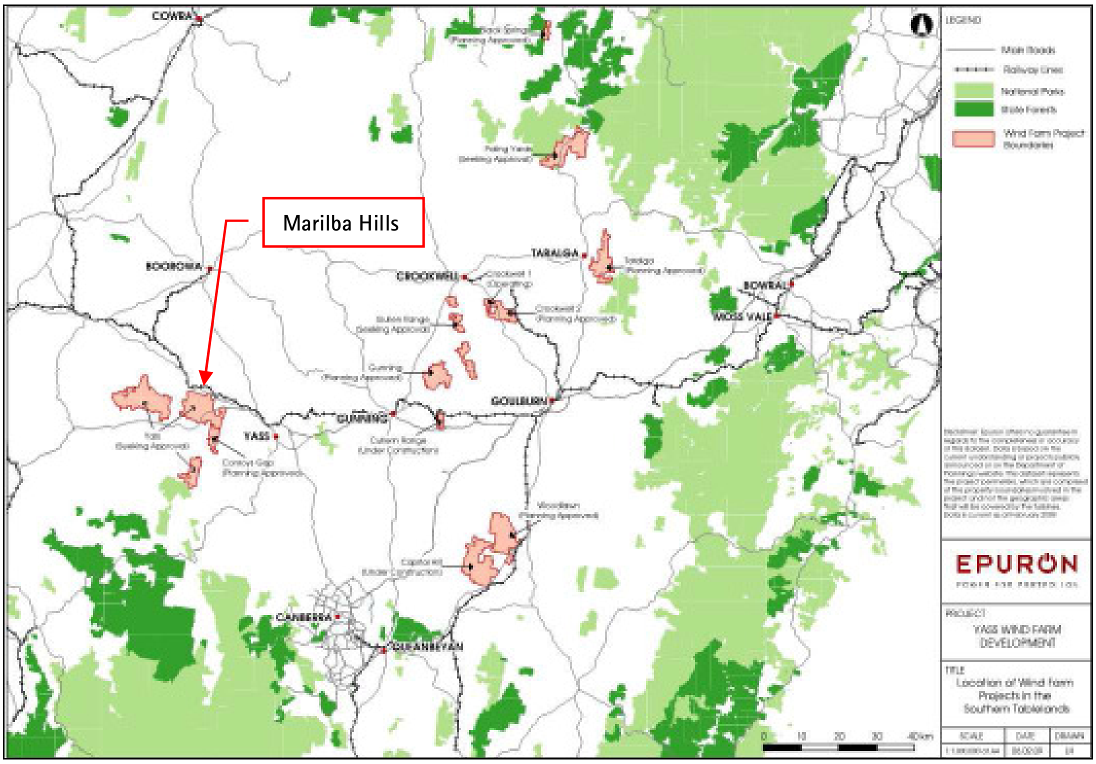

Image courtesy of EPURON

The surrounding sites are as follows:

- Conroys Gap (planning approved) – located approximately 11km to the south-east
- Carrolls Ridge (seeking approval) – located approximately 15km to the south
- Coppabella Hills (seeking approval) – located approximately 4.5km to the west

It should be noted that the cumulative noise emission from Conroys Gap wind farm and Coppabella Hills site have been included in the Marilba Hills noise impact assessment. In addition, the Carrolls Ridge wind farm will not impact receivers around Marilba Hills due to the large separation distance involved.

The cumulative effect of multiple wind farms on total noise level for those receivers previously assessed as part of the Conroys Gap wind farm has also been considered. The Guideline states that any new wind farm should meet the criteria using the background noise levels as they existed before the original wind farm site development. It is noted that our assessment uses the original criteria for Conroys Gap receivers in this instance.

The following table compares the relevant receiver noise levels predicted by Heggies Australia for the Conroys Gap Wind Farm against the cumulative noise level based on all three wind farms operating.

Table 12
Conroys Gap receivers cumulative level comparison in dBA re $2x10^{-5}$ Pa at $8ms^{-1}$

		Cumulative Noise Levels				
Receiver	Conroys Gap Prediction*	MM92E	V90 3MW (80m hub)	V90 3MW (100m hub)	Noise Criteria at $8ms^{-1}$	Comply?
G01	37	37	37	37	42	Yes
G02	35	35	35	35	39	Yes
G04**	38	40	40	40	45	Yes
G10**	41	41	42	42	45	Yes
G11	28	37	40	40	40	Yes
G17	35	36	37	37	37	Yes
G24	35	35	35	35	38	Yes

* Based on REpower MM82 2MW – Heggies report 40-1143-R2 26 July 2006 ** Involved limits apply

From the information summarised in Table 12, it is noted that the cumulative noise emission from the Yass Valley Wind Farm are likely to increase noise levels for Conroys Gap receivers that are in close proximity to the site. This effect is typified by the cumulative noise level at G11, which indicates that an increase of approximately 9-12dB is likely to result.

It is noted that compliance is achieved for both turbine types when considering noise limits based on Heggies' report 40-1143-R2 dated 26 July 2006.

6.5 WTG Tonality Assessment

Where tonality is a characteristic of a turbine's frequency spectrum, the Guideline states that a 5dBA penalty should be added to the cumulative predicted level at each receiver location. Tests for tonality have been independently conducted in accordance with *IEC-61400-11*, the results of which have been supplied to MDA by EPURON.

For the wind speed range considered within this assessment, we understand that tonality is not an audible component of either the MM92E or V90 3MW sound power spectra; therefore no penalty has been applied to the predicted results.

MDA recommends that tonality is assessed as part of the wind farm commissioning process.

6.6 WTG Annoying Characteristics

The Guideline has been developed with the inherent noise characteristic from turbines already taken into account. This includes aerodynamic noise from the blades passing through the air commonly referred to as "swish" or "swoosh".

It should be clarified that infrasound and "swoosh" are two separate characteristics. Infrasound is defined as soundwaves having frequency below the human audible range (below 20Hz).

Historically, turbine design located the rotating blades downwind of the tower, with the turbulence created by the tower being cut through by the blades, resulting in increased low frequency noise. Modern turbine designs have located the blades upwind of the tower and as such exhibit infrasound levels significantly lower than the old downwind design, with measured levels in fact below the threshold of human hearing[4]. In addition, the South Australia EPA has completed an extensive literature search and is not aware of infrasound being present at any modern wind farm site.

In light of these previous findings, no additional penalty has been applied to the predicted equivalent noise level at each receiver due to WTG annoying characteristics including infrasound.

6.7 Health Effects Due To WTG Operation

At receiver locations, any modern wind turbine generator system does not emit sufficient sound power to cause health effects such as have been claimed to be associated with them, including Vibro-Acoustic Disease (VAD). Calculations have shown that to be exposed to conditions similar to those referred to in papers on VAD[5], a receiver would have to be located within several metres of the blade tip of a turbine, and that the exposure would need to be continuous for ten years.

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[4] A McKenzie – Infra-sound, Low Frequency Noise & Vibration from Wind Turbines; AUSWIND 2004

[5] Aviat Space Environ Med. 1999 Mar;70(3 Pt 2):A46-53.Related Articles, Links Echocardiographic evaluation in 485 aeronautical workers exposed to different noise environments

Furthermore, no reputable published studies have shown any causal link between ill health effects and infrasound emitted by turbines. It should be noted that there have been no health-related complaints in South Australia due to wind farm operation.

6.8 Meteorological Effects On Noise Propagation

Meteorological factors such as wind direction, air pressure, temperature and humidity have an effect on the propagation of sound from a noise source. Our noise predictions have been modelled based on air absorption values at 10 degrees Celsius and 70% humidity. Additionally, it is noted that ISO9613-2:1996 predicts noise levels to receivers based on downwind conditions in all directions. In light of this, our meteorological discussion will focus on the effect of atmospheric stability and temperature effects on noise emission from the wind farm.

Atmospheric Stability and Wind Profile

The vertical wind velocity profile (or shear exponent) describes a change in wind velocity as a function of height. Wind velocity is generally at a minimum at ground level and follows an isotropic increase with altitude up to the jet stream. The primary factors that determine the wind velocity profile are ground surface roughness, topography and atmospheric stability.

Atmospheric stability is a measure of the degree to which the atmosphere resists turbulence and vertical motion. It is determined by the net heat flux to the ground, which is the sum of incoming solar and outgoing thermal radiation in addition to thermal exchange with the air and subsoil.

The concept of atmospheric stability can be further explained by considering the daily thermal exchange that occurs due to solar activity. During clear days the net flux is dominated by incoming solar radiation, heating the ground. Air is heated from below and rises, causing thermal turbulence and vertical air movement. As a result of this turbulence, the atmosphere is unstable, preventing significant changes in the vertical wind velocity profile over short distances.

At night the net flux is dominated by outgoing thermal radiation, resulting in cooling of the ground; the air is cooled from below. Vertical thermal turbulence reduces or stops, leading to a decoupling of horizontal layers of the air mass and thus creating greater changes in vertical wind profile over short distances.

The relevance of atmospheric stability to wind farms is that a change in the stability of the atmosphere leads to a change in wind profile and therefore a change in the relationship between background noise level at receiver locations and wind speeds measured at the site of the wind farm.

It is noted that our assessment takes into account the wind profile of the area and it would be expected that mast wind speed measurements made during long-term background noise monitoring would cover all stability conditions.

van den Berg Effect

In 2003, Dr G.P. van den Berg undertook a study of the effect of stable air on wind farm noise emissions at the Rhede Wind Park located in northwest Germany near the Dutch border. He conjectured that during periods where the air was highly stable (mostly at night) noise emissions from the wind farm increased significantly[6].

Dr van den Berg undertook a study of this kind at only one particular site with very specific topographical characteristics. The potential increase of noise levels due to stable air has become known as the eponymous "van den Berg effect" and has been raised on many other wind farm projects where the sites have very different characteristics from the wind farm studied by Dr van den Berg.

The issue of the van den Berg Effect was explored during the Taralga wind farm appeal heard by the Land and Environment Court of NSW[7] (LEC 2006). The judgement handed down by the court noted that the SA Guidelines adopted a very cautious approach to accommodate the impacts of any and all noise effects caused by wind farms by using a lower 35dBA limit instead of 40dBA, as adopted by New Zealand (NZS6808:1998).

A further observation was that if the van den Berg Effect did occur, it would be at night when people were unlikely to be outside their dwellings and the façade effect (estimated at 10dBA) would reduce the transmission of noise to the interior of the house.

The commissioner concluded:

> *I am satisfied that the combination of the low probability of occurrence of the van den Berg Effect, the small number of houses which would be impacted and the infrequent occasions when it did occur (if it did occur), does not warrant the extensive monitoring proposed.*

It was noted in the judgement that a precautionary approach to the possible (albeit low probability) occurrence of the van den Berg Effect would be to consider building remediation to those dwellings proven to be impacted by the phenomenon.

Marshall Day Acoustics has not observed the effect investigated by van den Berg, nor is aware of the phenomenon being reported at any operational Australian wind farm.

[6] G P van den Berg – *Effects of the wind profile at night on wind turbine sound*, Journal of Sound and Vibration, 2003.09.050

[7] Taralga Landscape Guardians Inc vs Minister for Planning and RES Southern Cross Pty Ltd(2007) NSWLEC59

Temperature Inversions

As previously discussed, the SA EPA Guideline has been adopted as the sole basis for this noise impact assessment. It is noted that the Guideline does not specify the inclusion of temperature inversion effects in the assessment. However, in light of the potential for inversions to increase noise levels generally, the phenomenon has been considered in the context of wind farm noise.

In a temperature inversion, the vertical motion in the atmosphere is suppressed due to mild atmospheric conditions (calm and cool conditions that are generally experienced in winter time). Temperature inversions reverse the normal atmospheric temperature gradient i.e. temperature increases with height, rather than decreases. The resulting colder layer of air (in contact with the ground) is trapped beneath a warmer layer of air and can cause sound waves propagating from a sound source below the inversion layer to be refracted downwards. It should be noted that this phenomenon has the most pronounced effect for ground based sources which are below the inversion layer.

The NSW INP has been referenced for guidance when considering temperature inversion effects. Table E3 from the INP indicates that for a moderate Class F inversion to occur, the wind speed required (2-3ms^{-1}) is below the cut-in wind speed for the assessed turbines (3-4ms^{-1}). It should be further noted that at cut-in wind speeds, the assessed turbines are emitting sound power levels between 10-12dB below the levels emitted at rated power.

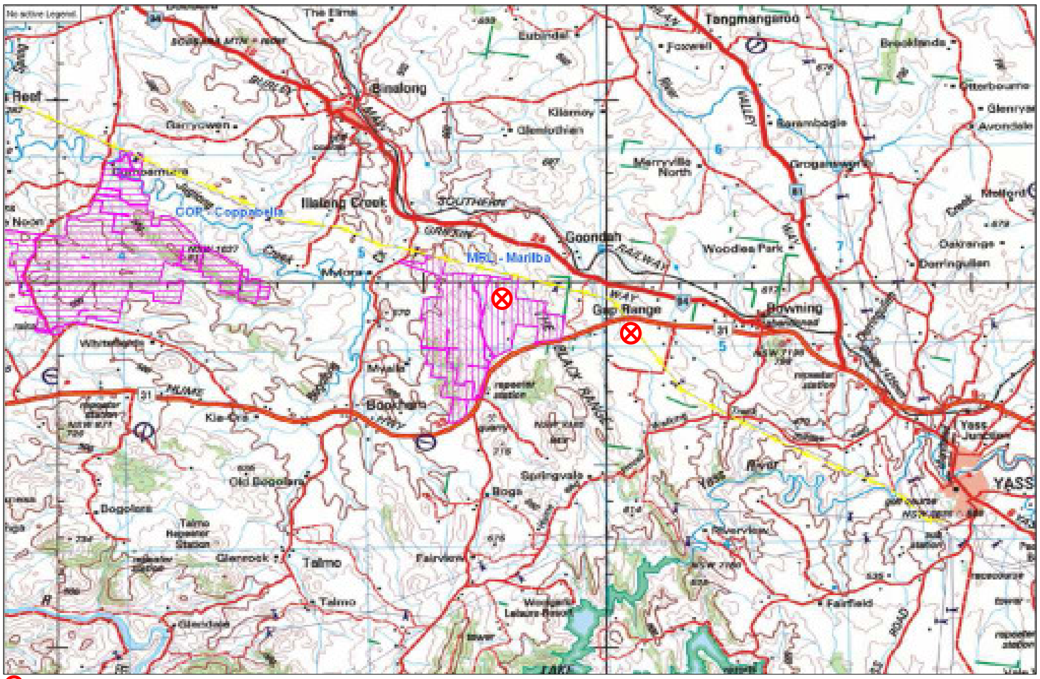
It is noted that ISO9613-2:1996 allows for downwind propagation of sound in all directions, which is analogous to moderate temperature inversion conditions.

Notwithstanding the above, if it is found that elevated wind farm noise levels are occurring as a result of temperature inversion effects then an adaptive management approach could be implemented.

6.9 Transformer Noise Levels

A total of two substations have been proposed for the Marilba Hills site. Each substation is comprised of dual 90MVA transformers which will be used to step-up the incoming voltage from the wind farm to match the 132kV requirement of the transmission line. Figure 13 indicates the proposed locations.

Figure 13
Proposed location of substations



⊗ Approximate substation locations. Image courtesy of EPURON

MDA has estimated the sound power level of each transformer as 101dBA. This level has been estimated from Figure AA1 from Australian Standard AS2374.6-1994 -*Power transformers – Determination of transformer and reactor sound levels.* It is noted that transformers of this nature may display strong tonality at 100Hz, therefore we have applied a +5dB correction to predicted results.

Background noise levels for the night period have been determined in accordance with the procedure detailed in Table 3.1 *Methods for determining background noise* from the *NSW Industrial Noise Policy*. Termed the rating background level (RBL), it is an overall single-figure background level representing the entire night-time period. The RBL is the level used for assessment purposes. Where it is found to be less than 30dBA, then it is set to 30dBA.

Noise levels have been predicted for each dual transformer installation to the nearest dwelling. Predicted noise levels, adjusted for tonality in accordance with Table 4.1 of the NSW Industrial Noise Policy, are detailed in Table 13.

Table 13
Predicted transformer noise levels (L_{eq}) in dBA re $2x10^{-5}$ Pa

Dwelling	Distance to Substation (km)	Predicted Transformer Level L_{eq}, dBA	Night-time RBL dBA	INP Intrusiveness Criteria (L_{90} + 5dB)	Comply?
G36	1.0	<10	30	35	Y
M20	2.5	-	30	35	Y

The predicted levels summarised in Table 13 indicate that noise emission from the closest substation to receivers G36 and M20 will be substantially below existing background noise levels.

MDA recommends that transformer noise level predictions be reviewed once the actual transformer has been selected for the development.

7.0 SITE CONSTRUCTION NOISE IMPACT ASSESSMENT

7.1 Construction Site Noise Sources

Construction tasks associated with the project include the following:

- Access road construction
- Turbine tower foundation construction
- Trench digging to accommodate underground cabling
- Assembly of turbine tower, nacelle and rotor blades.

It should be noted that some rock blasting may be required during the early part of the construction phase. This is covered in Section 7.5.

Equipment required to complete the tasks outlined above include:

- Bulldozer, grader, excavator, dump trucks, roller, concrete trucks, front end loader, crane, blasting dynamite, pneumatic jack hammer etc
- Concrete batching plant (located approximately 850m from the Hume Highway)
- All wheel drive vehicles and flat-bed delivery trucks.

In order to predict noise levels associated with the construction phase, we have used noise level data from previous projects of a similar nature in addition to data obtained from our noise source database. See Appendix L for equipment sound power levels used within this assessment.

7.2 Construction Site Noise Limits

Background noise levels for the day period have been determined in accordance with the procedure detailed in Table 3.1 *Methods for determining background noise* from the *NSW Industrial Noise Policy*. Section 7.3 Table 14 summarises the daytime background noise level for each site.

As detailed in Section 3.3, it is considered appropriate to allow the construction noise level when measured over a 15-minute period ($L_{A10,\ 15min}$) to exceed the background level (L_{A90}) by up to 10dB.

It will be a requirement that all construction companies and construction sub-contractors comply with the noise limits outlined in Section 7.3 Table 14.

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7.3 Construction Noise Assessment

Noise levels associated with the construction of each turbine installation have been predicted based on the sound power levels summarised in Appendix L.

We have predicted noise levels at each relevant receiver location based on a 15-minute assessment period, which is in line with the monitoring period outlined within the *NSW Industrial Noise Policy.*

Table 14 summarises the predicted noise levels at each relevant receiver location.

Table 14
Predicted construction noise level (L_{10}) at each relevant receiver location

Location	Background Noise Level	Limit L_{90}+ 10 dBA	Predicted Noise Level in dBA: Access Road Construction	Turbine Foundation Construction	Cable Trench Digging	WTG Assembly	Concrete Batching
C26*	30	40	33	33	33	<10	-
M04	33	43	10	10	<10	<10	-
G14	39	49	19	19	13	<10	-
G12*	31	41	15	15	<10	<10	-
G15*	34	44	17	17	13	<10	-
G30	34	44	15	15	10	<10	-
M18*	30	40	28	28	25	16	-

* Involved landowner

From the results summarised in Table 14, it can be seen that noise levels associated with the construction of the wind farm are expected to comply with noise limits set in accordance with the DECC *Environmental Noise Control Manual.*

We understand that provision has been made for onsite concrete batching. Should this scenario eventuate, MDA recommends that construction noise level predictions be reviewed. In addition, we recommend that predictions be reviewed once actual construction equipment has been selected for the development.

7.4 Construction Noise Control Measures

With regard to construction activities, reference should be made to *AS2436 – 1981: Guide to noise control on construction, maintenance and demolition sites*, which offers detailed guidance on the control of noise and vibration from demolition and construction activities. In particular, it is proposed that various practices be adopted during construction, including:

- Limiting the hours during which site activities are likely to create high levels of noise or vibration
- Establishing channels of communication between the contractor/developer, Local Authority and residents
- Appointing a site representative responsible for matters relating to noise and vibration
- Monitoring typical levels of noise and vibration during critical periods and at sensitive locations

All site access roads should be kept even so as to mitigate the potential for vibration from trucks.

Furthermore, it is envisaged that a variety of practicable noise control measures will be employed. These may include:

- Selection of machinery with low inherent potential for generation of noise and/or vibration
- Erection of barriers as necessary around items such as generators or high duty compressors
- Siting of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints and the use of vibration isolated support structures where necessary.

7.5 Blasting Assessment

Should bedrock be encountered during foundation excavation, it is possible that blasting may be required. No details are available at this stage however we understand that the minimum distance between blasting and residences is likely to be approximately 700m. At this distance a blast with a maximum instantaneous charge (MIC) of 30kg is unlikely to exceed the limits detailed in Section 3.4 in relation to air blast overpressure and impulsive vibration.

7.6 Vibration Assessment

The following table summarises the typical vibration levels of construction plant items in addition to the applicable vibration limit criteria.

Table 15
Typical construction plant vibration levels

Equipment	Predicted Peak Particle Velocity (mm/s) at 10m*	Predicted Peak Particle Velocity (mm/s) at 700m	Building Conservation Limit (mm/s) **	Impulsive Vibration Limit (mm/s)
Piling	12-30	0.2-0.5	15-50	8.6-17
Loader – breaking kerbs	6-8	0.1-0.13	15-50	8.6-17
15 tonne roller	7-8	0.1-0.13	15-50	8.6-17
7 tonne compactor	5-7	0.08-0.1	15-50	8.6-17
Roller	5-6	0.08-0.09	15-50	8.6-17
Pavement breaker	4.5-6	0.07-0.09	15-50	8.6-17
Bulldozer	2.5-4	0.04-0.06	15-50	8.6-17
Backhoe	1	0.02	15-50	8.6-17
Jackhammer	0.5	0.01	15-50	8.6-17

*Source: *RTA Environmental Noise Management Manual* (2001) ** Frequency dependent

As can be seen from Table 15, the vibration levels for typical construction and demolition plant will comply with building conservation and human exposure to vibration limits at the nearest receiver located 700m away. It should be noted that these vibration levels are indicative only and would be subject to determining the vibration spectra of each source. However, based on the large separation distance, vibration levels are expected to comply.

With respect to vibration dose values from construction activity, MDA has measured a value of $0.22m/s^{1.75}$ at a distance of 10m over the course of a typical day period for general construction. Activities associated with this measurement include impact piling, excavation, crane operation, roller, truck deliveries, jackhammer, vehicle movements and backhoe activity. It should be noted that this is within the range of acceptable vibration dose values for intermittent vibration (0.2-$0.4m/s^{1.75}$) resulting in a low probability of adverse comment.

7.7 Construction Traffic

The following table summarises the predicted daily rates of traffic during construction of up to 66 turbines. These values have been sourced from the report titled *Traffic Impact Study: Proposed Yass Valley Wind Farm – Coppabella Hills, Marilba Hills & Carrolls Ridge Precints* (December 2008) prepared by Bega Duo Designs.

Table 16
Estimated daily construction traffic volumes

Description	Trips per day
Construction and management staff*	54
Precinct setup*	10
Road construction	30
Foundation construction	102
Dust suppression	4
Substation & powerline construction	26
Internal cabling	6
Turbine erection	58

* Light vehicles only

It is understood that design of roads and intersections will be based around the Austroads single unit truck/bus (12.2m in length) however for substation and turbine erection oversize and over-mass B-doubles will be used.

7.8 Construction Traffic Noise Levels

MDA has estimated the current traffic noise levels on the surrounding road network. We have also predicted the increase to traffic noise levels based on the movement of vehicles associated with turbine construction for the Marilba Hills site. See Appendix M for a site overview map of the surrounding road network.

Table 17 summarises the current and estimated traffic counts on the surrounding road network, including percentage of heavy vehicles.

Table 17
Current and estimated traffic volumes in both directions

	Current		Estimated	
Road	AADT	Heavy Vehicle %	AADT	Heavy Vehicle %
Hume Highway at Bowning	7223	38	7463	39
Burley Griffin Way	1661	16	1901	24
Bookham Illalong Road	70	<10*	310	64
Berramangra Settlement Rd	<50	<10*	170	42
Garry Owen Rd	<50	<10*	170	42
Paynes Road	<200	<10*	320	27
Cumbamurra, Coppabella, Coppa Creek, Whitefields Roads	<30	<10*	150	46

* Based on estimates provided by Bega Duo Designs

Within the defined heavy vehicle routes detailed in Appendix M, it is uncertain as to the precise route that each heavy vehicle will take to gain access to the site.

Therefore, we have estimated the increase to traffic noise levels based on all heavy vehicles and staff cars using each major road, that is, the Hume Highway, Burley Griffin Way and Bookham Illalong Road. For smaller roads such as Garry Owen, we have assumed that up to 50% of traffic may use the same route.

MDA has estimated traffic noise levels using the Calculation of Road Traffic Noise (CRTN) algorithm. We have based our estimations on the available traffic count data and site heavy vehicle volumes as summarised in Tables 16 & 17.

Table 18 summarises the current and future estimated traffic noise levels at the nearest receivers.

Table 18
Estimated current and future traffic noise levels ($L_{eq\ 1-hour}$) dBA re $2x10^{-5}$ Pa

Receiver	Current traffic noise level	Future traffic noise level	Change in dB	ECRTN Criterion 7am-10pm ($L_{Aeq\ 1-hour}$)	Comply?
C26*	10	16	+6	55	Yes
M04	37	38	+1	55	Yes
G14	54	55	+1	60	Yes
G12*	44	44	-	60	Yes
G15*	49	49	-	60	Yes
G30	23	24	+1	60	Yes
M18*	31	32	+1	55	Yes

* Involved landowner

The levels summarised in Table 18 indicate that at receiver C26, the increase in traffic noise level is greater than 2dB however it should be noted that all estimated levels comply with ECRTN criterion.

8.0 COMPLIANCE MONITORING

MDA recommends that compliance monitoring be undertaken at regular intervals in order to ensure that the operation of the wind farm complies with noise limits. This monitoring is in addition to the compliance monitoring detailed in the Guideline and should cover all prevailing wind conditions and be conducted at positions representative of the nearest non-involved noise sensitive receivers.

MDA recommends that a monitoring strategy be developed prior to wind farm commissioning.

9.0 CONTINGENCY STRATEGY

Where it is determined that the operational wind farm exceeds noise limits set in the development approval conditions, the following noise mitigation measures may be considered:

- Using active noise control functions of turbines
- Acoustic treatment of receiver dwellings

In the first instance, all reasonable and feasible measures should be undertaken to reduce noise emission from the wind farm to the identified receiver location(s) where non-compliance occurs. The use of active noise control features of each turbine should be used as the primary control function to achieve compliance. If, after implementation of a control strategy, it is determined that excesses still occur then remedial measures should be considered for affected dwellings such as acoustically treating the windows with double glazing.

10.0 CONCLUSION

Noise emission from the Marilba Hills site has been predicted to over 70 dwellings located in the Marilba Hills Precinct near Yass, NSW.

One turbine layout has been assessed, with the predicted noise levels at all receiver locations found to fully comply with noise criteria set in accordance with SA EPA Guidelines and World Health Organisation guidelines for the representative turbine (MM92E).

Worst case turbine noise impacts have been modelled and indicate a marginally compliant layout. MDA recommends mitigation measures or a layout redesign would be required.

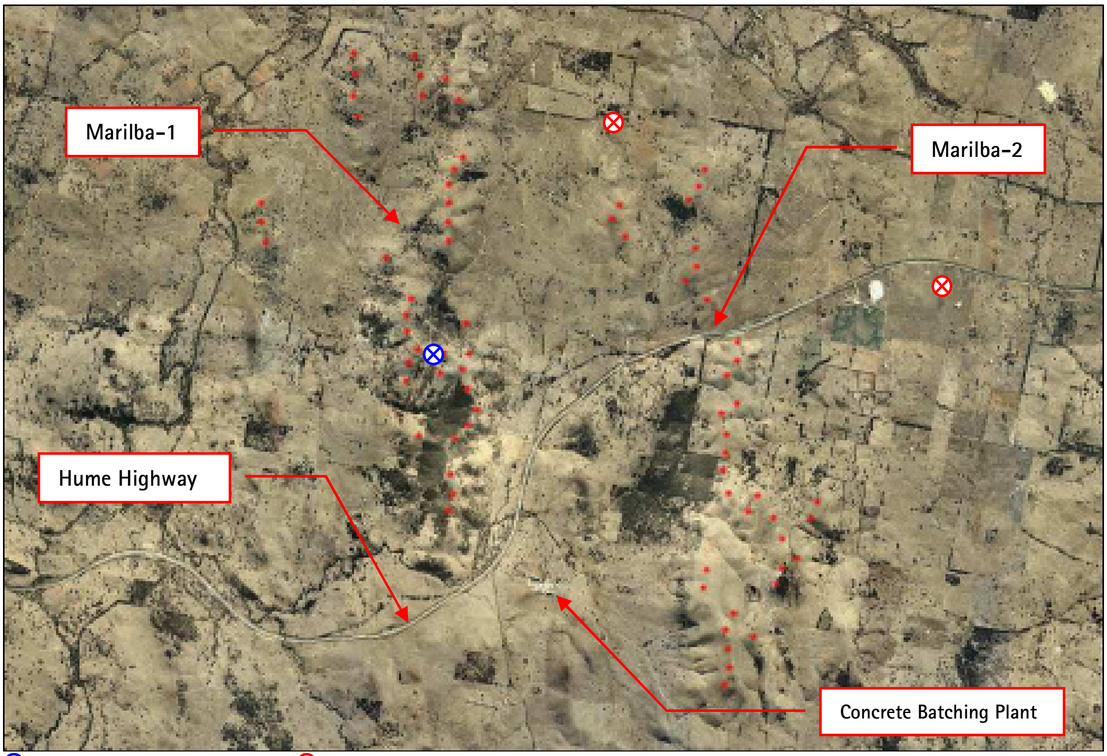
Construction noise and vibration has been assessed and has been found to comply with relevant guidelines. In addition, traffic noise associated with the construction of the wind farm will comply with ECRTN criteria.

Noise and vibration from blasting activities has been assessed and found to comply with ANZEC guidelines. A maximum instantaneous charge (MIC) of approximately 30kg is recommended.

APPENDIX A
ACOUSTIC TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
AGL	Above Ground Level.
dBA	Unit of overall noise level, in A-weighted decibels. The A-weighting approximates the average human response over the entire frequency range.
L_w	Sound power level is the measure of acoustic power radiated by a sound source.
L_{10}	Non-continuous noise levels are described in terms of the level exceeded for 10% of the measurement period (L_{10}). This is commonly referred to as the typical maximum level and is generally measured in dBA.
L_{90}	Background noise levels are described in terms of the level exceeded for 90% of the measurement period (L_{90}). This is commonly referred to as the typical minimum level and is generally measured in dBA.
L_{eq}	Continuous or semi-continuous noise levels are described in terms of the equivalent continuous sound level (L_{eq}). This is the constant sound level over a stated time period which is equivalent in total sound energy to the time-varying sound level measured over the same time period. This is commonly referred to as the average noise level and is generally measured in dBA.
L_{Aeq}	The "A" weighted equivalent continuous sound level.
Octave band	The noise level at a range of individual frequencies can be determined by dividing the frequency range (usually 63Hz to 4kHz) into 7 frequency bands called octave bands, with centre frequencies of 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz and 4kHz.

APPENDIX B
INDICATIVE SITE LAYOUT



⊗ Monitoring mast location ⊗ Proposed substation locations. Image courtesy of EPURON

Table B1

Location	Easting (m)	Northing (m)
Marilba Mast	653197	6150430
Substations:		
MRL A	656372	6153570
MRL B	661371	6150925

APPENDIX C
PRPOSED TURBINE LOCATIONS

Turbine	Easting	Northing	Turbine	Easting	Northing
Coppabella Hills					
COP_01	641141.84	6156569.77	COP_35	637734.71	6154728.57
COP_02	641328.80	6156230.56	COP_36	638034.40	6154843.44
COP_03	641680.85	6155979.76	COP_37	638166.21	6154479.94
COP_04	641967.31	6155722.98	COP_38	638037.58	6154243.37
COP_05	642099.72	6155401.79	COP_39	637761.77	6154114.28
COP_06	642361.55	6155082.24	COP_40	637485.25	6153973.88
COP_07	642670.90	6154792.69	COP_41	640060.51	6154985.99
COP_08	642980.24	6154509.78	COP_42	640049.35	6154673.89
COP_09	643736.42	6154321.18	COP_43	640014.63	6154384.33
COP_10	644120.75	6154082.09	COP_44	639888.78	6154038.25
COP_11	644496.90	6153842.12	COP_45	639464.04	6153587.56
COP_12	644712.42	6153513.92	COP_46	639516.45	6153264.17
COP_13	645051.25	6153228.09	COP_47	639400.40	6153013.34
COP_14	645590.39	6153096.38	COP_48	639307.90	6152751.07
COP_15	646003.79	6153010.05	COP_49	639700.29	6152377.48
COP_16	645833.87	6152763.14	COP_50	640458.28	6154179.56
COP_17	640381.72	6156076.65	COP_51	640492.14	6153813.19
COP_18	640567.82	6155715.39	COP_52	641783.30	6154241.99
COP_19	640848.12	6155409.05	COP_53	640693.44	6153510.48
COP_20	641174.72	6155345.02	COP_54	641113.93	6153632.62
COP_21	638470.99	6156113.57	COP_55	641397.68	6153769.25
COP_22	638226.99	6155966.60	COP_56	641555.84	6154081.20
COP_23	638733.49	6155811.44	COP_57	642115.30	6153126.21
COP_24	638730.79	6155516.30	COP_58	641848.55	6152808.95
COP_25	639063.96	6155074.42	COP_59	641695.34	6152353.95
COP_26	638886.10	6154872.44	COP_60	641924.31	6152502.84
COP_27	639022.16	6154555.90	COP_61	642214.01	6152812.85
COP_28	638845.28	6154224.79	COP_62	642992.32	6152607.21
COP_29	638504.44	6154174.13	COP_63	643511.38	6151853.65
COP_30	638392.83	6153925.33	COP_64	643442.43	6151582.49
COP_31	638212.64	6153718.37	COP_65	644492.82	6150530.25
COP_32	638011.95	6153523.93	COP_66	644669.92	6150208.74
COP_33	637973.18	6153233.88	COP_67	645540.03	6149909.53
COP_34	637788.04	6153025.88	COP_68	645506.95	6149548.71
COP_69	645912.85	6149537.68			

Turbine	Easting	Northing	Turbine	Easting	Northing
COP_70	646130.59	6150400.73	**Marilba Hills**		
COP_71	646492.43	6150200.28	MRL 01	652382	6154635
COP_72	633941.45	6154540.30	MRL 02	652405	6154327
COP_73	633979.79	6154224.49	MRL 03	652379	6153987
COP_74	633501.18	6154330.61	MRL 04	652443	6153673
COP_75	633765.44	6154029.05	MRL 05	653312	6154603
COP_76	633779.71	6153719.79	MRL 06	653407	6154294
COP_77	636938.39	6155490.12	MRL 07	653429	6153999
COP_78	636766.22	6155273.81	MRL 08	653792	6154253
COP_79	636525.48	6154799.73	MRL 09	653997	6153919
COP_80	636701.69	6155005.33	MRL 10	654050	6153041
COP_81	637922.76	6155172.35	MRL 11	653921	6152861
COP_82	638731.17	6156246.21	MRL 12	653839	6152630
COP_83	643622.85	6152121.02	MRL 13	653842	6152346
COP_84	643344.47	6154542.50	MRL 14	653825	6152055
COP_85	644107.15	6150725.34	MRL 15	653835	6151755
COP_86	646109.89	6149703.50	MRL 16	650966	6152351
Conroys Gap			MRL 17	650970	6152060
V01	657797	6146725	MRL 18	651030	6151737
V02	657750	6146448	MRL 19	652880	6151508
V03	658205	6146051	MRL 20	653261	6150880
V04	658089	6145805	MRL 21	653187	6150629
V05	658526	6145702	MRL 22	653201	6150375
V06	658125	6145510	MRL 23	653360	6150101
V07	658150	6145224	MRL 24	653220	6149898
V08	658079	6144965	MRL 25	653181	6149617
V09	657796	6143224	MRL 26	653766	6150044
V10	657776	6142954	MRL 27	653709	6149738
V11	657225	6142566	MRL 28	654107	6150500
V12	657148	6142128	MRL 29	654155	6150037
V13	658451	6140700	MRL 30	654059	6149791
V14	658500	6140304	MRL 31	654126	6149499
V15	658400	6140026	MRL 32	654271	6149176
			MRL 33	654138	6148935
			MRL 34	653938	6148738
			MRL 35	653374	6148775
			MRL 36	653868	6148187
			MRL 38	653909	6147881

Turbine	Easting	Northing	Turbine	Easting	Northing
MRL 39	653845	6147629			
MRL 43	657772	6152855			
MRL 44	657680	6152601			
MRL 45	657519	6152393			
MRL 46	656462	6152313			
MRL 47	656351	6152106			
MRL 48	656548	6151827			
MRL 49	657628	6151652			
MRL 50	657647	6151369			
MRL 51	657475	6151155			
MRL 52	657804	6150859			
MRL 53	658275	6150211			
MRL 54	658270	6149928			
MRL 55	658118	6149706			
MRL 56	658265	6149274			
MRL 57	658027	6149116			
MRL 58	658103	6148797			
MRL 59	658095	6148516			
MRL 60	658049	6148242			
MRL 61	658137	6147895			
MRL 62	658582	6147857			
MRL 63	658436	6147613			
MRL 64	658828	6147521			
MRL 65	659501	6147765			
MRL 66	659407	6147513			
MRL 67	658958	6147197			
MRL 68	659195	6146888			
MRL 69	658964	6146742			
MRL 70	658870	6146506			

APPENDIX D
RECEIVER LOCATIONS

Dwelling	Easting	Northing	Dwelling	Easting	Northing
Coppabella Hills					
C01	634541.63	6152997.75	C36	639230.73	6160371.38
C02	636009.92	6153231.28	C37	635457.4	6159657.3
C03	637353.94	6151270.03	C38	632047.61	6157837.01
C04	641149.01	6150591.98	C39	631508.27	6158554.66
C05	644196.28	6148246.55	C40	630864.01	6158341.98
C06	645147.61	6147452.9	C41	646822.55	6146838.75
C07	631743.84	6154014.29	C42	649145.52	6147576.19
C08	645783.29	6147090.28	C43	652333.09	6149876.1
C09	630848.62	6153136.44	C44	651694.45	6149353.94
C10	632778.32	6150353	C45	652108.76	6146650.6
C11	632017.69	6148189.78	C46	649022.6	6147320.81
C12	634113.98	6149264.93	C47	649751.62	6146653.97
C13	634466.26	6150956.32	C48	649388.38	6146698.94
C14	635386.67	6148215.38	C49	649010.21	6146839.33
C15	634548.03	6147184.98	C50	650453.02	6153370.45
C16	634452.17	6146886.87	C51	648216.03	6159649
C17	636266.59	6146244.22	C52	649583.93	6157887.98
C18	638491.13	6147769.73	Marilba Hills		
C19	639048.75	6148338.14	M01	658885	6154626
C20	639041.86	6147883.43	M02	658967	6154884
C21	640134.02	6147862.72	M03	658590	6154878
C22	641631.69	6147822.54	M04	658557	6154944
C23	643338.44	6147617.67	M05	661995	6152897
C24	650322.43	6151487.97	M06	661362	6152923
C25	650904.9	6151073.18	M07	662307	6152429
C26	650347.2	6153680.92	M08	660245	6151580
C27	651322.47	6154525.59	M09	650218	6146568
C28	648493.38	6156982.64	M10	650154	6146278
C29	645491.2	6156830.33	M11	650177	6146370
C30	643944.43	6159581.14	M12	650051	6146376
C31	645555.86	6160564.77	M13	650548	6145967
C32	644891.64	6161453.05	M14	650095	6146256
C33	644012.22	6160671.31	M15	650134	6146219
C34	643485.25	6160766.39	M16	650156	6146155
C35	639639.84	6159615.3	M17	650120	6146322

Dwelling	Easting	Northing	Dwelling	Easting	Northing
M18	652333	6149876			
M20	658743	6154508			
M21	651854	6155574			
M22	654105	6156790			
M23	651792	6156534			
Conroys Gap					
G01	656955	6140691	G33	655949	6150369
G02	655830	6142160	G34	660167	6151635
G02a	656066	6141866	G35	662856	6150456
G03	654913	6142552	G36	662352	6150964
G04	658616	6142092	G37	662944	6151152
G04a	659368	6143377	G38	662678	6148142
G04b	658267	6142549	G39	663628	6149297
G05	660294	6142075	G41	662272	6147338
G06	661339	6142115	G42	658195	6138491
G07	659736	6143497	G43	656469	6137652
G08	659548	6143435	G44	655423	6136237
G09	660108	6143295	G45	655567	6135982
G10	657463	6144500	G46	659015	6137292
G11	661209	6147630	G47	658669	6137052
G12	660201	6149381	G48	658809	6137051
G13	659983	6150849	G49	658608	6136920
G14	659547	6150658	G50	658702	6136982
G15	655374	6149637			
G16	655027	6147494			
G17	659823	6143216			
G18	662442	6150000			
G19	662932	6149397			
G20	661622	6145660			
G22	663768	6144604			
G23	661185	6144412			
G24	660294	6144222			
G26	654589	6142433			
G27	654358	6139578			
G29	654689	6144675			
G30	652108	6146650			
G31	651694	6149354			
G32	655766	6149602			

APPENDIX E
TURBINE SOUND POWER DATA

Figure E1

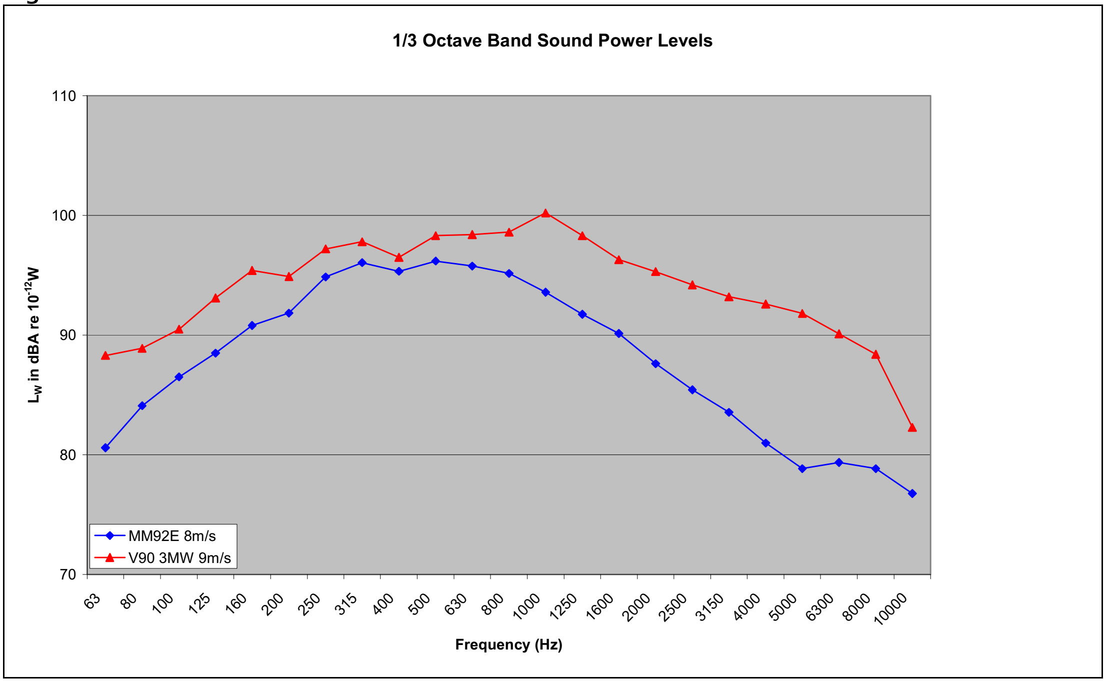


Table E1

Turbine sound power (L_W) in dBA re 10^{-12} W as a function of wind speed

	V_{10} ms^{-1}										
Turbine Type	3	4	5	6	7	8	9	10	11	12	13-15
REpower MM92E	95*	99*	101.6	103.6	104.4	105	105	105	105	105	
Vestas V90 3MW		97*	101.5	105.2	107.6	109	109.4	108.7	109.4	109.4	109.4

* Value extrapolated based on 2nd order polynomial.

It should be noted that test data was not available for the V90 3MW from 11ms^{-1} up to rated power of 15.5ms^{-1}. We have therefore used the maximum sound power level of 109.4dBA at 9ms^{-1} for this wind speed bin range.

APPENDIX F
RELEVANT RECEIVER LOGGER LOCATIONS

Logger location relative to dwelling C26

Logger location relative to dwelling M04

Logger location relative to dwelling G14

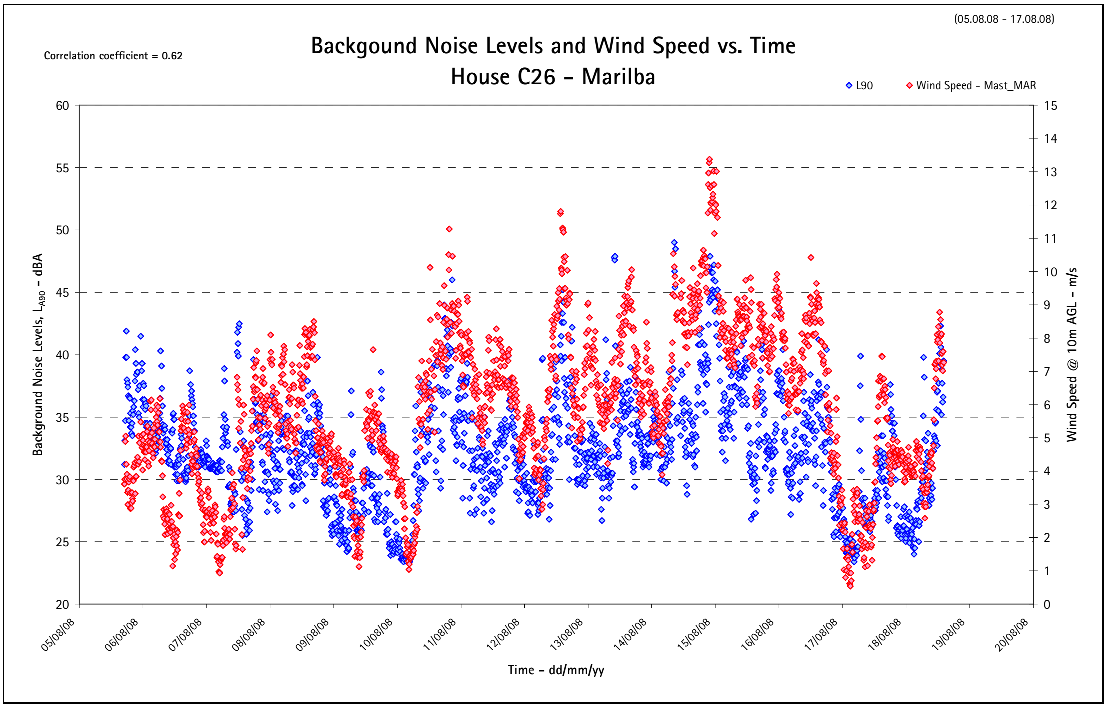
Logger location relative to dwelling G12

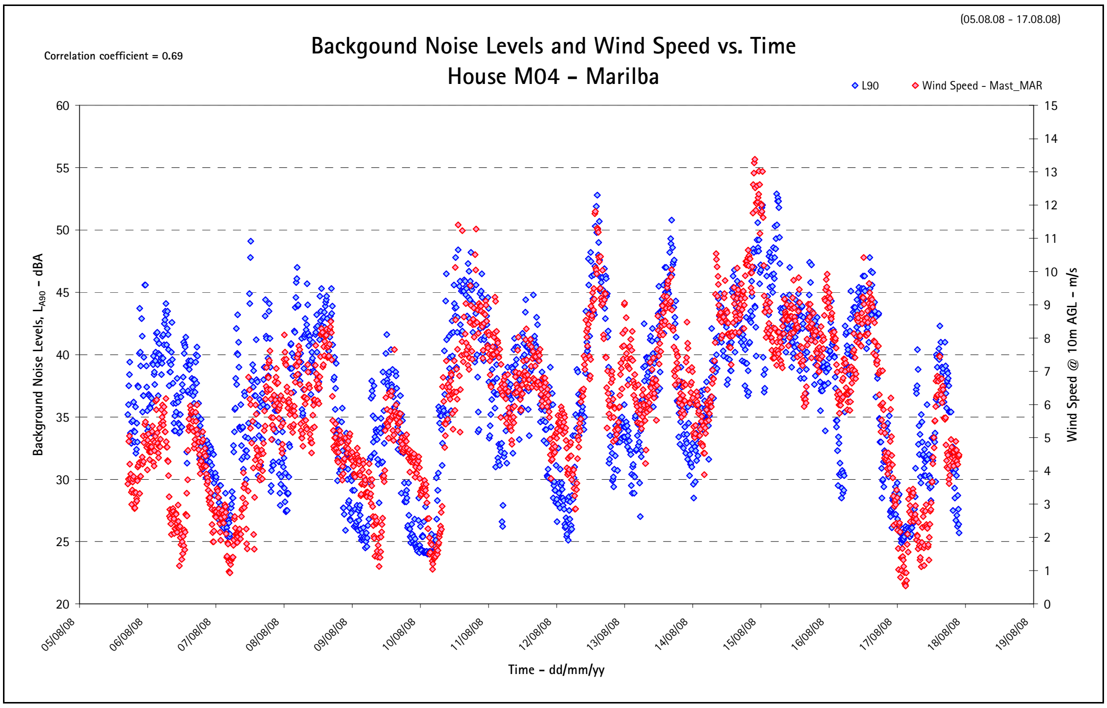
Logger location relative to dwelling G15

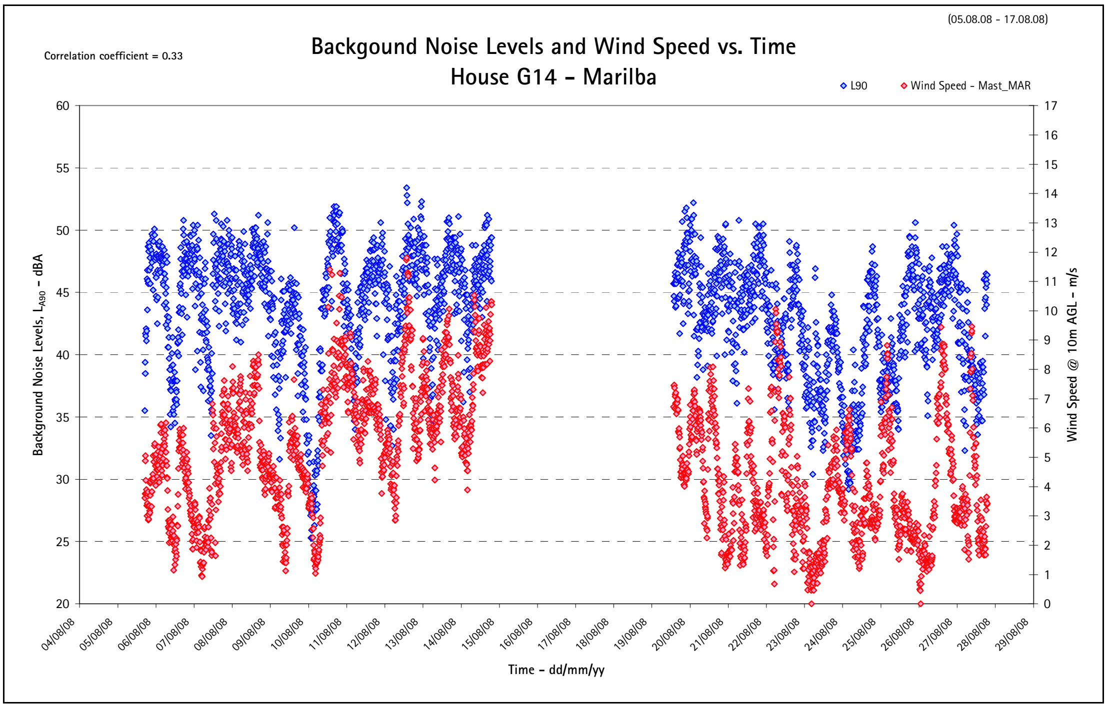
Logger location relative to dwelling G30

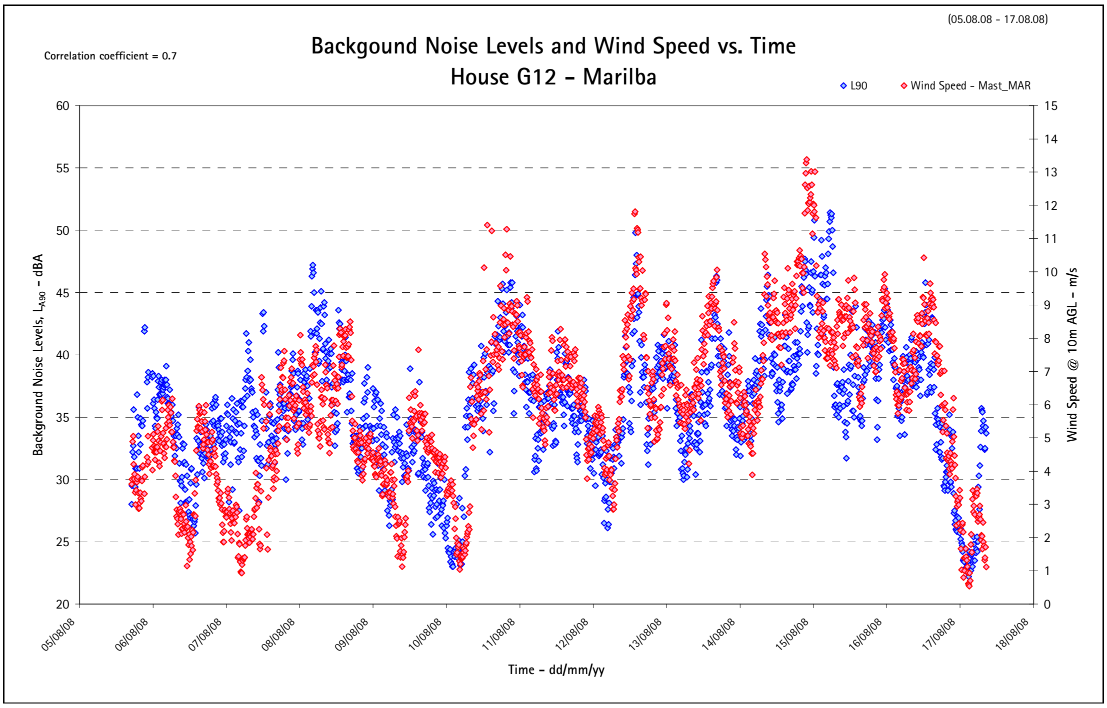
Logger location relative to dwelling M18

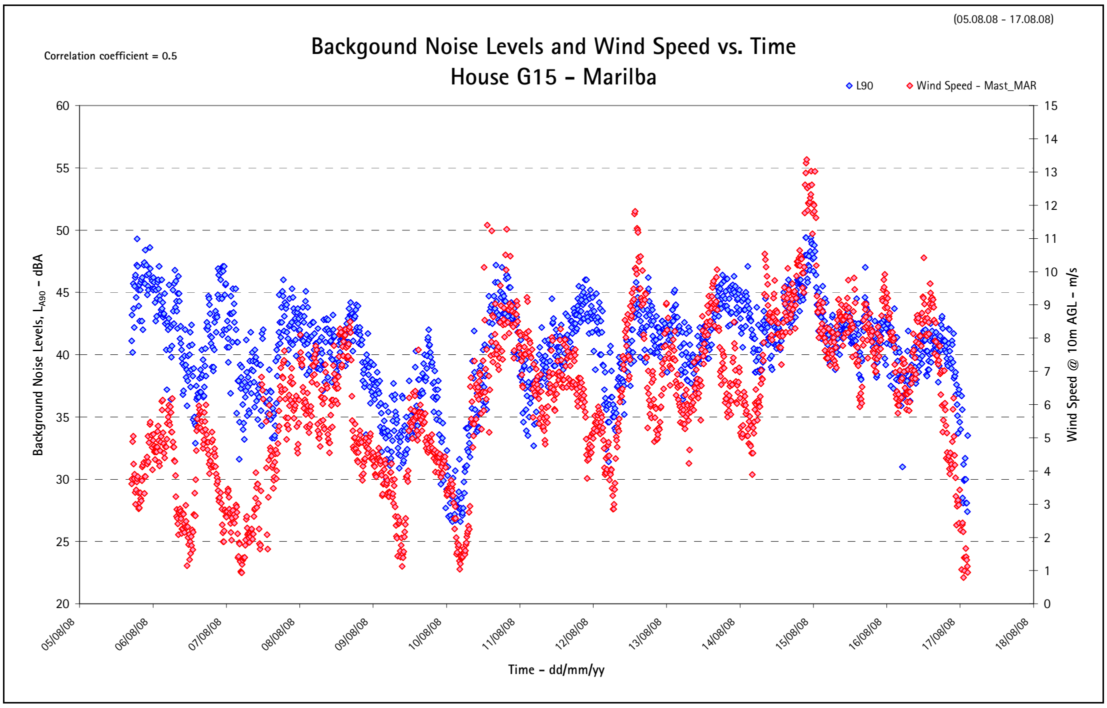
APPENDIX G
RELEVANT RECEIVER MEASURED L_{90} & MAST V_{10} WIND SPEED vs. Time

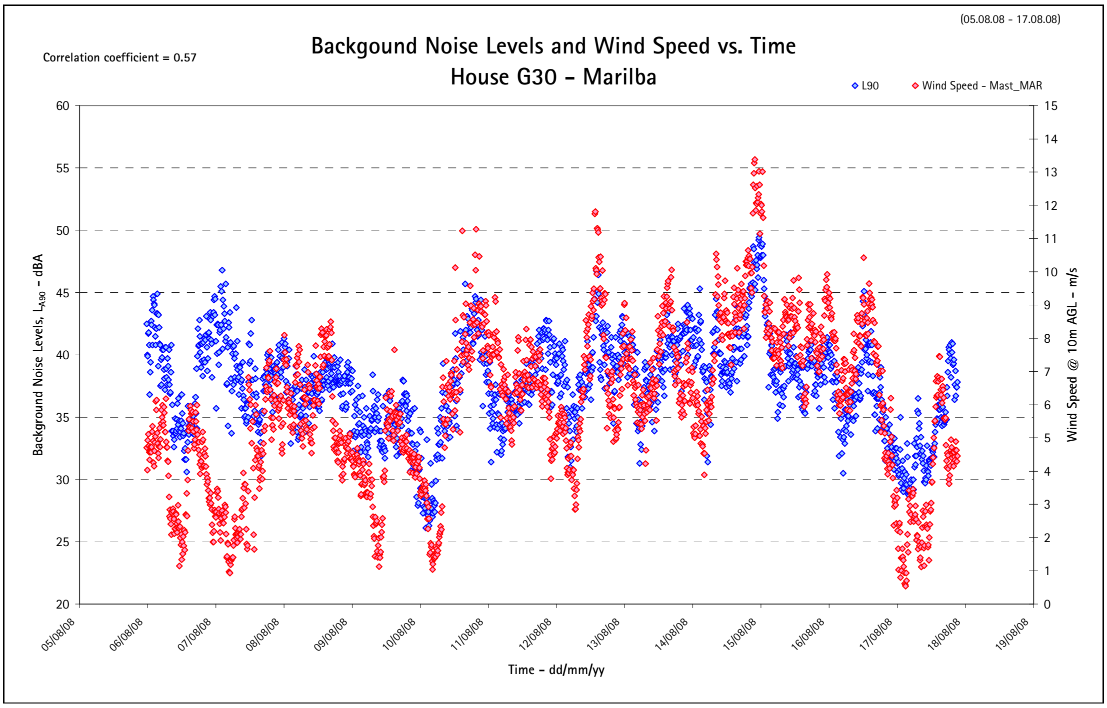


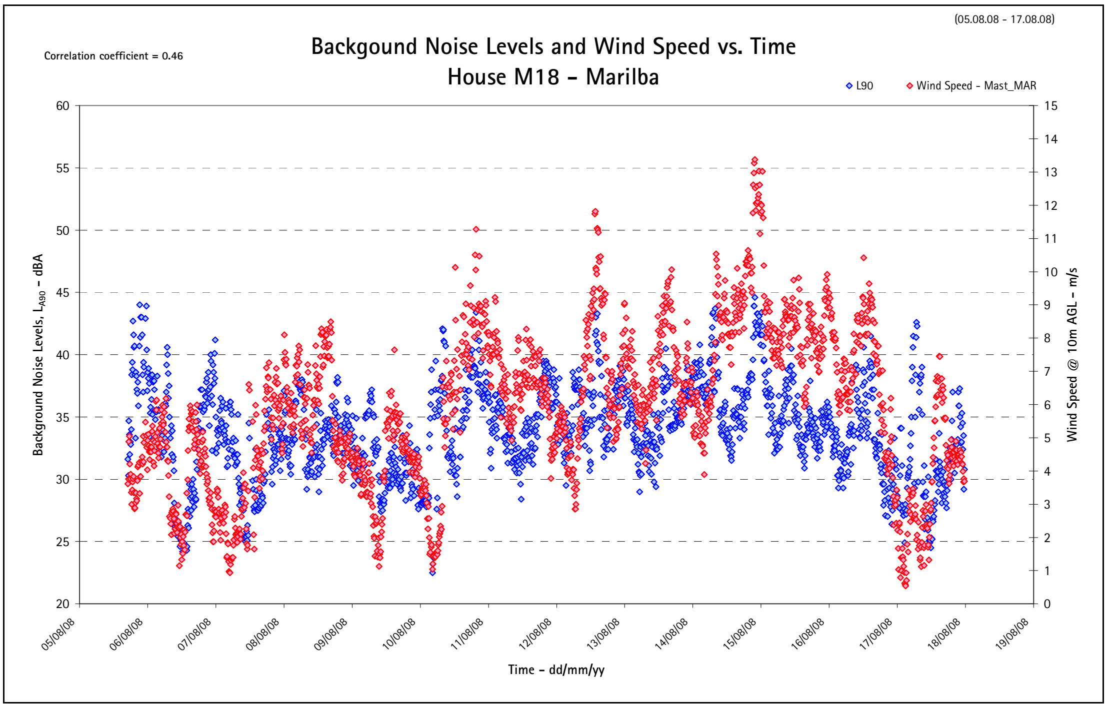



(05.08.08 - 17.08.08)
Correlation coefficient = 0.33
Backgound Noise Levels and Wind Speed vs. Time
House G14 - Marilba
L90
Wind Speed - Mast_MAR
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(05.08.08 - 17.08.08)
Correlation coefficient = 0.7
Backgound Noise Levels and Wind Speed vs. Time
House G12 - Marilba
L90
Wind Speed - Mast_MAR
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(05.08.08 - 17.08.08)
Correlation coefficient = 0.5
Backgound Noise Levels and Wind Speed vs. Time
House G15 - Marilba
L90
Wind Speed - Mast_MAR
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(05.08.08 - 17.08.08)
Correlation coefficient = 0.57
Backgound Noise Levels and Wind Speed vs. Time
House G30 - Marilba
L90
Wind Speed - Mast_MAR
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy


(05.08.08 - 17.08.08)
Correlation coefficient = 0.46
Backgound Noise Levels and Wind Speed vs. Time
House M18 - Marilba
L90
Wind Speed - Mast_MAR
Background Noise Levels, L_{A90} - dBA
Wind Speed @ 10m AGL - m/s
Time - dd/mm/yy
05/08/08
06/08/08
07/08/08
08/08/08
09/08/08
10/08/08
11/08/08
12/08/08
13/08/08
14/08/08
15/08/08
16/08/08
17/08/08
18/08/08
19/08/08

APPENDIX H
ISO 9613-2:1996 ATTENUATION FACTORS

The ISO9613-2: 1996 propagation model predicts sound pressure level at a field point using equation [1]:

$$L_p = L_{Wpoint} + D - A_{div} - A_{atm} - A_{ground} - A_{screen} - A_{misc} \quad [1]$$

where:

L_p is the sound pressure level at a field point, L_{wpoint} is the sound power level of a point source, D is the directivity index of the source in dB, A_n are the attenuation allowances for geometrical divergence, atmospheric absorption, ground hardness, screening and miscellaneous effects.

L_{Wpoint} – Point Source Sound Power Level

The sound power level data for each assessed turbine can be found in Appendix E. The sound power data provided by EPURON has been calculated in accordance with *IEC-61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* and is expressed in terms of A-weighted decibels (dBA), for each integer multiple of the wind speed range of interest in addition to linear 1/3 octave values from 50Hz to 10kHz.

It should be noted that for the wind speed bins where manufacturer-supplied data were not provided (3-4ms^{-1}), we have extrapolated sound power levels based on a 2nd order polynomial.

D – Directivity Factor

The directivity factor (D) allows for an adjustment to be made to the radiated sound power level where the source is understood to radiate higher levels of sound in the direction of interest. It is a convention of the IEC-61400-11 standard that sound power levels are derived from downwind sound pressure level measurements and as such, implies worst-case sound propagation conditions in all directions. As such, no directivity correction has been used in our model.

A_{div} – Unidirectional Spherical Divergence

A WTG is considered to be a point sound source radiating sound energy in a free-field. As such, sound energy propagating distance (r) will be attenuated according to equation [2]:

$$A_{div} = 20\log(r) + 11dB \quad [2]$$

A_{atm} – *Atmospheric Absorption*

Sound propagation through the atmosphere is considered to be a diabatic process in that as the wave front propagates outwards from the source, energy is converted to heat. The attenuation provided by this process is largely dependant on the relative humidity and temperature of the air through which the sound propagates.

Atmospheric attenuation is also frequency dependent, with attenuation increasing as a function of frequency. Table H1 summarises the octave band attenuation values used in our predictions.

Table H1
Octave band atmospheric attenuation coefficients

	Octave band mid frequency (Hz)							
Description	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Atmospheric attenuation (dB/km)	0.1	0.4	1.0	1.9	3.7	9.7	33.1	118.4

The attenuation coefficients summarised in above have been calculated based on 70% humidity, 10 degrees Celsius temperature and an atmospheric pressure of 101.325kPa.

A_{ground} – *Ground Effect*

The ISO9613-2:1996 standard describes three distinct ground surface types, namely hard, porous and mixed ground. The ground effect parameter input into the model uses a hard ground assumption, that is, 100% acoustically hard ground at the source and receiver positions.

A_{screen} – *Acoustic Screening*

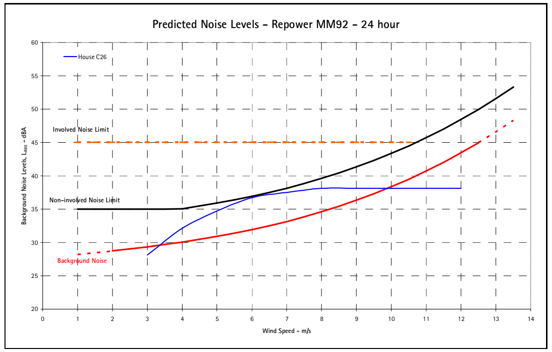
No barrier attenuation assumptions have been used within this model. It should be noted that attenuation due to topographic screening is inherently calculated by SoundPLAN from the digital terrain file.

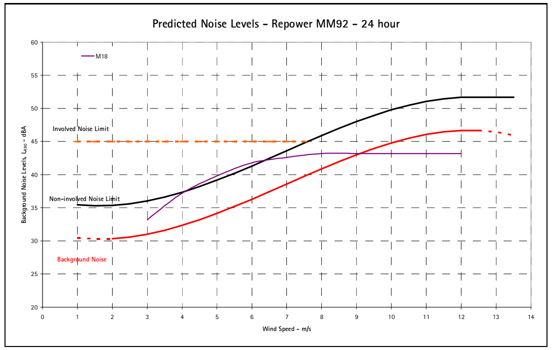
A_{misc} – *Miscellaneous Effects*

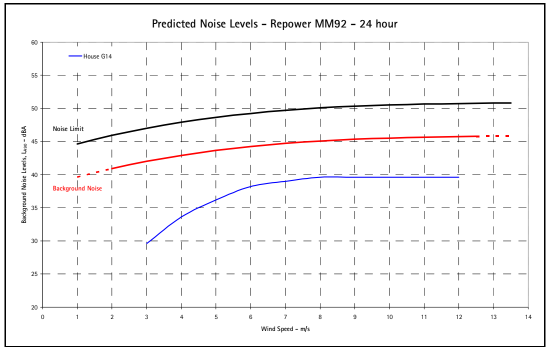
No miscellaneous attenuation affects have been used within this model.

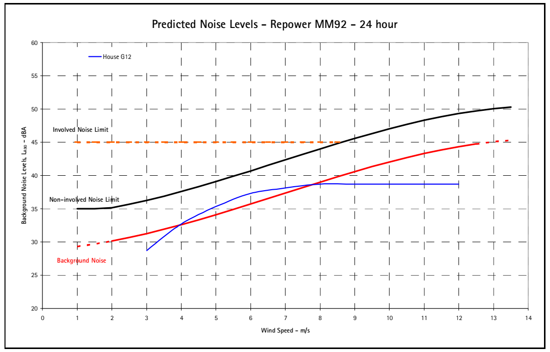
MARSHALL DAY Acoustics

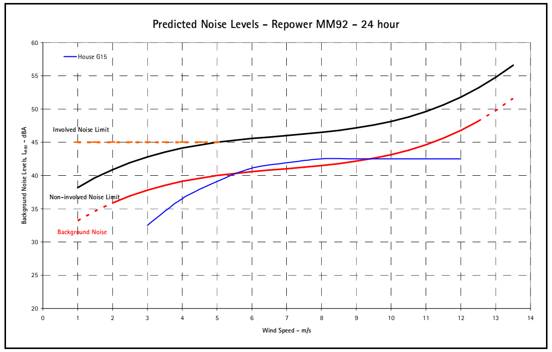
APPENDIX I
RELEVANT RECEIVER PREDICTED NOISE LEVELS vs NOISE LIMITS

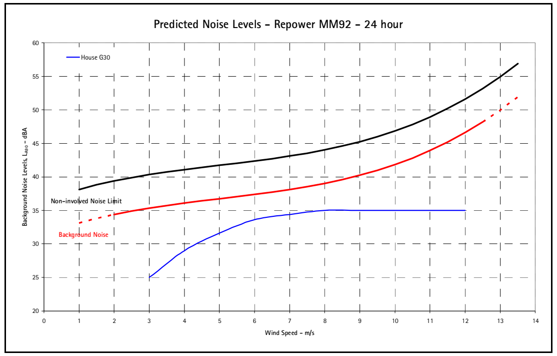


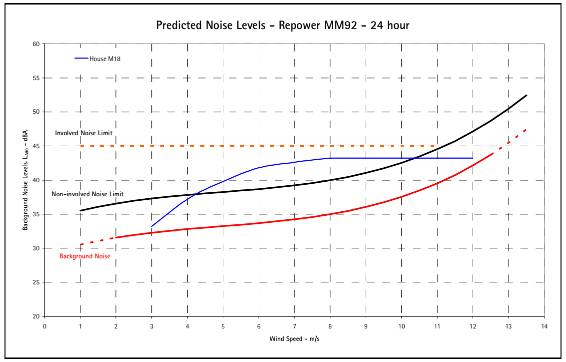


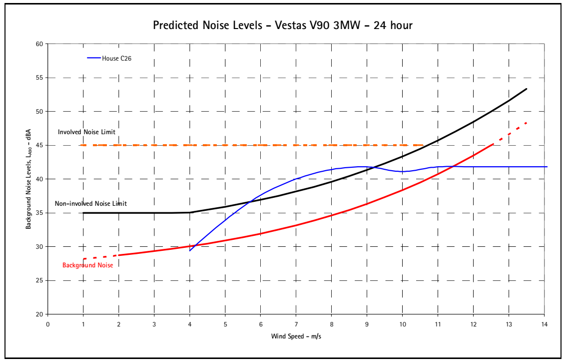


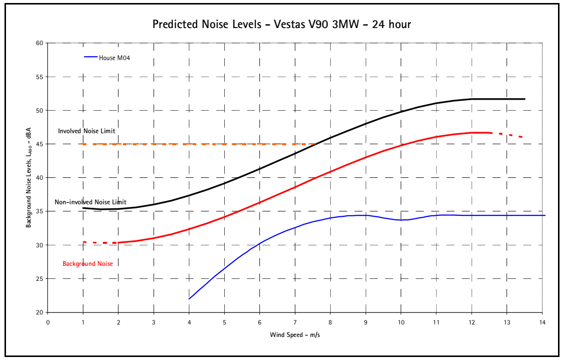


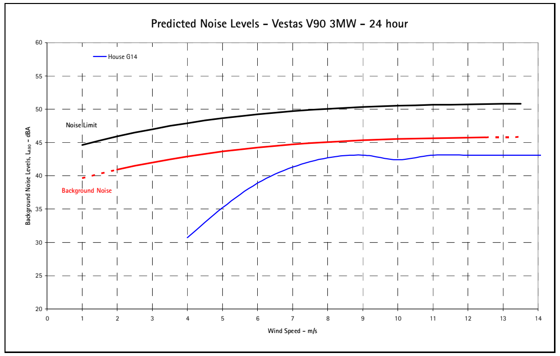


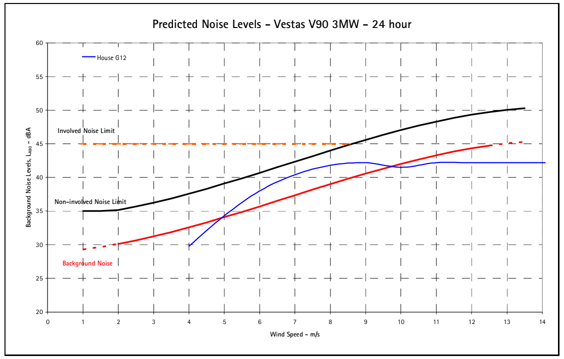


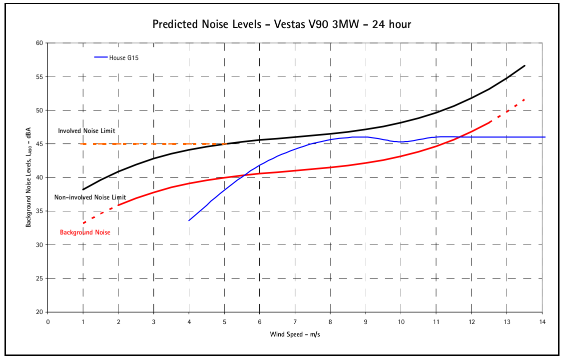

Predicted Noise Levels - Repower MM92 - 24 hour
House M18
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_{A90} - dBA
Wind Speed - m/s
60
55
50
45
40
35
30
25
20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

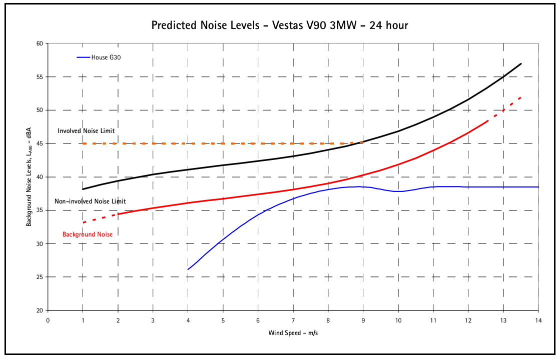

Predicted Noise Levels - Vestas V90 3MW - 24 hour
House C26
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_A90 - dBA
Wind Speed - m/s

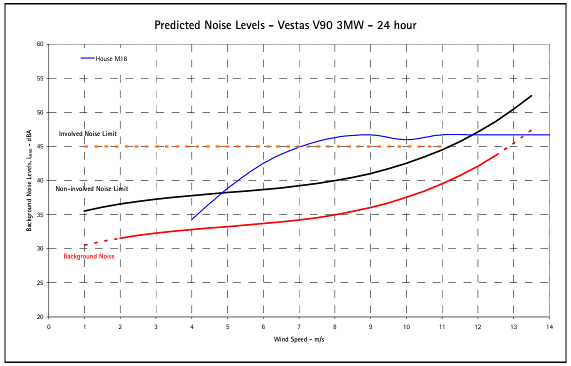

Predicted Noise Levels - Vestas V90 3MW - 24 hour
House M04
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_A90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Vestas V90 3MW - 24 hour
House G14
Noise Limit
Background Noise
Background Noise Levels, L_A90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Vestas V90 3MW - 24 hour
House G12
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_A90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Vestas V90 3MW - 24 hour
House G15
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_A90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Vestas V90 3MW - 24 hour
House G30
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L_A90 - dBA
Wind Speed - m/s


Predicted Noise Levels - Vestas V90 3MW - 24 hour
House M18
Involved Noise Limit
Non-involved Noise Limit
Background Noise
Background Noise Levels, L A90 - dBA
Wind Speed - m/s
60
55
50
45
40
35
30
25
20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

APPENDIX J
RECEIVER PREDICTED NOISE LEVELS RELATIVE TO COMPLIANCE LIMITS

Receiver	Associated Compliance	Prediction @ 9m/s	Difference Between Compliance Limits and Predicted Noise Levels - MM92 80m Hub									
			3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
G01	G04	37.1	-7.9	-3.9	-1.3	-0.3	-2.4	-4.8	-7.6	-9.9	-11.6	-12.4
G02	G02	35	-17.3	-9.9	-5.6	-3.3	-3.3	-4.4	-6.8	-9.7	-12.7	-15.8
G02a	G02	37	-15.3	-7.9	-3.6	-1.3	-1.3	-2.4	-4.8	-7.7	-10.7	-13.8
G03	G02	31.4	-20.9	-13.5	-9.2	-6.9	-6.9	-8.0	-10.4	-13.3	-16.3	-19.4
G04*	G04	39.5	-15.5	-11.5	-8.9	-6.9	-6.1	-5.5	-5.5	-7.5	-9.2	-10.0
G04a*	G04	35.1	-19.9	-15.9	-13.3	-11.3	-10.5	-9.9	-9.9	-11.9	-13.6	-14.4
G04b*	G04	42.7	-12.3	-8.3	-5.7	-3.7	-2.9	-2.3	-2.3	-4.3	-6.0	-6.8
G05	G17	33.8	-11.2	-7.2	-4.6	-2.6	-2.6	-3.3	-4.9	-6.5	-8.3	-10.0
G06	G17	25.8	-19.2	-15.2	-12.6	-10.6	-10.6	-11.3	-12.9	-14.5	-16.3	-18.0
G07	G17	36.1	-8.9	-4.9	-2.3	-0.3	-0.3	-1.0	-2.6	-4.2	-6.0	-7.7
G08*	G17	36.4	-18.6	-14.6	-12.0	-10.0	-9.2	-8.6	-8.6	-8.6	-8.6	-8.6
G09*	G17	35	-20.0	-16.0	-13.4	-11.4	-10.6	-10.0	-10.0	-10.0	-10.0	-10.0
G10*	G10	41.3	-13.7	-9.7	-7.1	-5.1	-4.3	-3.7	-3.7	-3.7	-3.7	-3.7
G11	G11	37.3	-11.5	-6.4	-3.5	-1.8	-1.8	-2.6	-4.2	-6.2	-8.2	-10.3
G12*	G12	38.7	-16.3	-12.3	-9.7	-7.7	-6.9	-6.3	-6.9	-8.3	-9.6	-10.6
G13	G14	37.7	-19.3	-16.2	-14.3	-12.9	-12.6	-12.4	-12.6	-12.8	-12.9	-13.0
G14	G14	39.6	-17.4	-14.3	-12.4	-11.0	-10.7	-10.5	-10.7	-10.9	-11.0	-11.1
G15*	G15	42.5	-12.5	-8.5	-5.9	-4.5	-4.1	-4.0	-4.6	-5.6	-7.1	-9.3
G16	G15	40.7	-12.1	-9.4	-7.7	-6.3	-5.9	-5.8	-6.4	-7.4	-8.9	-11.1
G17	G17	35.7	-9.3	-5.3	-2.7	-0.7	-0.7	-1.4	-3.0	-4.6	-6.4	-8.1
G18	G12	32.3	-13.9	-11.3	-10.2	-9.8	-10.6	-11.7	-13.3	-14.7	-16.0	-17.0
G19	G12	31.3	-14.9	-12.3	-11.2	-10.8	-11.6	-12.7	-14.3	-15.7	-17.0	-18.0
G20	G11	32.9	-15.9	-10.8	-7.9	-6.2	-6.2	-7.0	-8.6	-10.6	-12.6	-14.7
G22	G11	27.1	-21.7	-16.6	-13.7	-12.0	-12.0	-12.8	-14.4	-16.4	-18.4	-20.5
G23	G24	29.9	-15.1	-11.1	-8.5	-6.5	-6.6	-7.6	-9.6	-11.9	-14.3	-16.7
G24	G24	34.5	-10.5	-6.5	-3.9	-1.9	-2.0	-3.0	-5.0	-7.3	-9.7	-12.1
G26	G02	31.7	-20.6	-13.2	-8.9	-6.6	-6.6	-7.7	-10.1	-13.0	-16.0	-19.1
G27	G02	18.3	-34.0	-26.6	-22.3	-20.0	-20.0	-21.1	-23.5	-26.4	-29.4	-32.5
G29	G10	32.9	-15.5	-11.7	-9.3	-7.4	-6.9	-6.6	-7.1	-7.8	-8.7	-9.9
G30	G30	35	-15.3	-12.1	-10.1	-8.8	-8.7	-9.0	-10.2	-11.8	-13.9	-16.6
G31	M18	39.8	-7.5	-4.0	-1.8	-0.3	0.0	-0.2	-1.2	-2.7	-4.7	-7.3
G32	G15	41.7	-11.1	-8.4	-6.7	-5.3	-4.9	-4.8	-5.4	-6.4	-7.9	-10.1
G33	G15	41.8	-11.0	-8.3	-6.6	-5.2	-4.8	-4.7	-5.3	-6.3	-7.8	-10.0
G34	G14	36.2	-20.8	-17.7	-15.8	-14.4	-14.1	-13.9	-14.1	-14.3	-14.4	-14.5
G35	G14	30.4	-26.6	-23.5	-21.6	-20.2	-19.9	-19.7	-19.9	-20.1	-20.2	-20.3
G36	G14	31	-26.0	-22.9	-21.0	-19.6	-19.3	-19.1	-19.3	-19.5	-19.6	-19.7
G37	G14	30	-27.0	-23.9	-22.0	-20.6	-20.3	-20.1	-20.3	-20.5	-20.6	-20.7
G38	G11	32.6	-16.2	-11.1	-8.2	-6.5	-6.5	-7.3	-8.9	-10.9	-12.9	-15.0
G39	G12	25.1	-21.1	-18.5	-17.4	-17.0	-17.8	-18.9	-20.5	-21.9	-23.2	-24.2
G41	G11	33.7	-15.1	-10.0	-7.1	-5.4	-5.4	-6.2	-7.8	-9.8	-11.8	-13.9
G42	G11	33.5	-15.3	-10.2	-7.3	-5.6	-5.6	-6.4	-8.0	-10.0	-12.0	-14.1
G43	G11	27.7	-21.1	-16.0	-13.1	-11.4	-11.4	-12.2	-13.8	-15.8	-17.8	-19.9
G44	G11	13	-35.8	-30.7	-27.8	-26.1	-26.1	-26.9	-28.5	-30.5	-32.5	-34.6
G45	G11	12.6	-36.2	-31.1	-28.2	-26.5	-26.5	-27.3	-28.9	-30.9	-32.9	-35.0
G46	G11	19.4	-29.4	-24.3	-21.4	-19.7	-19.7	-20.5	-22.1	-24.1	-26.1	-28.2
G47	G11	26.5	-22.3	-17.2	-14.3	-12.6	-12.6	-13.4	-15.0	-17.0	-19.0	-21.1
G48	G11	25.4	-23.4	-18.3	-15.4	-13.7	-13.7	-14.5	-16.1	-18.1	-20.1	-22.2
G49	G11	26.6	-22.2	-17.1	-14.2	-12.5	-12.5	-13.3	-14.9	-16.9	-18.9	-21.0
G50	G11	26.2	-22.6	-17.5	-14.6	-12.9	-12.9	-13.7	-15.3	-17.3	-19.3	-21.4
M01	M04	33	-13.0	-10.3	-9.6	-9.7	-11.2	-12.9	-15.0	-16.8	-18.1	-18.7
M02	M04	32.4	-13.6	-10.9	-10.2	-10.3	-11.8	-13.5	-15.6	-17.4	-18.7	-19.3
M03	M04	33.9	-12.1	-9.4	-8.7	-8.8	-10.3	-12.0	-14.1	-15.9	-17.2	-17.8
M04	M04	30.6	-15.4	-12.7	-12.0	-12.1	-13.6	-15.3	-17.4	-19.2	-20.5	-21.1
M05	G14	30.2	-26.8	-23.7	-21.8	-20.4	-20.1	-19.9	-20.1	-20.3	-20.4	-20.5
M06	G14	31.6	-25.4	-22.3	-20.4	-19.0	-18.7	-18.5	-18.7	-18.9	-19.0	-19.1
M07	G14	30	-27.0	-23.9	-22.0	-20.6	-20.3	-20.1	-20.3	-20.5	-20.6	-20.7
M08	G14	36	-21.0	-17.9	-16.0	-14.6	-14.3	-14.1	-14.3	-14.5	-14.6	-14.7
M09	C42	28.4	-21.8	-18.2	-16.1	-14.7	-14.6	-14.8	-15.6	-16.5	-17.4	-18.4
M10	C42	29.1	-21.1	-17.5	-15.4	-14.0	-13.9	-14.1	-14.9	-15.8	-16.7	-17.7
M11	C42	29.1	-21.1	-17.5	-15.4	-14.0	-13.9	-14.1	-14.9	-15.8	-16.7	-17.7
M12	C42	29.6	-20.6	-17.0	-14.9	-13.5	-13.4	-13.6	-14.4	-15.3	-16.2	-17.2
M13	C42	30.5	-19.7	-16.1	-14.0	-12.6	-12.5	-12.7	-13.5	-14.4	-15.3	-16.3
M14	C42	29.4	-20.8	-17.2	-15.1	-13.7	-13.6	-13.8	-14.6	-15.5	-16.4	-17.4
M15	C42	29.8	-20.4	-16.8	-14.7	-13.3	-13.2	-13.4	-14.2	-15.1	-16.0	-17.0
M16	C42	30.1	-20.1	-16.5	-14.4	-13.0	-12.9	-13.1	-13.9	-14.8	-15.7	-16.7
M17	C42	29.2	-21.0	-17.4	-15.3	-13.9	-13.8	-14.0	-14.8	-15.7	-16.6	-17.6
M18*	M18	43.2	-11.8	-7.8	-5.2	-3.2	-2.4	-1.8	-1.8	-1.8	-1.8	-3.9
M20	M04	34.6	-11.4	-8.7	-8.0	-8.1	-9.6	-11.3	-13.4	-15.2	-16.5	-17.1
M21*	C26	38.9	-16.1	-12.1	-9.5	-7.5	-6.7	-6.1	-6.1	-6.1	-6.8	-9.6
M22	C26	33.2	-11.8	-7.8	-6.1	-5.1	-5.5	-6.4	-8.1	-10.1	-12.5	-15.3
M23	C26	34.7	-10.3	-6.3	-4.6	-3.6	-4.0	-4.9	-6.6	-8.6	-11.0	-13.8
C26*	C26	38.1	-16.9	-12.9	-10.3	-8.3	-7.5	-6.9	-6.9	-6.9	-7.6	-10.4
C27*	C26	40.1	-14.9	-10.9	-8.3	-6.3	-5.5	-4.9	-4.9	-4.9	-5.6	-8.4
C25*	C26	42	-13.0	-9.0	-6.4	-4.4	-3.6	-3.0	-3.0	-3.0	-3.7	-6.5
C50*	C26	39.3	-15.7	-11.7	-9.1	-7.1	-6.3	-5.7	-5.7	-5.7	-6.4	-9.2

* Involved land owner limits apply

			Predicted Noise Levels - MM92 80m Hub									
Receiver	Associated Compliance	Prediction @ 9m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
G01	G04	37.1	27.1	31.1	33.7	35.7	36.5	37.1	37.1	37.1	37.1	37.1
G02	G02	35	25.0	29.0	31.6	33.6	34.4	35.0	35.0	35.0	35.0	35.0
G02a	G02	37	27.0	31.0	33.6	35.6	36.4	37.0	37.0	37.0	37.0	37.0
G03	G02	31.4	21.4	25.4	28.0	30.0	30.8	31.4	31.4	31.4	31.4	31.4
G04*	G04	39.5	29.5	33.5	36.1	38.1	38.9	39.5	39.5	39.5	39.5	39.5
G04a*	G04	35.1	25.1	29.1	31.7	33.7	34.5	35.1	35.1	35.1	35.1	35.1
G04b*	G04	42.7	32.7	36.7	39.3	41.3	42.1	42.7	42.7	42.7	42.7	42.7
G05	G17	33.8	23.8	27.8	30.4	32.4	33.2	33.8	33.8	33.8	33.8	33.8
G06	G17	25.8	15.8	19.8	22.4	24.4	25.2	25.8	25.8	25.8	25.8	25.8
G07	G17	36.1	26.1	30.1	32.7	34.7	35.5	36.1	36.1	36.1	36.1	36.1
G08*	G17	36.4	26.4	30.4	33.0	35.0	35.8	36.4	36.4	36.4	36.4	36.4
G09*	G17	35	25.0	29.0	31.6	33.6	34.4	35.0	35.0	35.0	35.0	35.0
G10*	G10	41.3	31.3	35.3	37.9	39.9	40.7	41.3	41.3	41.3	41.3	41.3
G11	G11	37.3	27.3	31.3	33.9	35.9	36.7	37.3	37.3	37.3	37.3	37.3
G12*	G12	38.7	28.7	32.7	35.3	37.3	38.1	38.7	38.7	38.7	38.7	38.7
G13	G14	37.7	27.7	31.7	34.3	36.3	37.1	37.7	37.7	37.7	37.7	37.7
G14	G14	39.6	29.6	33.6	36.2	38.2	39.0	39.6	39.6	39.6	39.6	39.6
G15*	G15	42.5	32.5	36.5	39.1	41.1	41.9	42.5	42.5	42.5	42.5	42.5
G16	G15	40.7	30.7	34.7	37.3	39.3	40.1	40.7	40.7	40.7	40.7	40.7
G17	G17	35.7	25.7	29.7	32.3	34.3	35.1	35.7	35.7	35.7	35.7	35.7
G18	G12	32.3	22.3	26.3	28.9	30.9	31.7	32.3	32.3	32.3	32.3	32.3
G19	G12	31.3	21.3	25.3	27.9	29.9	30.7	31.3	31.3	31.3	31.3	31.3
G20	G11	32.9	22.9	26.9	29.5	31.5	32.3	32.9	32.9	32.9	32.9	32.9
G22	G11	27.1	17.1	21.1	23.7	25.7	26.5	27.1	27.1	27.1	27.1	27.1
G23	G24	29.9	19.9	23.9	26.5	28.5	29.3	29.9	29.9	29.9	29.9	29.9
G24	G24	34.5	24.5	28.5	31.1	33.1	33.9	34.5	34.5	34.5	34.5	34.5
G26	G02	31.7	21.7	25.7	28.3	30.3	31.1	31.7	31.7	31.7	31.7	31.7
G27	G02	18.3	8.3	12.3	14.9	16.9	17.7	18.3	18.3	18.3	18.3	18.3
G29	G10	32.9	22.9	26.9	29.5	31.5	32.3	32.9	32.9	32.9	32.9	32.9
G30	G30	35	25.0	29.0	31.6	33.6	34.4	35.0	35.0	35.0	35.0	35.0
G31	M18	39.8	29.8	33.8	36.4	38.4	39.2	39.8	39.8	39.8	39.8	39.8
G32	G15	41.7	31.7	35.7	38.3	40.3	41.1	41.7	41.7	41.7	41.7	41.7
G33	G15	41.8	31.8	35.8	38.4	40.4	41.2	41.8	41.8	41.8	41.8	41.8
G34	G14	36.2	26.2	30.2	32.8	34.8	35.6	36.2	36.2	36.2	36.2	36.2
G35	G14	30.4	20.4	24.4	27.0	29.0	29.8	30.4	30.4	30.4	30.4	30.4
G36	G14	31	21.0	25.0	27.6	29.6	30.4	31.0	31.0	31.0	31.0	31.0
G37	G14	30	20.0	24.0	26.6	28.6	29.4	30.0	30.0	30.0	30.0	30.0
G38	G11	32.6	22.6	26.6	29.2	31.2	32.0	32.6	32.6	32.6	32.6	32.6
G39	G12	25.1	15.1	19.1	21.7	23.7	24.5	25.1	25.1	25.1	25.1	25.1
G41	G11	33.7	23.7	27.7	30.3	32.3	33.1	33.7	33.7	33.7	33.7	33.7
G42	G11	33.5	23.5	27.5	30.1	32.1	32.9	33.5	33.5	33.5	33.5	33.5
G43	G11	27.7	17.7	21.7	24.3	26.3	27.1	27.7	27.7	27.7	27.7	27.7
G44	G11	13	3.0	7.0	9.6	11.6	12.4	13.0	13.0	13.0	13.0	13.0
G45	G11	12.6	2.6	6.6	9.2	11.2	12.0	12.6	12.6	12.6	12.6	12.6
G46	G11	19.4	9.4	13.4	16.0	18.0	18.8	19.4	19.4	19.4	19.4	19.4
G47	G11	26.5	16.5	20.5	23.1	25.1	25.9	26.5	26.5	26.5	26.5	26.5
G48	G11	25.4	15.4	19.4	22.0	24.0	24.8	25.4	25.4	25.4	25.4	25.4
G49	G11	26.6	16.6	20.6	23.2	25.2	26.0	26.6	26.6	26.6	26.6	26.6
G50	G11	26.2	16.2	20.2	22.8	24.8	25.6	26.2	26.2	26.2	26.2	26.2
M01	M04	33	23.0	27.0	29.6	31.6	32.4	33.0	33.0	33.0	33.0	33.0
M02	M04	32.4	22.4	26.4	29.0	31.0	31.8	32.4	32.4	32.4	32.4	32.4
M03	M04	33.9	23.9	27.9	30.5	32.5	33.3	33.9	33.9	33.9	33.9	33.9
M04	M04	30.6	20.6	24.6	27.2	29.2	30.0	30.6	30.6	30.6	30.6	30.6
M05	G14	30.2	20.2	24.2	26.8	28.8	29.6	30.2	30.2	30.2	30.2	30.2
M06	G14	31.6	21.6	25.6	28.2	30.2	31.0	31.6	31.6	31.6	31.6	31.6
M07	G14	30	20.0	24.0	26.6	28.6	29.4	30.0	30.0	30.0	30.0	30.0
M08	G14	36	26.0	30.0	32.6	34.6	35.4	36.0	36.0	36.0	36.0	36.0
M09	C42	28.4	18.4	22.4	25.0	27.0	27.8	28.4	28.4	28.4	28.4	28.4
M10	C42	29.1	19.1	23.1	25.7	27.7	28.5	29.1	29.1	29.1	29.1	29.1
M11	C42	29.1	19.1	23.1	25.7	27.7	28.5	29.1	29.1	29.1	29.1	29.1
M12	C42	29.6	19.6	23.6	26.2	28.2	29.0	29.6	29.6	29.6	29.6	29.6
M13	C42	30.5	20.5	24.5	27.1	29.1	29.9	30.5	30.5	30.5	30.5	30.5
M14	C42	29.4	19.4	23.4	26.0	28.0	28.8	29.4	29.4	29.4	29.4	29.4
M15	C42	29.8	19.8	23.8	26.4	28.4	29.2	29.8	29.8	29.8	29.8	29.8
M16	C42	30.1	20.1	24.1	26.7	28.7	29.5	30.1	30.1	30.1	30.1	30.1
M17	C42	29.2	19.2	23.2	25.8	27.8	28.6	29.2	29.2	29.2	29.2	29.2
M18*	M18	43.2	33.2	37.2	39.8	41.8	42.6	43.2	43.2	43.2	43.2	43.2
M20	M04	34.6	24.6	28.6	31.2	33.2	34.0	34.6	34.6	34.6	34.6	34.6
M21*	C26	38.9	28.9	32.9	35.5	37.5	38.3	38.9	38.9	38.9	38.9	38.9
M22	C26	33.2	23.2	27.2	29.8	31.8	32.6	33.2	33.2	33.2	33.2	33.2
M23	C26	34.7	24.7	28.7	31.3	33.3	34.1	34.7	34.7	34.7	34.7	34.7
C26*	C26	38.1	28.1	32.1	34.7	36.7	37.5	38.1	38.1	38.1	38.1	38.1
C27*	C26	40.1	30.1	34.1	36.7	38.7	39.5	40.1	40.1	40.1	40.1	40.1
C25*	C26	42	32.0	36.0	38.6	40.6	41.4	42.0	42.0	42.0	42.0	42.0
C50*	C26	39.3	29.3	33.3	35.9	37.9	38.7	39.3	39.3	39.3	39.3	39.3

* Involved land owner limits apply

MARSHALL DAY Acoustics

Difference Between Compliance Limits and Predicted Noise Levels - V90 3MW 78.8m Hub

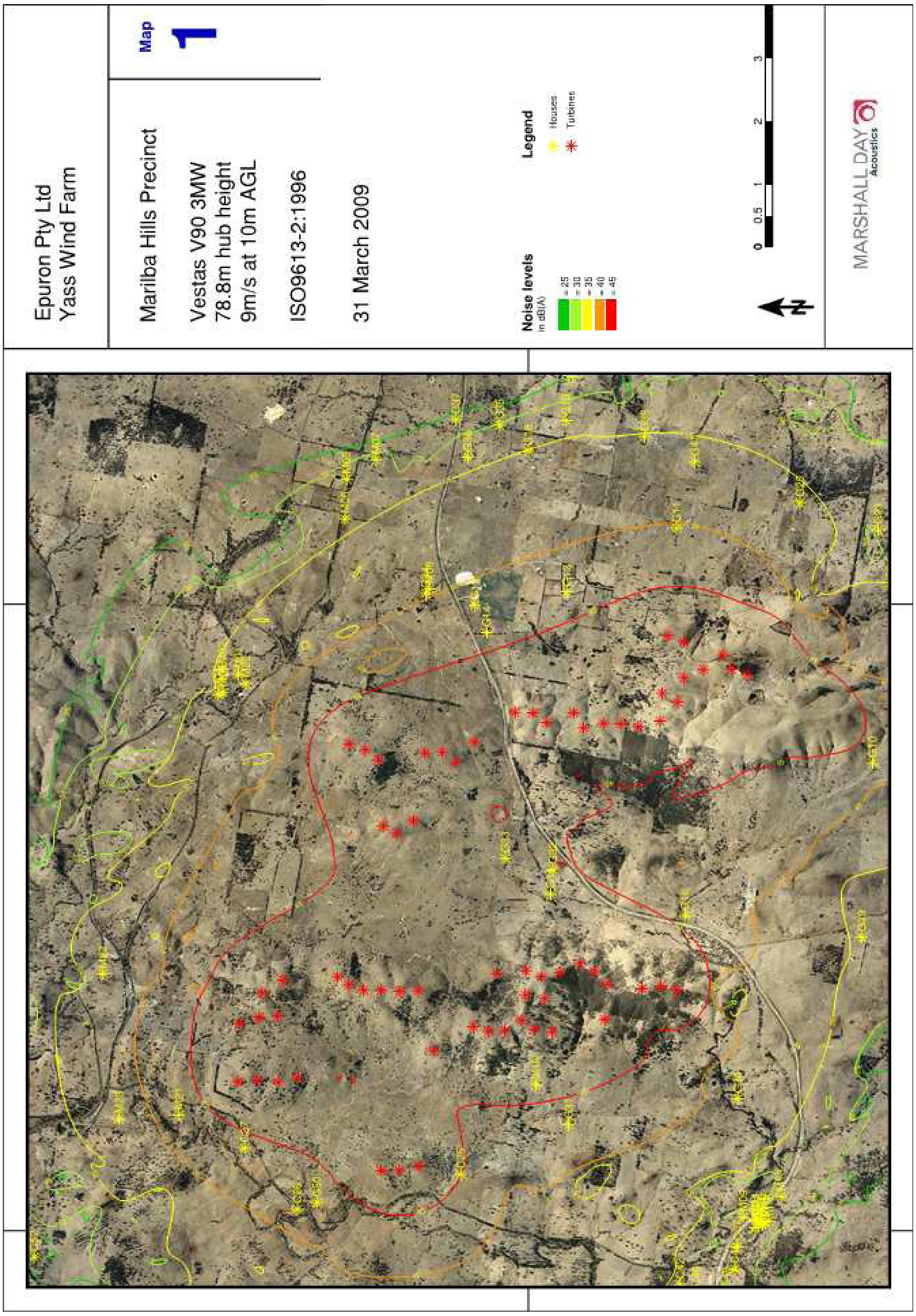
Receiver	Associated Compliance	Prediction @ 9m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s	14m/s	15m/s
G01	G04	37.1	-10.3	-5.8	-3.1	-3.6	-5.2	-7.6	-10.6	-11.6	-12.4	-11.9	-9.9	-6.1
G02	G02	35.2	-16.1	-9.9	-5.9	-4.3	-4.6	-6.6	-10.2	-12.5	-15.6	-18.4	-20.7	-22.2
G02a	G02	37.2	-14.1	-7.9	-3.9	-2.3	-2.6	-4.6	-8.2	-10.5	-13.6	-16.4	-18.7	-20.2
G03	G02	32.6	-18.7	-12.5	-8.5	-6.9	-7.2	-9.2	-12.8	-15.1	-18.2	-21.0	-23.3	-24.8
G04*	G04	39.7	-17.7	-13.2	-9.5	-7.1	-5.7	-5.3	-8.0	-9.0	-9.8	-9.3	-7.3	-5.3
G04a*	G04	36.4	-21.0	-16.5	-12.8	-10.4	-9.0	-8.6	-11.3	-12.3	-13.1	-12.6	-10.6	-8.6
G04b*	G04	42.8	-14.6	-10.1	-6.4	-4.0	-2.6	-2.2	-4.9	-5.9	-6.7	-6.2	-4.2	-2.2
G05	G17	34.7	-12.7	-8.2	-4.5	-2.9	-2.8	-4.0	-6.3	-7.4	-9.1	-10.9	-12.6	-14.2
G06	G17	26.5	-20.9	-16.4	-12.7	-11.1	-11.0	-12.2	-14.5	-15.6	-17.3	-19.1	-20.8	-22.4
G07	G17	37.2	-10.2	-5.7	-2.0	-0.4	-0.3	-1.5	-3.8	-4.9	-6.6	-8.4	-10.1	-11.7
G08*	G17	37.5	-19.9	-15.4	-11.7	-9.3	-7.9	-7.5	-8.2	-7.5	-7.5	-8.1	-9.8	-11.4
G09*	G17	36.2	-21.2	-16.7	-13.0	-10.6	-9.2	-8.8	-9.5	-8.8	-8.8	-9.4	-11.1	-12.7
G10*	G10	41.6	-15.8	-11.3	-7.6	-5.2	-3.8	-3.4	-4.1	-3.4	-3.4	-3.4	-4.6	-6.9
G11	G11	40.6	-9.5	-4.7	-1.3	**0.3**	**0.3**	-0.9	-3.6	-4.9	-7.0	-9.1	-10.9	-12.6
G12*	G12	42.2	-15.2	-10.7	-7.0	-4.6	-3.2	-3.4	-5.5	-6.1	-7.1	-7.9	-8.2	-8.2
G13	G14	41.2	-19.1	-15.3	-12.2	-10.3	-9.3	-9.1	-10.0	-9.4	-9.5	-9.6	-9.7	-9.7
G14	G14	43.1	-17.2	-13.4	-10.3	-8.4	-7.4	-7.2	-8.1	-7.5	-7.6	-7.7	-7.8	-7.8
G15*	G15	46	-11.4	-6.9	-3.8	-1.8	-0.9	-1.1	-2.8	-3.6	-5.8	-8.8	-12.7	-17.8
G16	G15	44	-12.5	-8.9	-5.8	-3.8	-2.9	-3.1	-4.8	-5.6	-7.8	-10.8	-14.7	-19.8
G17	G17	36.8	-10.6	-6.1	-2.4	-0.8	-0.7	-1.9	-4.2	-5.3	-7.0	-8.8	-10.5	-12.1
G18	G12	36.1	-13.9	-10.9	-8.8	-8.0	-8.3	-9.5	-11.6	-12.2	-13.2	-14.0	-14.3	-14.3
G19	G12	35	-15.0	-12.0	-9.9	-9.1	-9.4	-10.6	-12.7	-13.3	-14.3	-15.1	-15.4	-15.4
G20	G11	36.5	-13.6	-8.8	-5.4	-3.8	-3.8	-5.0	-7.7	-9.0	-11.1	-13.2	-15.0	-16.7
G22	G11	30.5	-19.6	-14.8	-11.4	-9.8	-9.8	-11.0	-13.7	-15.0	-17.1	-19.2	-21.0	-22.7
G23	G24	33.1	-14.3	-9.8	-6.1	-4.6	-4.8	-6.4	-9.4	-11.1	-13.5	-15.9	-18.2	-20.3
G24	G24	34.9	-12.5	-8.0	-4.3	-2.8	-3.0	-4.6	-7.6	-9.3	-11.7	-14.1	-16.4	-18.5
G26	G02	33	-18.3	-12.1	-8.1	-6.5	-6.8	-8.8	-12.4	-14.7	-17.8	-20.6	-22.9	-24.4
G27	G02	18.3	-33.0	-26.8	-22.8	-21.2	-21.5	-23.5	-27.1	-29.4	-32.5	-35.3	-37.6	-39.1
G29	G10	36	-15.0	-10.7	-7.1	-5.0	-3.9	-4.0	-5.4	-5.6	-6.8	-8.3	-10.2	-12.5
G30	G30	38.5	-15.0	-11.1	-8.1	-6.4	-5.9	-6.7	-9.0	-10.4	-13.1	-16.5	-20.6	-25.6
G31	M18	43.4	-6.8	-2.7	**0.5**	**2.4**	**3.0**	**2.4**	**0.2**	-1.1	-3.7	-7.1	-11.2	-16.3
G32	G15	45.2	-11.3	-7.7	-4.6	-2.6	-1.7	-1.9	-3.6	-4.4	-6.6	-9.6	-13.5	-18.6
G33	G15	45.2	-11.3	-7.7	-4.6	-2.6	-1.7	-1.9	-3.6	-4.4	-6.6	-9.6	-13.5	-18.6
G34	G14	39.8	-20.5	-16.7	-13.6	-11.7	-10.7	-10.5	-11.4	-10.8	-10.9	-11.0	-11.1	-11.1
G35	G14	34.4	-25.9	-22.1	-19.0	-17.1	-16.1	-15.9	-16.8	-16.2	-16.3	-16.4	-16.5	-16.5
G36	G14	34.9	-25.4	-21.6	-18.5	-16.6	-15.6	-15.4	-16.3	-15.7	-15.8	-15.9	-16.0	-16.0
G37	G14	34.2	-26.1	-22.3	-19.2	-17.3	-16.3	-16.1	-17.0	-16.4	-16.5	-16.6	-16.7	-16.7
G38	G11	36.2	-13.9	-9.1	-5.7	-4.1	-4.1	-5.3	-8.0	-9.3	-11.4	-13.5	-15.3	-17.0
G39	G12	28.6	-21.4	-18.4	-16.3	-15.5	-15.8	-17.0	-19.1	-19.7	-20.7	-21.5	-21.8	-21.8
G41	G11	37.1	-13.0	-8.2	-4.8	-3.2	-3.2	-4.4	-7.1	-8.4	-10.5	-12.6	-14.4	-16.1
G42	G11	33.5	-16.6	-11.8	-8.4	-6.8	-6.8	-8.0	-10.7	-12.0	-14.1	-16.2	-18.0	-19.7
G43	G11	27.7	-22.4	-17.6	-14.2	-12.6	-12.6	-13.8	-16.5	-17.8	-19.9	-22.0	-23.8	-25.5
G44	G11	13	-37.1	-32.3	-28.9	-27.3	-27.3	-28.5	-31.2	-32.5	-34.6	-36.7	-38.5	-40.2
G45	G11	12.6	-37.5	-32.7	-29.3	-27.7	-27.7	-28.9	-31.6	-32.9	-35.0	-37.1	-38.9	-40.6
G46	G11	19.4	-30.7	-25.9	-22.5	-20.9	-20.9	-22.1	-24.8	-26.1	-28.2	-30.3	-32.1	-33.8
G47	G11	26.5	-23.6	-18.8	-15.4	-13.8	-13.8	-15.0	-17.7	-19.0	-21.1	-23.2	-25.0	-26.7
G48	G11	25.4	-24.7	-19.9	-16.5	-14.9	-14.9	-16.1	-18.8	-20.1	-22.2	-24.3	-26.1	-27.8
G49	G11	26.6	-23.5	-18.7	-15.3	-13.7	-13.7	-14.9	-17.6	-18.9	-21.0	-23.1	-24.9	-26.6
G50	G11	26.2	-23.9	-19.1	-15.7	-14.1	-14.1	-15.3	-18.0	-19.3	-21.4	-23.5	-25.3	-27.0
M01	M04	36.8	-12.9	-10.3	-8.7	-8.6	-9.5	-11.2	-13.7	-14.3	-14.9	-14.6	-13.4	-11.0
M02	M04	36.2	-13.5	-10.9	-9.3	-9.2	-10.1	-11.8	-14.3	-14.9	-15.5	-15.2	-14.0	-11.6
M03	M04	37.8	-11.9	-9.3	-7.7	-7.6	-8.5	-10.2	-12.7	-13.3	-13.9	-13.6	-12.4	-10.0
M04	M04	34.4	-15.3	-12.7	-11.1	-11.0	-11.9	-13.6	-16.1	-16.7	-17.3	-17.0	-15.8	-13.4
M05	G14	34.4	-25.9	-22.1	-19.0	-17.1	-16.1	-15.9	-16.8	-16.2	-16.3	-16.4	-16.5	-16.5
M06	G14	35.6	-24.7	-20.9	-17.8	-15.9	-14.9	-14.7	-15.6	-15.0	-15.1	-15.2	-15.3	-15.3
M07	G14	34.3	-26.0	-22.2	-19.1	-17.2	-16.2	-16.0	-16.9	-16.3	-16.4	-16.5	-16.6	-16.6
M08	G14	39.7	-20.6	-16.8	-13.7	-11.8	-10.8	-10.6	-11.5	-10.9	-11.0	-11.1	-11.2	-11.2
M09	C42	32.6	-20.4	-16.4	-13.3	-11.6	-11.0	-11.4	-13.0	-13.2	-14.2	-15.2	-16.2	-17.2
M10	C42	33.3	-19.7	-15.7	-12.6	-10.9	-10.3	-10.7	-12.3	-12.5	-13.5	-14.5	-15.5	-16.5
M11	C42	33.1	-19.9	-15.9	-12.8	-11.1	-10.5	-10.9	-12.5	-12.7	-13.7	-14.7	-15.7	-16.7
M12	C42	33.7	-19.3	-15.3	-12.2	-10.5	-9.9	-10.3	-11.9	-12.1	-13.1	-14.1	-15.1	-16.1
M13	C42	34.6	-18.4	-14.4	-11.3	-9.6	-9.0	-9.4	-11.0	-11.2	-12.2	-13.2	-14.2	-15.2
M14	C42	33.5	-19.5	-15.5	-12.4	-10.7	-10.1	-10.5	-12.1	-12.3	-13.3	-14.3	-15.3	-16.3
M15	C42	33.9	-19.1	-15.1	-12.0	-10.3	-9.7	-10.1	-11.7	-11.9	-12.9	-13.9	-14.9	-15.9
M16	C42	34.1	-18.9	-14.9	-11.8	-10.1	-9.5	-9.9	-11.5	-11.7	-12.7	-13.7	-14.7	-15.7
M17	C42	33.3	-19.7	-15.7	-12.6	-10.9	-10.3	-10.7	-12.3	-12.5	-13.5	-14.5	-15.5	-16.5
M18*	M18	46.7	-10.7	-6.2	-2.5	-0.1	**1.3**	**1.7**	**1.0**	**1.7**	-0.4	-3.8	-7.9	-13.0
M20	M04	38.4	-11.3	-8.7	-7.1	-7.0	-7.9	-9.6	-12.1	-12.7	-13.3	-13.0	-11.8	-9.4
M21*	C26	42.4	-15.0	-10.5	-6.8	-4.4	-3.0	-2.6	-3.3	-3.3	-6.1	-9.2	-12.8	-16.8
M22	C26	37	-10.4	-6.8	-4.1	-2.9	-3.0	-4.3	-7.0	-8.7	-11.5	-14.6	-18.2	-22.2
M23	C26	38.4	-9.0	-5.4	-2.7	-1.5	-1.6	-2.9	-5.6	-7.3	-10.1	-13.2	-16.8	-20.8
C26*	C26	41.8	-15.6	-11.1	-7.4	-5.0	-3.6	-3.2	-3.9	-3.9	-6.7	-9.8	-13.4	-17.4
C27*	C26	43.6	-13.8	-9.3	-5.6	-3.2	-1.8	-1.4	-2.1	-2.1	-4.9	-8.0	-11.6	-15.6
C25*	C26	45.5	-11.9	-7.4	-3.7	-1.3	**0.1**	**0.5**	-0.2	-0.2	-3.0	-6.1	-9.7	-13.7
C50*	C26	42.9	-14.5	-10.0	-6.3	-3.9	-2.5	-2.1	-2.8	-2.8	-5.6	-8.7	-12.3	-16.3

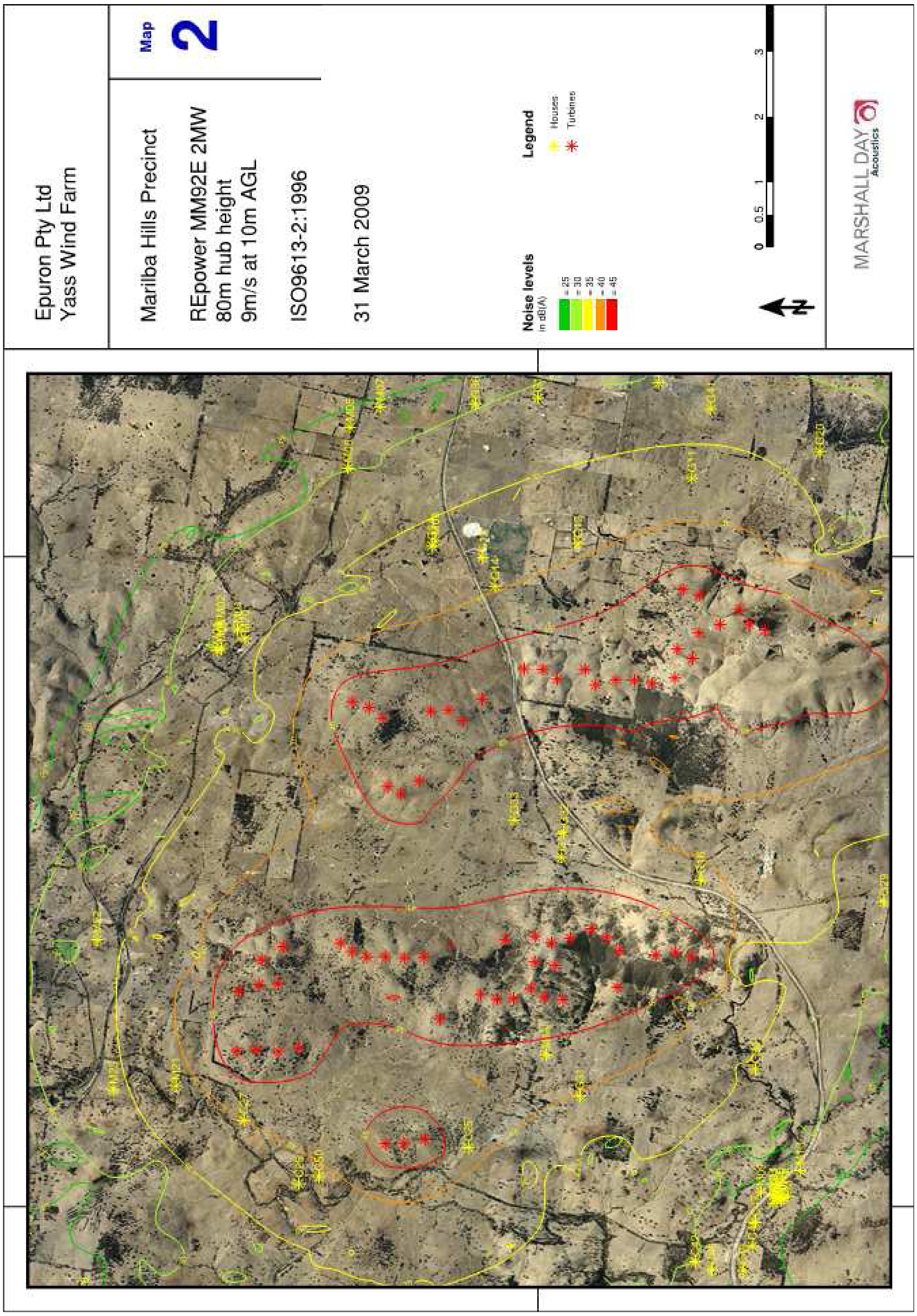
* Involved land owner limits apply

Receiver	Associated Compliance	Prediction @ 9m/s	Predicted Noise Levels - V90 3MW 78.8m Hub											
			4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s	14m/s	15m/s
G01	G04	37.1	24.7	29.2	32.9	35.3	36.7	37.1	36.4	37.1	37.1	37.1	37.1	37.1
G02	G02	35.2	22.8	27.3	31.0	33.4	34.8	35.2	34.5	35.2	35.2	35.2	35.2	35.2
G02a	G02	37.2	24.8	29.3	33.0	35.4	36.8	37.2	36.5	37.2	37.2	37.2	37.2	37.2
G03	G02	32.6	20.2	24.7	28.4	30.8	32.2	32.6	31.9	32.6	32.6	32.6	32.6	32.6
G04*	G04	39.7	27.3	31.8	35.5	37.9	39.3	39.7	39.0	39.7	39.7	39.7	39.7	39.7
G04a*	G04	36.4	24.0	28.5	32.2	34.6	36.0	36.4	35.7	36.4	36.4	36.4	36.4	36.4
G04b*	G04	42.8	30.4	34.9	38.6	41.0	42.4	42.8	42.1	42.8	42.8	42.8	42.8	42.8
G05	G17	34.7	22.3	26.8	30.5	32.9	34.3	34.7	34.0	34.7	34.7	34.7	34.7	34.7
G06	G17	26.5	14.1	18.6	22.3	24.7	26.1	26.5	25.8	26.5	26.5	26.5	26.5	26.5
G07	G17	37.2	24.8	29.3	33.0	35.4	36.8	37.2	36.5	37.2	37.2	37.2	37.2	37.2
G08*	G17	37.5	25.1	29.6	33.3	35.7	37.1	37.5	36.8	37.5	37.5	37.5	37.5	37.5
G09*	G17	36.2	23.8	28.3	32.0	34.4	35.8	36.2	35.5	36.2	36.2	36.2	36.2	36.2
G10*	G10	41.6	29.2	33.7	37.4	39.8	41.2	41.6	40.9	41.6	41.6	41.6	41.6	41.6
G11	G11	40.6	28.2	32.7	36.4	38.8	40.2	40.6	39.9	40.6	40.6	40.6	40.6	40.6
G12*	G12	42.2	29.8	34.3	38.0	40.4	41.8	42.2	41.5	42.2	42.2	42.2	42.2	42.2
G13	G14	41.2	28.8	33.3	37.0	39.4	40.8	41.2	40.5	41.2	41.2	41.2	41.2	41.2
G14	G14	43.1	30.7	35.2	38.9	41.3	42.7	43.1	42.4	43.1	43.1	43.1	43.1	43.1
G15*	G15	46	33.6	38.1	41.8	44.2	45.6	46.0	45.3	46.0	46.0	46.0	46.0	46.0
G16	G15	44	31.6	36.1	39.8	42.2	43.6	44.0	43.3	44.0	44.0	44.0	44.0	44.0
G17	G17	36.8	24.4	28.9	32.6	35.0	36.4	36.8	36.1	36.8	36.8	36.8	36.8	36.8
G18	G12	36.1	23.7	28.2	31.9	34.3	35.7	36.1	35.4	36.1	36.1	36.1	36.1	36.1
G19	G12	35	22.6	27.1	30.8	33.2	34.6	35.0	34.3	35.0	35.0	35.0	35.0	35.0
G20	G11	36.5	24.1	28.6	32.3	34.7	36.1	36.5	35.8	36.5	36.5	36.5	36.5	36.5
G22	G11	30.5	18.1	22.6	26.3	28.7	30.1	30.5	29.8	30.5	30.5	30.5	30.5	30.5
G23	G24	33.1	20.7	25.2	28.9	31.3	32.7	33.1	32.4	33.1	33.1	33.1	33.1	33.1
G24	G24	34.9	22.5	27.0	30.7	33.1	34.5	34.9	34.2	34.9	34.9	34.9	34.9	34.9
G26	G02	33	20.6	25.1	28.8	31.2	32.6	33.0	32.3	33.0	33.0	33.0	33.0	33.0
G27	G02	18.3	5.9	10.4	14.1	16.5	17.9	18.3	17.6	18.3	18.3	18.3	18.3	18.3
G29	G10	36	23.6	28.1	31.8	34.2	35.6	36.0	35.3	36.0	36.0	36.0	36.0	36.0
G30	G30	38.5	26.1	30.6	34.3	36.7	38.1	38.5	37.8	38.5	38.5	38.5	38.5	38.5
G31	M18	43.4	31.0	35.5	39.2	41.6	43.0	43.4	42.7	43.4	43.4	43.4	43.4	43.4
G32	G15	45.2	32.8	37.3	41.0	43.4	44.8	45.2	44.5	45.2	45.2	45.2	45.2	45.2
G33	G15	45.2	32.8	37.3	41.0	43.4	44.8	45.2	44.5	45.2	45.2	45.2	45.2	45.2
G34	G14	39.8	27.4	31.9	35.6	38.0	39.4	39.8	39.1	39.8	39.8	39.8	39.8	39.8
G35	G14	34.4	22.0	26.5	30.2	32.6	34.0	34.4	33.7	34.4	34.4	34.4	34.4	34.4
G36	G14	34.9	22.5	27.0	30.7	33.1	34.5	34.9	34.2	34.9	34.9	34.9	34.9	34.9
G37	G14	34.2	21.8	26.3	30.0	32.4	33.8	34.2	33.5	34.2	34.2	34.2	34.2	34.2
G38	G11	36.2	23.8	28.3	32.0	34.4	35.8	36.2	35.5	36.2	36.2	36.2	36.2	36.2
G39	G12	28.6	16.2	20.7	24.4	26.8	28.2	28.6	27.9	28.6	28.6	28.6	28.6	28.6
G41	G11	37.1	24.7	29.2	32.9	35.3	36.7	37.1	36.4	37.1	37.1	37.1	37.1	37.1
G42	G11	33.5	21.1	25.6	29.3	31.7	33.1	33.5	32.8	33.5	33.5	33.5	33.5	33.5
G43	G11	27.7	15.3	19.8	23.5	25.9	27.3	27.7	27.0	27.7	27.7	27.7	27.7	27.7
G44	G11	13	0.6	5.1	8.8	11.2	12.6	13.0	12.3	13.0	13.0	13.0	13.0	13.0
G45	G11	12.6	0.2	4.7	8.4	10.8	12.2	12.6	11.9	12.6	12.6	12.6	12.6	12.6
G46	G11	19.4	7.0	11.5	15.2	17.6	19.0	19.4	18.7	19.4	19.4	19.4	19.4	19.4
G47	G11	26.5	14.1	18.6	22.3	24.7	26.1	26.5	25.8	26.5	26.5	26.5	26.5	26.5
G48	G11	25.4	13.0	17.5	21.2	23.6	25.0	25.4	24.7	25.4	25.4	25.4	25.4	25.4
G49	G11	26.6	14.2	18.7	22.4	24.8	26.2	26.6	25.9	26.6	26.6	26.6	26.6	26.6
G50	G11	26.2	13.8	18.3	22.0	24.4	25.8	26.2	25.5	26.2	26.2	26.2	26.2	26.2
M01	M04	36.8	24.4	28.9	32.6	35.0	36.4	36.8	36.1	36.8	36.8	36.8	36.8	36.8
M02	M04	36.2	23.8	28.3	32.0	34.4	35.8	36.2	35.5	36.2	36.2	36.2	36.2	36.2
M03	M04	37.8	25.4	29.9	33.6	36.0	37.4	37.8	37.1	37.8	37.8	37.8	37.8	37.8
M04	M04	34.4	22.0	26.5	30.2	32.6	34.0	34.4	33.7	34.4	34.4	34.4	34.4	34.4
M05	G14	34.4	22.0	26.5	30.2	32.6	34.0	34.4	33.7	34.4	34.4	34.4	34.4	34.4
M06	G14	35.6	23.2	27.7	31.4	33.8	35.2	35.6	34.9	35.6	35.6	35.6	35.6	35.6
M07	G14	34.3	21.9	26.4	30.1	32.5	33.9	34.3	33.6	34.3	34.3	34.3	34.3	34.3
M08	G14	39.7	27.3	31.8	35.5	37.9	39.3	39.7	39.0	39.7	39.7	39.7	39.7	39.7
M09	C42	32.6	20.2	24.7	28.4	30.8	32.2	32.6	31.9	32.6	32.6	32.6	32.6	32.6
M10	C42	33.3	20.9	25.4	29.1	31.5	32.9	33.3	32.6	33.3	33.3	33.3	33.3	33.3
M11	C42	33.1	20.7	25.2	28.9	31.3	32.7	33.1	32.4	33.1	33.1	33.1	33.1	33.1
M12	C42	33.7	21.3	25.8	29.5	31.9	33.3	33.7	33.0	33.7	33.7	33.7	33.7	33.7
M13	C42	34.6	22.2	26.7	30.4	32.8	34.2	34.6	33.9	34.6	34.6	34.6	34.6	34.6
M14	C42	33.5	21.1	25.6	29.3	31.7	33.1	33.5	32.8	33.5	33.5	33.5	33.5	33.5
M15	C42	33.9	21.5	26.0	29.7	32.1	33.5	33.9	33.2	33.9	33.9	33.9	33.9	33.9
M16	C42	34.1	21.7	26.2	29.9	32.3	33.7	34.1	33.4	34.1	34.1	34.1	34.1	34.1
M17	C42	33.3	20.9	25.4	29.1	31.5	32.9	33.3	32.6	33.3	33.3	33.3	33.3	33.3
M18*	M18	46.7	34.3	38.8	42.5	44.9	46.3	46.7	46.0	46.7	46.7	46.7	46.7	46.7
M20	M04	38.4	26.0	30.5	34.2	36.6	38.0	38.4	37.7	38.4	38.4	38.4	38.4	38.4
M21*	C26	42.4	30.0	34.5	38.2	40.6	42.0	42.4	41.7	42.4	42.4	42.4	42.4	42.4
M22	C26	37	24.6	29.1	32.8	35.2	36.6	37.0	36.3	37.0	37.0	37.0	37.0	37.0
M23	C26	38.4	26.0	30.5	34.2	36.6	38.0	38.4	37.7	38.4	38.4	38.4	38.4	38.4
C26*	C26	41.8	29.4	33.9	37.6	40.0	41.4	41.8	41.1	41.8	41.8	41.8	41.8	41.8
C27*	C26	43.6	31.2	35.7	39.4	41.8	43.2	43.6	42.9	43.6	43.6	43.6	43.6	43.6
C25*	C26	45.5	33.1	37.6	41.3	43.7	45.1	45.5	44.8	45.5	45.5	45.5	45.5	45.5
C50*	C26	42.9	30.5	35.0	38.7	41.1	42.5	42.9	42.2	42.9	42.9	42.9	42.9	42.9

* Involved land owner limits apply

APPENDIX K
SOUNDPLAN NOISE CONTOUR PLOTS




Epuron Pty Ltd
Yass Wind Farm
Map 2
Marilba Hills Precinct
REpower MM92E 2MW
80m hub height
9m/s at 10m AGL
ISO9613-2:1996
31 March 2009
Legend
Houses
Turbines
Noise levels
in dB(A)
0 0.5 1 2 3
N
MARSHALL DAY Acoustics

APPENDIX L
CONSTRUCTION EQUIPMENT SOUND POWER LEVELS

Table L1
Construction equipment (L_{10}) sound power levels in dB, re 10^{-12} W

	Octave band mid frequency							
Description	63	125	250	500	1k	2k	4k	dBA
Excavator	121	126	111	107	106	101	96	113
Grader	118	124	115	114	115	114	113	120
Dump truck	111	105	108	106	107	104	99	111
Rock breaking	113	115	117	122	121	120	118	126
Concrete truck	104	101	96	95	94	93	91	100
Front end loader	120	117	101	101	92	88	88	104
Crane	108	105	109	107	111	105	97	113
Bulldozer	113	119	110	109	110	109	108	115
Concrete batching	118	115	110	109	108	107	105	114
Delivery trucks	118	110	99	104	99	95	91	105
4WD vehicles	96	92	88	84	84	80	75	88

APPENDIX M
SURROUNDING ROAD NETWORK