6 BACKGROUND LEVELS AND NOISE LIMITS

6.1 Measurement Locations

The locations for the background noise measurements were selected based on the potential for acoustic impact to the nearest receivers, as recommended by Table 3.1 of the NSW INP. The SA EPA Guidelines recommend that the measurement locations should be located at least 5 metres from a reflecting surface (other than the ground) and locations within 20 metres of a residence are generally appropriate.

Monitoring equipment was generally placed in the vicinity of the residence at a suitable location that would be protected from the prevailing wind direction in order to protect the microphone from wind induced noise effects. Care was taken not to place the equipment in locations that would be affected by extraneous noise sources.

Background noise monitoring locations were selected based on the predicted wind farm noise level from the preliminary layout at reference conditions.

The relative proximity of some receiver locations to one another and their similar wind exposure and surrounding environment meant that background noise monitoring could be conducted at one representative location and be considered indicative of other similar locations.

A total of 8 locations were monitored around the proposed wind farm site. These are listed in **Table 12**.

Table 12 Measurement Locations

Location	Indicative of	Notes / Similar Characteristic for wind induced noise
Benbullen*	Benbullen, Hyland Grange, H3, Mohawke	Geographic proximity, exposure to wind
Glenfinnan*	Glenfinnan, Woodbine, Mia Mia, Old Curry Flat, Curry Flat	Geographic proximity, exposure to wind
Yandra*	Yandra, Wyuna	Geographic proximity, exposure to wind
Rockybah*	Rockybah, Roselea, Lofyvale	Geographic proximity, exposure to wind
Boco*	Boco, Riverside, Rosemount	Geographic proximity, exposure to wind
Brooklyn*	Brooklyn, Sherwood, Telembugrm, Windella, Bungee, Kanoute, Kangaroo Camp Retreat, H2	Geographic proximity, exposure to wind.
Old Springfield*	Old Springfield, Springfield, Avonlake, Nestlebrae, Mountain View, Tinbery Lodge, Kenilworth, Edendale, Lyndarra	Geographic proximity, exposure to wind
Coopers Hill*	Coopers Hill, Kelton Plain, H1, Wodburn, Belmore, Peters Park, Coombala, Roslyn, Monastery, Xenmor	Geographic proximity, exposure to wind

Note: * Denotes the location is involved with the project

It is anticipated that further baseline background noise monitoring will be conducted before project commissioning in order to obtain more comprehensive and representative data.

At each location noise monitoring equipment was placed in the vicinity of the residence and the position of the monitoring equipment was documented with photographs.

A weather station was placed at Yandra, capable of measuring wind speed, direction, rainfall, temperature and humidity. This data was used to identify and exclude any data during rain periods, which may have affected the background noise levels. The measured data for rain confirmed that the monitoring periods were generally dry and as a result no data points were rejected due to rain.

The SA EPA Guidelines require measurements to be conducted in 10 minute intervals, while the NSW INP request 15 minute interval data. Given that almost all wind data, including the wind farm site monitored data, is in 10 minute intervals, this period was used for all measurements.

Simultaneous noise monitoring and wind monitoring from Boco Rock was conducted during the period 25th March through 9th April 2009.

Local noise data was then correlated to the wind speed measured at a reference wind monitoring mast normally at 10 metres AGL. As mentioned in **Section 2.1**, because original investigations were based on 80m hub heights and no wind data was available at either 10m or 80m AGL, wind speed data was extrapolated to hub height (80m AGL) based on simultaneous data available from anemometers at 45m and 60m using the wind profile power law.

6.2 Measurement Details

The measurement location, monitoring period, equipment type and serial number of the noise logger used for all testing are summarised in **Table 13**.

The SA EPA Guidelines require a set of approximately 2,000 valid data points. All data points below the cut-in wind speed of the proposed turbines and any adversely affected data (rain, external extraneous noise sources etc) should be excluded. The cut-in wind speed for the proposed turbines is 3 m/s. The number of valid data points for each location is also shown in **Table 13.**

The measured background noise levels (L_{A90}) are then plotted against the extrapolated 80 metre wind speed to obtain a background versus wind speed characteristic for each location.

The line of best fit for the data set is then determined, as required by the SA EPA Guideline using a linear, second order (quadratic) or third order (cubic) polynomial. The Guideline requires that the correlation coefficient for each line type be reported and the one with the highest correlation coefficient used. As required, the R^2 value, which is a measure of the correlation coefficient for each of the three type of line of best fit are also shown. At each location the cubic polynomial gave the highest correlation and was therefore used for the line of best fit. The SA EPA Guideline does not specify a minimum acceptable correlation coefficient.

Table 13 Measurement Details for each Location

Measurement Location	Measurement Period	Noise Logger Model # Serial number	Total No. of monitoring intervals	No. of valid data points		Correlation Coefficient (R^2)		
				All	Night	Linear	Quad.	Cubic
Benbullen*	25-03-2009 - 16:00 09-04-2009 - 12:00	ARL EL-316 #16-004-033	2137	1802	666	0.482	0.470	0.470
Glenfinnan*	25-03-2009 - 19:00 09-04-2009 - 10:00	ARL EL-316 #16-306-001	2107	1783	666	0.318	0.317	0.314
Yandra*	25-03-2009 - 17:00 09-04-2009 - 11:00	ARL EL-316 #16-207-013	2124	1789	666	0.373	0.371	0.371
Rockybah*	25-03-2009 - 18:30 09-04-2009 - 14:00	ARL EL-316 #16-306-044	2134	1781	666	0.282	0.280	0.278
Boco*	26-03-2009 - 09:15 07-04-2009 - 18:00	ARL EL-316 #16-306-040	1781	1405	531	0.087	0.086	0.075
Brooklyn*	26-03-2009 - 08:45 08-04-2009 - 06:00	ARL EL-316 #16-306-042	1856	1378	448	0.342	0.338	0.337
Old Springfield*	26-03-2009 - 11:00 09-04-2009 - 13:30	ARL EL-316 #16-203-528	2031	1675	602	0.212	0.206	0.205
Coopers Hill*	26-03-2009 - 10:15 09-04-2009 - 15:00	ARL EL-316 #16-203-530	2046	1664	591	0.363	0.357	0.357

* Denotes the location is involved with the project

Measurement data at two of the monitoring locations fell just short of the preferred 2000 intervals, however, as over 90% of the data was collected the result is still deemed statistically relevant.

6.3 Night Period Analysis

Measurement data was also reduced and analysed for only the night period (10:00 pm to 7:00 am). The resulting reduced data sets, which include typically 450 to 650 data points, were fitted with a cubic polynomial regression line of best fit.

The regression line for night only data is generally lower than that for all data by between 3 dB to 5 dB. This is attributed to two main factors, that extraneous noise sources (animals, traffic etc.) are lower during the night period and that the wind shear profile for the night period is usually greater for that compared to the day which results in lower ground level wind speeds for a given hub height reference wind speed, when compared to that during the day period.

It should be noted that the minimum criteria noise level for project involved receptors (45 dBA from WHO) and project uninvolved receptors (35 dBA from SA EPA Guideline) are not changed.

The resulting effect on project involved receptors criteria with consideration to only the lower night period background data is generally minimal with the criteria being exactly the same (criteria is a constant 45 dBA as background noise regression lines are always less than 35 dBA) or marginally higher at high wind speeds where compliance is more easily achieved.

The criteria for project uninvolved receptors with consideration to only the night period background data is generally marginally lower at medium to high wind speeds.

6.4 Rating Background Levels

The Rating Background Level (RBL) for each location during each time period is shown in **Table 14**. Note, that the results are based on 10 minute logging intervals, rather than the 15 minute intervals required in the NSW INP.

Table 14 RBL for each Period at each Location

	Rating Background Level (dBA)		
Location	**Day**	**Evening**	**Night**
Benbullen*	25.0	22.6	22.6
Glenfinnan*	27.3	23.0	22.5
Yandra*	25.6	22.1	21.4
Rockybah*	29.6	29.9	29.4
Boco*	25.9	33.7	22.2
Brooklyn*	24.8	27.2	22.5
Old Springfield*	25.6	22.9	22.6
Coopers Hill*	22.2	20.3	20.2

* Denotes the location is involved with the project

The entire set of noise logger results, showing the measured L_{A90}, L_{Aeq} and L_{A10} noise levels, together with wind speed, are shown in **Appendix C.**

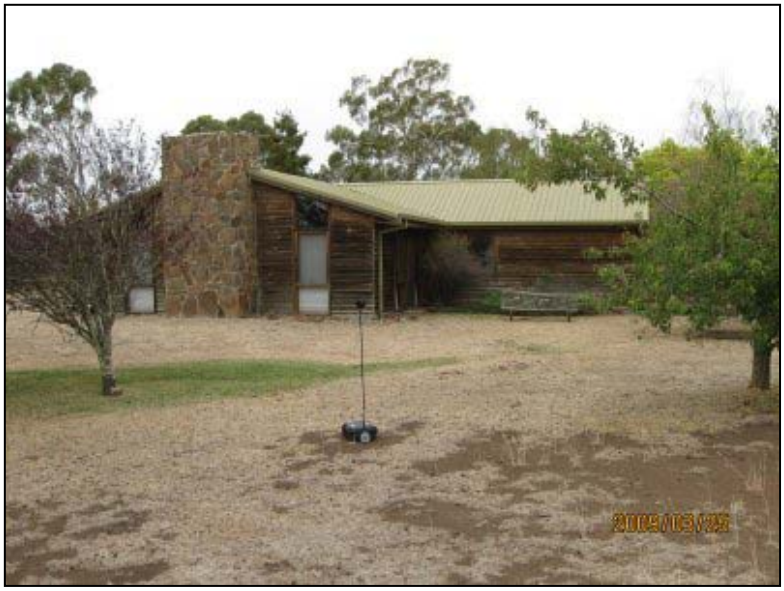
The horizontal distance between each of the assessment locations and WTG's for the proposed layouts are shown in **Appendix E.**

6.5 Benbullen

The property of Benbullen is located directly to the north east of the proposed wind farm, approximately 0.9 km from the nearest proposed WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site.

The residence is relatively protected in all directions except the north east by an established garden and mature trees. The measurement location was just to the north of the house. The monitoring location is shown in **Figure 5.**

Figure 5 Benbullen Measurement Location

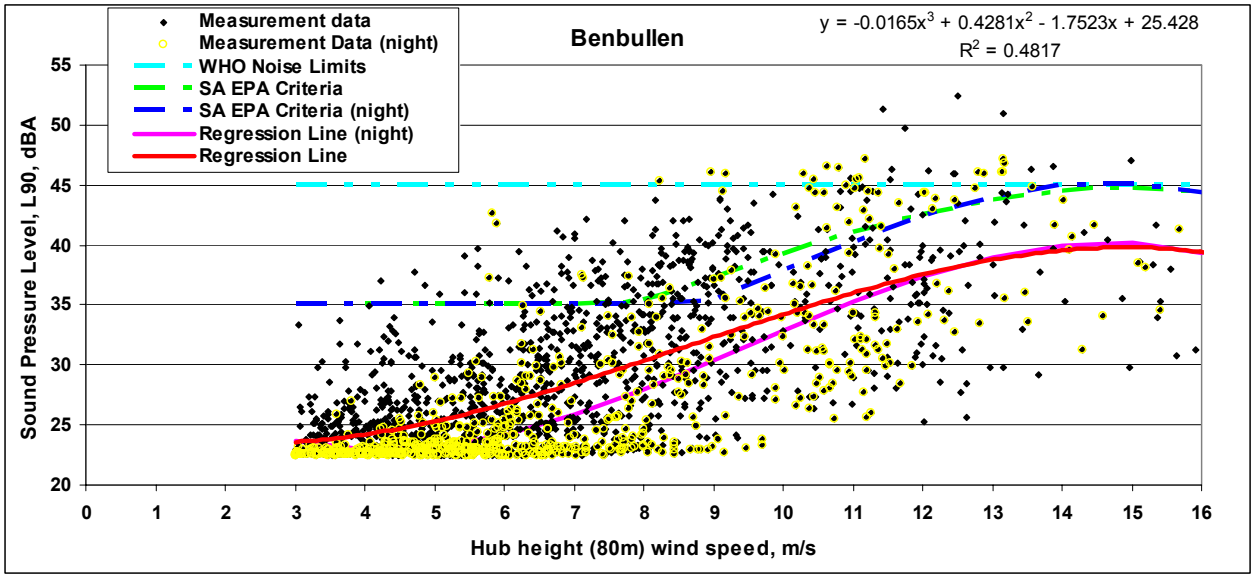


The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 6.**

Graphically represented noise statistical indices, together with wind speed are presented in **Appendix C1**.

The daytime Rating Background Level (RBL), determined for construction noise impact assessment purposes was 25 dBA.

Figure 6 Background Noise Measurements and Noise Criteria Curve - Benbullen



6.6 Boco

The Boco property is located centrally to the proposed wind farm, approximately 1.7 km from the nearest WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site. The residence is relatively protected by topography being located at the bottom of Maclaughlin River Valley and some surrounding trees.

The measurement location, shown in **Figure 7,** was to the south of the house on a small stone wall.

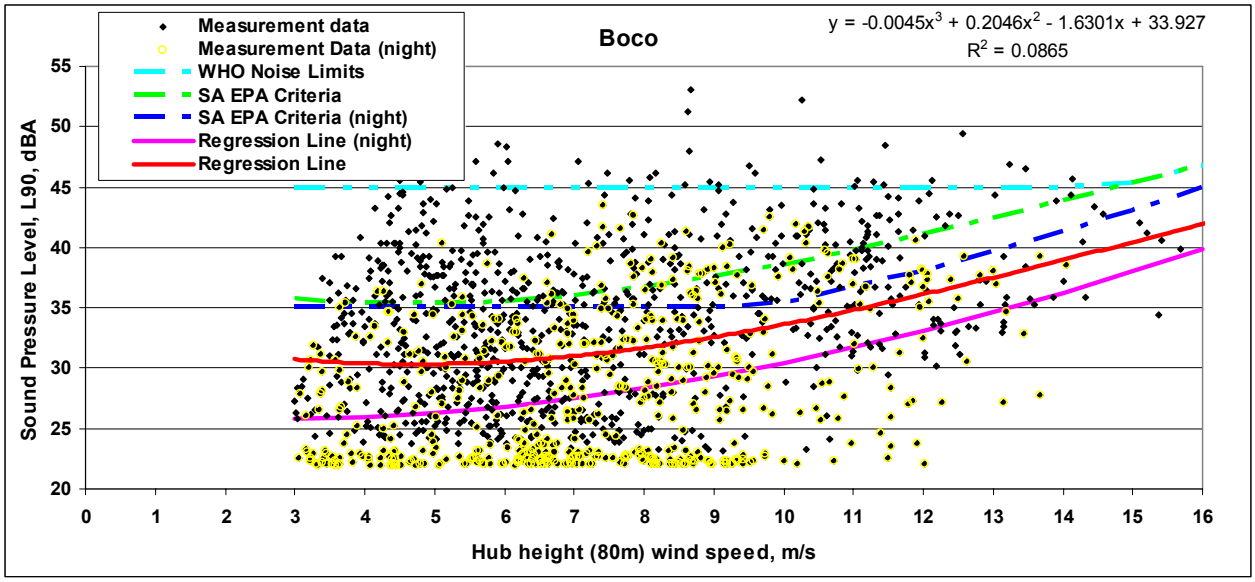
Figure 7 Boco Measurement Location

The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 8.**

Graphically represented noise statistical indices, together with wind speed are presented in **Appendix C2.**

The daytime RBL was 25.9 dBA.

Figure 8 Background Noise Measurements and Noise Criteria Curve – Boco



6.7 Brooklyn

The Brooklyn property is located to the south east of the proposed wind farm, approximately 2.7 km from the nearest WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site.

The residence is relatively protected by topography from the north west and large established pine trees, which act as windbreaks. The noise monitoring equipment was positioned to the north of the house. The measurement location is shown in **Figure 9**

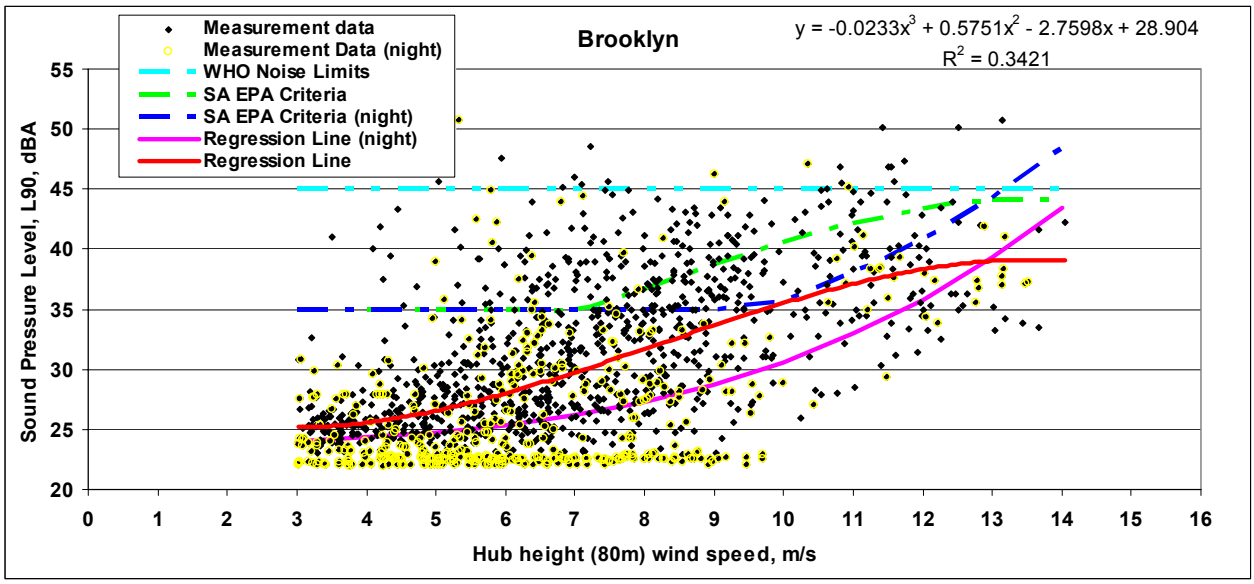
Figure 9 Brooklyn Measurement Location

The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 10.**

Graphically represented noise statistical indices, together with wind speed are presented in **Appendix C3.**

The daytime RBL was 24.8 dBA.

Figure 10 Background Noise Measurements and Noise Criteria Curve – Brooklyn



6.8 Coopers Hill

The property of Coopers Hill is located to the south of the proposed wind farm approximately 0.9 km from the nearest proposed WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site.

The residence is relatively protected from winds by topography to the west, but is exposed from other directions. The noise monitoring equipment was positioned to the west of the house. The measurement location is shown in **Figure 11** below.

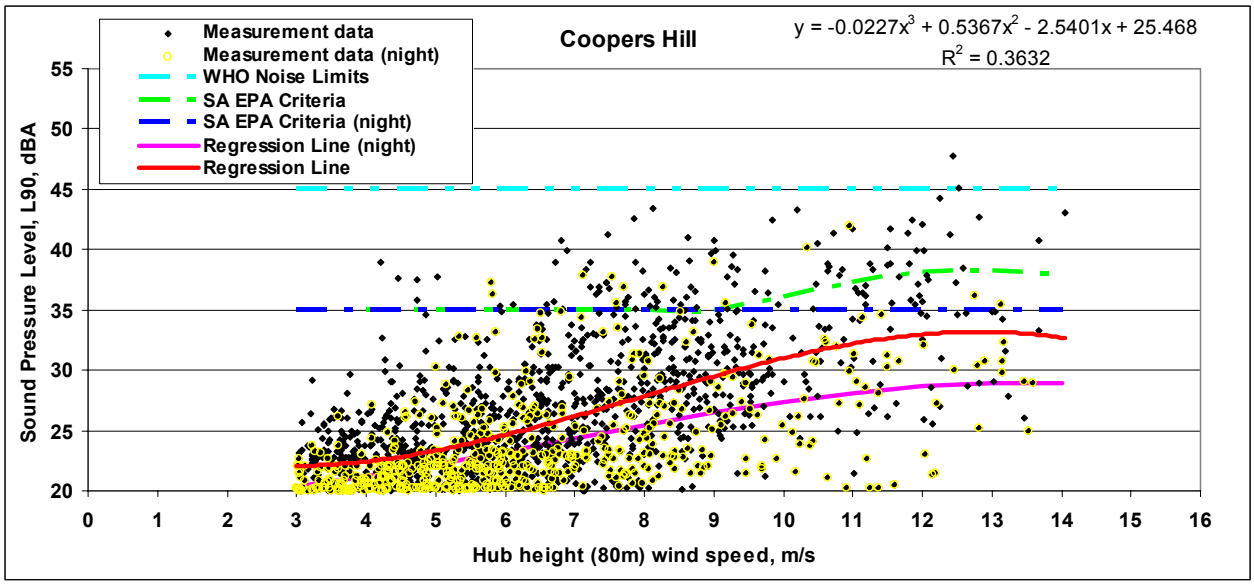
Figure 11 Measurement location Coopers Hill

The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 12**.

Graphically represented noise statistical indices, together with wind speed are presented in **Appendix C4.**

The Rating Background Level (RBL) was 22.2 dBA for the day period.

Figure 12 Background Noise Measurements and Noise Criteria Curve - Coopers Hill



6.9 Glenfinnan

The property of Glenfinnan is located directly to the north-northeast of the proposed wind farm, approximately 0.9 km from the nearest proposed WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site.

The residence is well protected from the wind in all by mature trees, with a tall pine windbreak to the north and smaller trees and shrubs in the garden. The measurement location is shown in **Figure 13.**

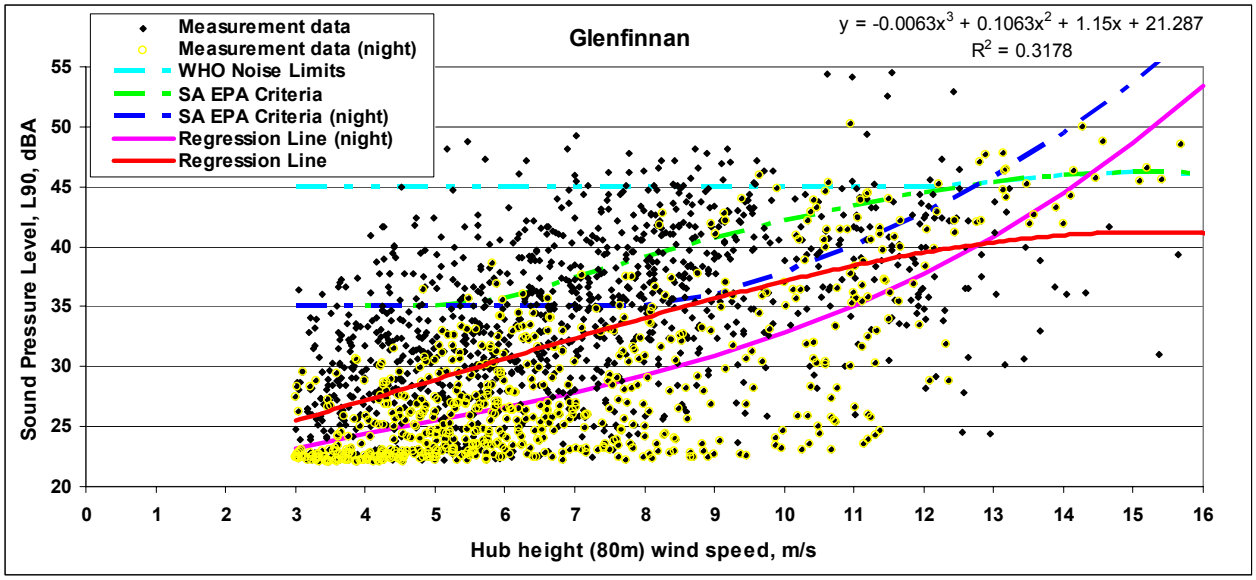
Figure 13 Glenfinnan Measurement Location

The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 14.**

Graphically represented noise statistical indices, together with wind speed are presented in **Appendix C5.**

The daytime Rating Background Level (RBL), determined for construction noise impact assessment purposes was 27.3 dBA.

Figure 14 Background Noise Measurements and Noise Criteria Curve – Glenfinnan



6.10 Old Springfield

The property of Old Springfield is located to the northeast of the proposed wind farm approximately 3 km from the nearest proposed WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site.

The residence is protected from the wind by tall pine trees to the west, there was however only a few smaller trees and shrubs located around the garden. Noise monitoring equipment was placed to the south of the house, shown in **Figure 15** below.

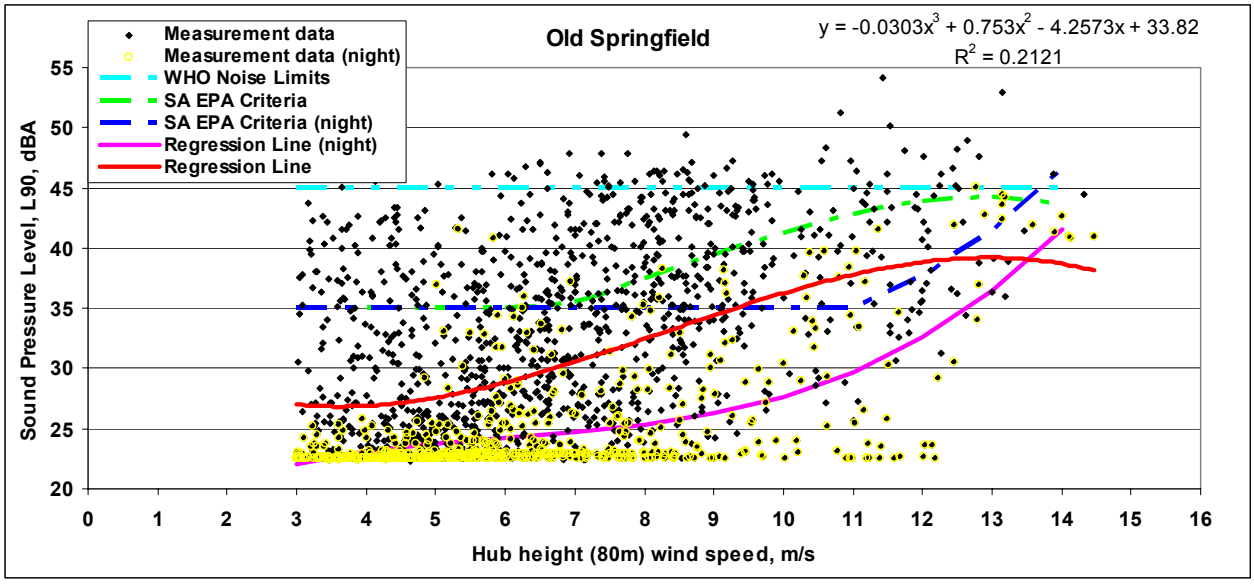
Figure 15 Old Springfield Measurement Location

The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 16**.

Graphically represented noise statistical indices, together with wind speed are presented in **Appendix C6.**

The Rating Background Level (RBL) was 25.6 dBA for the day period.

Figure 16 Background Noise Measurements and Noise Criteria Curve – Old Springfield



6.11 Rockybah

The property of Rockybah is located in the north region of the proposed wind farm site approximately 0.9 km from the nearest proposed WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site.

A number of large trees and a well established garden grow around the house yard area, offering protection from the wind in most directions except from the east. The measurement location was to the east of the house and is shown in **Figure 17.**

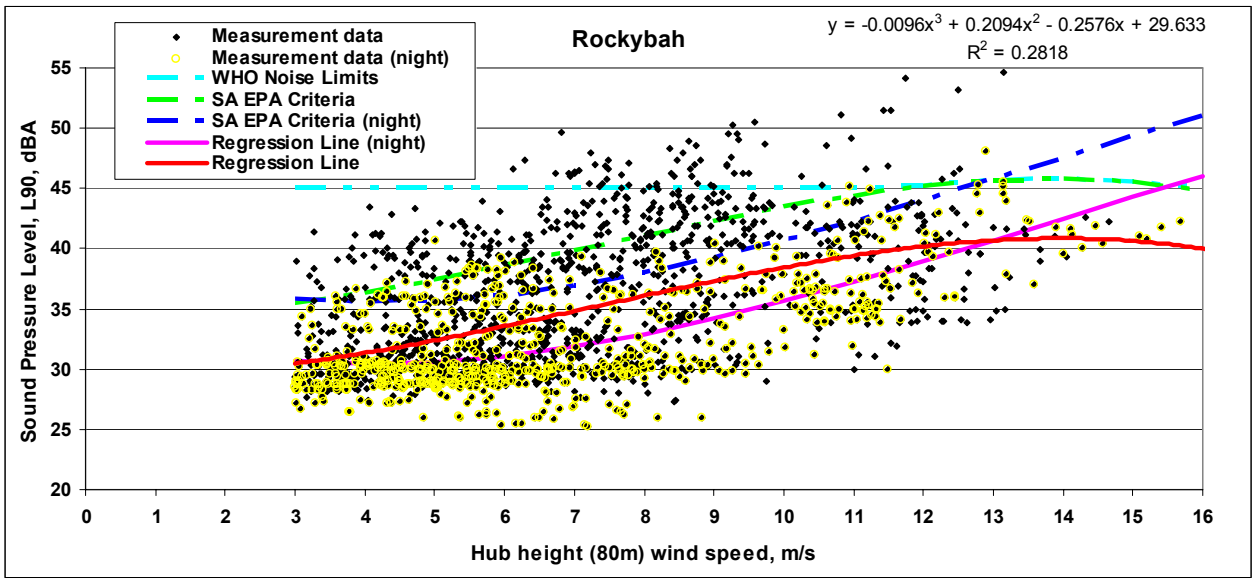
Figure 17 Rockybah Measurement Location

The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 18.**

Graphically represented noise statistical indices, are presented in **Appendix C7.**

The daytime RBL was 29.6 dBA.

Figure 18 Background Noise Measurements and Noise Criteria Curve - Rockybah



6.12 Yandra

The residence of Yandra is located to the north east of the proposed wind farm approximately 0.7 km from the nearest proposed WTG. This residence is occupied by one of the landowners that make up part of the proposed Boco Rock wind farm site.

A number of large trees and a well established garden grow around the house yard area. The measurement location was to the north east of the house and is shown in **Figure 19.**

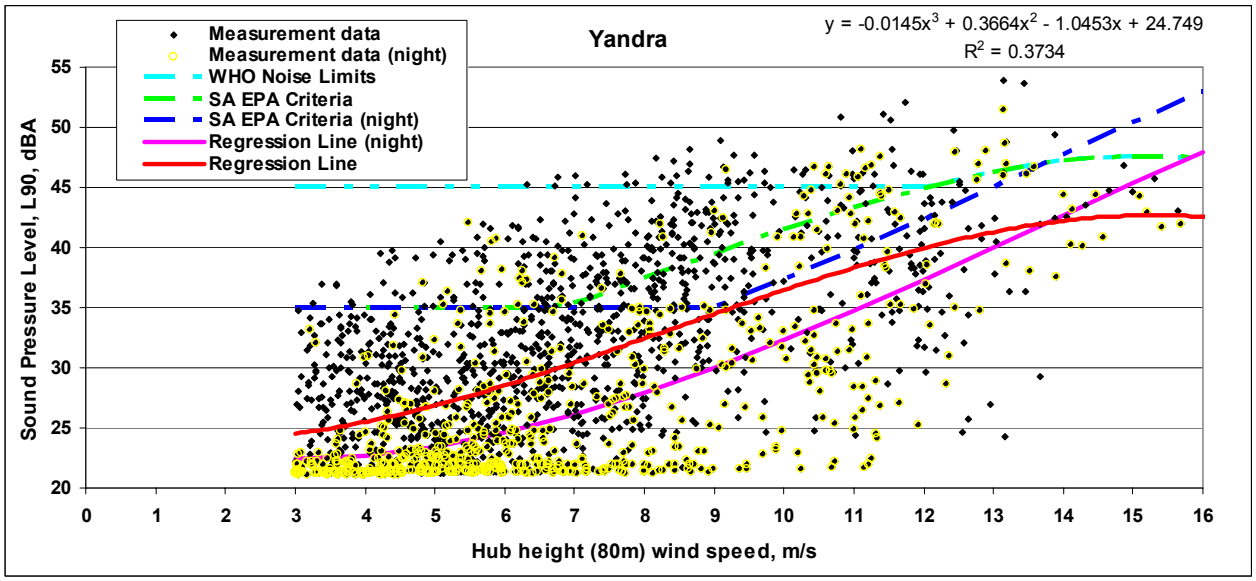
Figure 19 Yandra Measurement Location

The results of the background noise monitoring taken in March-April 2009, showing the data points, line of best fit and the Noise Criteria Curve are shown in **Figure 20**.

Graphically represented noise statistical indices, together with wind speed are presented in **Appendix C8**. Higher noise levels at dawn were a feature of this location and likely a result of birds**.**

The daytime RBL, determined for construction noise impact assessment purposes, was 25.6 dBA.

Figure 20 Background Noise Measurements and Noise Criteria Curve – Yandra



7 ACOUSTIC ASSESSMENT OF PROPOSED WIND FARM BASE LAYOUT

An assessment of the acceptability of wind farm noise levels at all assessment receivers located within a distance of 6 km of the proposed wind farm was made in accordance with SA EPA Guideline criteria and the pre-existing background noise level regression analysis detailed in **Section 6**.

Results for both WTG layouts are shown in **Table 11** of **Section 5.2**, with the predicted noise levels for the 107WTG layout slightly higher than those of the 125WTG layout.

7.1 Predicted Noise Levels – 107 WTG Layout, Siemens SWT-2.3-101 (2.3 MW), 101 m Rotor Diameter, 100 m Hub Height

The assessment figures contained in **Appendix A1** depict the predicted WTG noise level curves for the base 107 WTG layout equipped with 101m rotor diameter, Siemens SWT-2.3-101, 2.3 MW WTG's superimposed over SA EPA Guideline Criteria and WHO based noise limits.

All non project involved receivers were well below the *'Background + 5 dBA'* intrusive criteria. Furthermore, most non project involved receivers are predicted to be below the background noise regression line.

Several receptors are found to exceed SA EPA Guidelines *'Background + 5 dBA'* intrusive criteria, these being: Benbullen, Coopers Hill, Kelton Plain, Avon Lake and Yandra. It should be noted however, that all of these receptors are project involved and within WHO criteria.

Furthermore, all receptors would achieve their respective criteria with consideration to the night-time only regression line based limits.

7.2 Predicted Noise Levels – 125 WTG Layout, Repower MM92 (2.05 MW), 92.5 m Rotor Diameter, 100 m Hub Height

The assessment figures contained in **Appendix A2** depict the predicted WTG noise level curves for the base 125 WTG layout equipped with Repower MM92 2.05 MW WTG's superimposed over SA EPA Guideline Criteria and WHO based limits.

For this layout, all non project involved receivers were well below the *'Background + 5 dBA'* intrusive criteria. Furthermore, most non project involved receivers are predicted to be below the background noise regression line.

All receivers predicted to exceed SA EPA Guidelines *'Background + 5 dBA'* intrusive criteria (Benbullen, Coopers Hill, Kelton Plain, Avon Lake and Yandra) are project involved, and are within the nominated WHO guideline noise limits.

Furthermore, all receptors would achieve their respective criteria with consideration to the night-time only regression line based limits.

7.3 Assessment of Tonality and Infrasound

WTG manufacturers are obliged to conduct independent tests in accordance with IEC 61400-11. A part of this assessment is to conduct a tonal audibility test. The tonal audibility ΔLta is typically assessed using the methodology outlined in *Joint Nordic Method Version 2 – Objective Method for Assessing the Audibility of Tones in Noise*.

The warranted tonal audibility data ΔLa,k values have been supplied by the WTG manufacturers as follows.

Table 15 Audible tonality assessment to IEC 61400-11

Wind speed m/s	Manufacturer/WTG – ΔLa,k value – audible tonality	
	Siemens SWT-2.3-101 (2.3 MW)	**Repower MM92 (2.05 MW)**
3	No data	No data
4	≤4	No data
5	≤4	-13.73
6	≤4	-10.22
7	≤4	-11.72
8	≤4	-10.49
9	≤4	-9.58
10	≤4	No data

For the purposes of the assessment tonality was not deemed to be audible (ΔLa,k <-3) and hence no penalty has been applied.

Infrasound is not tested as an obligatory part of IEC 61400-11. It is noted that, in general, modern WTGs do not exhibit significant infrasound emissions.

7.4 Project involved residences

The proponent Wind Prospect CWP intends to enter into noise agreements with project involved residences prior to construction. Under the SA EPA Guidelines these residences are not required to comply to the 35 dBA or 'background + 5 dBA' limits. However, it is necessary to ensure that the project does not result in an 'unreasonable interference' with the amenity of these areas or cause any adverse health affects.

The World Health Organisation (WHO) publication '*Guidelines for Community Noise'* identifies the main health risks associated with noise and derives acceptable environmental noise limits for various activities and environments.

For the assessment of project involved residences the adopted external criteria of 45 dBA or the level given by the SA EPA Guideline criteria, where higher, will be adopted. Effectively this becomes 45 dBA or background + 5 dBA, whichever is the higher.

The predicted noise levels shown in **Table 11** and **Appendix A1** and **A2** indicate that for all WTG scenarios and wind speeds, external noise levels from WTG's are below 45 dBA.

Predicted external noise levels will be further mitigated by shielding effects of the building, with the anticipated internal noise levels similarly reduced by the façade of the dwelling.

It should be further noted that all predicted noise levels are considered to be conservative with the model assuming 'hard ground', average downwind propagation from all WTG's to each receiver and a well developed moderate ground based temperature inversion, a scenario which is not able to be re-created in reality.

7.5 Temperature Inversions

The SA EPA Guidelines do not require or suggest temperature inversions be included during wind farm noise assessments. The NSW INP states that temperature inversions be included in an assessment if they are deemed to be a prevalent feature of the environment, which generally requires they occur for greater than 30% of the total night-time during winter (approximately two nights per week between 6:00 pm and 7:00 am). Currently there is insufficient data available to accurately determine the prevalence of temperature inversions.

Temperature inversion is an atmospheric condition in which temperature increases with height above ground. Such conditions may increase noise levels by focussing sound wave propagation paths at a single point. Temperature inversions occurring within the lowest 50m to 100m of atmosphere can affect noise levels measured on the ground. Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind.

Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near to the ground. The effect of temperature inversions on noise propagation from WTG's is therefore not typical of other sources.

WTG's for the Boco Rock Wind Farm project are located on top of elevated ridges. The hub height (assumed acoustic centre of the WTG) is located typically on average 160m higher than receiver locations on the surrounding area. It is therefore unlikely that conventional temperature inversion conditions, in the lower 100m of the atmosphere, would affect noise propagation from such an elevated source.

A further consideration must be that temperature inversions require little to no wind in order to minimise atmospheric mixing and hence develop. During calm conditions the WTGs are unlikely to operate, as cut-in speed is 3m/s.

Notwithstanding the above, an adaptive management approach could be implemented if undue noise impacts are identified during WTG operation that are related to temperature inversion effects.

7.6 Atmospheric stability and wind profile

The wind velocity at a location can be represented by a vertical profile (gradient) that generally is at a minimum at ground level and increases with altitude. The wind velocity profile is primarily determined by physical factors such as surface roughness and topographic (relief) effects, which are reasonably constant over time, however can also be affected by more variable local atmospheric conditions including atmospheric stability and turbulence.

Atmospheric stability is determined by the total heat flux to the ground, primarily being the sum of incoming solar and outgoing thermal radiation and heat exchanged with the air. During clear summer days (incoming radiation dominates) air is heated from below and rises, causing significant thermal mixing, vertical air movements and turbulence. This process limits large variations in the vertical wind velocity profile.

During clear nights when outgoing radiation dominates, air is cooled from below, air density is greatest closer to the ground and minimal thermal mixing occurs. This leads to a stable atmosphere where horizontal layers of air are largely decoupled and allows for a higher wind velocity gradient.

The noise assessment methodology outlined in the SA EPA Guidelines, as do many other similar wind farm noise assessment methodologies, by necessity rely on the independently verified reference sound power data available for specific wind turbines measured at a manufacturer's test site. The measurement procedure has been standardised (IEC 61400-11) to require sound power data to be measured coincidentally with reference wind speed measurements at an altitude of 10 metres.

As discussed in **Section 5.2** the SA EPA Guideline methodology has been adapted to the alternative reference wind speed at a height of 80 metres AGL which is more representative of hub height wind speed. Accordingly the turbine sound power level data has been amended to the appropriate 80 metre AGL wind speed. This approach goes some way to alleviating the variability that changing wind profiles has with respect to a 10 metre reference height.

While the proposed layouts meet the requirements of the SA EPA Guidelines, some uncertainty remains as to the likely noise conditions that will result under specific atmospheric conditions over time. The SA EPA Guidelines noise limits are generally set within the requirements of the WHO Guidelines that relate to health impacts, and it is highly unlikely that the remaining uncertainty could lead to health impacts. However, it is possible that under certain conditions the amenity of existing dwellings could be reduced notwithstanding compliance with SA EPA Guidelines. These conditions are likely to be variable and intermittent, and not result in a long-term loss in amenity.

An adaptive management approach could be implemented if undue noise impacts are identified during WTG operation that are related to elevated WTG noise levels during stable atmosphere conditions.

7.7 Adaptive Management

If undue WTG noise impacts are identified during operations due to temperature inversion, atmospheric stability or other reasons, then an 'adaptive management' approach can be implemented to mitigate or remove the impact. This process could include;

- Receiving and documenting noise impact complaint through 'hotline' or other means.
- Investigating the nature of the reported impact.
- Identifying exactly what conditions or times lead to undue impacts.
- Operating WTG's in a reduced 'noise optimised' mode during identified times and conditions (sector management).
- Turning off WTG's that are identified as causing the undue impact.
- Providing acoustic upgrades (glazing, façade, masking noise etc) to affected dwellings.

7.8 Wind Turbine Vibration

Vibration or more specifically the oscillatory movement of receptor structures could potentially propagate from a source (in this case a wind farm) through either a ground path (ground borne vibration) or an airborne path as sound which could couple with lightweight structures and produce a movement in the structure.

7.8.1 Ground borne

Ground borne vibration levels attenuate with distance with varying amounts dependant upon such variables as frequency and geotechnical parameters. There are a few documented research reports with regards to wind farm generated ground vibration.

The Snow Report (*Low Frequency Noise & Vibration Measurements at a Modern Wind Farm*, ETSU W/13/01392/REP, D J Snow, 1997) describes measurements taken at a wind farm consisting of eleven 450 kW WTG's, where noise and vibration measurements were taken at increasingly distant points up to 1 kilometre. Low frequency vibration was determined down to 0.1 Hz with varying wind speeds and on/off operation. The research found that the absolute level of vibration signals measured at any frequency at 100 metres from the nearest WTG were significantly below the most stringent criteria given by BS 6472:1992 Evaluation of human exposure to vibration in buildings (1Hz to 80Hz). Furthermore vibration in the 0.5Hz to 1Hz range remained at similar levels when the wind farm was not operating, suggesting that the vibration measured may have been due to other (ambient) sources.

Detailed *Microseismic and infrasound monitoring of low frequency noise and vibrations from wind farms* were undertaken by the Applied and Environmental Geophysics Group of Keele University as part of a comprehensive report giving '*Recommendations on The Siting of Wind Farm in the Vicinity the Eskdalemuir, Scotland*'. The Eskadelmuir Seismic Array (EKA) is in the southern uplands of Scotland and is sited on a very quiet magnetic and seismic environment with twin 9 km long lines of seismometer instrumentation which are sensitive enough to pick up nuclear explosions from up to 15,000 km away. It should be noted that the objective of the study was to measure vibration levels many orders of magnitude lower than project criteria detailed in **Section 2.6**

The Eskdalemuir report details results taken from St Breock Downs wind farm (possibly the same measurements taken in the Snow Report). From the documented seismic vibration measurements taken at 25 metres from a single WTG a peak particle velocity (PPV) of approximately $8x10^{-5}$ mm/s has been calculated. This is approximately 2500 orders of magnitude lower than project criteria. Whilst we note that turbines proposed for Boco Rock Wind Farm are larger than those measured above we are confident that ground vibration will be completely imperceptible at surrounding receptors. Furthermore, our own experience and observations at other operating wind farms has not indicated perceptible ground vibration at any distance from turbines.

7.8.2 Air borne

A good deal of misunderstanding and attention has been given in recent times to low frequency noise and infrasound generated by wind farms. Infrasound at sufficient levels has the potential to be perceived as vibration or alternatively cause the movement of lightweight structures which then in turn are perceived as vibration. It should be noted that the sometimes audible cyclical modulation of aerodynamic noise, the '*swish swish'* of blades, is often mistakenly identified as low frequency noise, where it actually is the low frequency modulation of audible noise.

The subject is most complex, dealing with frequencies that are sub audible, requiring alternative frequency weighting scales, specialist measurement equipment and techniques, and evaluating the variance of hearing sensitivity in a population at low frequency. Furthermore, it will depend on many variables including turbine type and size, wind conditions (including turbulence), propagation distance, building structure and materials, room sizing and positioning within room.

Comprehensive review, measurement testing and evaluation are offered in numerous technical reports investigating infrasound and low frequency noise from wind farms including;

A Review of Published Research on Low Frequency Noise and its Effects - Report for Defra by Dr Geoff Leventhall assisted by Dr Peter Pelmear and Dr Stephen Benton - 2002 (refer http://www.defra.gov.uk/environment/quality/noise/research/lowfrequency/documents/lowfreqnoise.pdf)

The Measurement of Low Frequency Noise at Three UK Wind Farms - report for DTI by Hayes McKenzie Partnership – 2006 (refer http://www.berr.gov.uk/files/file31270.pdf)

Wind turbines & Infrasound 2006 - Report for Canadian Wind Energy Association (CanWEA) by Howe Gastmeier Chapnik Limited (HGC Engineering) - 2006
(refer http://www.canwea.ca/images/uploads/File/CanWEA_Infrasound_Study_Final.pdf)

The consensus drawn by all investigations is that infrasound noise emissions from modern WTG's are significantly below the recognised threshold of perception for acoustic energy within this range.

8 ASSESSMENT OF CONSTRUCTION NOISE & VIBRATION LEVELS

8.1 Construction Noise

Construction activities include;

- construction of access roads,
- establishment of turbine tower foundations and electrical substation,
- digging of trenches to accommodate underground power cables,
- erection of turbine towers and assembly of WTG's.

The equipment required to complete the above tasks will typically include;

- excavator/grader, bulldozer, dump trucks, vibratory roller
- bucket loader, rock breaker, drill rig, excavator/grader, bulldozer, dump truck, flat bed truck, concrete truck
- excavator, flat bed trucks
- cranes, fork lift, and various 4WD and service vehicles.

The anticipated construction period is anticipated to be less than 18 to 24 months, with civil works expected to span approximately 12 to 15 months, however, due to the large area of the wind farm site, intensive works will be located within a distance of potential impact for each surrounding residential receiver for only very short and intermittent periods of time. It is therefore considered appropriate that construction noise levels up to 20 dBA above background noise levels would be considered acceptable for short term intensive civil works that are anticipated to produce high noise levels.

Computer noise models of typical construction scenarios were developed which included all anticipated mobile equipment for the activity operating simultaneously at full load. A de-rating factor of 8 dBA was selected to convert modelled full load simultaneous operation to typical operations of multiple mobile construction vehicles.

To look at the possible worst case construction scenario for all nearby receivers, all four different construction activities were modelled at each turbine location and the highest noise levels for each receiver predicted.

The resulting predicted construction noise level for the relevant 'worst case' scenario is detailed in **Table 16** together with the Rating Background Level (RBL) obtained during the background noise monitoring campaign.

Table 16 Predicted Construction Noise Levels

Receiver Location	Distance to WTG Construction Site (km)	Rating Background Level (RBL), dBA	Short Term (<4 weeks) Construction Noise Limit	Predicted Construction Noise Levels, L_{Aeq}, dBA			
				Construction of Access roads	Establishment of turbine tower foundations	Trench excavation	WTG erection and assembly
Avonlake* **	0.94	26	46	31	50	31	39
Belmore	4.65	22	42	14	33	14	22
Benbullen*	0.85	25	45	25	44	25	33
Boco*	1.59	26	46	18	37	18	26
Brooklyn*	3.32	25	45	19	38	19	27
Bungee	3.08	25	45	17	36	17	25
Clifton	5.89	25	45	0	19	0	8
Coombala	3.22	22	42	19	38	19	27
Coopers Hill*	0.94	22	42	35	54	35	43
Curry Flat	3.26	27	47	8	27	8	16
Edendale	4.63	26	46	3	22	3	11
Glenfinnan*	0.86	27	47	35	54	35	43
H1	4.29	22	42	15	34	15	23
H2	5.89	25	45	0	19	0	8
H3	5.23	25	45	2	21	2	10
Hyland Grange	5.17	25	45	2	21	2	10
Kangaroo Camp Retreat	5.74	25	45	11	30	11	19
Kanoute	6.06	25	45	10	29	10	18
Kelton Plain* **	1.84	22	42	27	46	27	35
Kenilworth	4.58	26	46	4	23	4	12
Lofty Vale	5.63	30	50	1	20	1	9
Lynndarra	4.51	26	46	4	23	4	12
Mia Mia	2.98	27	47	20	39	20	28
Mohawke	5.08	25	45	2	21	2	10
monastery	5.86	22	42	11	30	11	19
Mountain View	5.15	26	46	13	32	13	21
Nestlebrae* **	0.82	26	46	36	55	36	44
Old Curry Flat	3.45	27	47	8	27	8	16
Old Springfield*	3.04	26	46	9	28	9	17
Peters Park	4.75	22	42	14	33	14	22
Riverside*	3.20	26	46	19	38	19	27

Rockybah*	1.47	30	50	29	48	29	37
Roselea*	1.34	30	50	30	49	30	38
Rosemount	8.56	26	46	5	24	5	13
Roslyn	5.31	22	42	12	31	12	20
Sherwood*	2.09	25	45	14	33	14	22
Springfield*	3.88	26	46	6	25	6	14
Telembugrm*	2.13	25	45	14	33	14	22
Tinbery Lodge	3.97	26	46	16	35	16	24
Windella*	4.44	25	45	15	34	15	23
Wodburn	4.94	22	42	13	32	13	21
Woodbine	1.55	27	47	18	37	18	26
Wyuna*	1.81	26	46	27	46	27	35
Xenmor	4.55	22	42	4	23	4	12
Yandra*	1.12	26	46	33	52	33	41

* Denotes the property is involved with the project

** Denotes that the property has no current dwelling or is uninhabited

The predicted 'worst case' construction noise impacts are for most receiver locations below the existing typical daytime rating background level.

Some nearby receivers may receive elevated construction noise levels when turbine foundation civil works are located nearby, however, due to the anticipated short period of localised works would likely be considered satisfactory. Elevated noise levels predicted for Coopers Hill, Glennfinnan and Yandra during turbine foundation establishment are a result of the operation of a rock-breaker. Operation of the rock-breaker is dependent upon the geotechnical conditions of the foundation site and would be operated intermittently at most. Consideration for mitigative measures such as localised shrouding may be needed if adverse conditions are experienced if and when operating the rock-breaker at the most exposed positions.

In consideration that the predicted levels represent 'worst case' construction scenarios and are within limits which would be considered acceptable, it is unlikely that construction noise will cause any unnecessary impact.

8.1.1 Concrete Batching Plants

Portable concrete batching plants (combined SWL 115 dBA) may be required to supply concrete onsite. Up to five batch plant locations may be required to minimise the distance between the batching plant and the foundations being poured. Batching plant equipment may be relocated between the sites as the works progress to different areas of the site.

A noise model was developed to assess noise from the different concrete batching plant locations. The predicted noise levels for the proposed batch plant sites located at the Collector Substation, Brechnoch Road, Avonlake Road, Yandra Road, and South Yandra Road at the nearest affected properties are shown in **Table 17** through **Table 21** respectively.

The predicted noise levels are anticipated to comply with the applicable noise limit for the NSW Industrial Noise Policy at all inhabited receptors. In most cases concrete batch plant noise will be below ambient background noise levels and likely be inaudible.

Table 17 Concrete Batch Plant at Collector Substation

Receiver Location	Rating Background Level (RBL), dBA	Short Term (<4 weeks) Construction Noise Limit	Predicted Noise Level, dBA
Boco*	26	46	23
Nestlebrae* **	26	46	20
Riverside*	26	46	15

* Denotes the property is involved with the project

** Denotes that the property has no current dwelling or is uninhabited

Table 18 Concrete Batch Plant at Brechnoch Road

Receiver Location	Rating Background Level (RBL)	Short Term (<4 weeks) Construction Noise Limit	Predicted Noise Level, dBA
Roselea*	30	50	32
Rockybah*	30	50	26
Wyuna*	26	46	12
Yandra*	26	46	10

* Denotes the property is involved with the project

** Denotes that the property has no current dwelling or is uninhabited

Table 19 Concrete Batch Plant at Avonlake Road

Receiver Location	Rating Background Level (RBL)	Short Term (<4 weeks) Construction Noise Limit	Predicted Noise Level, dBA
Avonlake* **	26	46	58
Mountain View	26	46	17
Wodburn	22	42	14
H1	22	42	14
Tinbery Lodge	26	46	13
Kelton Plain* **	22	42	12
Sherwood	22	42	10

* Denotes the property is involved with the project

** Denotes that the property has no current dwelling or is uninhabited

Table 20 Concrete Batch Plant at Yandra Road

Receiver Location	Rating Background Level (RBL)	Short Term (<4 weeks) Construction Noise Limit	Predicted Noise Level, dBA
Glenfinnan*	27	47	24
Wyuna*	26	46	24
Yandra*	26	46	22
Woodbine	27	47	18
Benbullen*	25	45	16
Mia Mia	27	47	14
Old Curry Flat	27	47	12

* Denotes the property is involved with the project

** Denotes that the property has no current dwelling or is uninhabited

Table 21 Concrete Batch Plant at South Yandra Road

Receiver Location	Rating Background Level (RBL)	Short Term (<4 weeks) Construction Noise Limit	Predicted Noise Level
Yandra*	26	46	29
Wyuna*	26	46	23
Benbullen*	25	45	16
Glenfinnan*	27	47	15
Rockybah*	30	50	12
Woodbine	27	47	11

* Denotes the property is involved with the project

** Denotes that the property has no current dwelling or is uninhabited

8.2 Construction Vibration Assessment

The activities and equipment with the potential to generate the highest levels of ground vibration are the operation of the vibratory roller during construction of access roads and the operation of the rock breaker during establishment of turbine tower foundations. Typical vibration levels from these sources are presented in **Table 22**.

Table 22 Typical Vibration Emission Levels from Construction Plant

Activity	PPV Vibration Level (mm/s) at Distance		
	10m	20m	30m
4-Tonne Vibratory Roller	2.0 - 2.4	0.4 - 1.2	0.2 - 0.8
Hydraulic Hammer (30t)	3	1.5	1.0

It is evident that given the large distances between receptors and structures where construction works are likely to be undertaken (refer **Appendix E**), the building damage and human comfort vibration criteria will easily be met during construction.

8.3 Blasting

8.3.1 Blasting Assessment

As part of the civil works it is expected that infrequent blasting will be required to clear obstacles and prepare WTG foundations. It is anticipated that a single blast every 2-3 days may be required for a period of approximately 2 weeks.

Blasting may be required in some areas to clear large rock outcrops to prepare turbine foundations.

The proposed wind farm site is a green field site where no previous blasting or blast monitoring has been conducted and therefore no specific site laws exist. We have therefore adopted a site law derived from measurement data at a different site to give an indicative result.

The 5% site laws for ground vibration and airblast are:

Ground Vibration $PVS\ (5\%) = 16202\ (SD_1)^{-2.03}$

Airblast $SPL(5\%) = 189.3 - 31.8 \log (SD_2)$

where PVS (5%) and SPL (5%) are the levels of ground vibration (Peak Vector Sum - mm/s) and airblast (dB Linear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

SD_1 and SD_2 are the ground vibration and airblast scaled distances, where:

$$SD_1 = \frac{\text{Distance}}{\sqrt{\text{MIC}}} \quad (m.kg^{-0.5})$$

and,

$$SD_2 = \frac{\text{Distance}}{\sqrt[3]{\text{MIC}}} \quad (m.kg^{-0.33})$$

Based on the blast emissions site laws, calculations were also conducted to indicate the allowable MIC's for compliance with the general EPA Human Comfort criteria of 115 dB Linear (airblast) and 5 mm/s (ground vibration).

The closest anticipated distance between blasting and residences would be approximately 730 metres (WTG 115 and Yandra). At this distance the predicted maximum MIC of up to 38 kg is likely to produce an airblast overpressure below the acceptable level of 115 dB Linear. An MIC of 36kg is expected to result in a vibration level (Peak Vector Sum) of 0.94 mm/s well within the recommended maximum level of 5 mm/s in the ANZECC Guidelines.

It is evident that the anticipated blasting is likely to meet all human comfort limits and building damage assessment criteria are easily met. All other sources of vibration would be less then above.

8.4 Traffic Noise

Traffic generated by the project during its construction phase has been evaluated in *Traffic and Transport Study: Proposed Boco Rock Wind Farm* (March 2009) prepared by Bega Duo Designs. Traffic generated by the project during its operational phase will be insignificant.

Project construction traffic for the Boco Rock wind farm will primarily utilise the local roads of Springfield Road, Avon Lake Road, Snowy River Way (Ando Road), Yandra Road, Bungarby Road and Boco Road. Beyond the project area traffic will use the Monaro Highway and other National Highways.

The projected maximum construction traffic on proposed access roads represent in some cases a significant increase in traffic movements, which result in the increase in existing traffic noise levels shown in **Table 21.**

The projected increase in road traffic noise levels on all local roads is expected to be greater than 2 dBA during peak construction periods, however, road traffic noise levels are anticipated to meet the Roads and Traffic Authority of NSW (RTA) *Environmental Criteria for Road Traffic Noise (ECRTN) 1999* target for a local road of daytime $L_{Aeq(1\ hour)}$ = 55 dBA at modest setback distances. We note that being a rural farming community that most receptors are at much greater setback distances from their road frontage and therefore will easily meet the ECRTN requirement.

Table 23 Construction Traffic Noise

Proposed Access Road	VPD Current	VPD Projected Maximum Construction Traffic	Projected increase in existing road traffic noise level	ECRTN classification	ECRTN requirement	Approximate distance at which ECRTN requirement is achieved
Monaro Highway	1907	240	0.5 dBA	Freeway / Arterial	$L_{eq(15hr)}$ 60 dBA	25 m
Springfield Road	200	Up to 240	3.5 dBA	Local	$L_{eq(1hr)}$ 55 dBA	55 m
Snowy River Way	114	Up to 240	5 dBA	Local	$L_{eq(1hr)}$ 55 dBA	40 m
Avon Lake Road	< 50	Up to 240	7.5 dBA	Local	$L_{eq(1hr)}$ 55 dBA	35 m
Yandra Road	< 30	Less than 100	6 dBA	Local	$L_{eq(1hr)}$ 55 dBA	20 m
Boco Road	< 30	Less than 100	6 dBA	Local	$L_{eq(1hr)}$ 55 dBA	20 m

8.4.1 Night-time deliveries

There could potentially be deliveries of equipment scheduled for out of hours, necessitated by traffic congestion considerations and safe passage of heavy vehicle convoys or especially long loads. Night-time traffic has the potential to cause sleep disturbance to residential receivers along the route. This potentially affects receivers situated closer to the road such as in Nimmatabel.

Preliminary calculations indicate that maximum noise levels at a residence approximately 10 metres from the road as a result of a heavy vehicle pass-by would be in the range 45-80 dBA. We would anticipate that night-time background noise levels along affected routes could be as low as 30 dBA and as such maximum noise levels from pass-bys may have the potential for sleep disturbance. However, the Monaro Highway is already a significant route (~1900 vpd) and carries significant heavy vehicles and it is unlikely project related night-time traffic would be of any greater impact than vehicles already using the route.

To minimise potential noise impacts associated with night-time deliveries some potential measures to be considered are;

- Prior notification of affected public where night-time convoys are scheduled
- Restricted use of exhaust/engine brakes in built up areas

9 CONCLUSION

WTG noise has been predicted and assessed against relevant criteria prescribed by the SA EPA Guideline and World Health Organisation (WHO) goals where appropriate. An evaluation of night-time baseline data was also included.

The 107 WTG layout, comprising Siemens SWT-2.3-101, 101m rotor diameter, 100m hub height, 2.3 MW turbines was predicted to comply with all relevant noise criteria, SA EPA Guideline and WHO limits, at all respective receivers.

The 125 WTG layout, comprising Repower MM92, 92.5m rotor diameter, 100m hub height, 2.05 MW turbines was predicted to comply with all relevant noise criteria, SA EPA Guideline and WHO limits, at all respective receivers.

WTG vibration levels have been evaluated and based upon overseas research available were found to be acceptable.

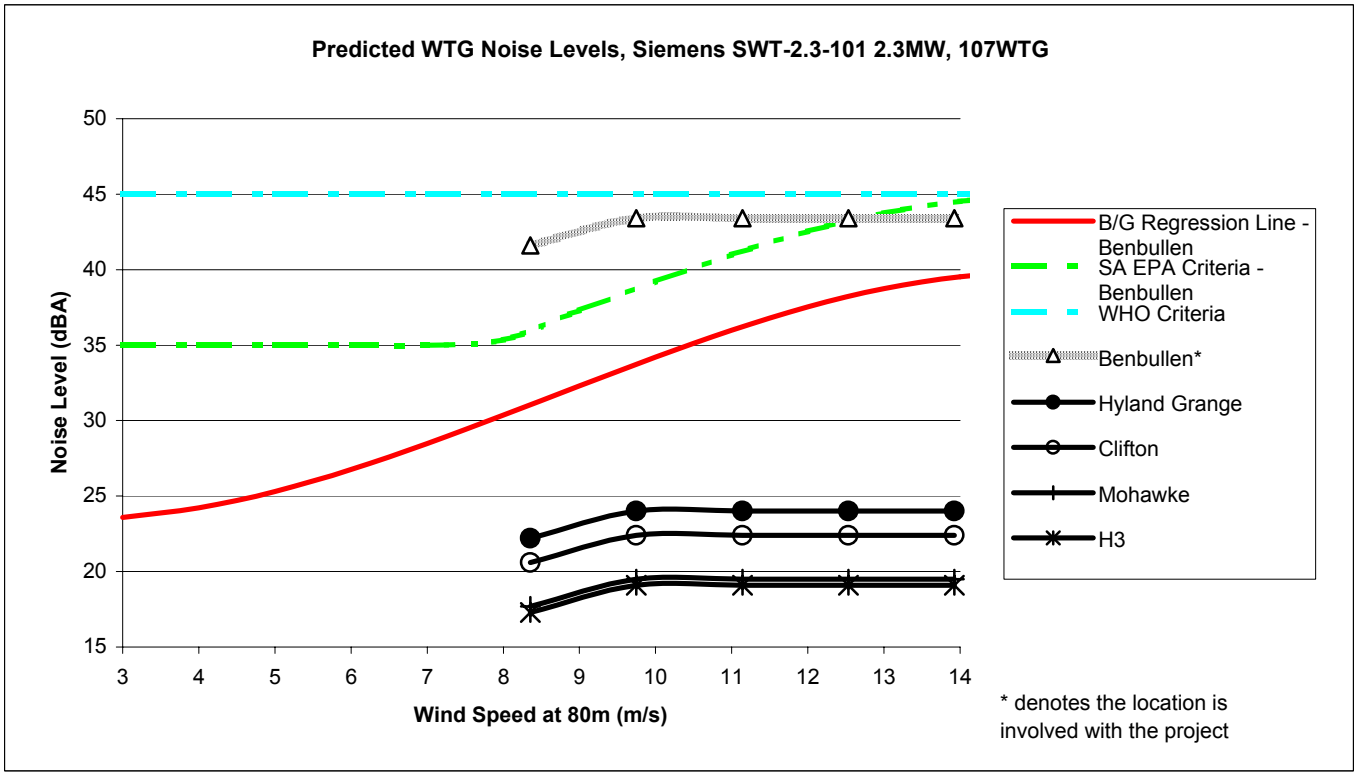
Construction noise and vibration impacts have been assessed and the 'worst case' scenarios modelled were found to be generally acceptable.

Blasting impact has been assessed and found to be acceptable. With a maximum instantaneous charge (MIC) of up to 36 kg, the airblast overpressure is anticipated to be below the acceptable level of 115 dB Linear for all existing residences. Similarly, vibration levels are anticipated to be well below the acceptable criteria.

Construction traffic noise impact has been assessed and the 'worst case' maximum construction traffic generated scenario would increase existing traffic noise levels along local roads by up to 3-7 dBA but due to the typically large setback of dwellings from the road network would result in noise level that would be considered acceptable under the ECRTN.

WIND TURBINE GENERATOR

ASSESSMENT GRAPHS


Predicted WTG Noise Levels, Siemens SWT-2.3-101 2.3MW, 107WTG
Noise Level (dBA)
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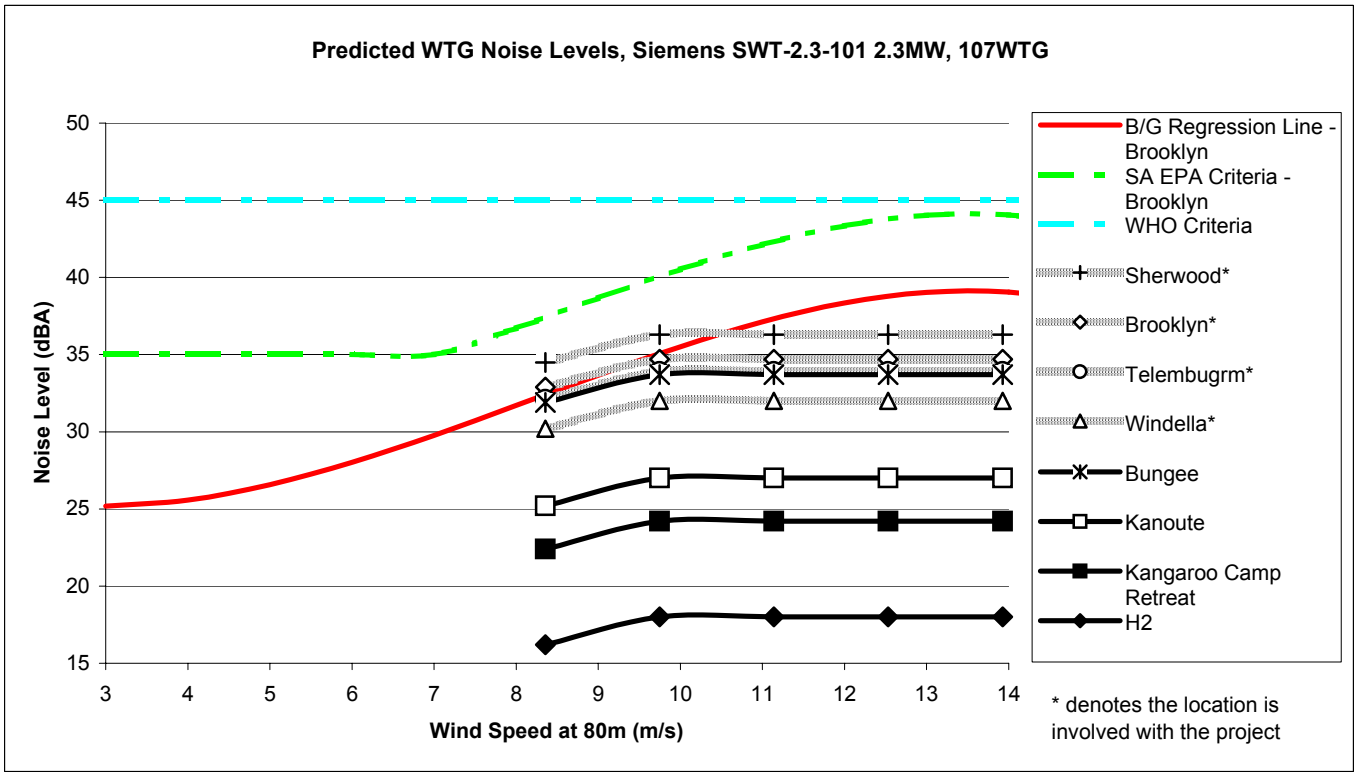
Wind Speed at 80m (m/s)
B/G Regression Line - Benbullen
SA EPA Criteria - Benbullen
WHO Criteria
Benbullen*
Hyland Grange
Clifton
Mohawke
H3
* denotes the location is involved with the project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Noise Level (dBA)
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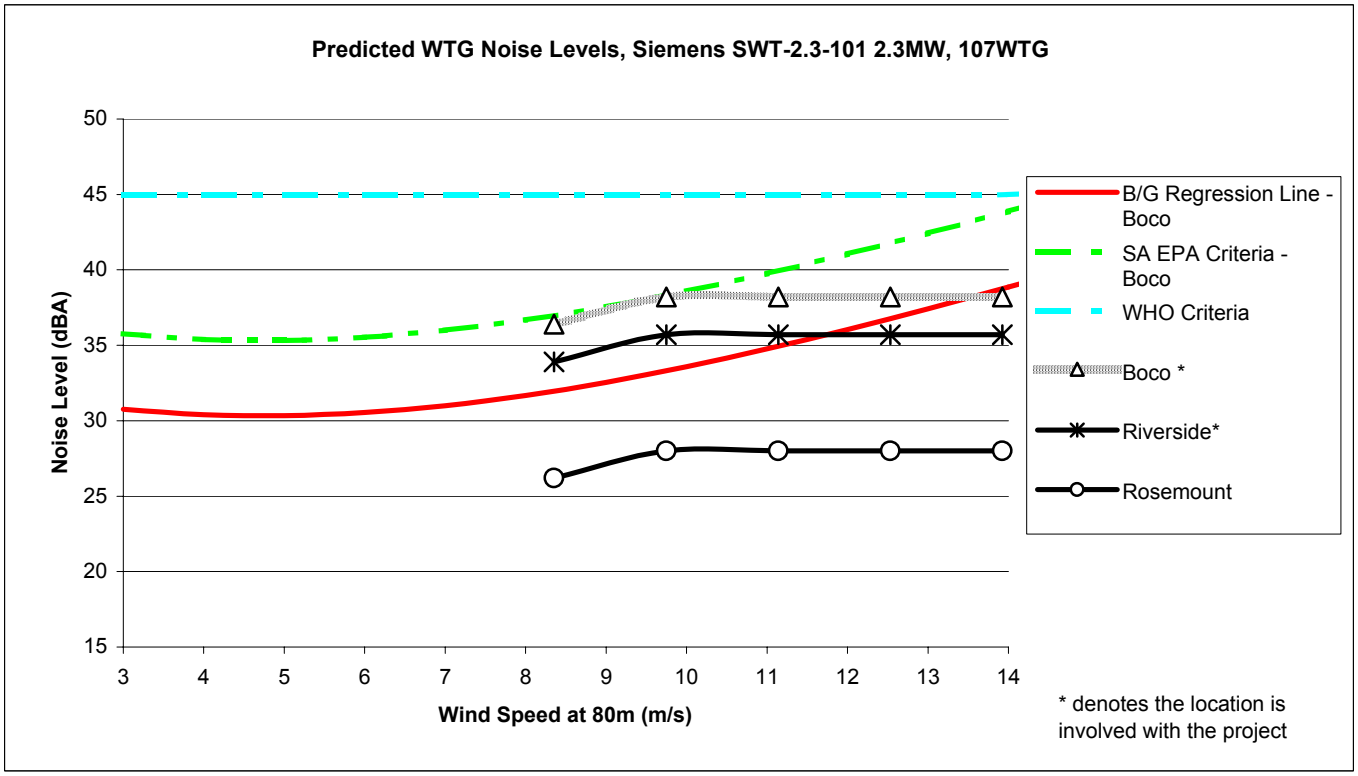
Wind Speed at 80m (m/s)
B/G Regression Line - Brooklyn
SA EPA Criteria - Brooklyn
WHO Criteria
Sherwood*
Brooklyn*
Telembugrm*
Windella*
Bungee
Kanoute
Kangaroo Camp Retreat
H2
* denotes the location is involved with the project


Predicted WTG Noise Levels, Siemens SWT-2.3-101 2.3MW, 107WTG
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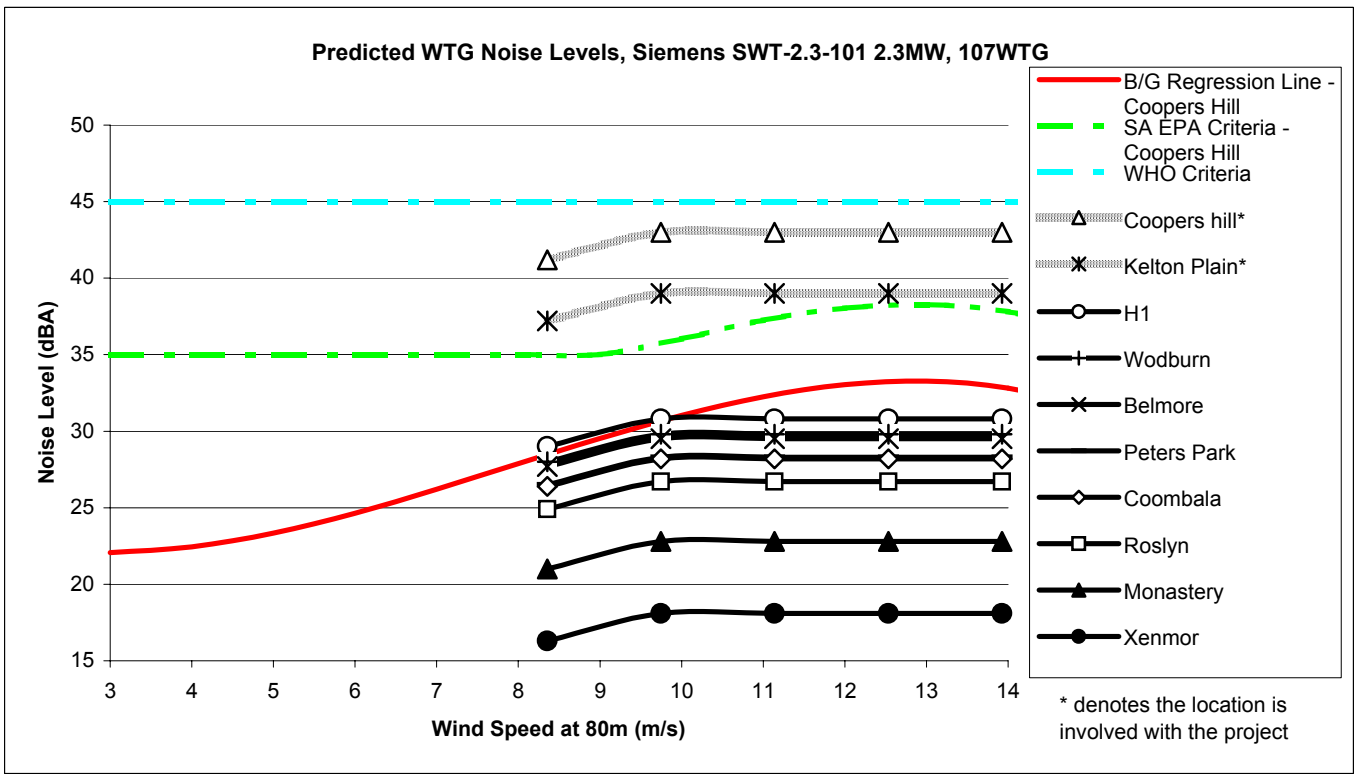
Wind Speed at 80m (m/s)
B/G Regression Line - Boco
SA EPA Criteria - Boco
WHO Criteria
Boco *
Riverside*
Rosemount
* denotes the location is involved with the project


Predicted WTG Noise Levels, Siemens SWT-2.3-101 2.3MW, 107WTG
Noise Level (dBA)
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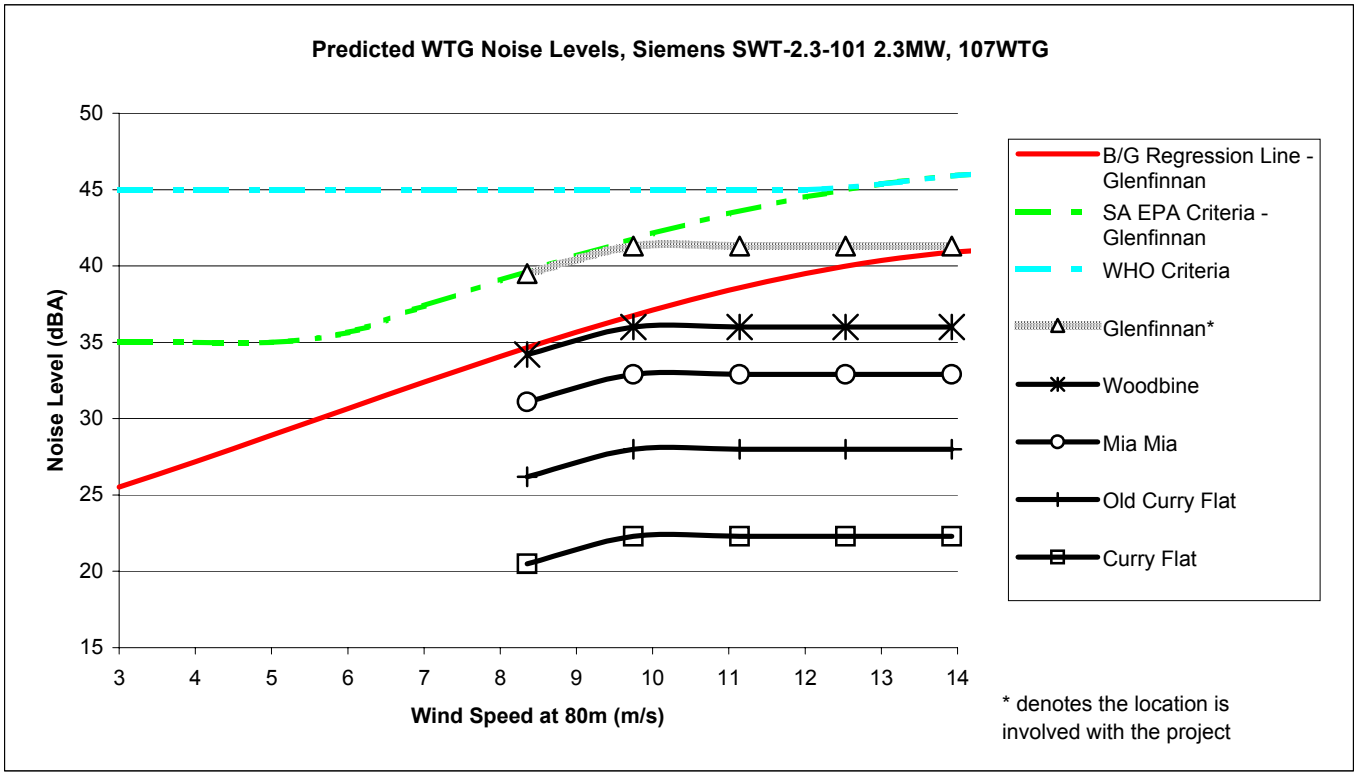
Wind Speed at 80m (m/s)
B/G Regression Line - Coopers Hill
SA EPA Criteria - Coopers Hill
WHO Criteria
Coopers hill*
Kelton Plain*
H1
Wodburn
Belmore
Peters Park
Coombala
Roslyn
Monastery
Xenmor
* denotes the location is involved with the project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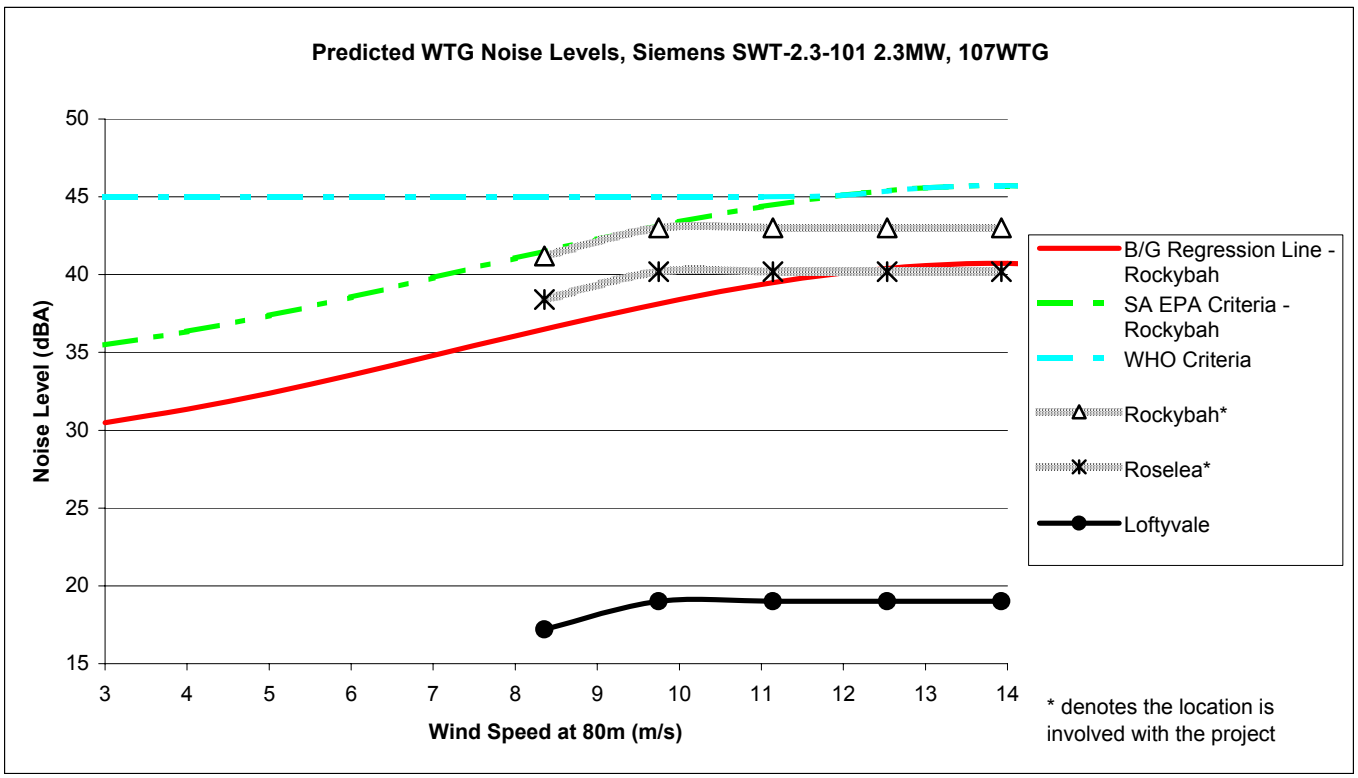
Wind Speed at 80m (m/s)
B/G Regression Line - Glenfinnan
SA EPA Criteria - Glenfinnan
WHO Criteria
Glenfinnan*
Woodbine
Mia Mia
Old Curry Flat
Curry Flat
* denotes the location is involved with the project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Noise Level (dBA)
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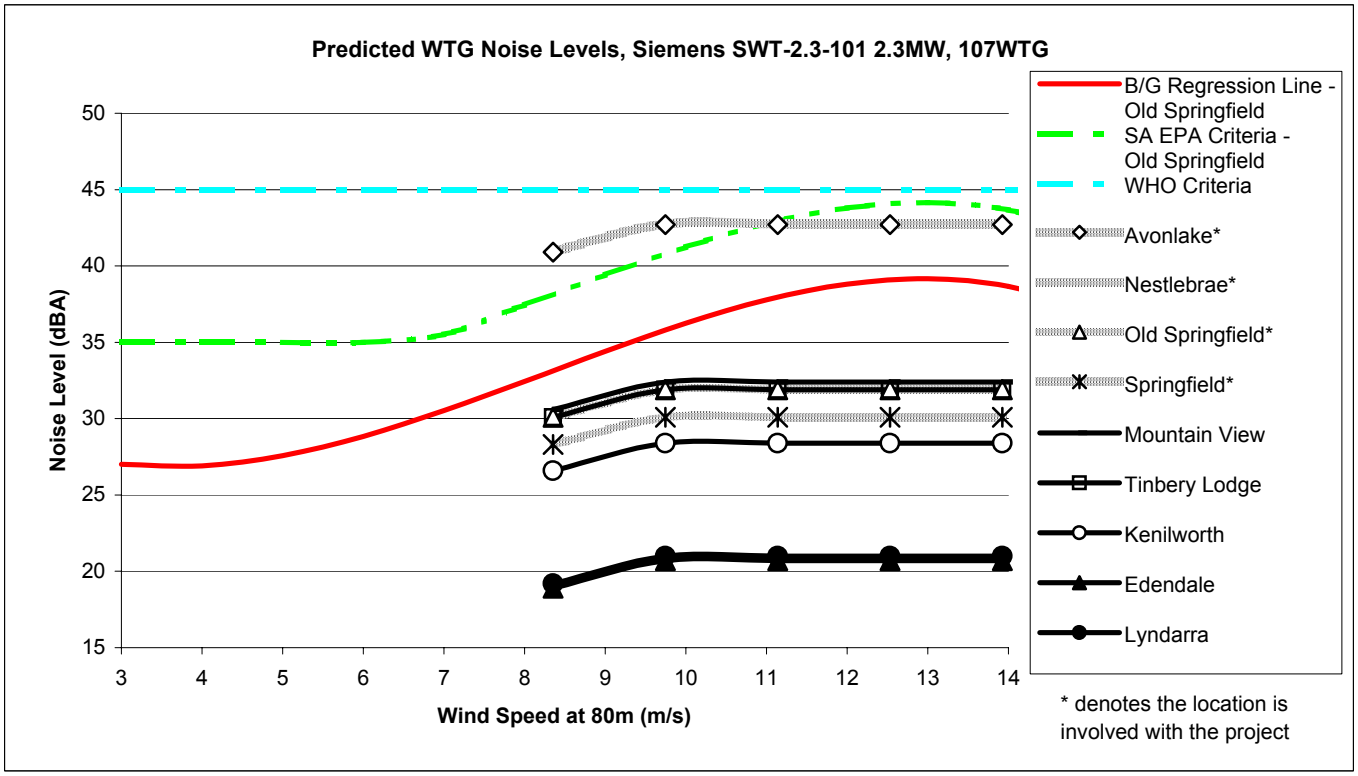
Wind Speed at 80m (m/s)
B/G Regression Line - Rockybah
SA EPA Criteria - Rockybah
WHO Criteria
Rockybah*
Roselea*
Loftyvale
* denotes the location is involved with the project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Noise Level (dBA)
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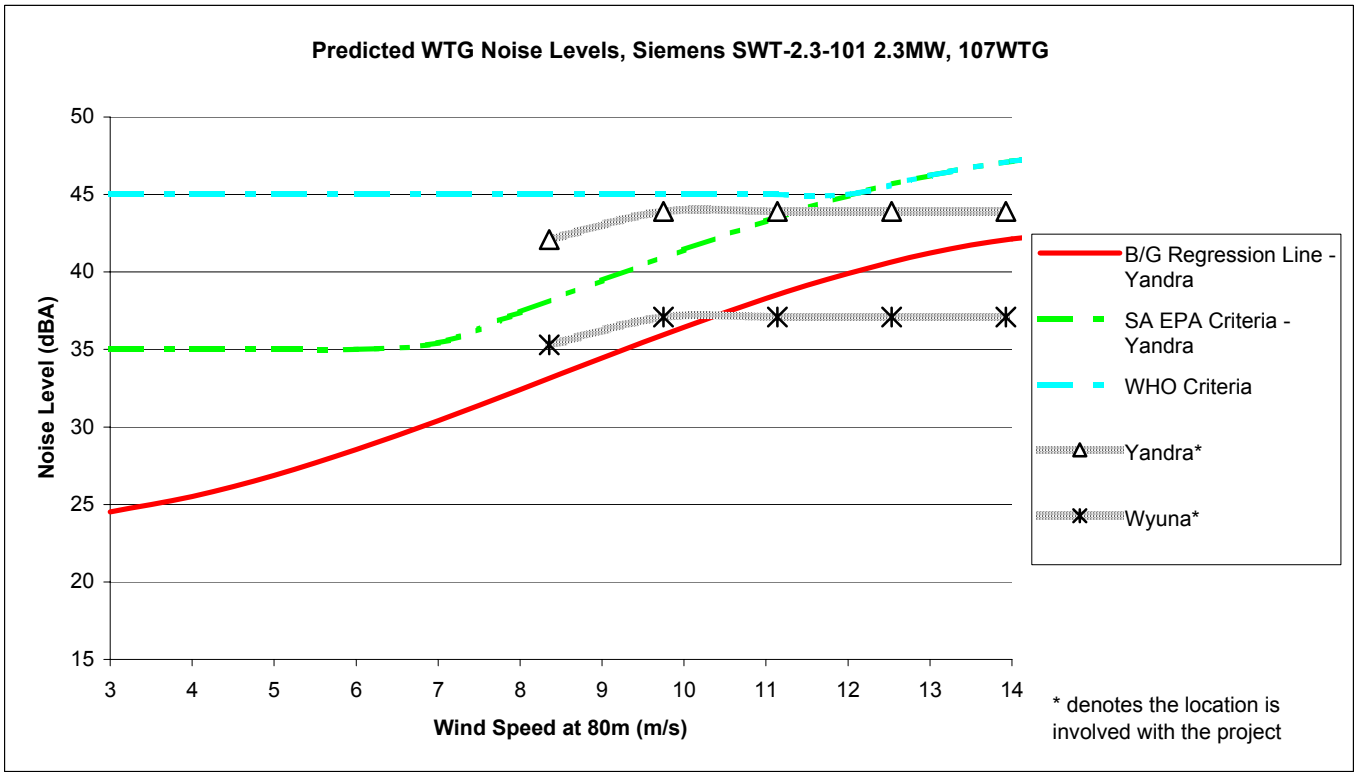
Wind Speed at 80m (m/s)
B/G Regression Line - Old Springfield
SA EPA Criteria - Old Springfield
WHO Criteria
Avonlake*
Nestlebrae*
Old Springfield*
Springfield*
Mountain View
Tinbery Lodge
Kenilworth
Edendale
Lyndarra
* denotes the location is involved with the project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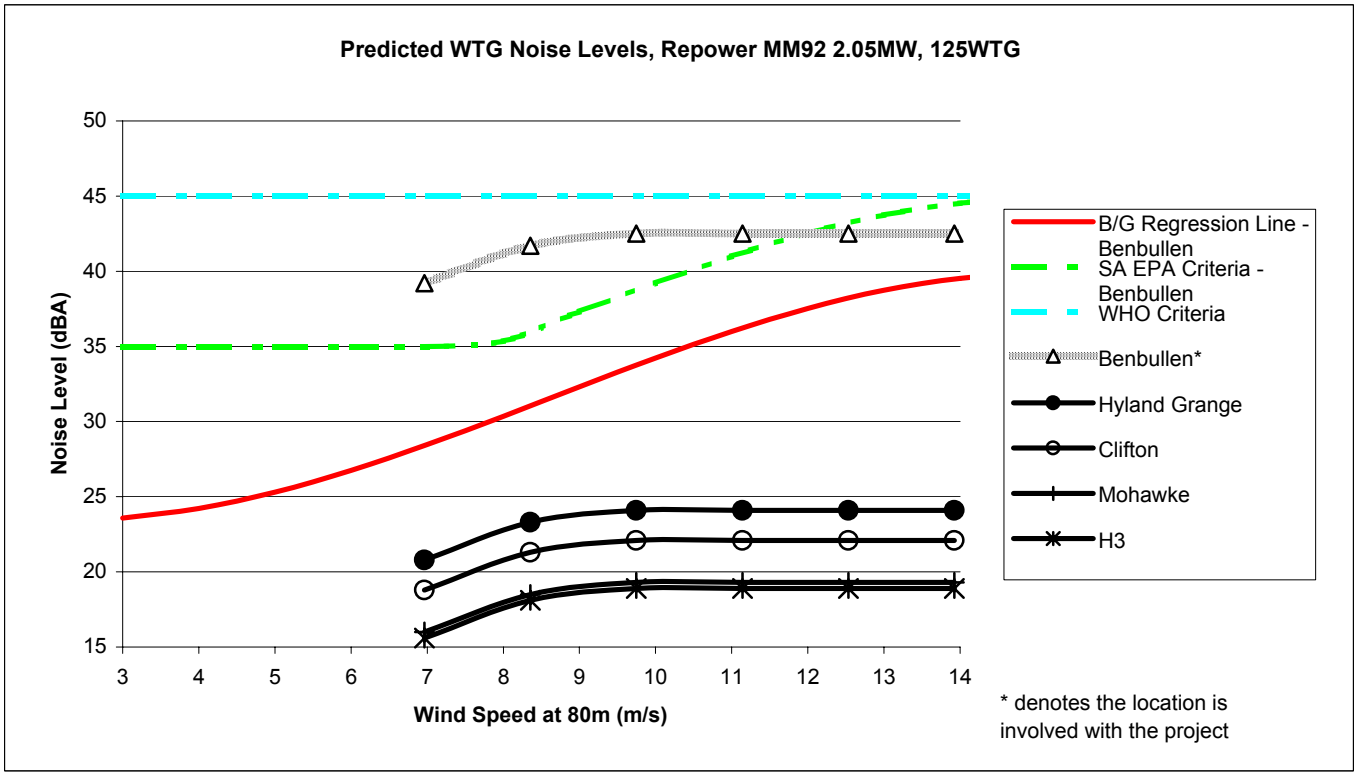
Wind Speed at 80m (m/s)
B/G Regression Line - Yandra
SA EPA Criteria - Yandra
WHO Criteria
Yandra*
Wyuna*
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
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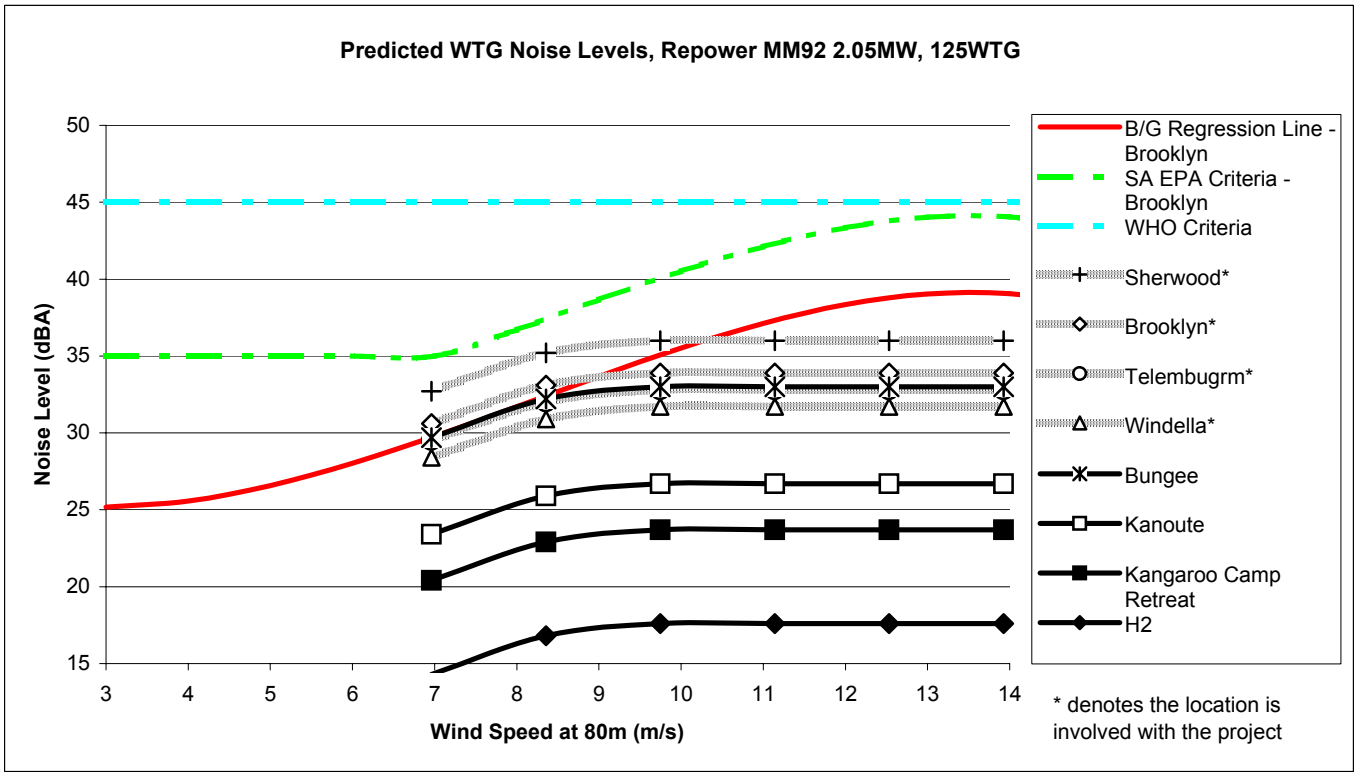
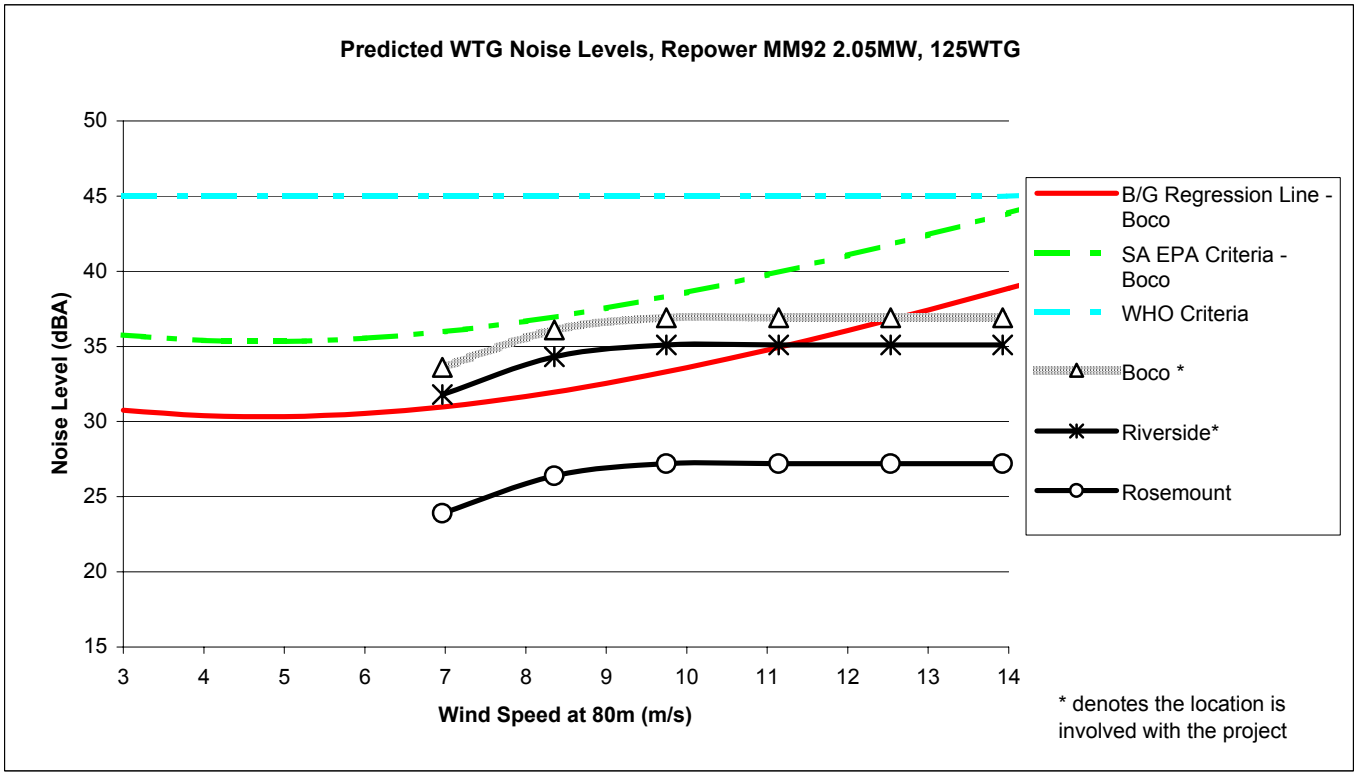
Wind Speed at 80m (m/s)
B/G Regression Line - Benbullen
SA EPA Criteria - Benbullen
WHO Criteria
Benbullen*
Hyland Grange
Clifton
Mohawke
H3
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
50
45
40
35
30
25
20
15
3
4
5
6
7
8
9
10
11
12
13
14
Wind Speed at 80m (m/s)
B/G Regression Line - Brooklyn
SA EPA Criteria - Brooklyn
WHO Criteria
Sherwood*
Brooklyn*
Telembugrm*
Windella*
Bungee
Kanoute
Kangaroo Camp Retreat
H2
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
50
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6
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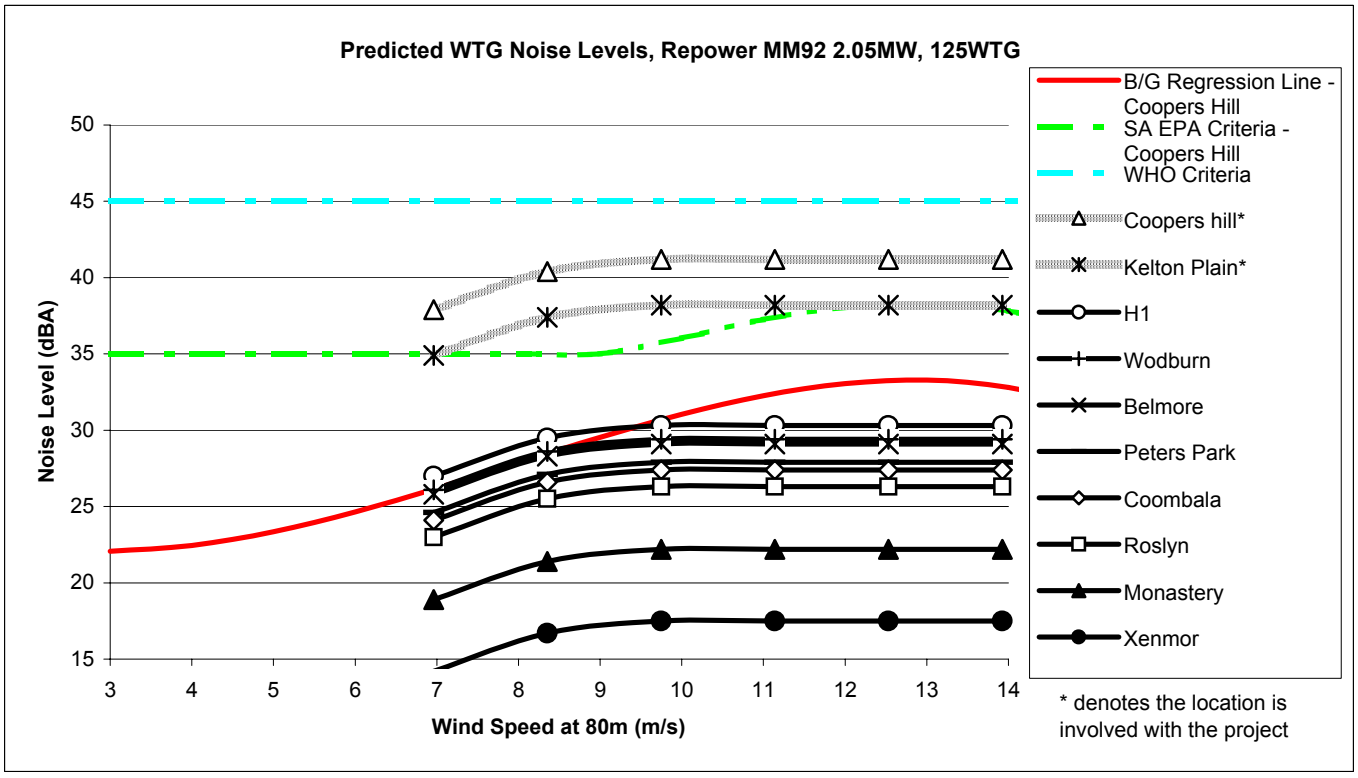
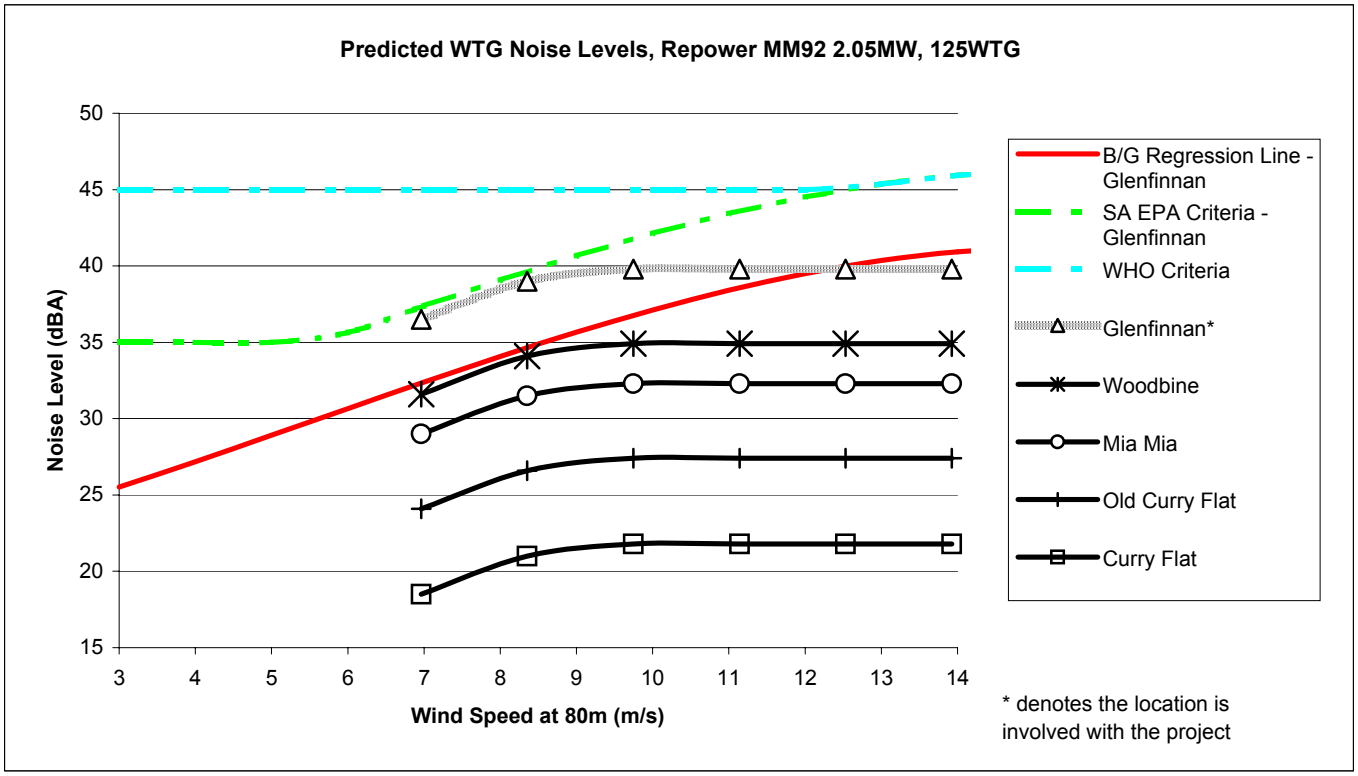
8
9
10
11
12
13
14
Wind Speed at 80m (m/s)
B/G Regression Line - Boco
SA EPA Criteria - Boco
WHO Criteria
Boco *
Riverside*
Rosemount
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
50
45
40
35
30
25
20
15
3
4
5
6
7
8
9
10
11
12
13
14
Wind Speed at 80m (m/s)
B/G Regression Line - Coopers Hill
SA EPA Criteria - Coopers Hill
WHO Criteria
Coopers hill*
Kelton Plain*
H1
Wodburn
Belmore
Peters Park
Coombala
Roslyn
Monastery
Xenmor
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
50
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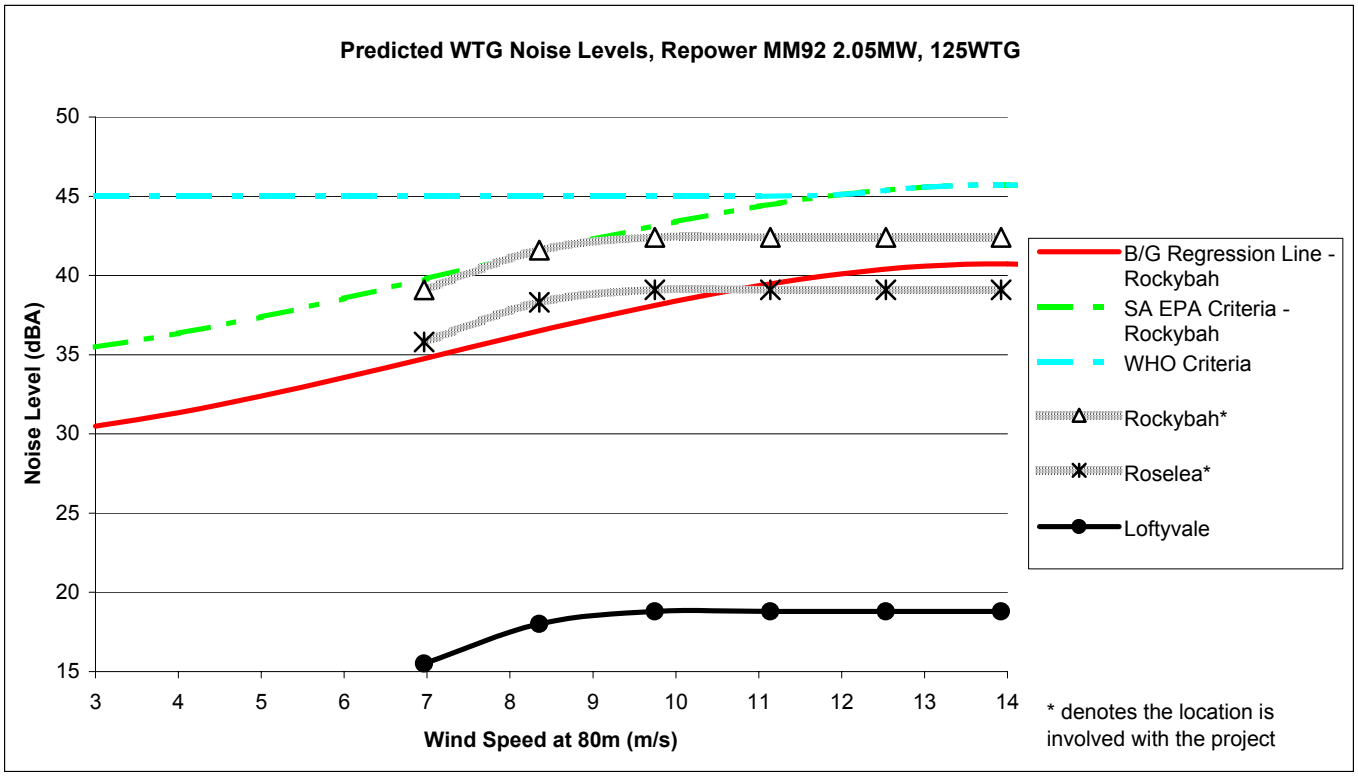
5
6
7
8
9
10
11
12
13
14
Wind Speed at 80m (m/s)
B/G Regression Line - Glenfinnan
SA EPA Criteria - Glenfinnan
WHO Criteria
Glenfinnan*
Woodbine
Mia Mia
Old Curry Flat
Curry Flat
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
50
45
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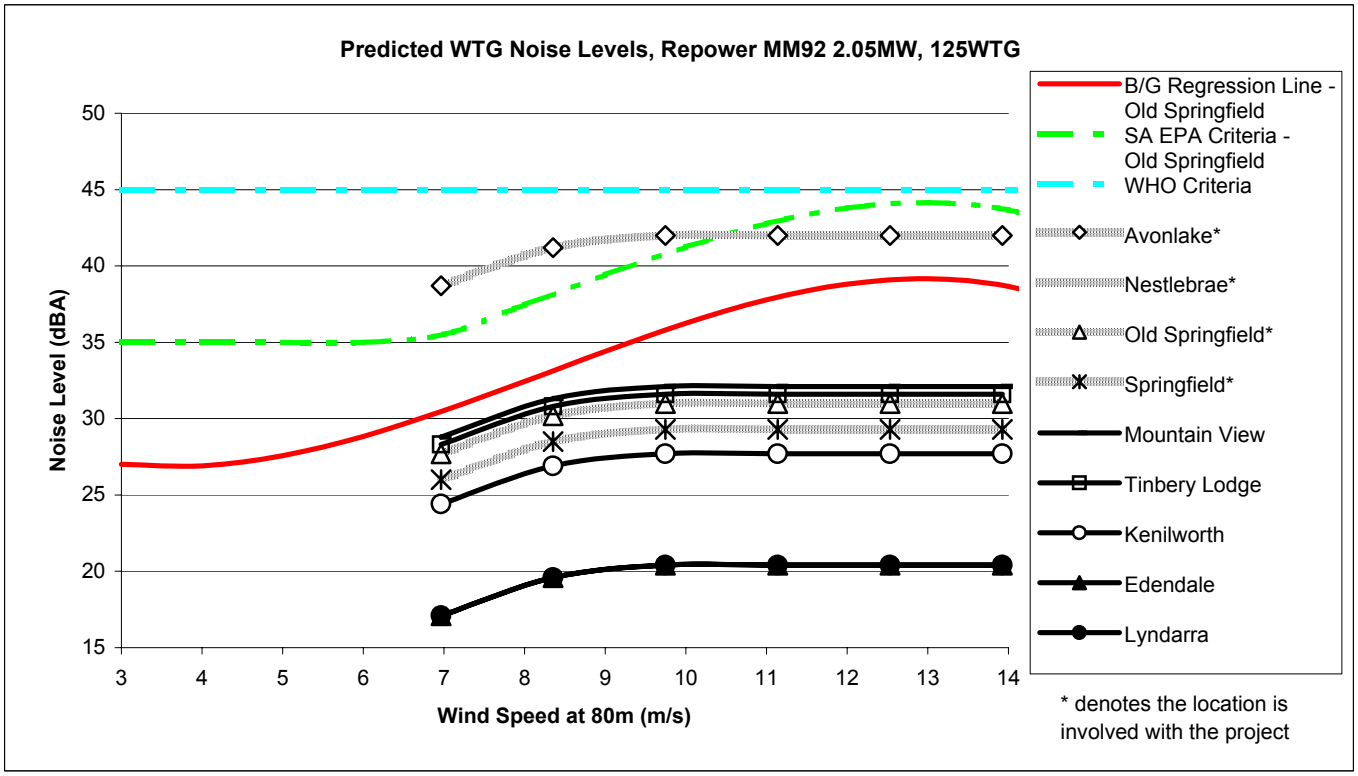
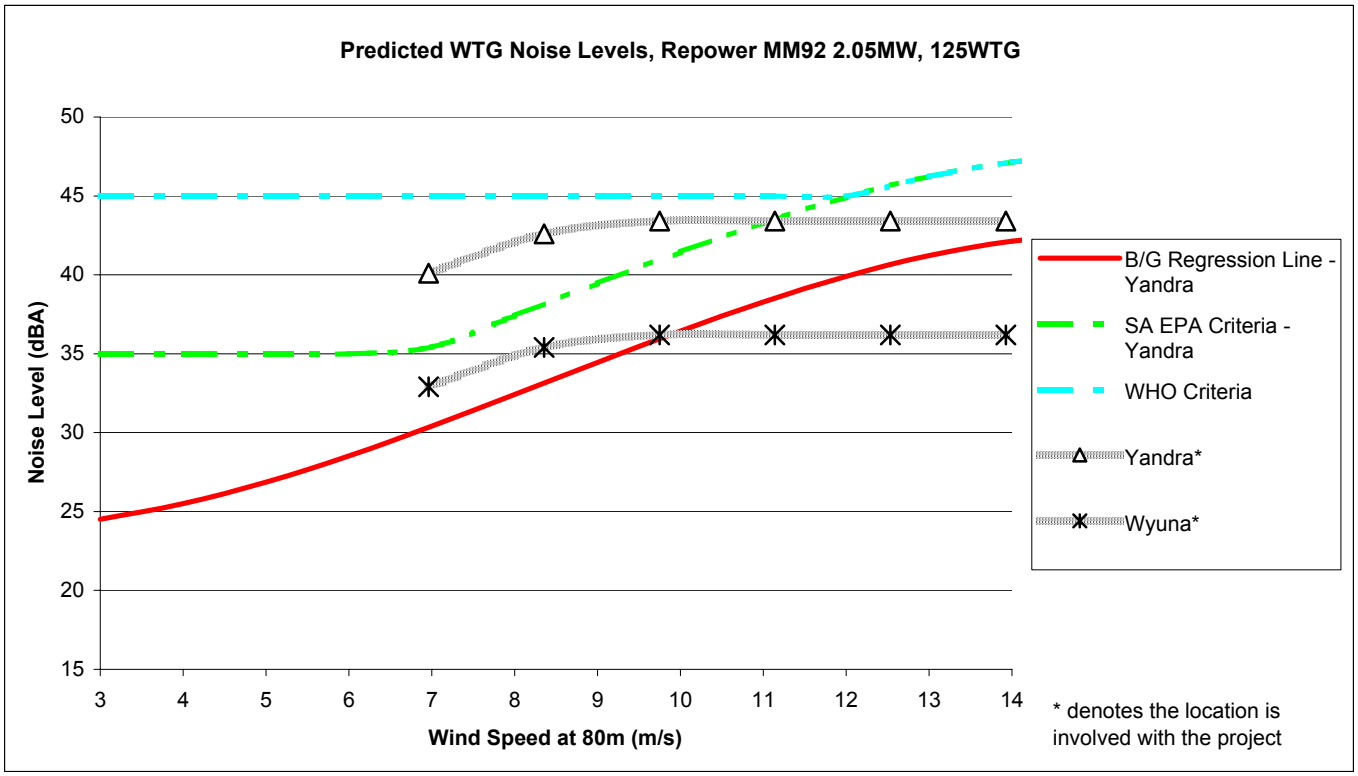
15
3
4
5
6
7
8
9
10
11
12
13
14
Wind Speed at 80m (m/s)
B/G Regression Line - Rockybah
SA EPA Criteria - Rockybah
WHO Criteria
Rockybah*
Roselea*
Loftyvale
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
50
45
40
35
30
25
20
15
3
4
5
6
7
8
9
10
11
12
13
14
Wind Speed at 80m (m/s)
B/G Regression Line - Old Springfield
SA EPA Criteria - Old Springfield
WHO Criteria
Avonlake*
Nestlebrae*
Old Springfield*
Springfield*
Mountain View
Tinbery Lodge
Kenilworth
Edendale
Lyndarra
* denotes the location is involved with the project


Predicted WTG Noise Levels, Repower MM92 2.05MW, 125WTG
Noise Level (dBA)
50
45
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11
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14
Wind Speed at 80m (m/s)
B/G Regression Line - Yandra
SA EPA Criteria - Yandra
WHO Criteria
Yandra*
Wyuna*
* denotes the location is involved with the project

Wind speed (at 80m AGL), m/s	8.4	9.7	11.1	12.5	13.9
B/G Regression Line - Benbullen	31	34	36	38	39
SA EPA Criteria - Benbullen	36	39	41	43	44
WHO Criteria	45	45	45	45	45
Predicted WTG Noise Levels,					
Benbullen*	41.6	43.4	43.4	43.4	43.4
Clifton	20.6	22.4	22.4	22.4	22.4
H3	17.3	19.1	19.1	19.1	19.1
Hyland Grange	22.2	24.0	24.0	24.0	24.0
Mohawke	17.7	19.5	19.5	19.5	19.5
B/G Regression Line - Boco	32	33	35	37	39
SA EPA Criteria - Boco	37	38	40	42	44
WHO Criteria	45	45	45	45	45
Predicted WTG Noise Levels					
Boco *	36.4	38.2	38.2	38.2	38.2
Riverside*	33.9	35.7	35.7	35.7	35.7
Rosemount	26.2	28.0	28.0	28.0	28.0
B/G Regression Line - Brooklyn	32	35	37	39	39
SA EPA Criteria - Brooklyn	37	40	42	44	44
WHO Criteria	45	45	45	45	45
Predicted WTG Noise Levels					
Brooklyn*	32.9	34.7	34.7	34.7	34.7
Bungee	31.9	33.7	33.7	33.7	33.7
Sherwood*	34.5	36.3	36.3	36.3	36.3
Telembugrm*	32.1	33.9	33.9	33.9	33.9
Windella*	30.2	32.0	32.0	32.0	32.0
Kanoute	25.2	27.0	27.0	27.0	27.0
H2	16.2	18.0	18.0	18.0	18.0
Kangaroo Camp Retreat	22.4	24.2	24.2	24.2	24.2
B/G Regression Line - Coopers Hill	28	31	32	33	33
SA EPA Criteria - Coopers Hill	35	36	37	38	38
WHO Criteria	45	45	45	45	45
Predicted WTG Noise Levels					
Coopers hill*	41.2	43.0	43.0	43.0	43.0
Kelton Plain*	37.2	39.0	39.0	39.0	39.0
H1	29.0	30.8	30.8	30.8	30.8
Wodburn	28.0	29.8	29.8	29.8	29.8
Belmore	27.7	29.5	29.5	29.5	29.5
Peters Park	26.5	28.3	28.3	28.3	28.3
Coombala	26.4	28.2	28.2	28.2	28.2
Roslyn	24.9	26.7	26.7	26.7	26.7
Monastery	21.0	22.8	22.8	22.8	22.8
Xenmor	16.3	18.1	18.1	18.1	18.1

Wind speed (at 80m AGL), m/s	8.4	9.7	11.1	12.5	13.9
B/G Regression Line - Glenfinnan	35	37	39	40	41
SA EPA Criteria - Glenfinnan	40	42	44	45	46
WHO Criteria	45	45	45	45	46
Predicted WTG Noise Levels					
Glenfinnan*	39.5	41.3	41.3	41.3	41.3
Woodbine	34.2	36.0	36.0	36.0	36.0
Mia Mia	31.1	32.9	32.9	32.9	32.9
Old Curry Flat	26.2	28.0	28.0	28.0	28.0
Curry Flat	20.5	22.3	22.3	22.3	22.3
B/G Regression Line - Old Springfield	33	36	38	39	39
SA EPA Criteria - Old Springfield	38	41	43	44	44
WHO Criteria	45	45	45	45	45
Predicted WTG Noise Levels					
Old Springfield*	30.1	31.9	31.9	31.9	31.9
Springfield*	28.3	30.1	30.1	30.1	30.1
Avonlake*	40.9	42.7	42.7	42.7	42.7
Nestlebrae*	41.0	42.8	42.8	42.8	42.8
Mountain View	30.6	32.4	32.4	32.4	32.4
Tinbery Lodge	30.1	31.9	31.9	31.9	31.9
Kenilworth	26.6	28.4	28.4	28.4	28.4
Edendale	18.9	20.7	20.7	20.7	20.7
Lyndarra	19.2	21.0	21.0	21.0	21.0
B/G Regression Line - Rockybah	36	38	39	40	41
SA EPA Criteria - Rockybah	41	43	44	45	46
WHO Criteria	45	45	45	45	46
Predicted WTG Noise Levels					
Rockybah*	41.2	43.0	43.0	43.0	43.0
Roselea*	38.4	40.2	40.2	40.2	40.2
Loftyvale	17.2	19.0	19.0	19.0	19.0
B/G Regression Line - Yandra	33	36	39	41	42
SA EPA Criteria - Yandra	38	41	44	46	47
WHO Criteria	45	45	45	46	47
Predicted WTG Noise Levels					
Yandra*	42.1	43.9	43.9	43.9	43.9
Wyuna*	35.3	37.1	37.1	37.1	37.1

Wind speed (at 80m AGL), m/s	7.0	8.4	9.7	11.1	12.5	13.9
B/G Regression Line - Benbullen	28	31	34	36	38	39
SA EPA Criteria - Benbullen	35	36	39	41	43	44
WHO Criteria	45	45	45	45	45	45
Predicted WTG Noise Levels,						
Benbullen*	39.2	41.7	42.5	42.5	42.5	42.5
Clifton	18.8	21.3	22.1	22.1	22.1	22.1
H3	15.6	18.1	18.9	18.9	18.9	18.9
Hyland Grange	20.8	23.3	24.1	24.1	24.1	24.1
Mohawke	16.0	18.5	19.3	19.3	19.3	19.3
B/G Regression Line - Boco	31	32	33	35	37	39
SA EPA Criteria - Boco	36	37	38	40	42	44
WHO Criteria	45	45	45	45	45	45
Predicted WTG Noise Levels,						
Boco *	33.6	36.1	36.9	36.9	36.9	36.9
Riverside*	31.8	34.3	35.1	35.1	35.1	35.1
Rosemount	23.9	26.4	27.2	27.2	27.2	27.2
B/G Regression Line - Brooklyn	30	32	35	37	39	39
SA EPA Criteria - Brooklyn	35	37	40	42	44	44
WHO Criteria	45	45	45	45	45	45
Predicted WTG Noise Levels,						
Brooklyn*	30.6	33.1	33.9	33.9	33.9	33.9
Bungee	29.7	32.2	33.0	33.0	33.0	33.0
Sherwood*	32.7	35.2	36.0	36.0	36.0	36.0
Telembugrm*	29.5	32.0	32.8	32.8	32.8	32.8
Windella*	28.4	30.9	31.7	31.7	31.7	31.7
Kanoute	23.4	25.9	26.7	26.7	26.7	26.7
H2	14.3	16.8	17.6	17.6	17.6	17.6
Kangaroo Camp Retreat	20.4	22.9	23.7	23.7	23.7	23.7
B/G Regression Line - Coopers Hill	26	28	31	32	33	33
SA EPA Criteria - Coopers Hill	35	35	36	37	38	38
WHO Criteria	45	45	45	45	45	45
Predicted WTG Noise Levels,						
Coopers hill*	37.9	40.4	41.2	41.2	41.2	41.2
Kelton Plain*	34.9	37.4	38.2	38.2	38.2	38.2
H1	27.0	29.5	30.3	30.3	30.3	30.3
Wodburn	26.1	28.6	29.4	29.4	29.4	29.4
Belmore	25.8	28.3	29.1	29.1	29.1	29.1
Peters Park	24.6	27.1	27.9	27.9	27.9	27.9
Coombala	24.1	26.6	27.4	27.4	27.4	27.4
Roslyn	23.0	25.5	26.3	26.3	26.3	26.3
Monastery	18.9	21.4	22.2	22.2	22.2	22.2
Xenmor	14.2	16.7	17.5	17.5	17.5	17.5

Wind speed (at 80m AGL), m/s	7.0	8.4	9.7	11.1	12.5	13.9
B/G Regression Line - Glenfinnan	32	35	37	39	40	41
SA EPA Criteria - Glenfinnan	37	40	42	44	45	46
WHO Criteria	45	45	45	45	45	46
Predicted WTG Noise Levels,						
Glenfinnan*	36.5	39.0	39.8	39.8	39.8	39.8
Woodbine	31.6	34.1	34.9	34.9	34.9	34.9
Mia Mia	29.0	31.5	32.3	32.3	32.3	32.3
Old Curry Flat	24.1	26.6	27.4	27.4	27.4	27.4
Curry Flat	18.5	21.0	21.8	21.8	21.8	21.8
B/G Regression Line - Old Springfield	30	33	36	38	39	39
SA EPA Criteria - Old Springfield	35	38	41	43	44	44
WHO Criteria	45	45	45	45	45	45
Predicted WTG Noise Levels,						
Old Springfield*	27.7	30.2	31.0	31.0	31.0	31.0
Springfield*	26.0	28.5	29.3	29.3	29.3	29.3
Avonlake*	38.7	41.2	42.0	42.0	42.0	42.0
Nestlebrae*	38.7	41.2	42.0	42.0	42.0	42.0
Mountain View	28.8	31.3	32.1	32.1	32.1	32.1
Tinbery Lodge	28.3	30.8	31.6	31.6	31.6	31.6
Kenilworth	24.4	26.9	27.7	27.7	27.7	27.7
Edendale	17.1	19.6	20.4	20.4	20.4	20.4
Lyndarra	17.1	19.6	20.4	20.4	20.4	20.4
B/G Regression Line - Rockybah	35	36	38	39	40	41
SA EPA Criteria - Rockybah	40	41	43	44	45	46
WHO Criteria	45	45	45	45	45	46
Predicted WTG Noise Levels,						
Rockybah*	39.1	41.6	42.4	42.4	42.4	42.4
Roselea*	35.8	38.3	39.1	39.1	39.1	39.1
Loftyvale	15.5	18.0	18.8	18.8	18.8	18.8
B/G Regression Line - Yandra	30	33	36	39	41	42
SA EPA Criteria - Yandra	35	38	41	44	46	47
WHO Criteria	45	45	45	45	46	47
Predicted WTG Noise Levels,						
Yandra*	40.1	42.6	43.4	43.4	43.4	43.4
Wyuna*	32.9	35.4	36.2	36.2	36.2	36.2

WIND TURBINE GENERATOR

SOUND POWER LEVEL MEASUREMENT REPORTS - IEC 61400-11

SWT-2.3-101
Acoustic Emission

Sound Power Levels

The warranted sound power levels are presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 80 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**6**	**7**	**8**	**9**	**10**
Sound power level	105.1	107.0	107.0	107.0	107.0

Tabel 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10m height.

Octave band, center frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	81.1	92.3	96.4	100.0	100.2	96.8	89.4	85.1

Table 2: Typical octave band for 6 m/s

Octave band, center frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	83.5	94.4	98.1	102.1	102.1	98.4	91.2	87.2

Table 3: Typical octave band for 8 m/s

Noise Restricted Operation

Lower sound power levels can be achieved with the SWT-2.3-101 wind turbine by controlling the turbine in noise restricted operation. This noise restricted mode of operation will, depending on the mode, have an impact on the power output of the turbine. Please contact Siemens for further information on this option.

Power Curve &

Sound Power Level

REpower MM92

[2050 kW]

REpower Systems AG
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22297 Hamburg

Tel.: +49 - 40 - 5555090 - 0
Fax: +49 - 40 - 5555090 - 3999

www.repower.de

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Table of Content

Applicable Documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Title	Document no.

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of Abbreviations and Units

Abbreviation/Unit	Description
WEC	Wind Energy Converter (equal to Wind Turbine Generator System [WTGS])
IEC	International Electrotechnical Commission
FGW	Fördergesellschaft Windenergie e.V.
ct	Thrust coefficient
cp	Power coefficient

1 Power Curve and Sound Power Level MM92 2050 kW

1.1 General Information

Rotor diameter:	92.5	m
Air density:	1.225	kg/m³
Cut in wind speed:	approx. 3.0	m/s
Cut out wind speed:	24	m/s
Wind speed at hub height:	10 minutes mean values	
Blades:	clean, no ice/snow formation	

1.2 Conditions for power curve measurement

Verification according to IEC 61400-12-1: 2005[1]

Turbulence intensity:	6 to 12	%
Terrain:	not complex according to IEC 61400-12-1: 2005[1]	
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.2	
air density at location (10 minutes mean value):	≥ 1.13	kg/m³
Temperature range:	≤ 35	°C
Power factor:	cos phi ~ 1	
Anemometer type:	Thies First Class	

1.3 Conditions for sound power level measurement

Verification according to IEC 61400-11: 2002 + A1: 2006

Roughness length (average peak):	0.05 m

[1] For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

No obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the wind turbine or met mast.

2 Guaranteed electrical Power Curve und guaranteed Sound Power Level[2]

Wind speed v [m/s] [3]	**Power P [kW]**	**Sound Power Level L_{WA}[dB(A)] [4]**	**Thrust coefficient ct[-]**	**Power coefficient cp [-]**
3.0	20	--	0.98	0.180
4.0	94	--	0.87	0.357
5.0	205	--	0.79	0.398
6.0	391	100.4	0.79	0.440
7.0	645	101.8	0.79	0.457
8.0	979	103.3	0.79	0.465
9.0	1375	104.2	0.74	0.458
10.0	1795	104.2	0.69	0.436
11.0	2000	104.2	0.54	0.365
12.0	2040	104.2	0.39	0.287
13.0	2050	104.2	0.29	0.227
14.0	2050	104.2	0.23	0.182
15.0	2050	104.2	0.19	0.148
16.0	2050	104.2	0.15	0.122
17.0	2050	104.2	0.13	0.101
18.0	2050	104.2	0.11	0.085
19.0	2050	104.2	0.09	0.073
20.0	2050	104.2	0.08	0.062
21.0	2050	104.2	0.07	0.054
22.0	2050	104.2	0.06	0.047
23.0	2050	104.2	0.06	0.041
24.0	2050	104.2	0.05	0.036

[2] Valid for unrestricted operation only. During sound reduced operation different power and sound levels are effective.

[3] Wind speed at hub height

[4] Sound power level at hub height

3 Calculated Sound Power Level MM92 2050 kW for sound propagation (for information only)

3.1 Sound Power Level according to IEC for different Hub Heights

HH	v_{10}[5] [m/s]	5.0	6.0	7.0	8.0	9.0	10.0
68.5m	L_{WA}[6] [dB(A)]	101.2	103.1	104.2	104.2	104.2	104.2
78.5m	L_{WA}[6] [dB(A)]	101.4	103.3	104.2	104.2	104.2	104.2
80m	L_{WA}[6] [dB(A)]	101.4	103.3	104.2	104.2	104.2	104.2
100m	L_{WA}[6] [dB(A)]	101.7	103.4	104.2	104.2	104.2	104.2

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11 : 2002 + A1 : 2006
The calculation of the wind speed in 10m height is based on a roughness length of 0.05m, equivalent to a vertical wind shear coefficient of 0.14.

3.2 Sound Power Level according to FGW Guideline at 95% of rated power

The sound power level measured according to the "Technische Richtlinie für Windenergieanlagen Teil 1: Rev. 18 der FGW" at 95% of the rated power is independent of the hub height:

$$\mathbf{L_{WA,\,95\%} = 104.2\ dB(A)}$$

[5] Wind speed at 10m height

[6] Sound power level at hub height

WINDTEST
Grevenbroich GmbH

Excerpt from the acoustic test report SE06010B2 about the wind turbine type REpower MM92 at St. Michaelisdonn / Germany

25.05.2007

SE06010B2A1

REpower Dokumenten-Nummer	Rev.
D-2.9-VM.SM.03-D	A-GB
Freigabe	Datum
SK	25.05.2007

Durch das DAP Deutsches Akkreditierungssystem Prüfwesen GmbH akkreditiertes Prüflaboratorium.

Die Akkreditierung gilt für die in der Urkunde aufgeführten Prüfverfahren.

Deutscher Akkreditierungs Rat

DPT-P-03.175-00-97-00

WINDTEST Grevenbroich GmbH, Frimmersdorfer Straße 73, 41517 Grevenbroich, Telefon 0 21 81 / 22 78-0, Telefax 0 21 81 / 22 78-11, info@windtest-nrw.de

WINDTEST
Grevenbroich GmbH

Excerpt from the acoustic test report SE06010B2 about the wind turbine type REpower MM92 at St. Michaelisdonn / Germany

Abridged report SE06010B2A1

Location:	St. Michaelisdonn / Germany, Ser.-No. 90001
Customer:	REpower Systems AG Rödemis Hallig D-25813 Husum
Supplier:	WINDTEST Grevenbroich GmbH Frimmersdorfer Str. 73 D-41517 Grevenbroich

Date of Order:	12.06.06		**Order Number:**	06 0058 06

Editor:	**Auditor:**
Dipl.-Met. Klaus Hanswillemenke	Dipl.-Ing. Thomas Fischer

Grevenbroich, 25.05.2007

REpower Dokumenten-Nummer	Rev.
D-2.9-VM.SM.03-D	A -GB
Freigabe	**Datum**
SK	25.05.2007

Excerpt from the acoustic test report SE06010B2

Summary of results from the acoustic noise measurement at the wind turbine type REpower MM92 according to

IEC 61400-11:2002: Wind turbine generator systems – Part 11: Acoustic noise measurement techniques.

General information		Technical data (manufacturers specifications)	
Manufacturer:	REpower Systems AG	Rated power (generator):	2000 kW
	Rödemis Hallig	Rotor diameter:	92,5 m
	D-25813 Husum	Hub height above ground:	80 m
Serial No.:	90001	Tower design:	Steel tube
Location:	RW: 3505388 HW: 5983725	Power control	Pitch
Supplementary data about the rotor (manufacturers specifications		**Supplementary data about gearbox and generator (manufacturers specifications)**	
Rotor blade manufacturer:	LM or similar	Gearbox manufacturer:	Eickhoff or similar
Blade type:	LM 45.3_P	Gearbox type:	CPNHZ-224
Blade pitch setting:	---°	Generator manufacturer:	VEM or similar
Number of blades	3	Generator type:	DASAA5025-4UA
Rotor speed range:	7,8 – 15,0 rpm	Generator speed range:	1000 – 1800 rpm

Test report for the power curve: REpower document No. D-2.9-VM.LK.01-A Rev B-GB

	Reference point		Noise emission-parameter		Comments
	Standardized wind speed at 10 m height	Electrical active power			
Sound power level $L_{WA,P}$	6 ms^{-1}	1088 kW	101,6 dB		95 % rated power at 7,6 m/s
	7 ms^{-1}	1640 kW	102,9 dB		> 95 % rated power
	8 ms^{-1}	1980 kW	103,0 dB		---
	9 ms^{-1}	2025 kW	102,1 dB		
	10 ms^{-1}	---	---		
Tonality for the vicinity of the wind turbine $\Delta L_{a,k}$	6 ms^{-1}	1088 kW	0 dB	6 ms^{-1}	95 % rated power at 7,6 m/s
	7 ms^{-1}	1640 kW	0 dB	7 ms^{-1}	> 95 % rated power
	8 ms^{-1}	1980 kW	0 dB	8 ms^{-1}	---
	9 ms^{-1}	2025 kW	0 dB	9 ms^{-1}	
	10 ms^{-1}	---	---	10 ms^{-1}	
Impulsivity for the vicinity of the wind turbine	6 ms^{-1}	1088 kW	0 dB		95 % rated power at 7,6 m/s
	7 ms^{-1}	1640 kW	0 dB		> 95 % rated power
	8 ms^{-1}	1980 kW	0 dB		---
	9 ms^{-1}	2025 kW	0 dB		
	10 ms^{-1}	---	---		

Third octave sound power level at v_{10} = 7,6 ms^{-1} in dB

Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	74,44	78,59	82,1	84,5	86,49	88,8	89,83	92,86	94,05	93,33	94,18	93,76
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	93,15	91,59	89,74	88,14	85,61	83,43	81,54	78,98	76,84	77,37	76,84	74,76

Octave sound power level at v_{10} = 7,6 ms^{-1} in dB

Frequency	63	125	250	500	1000	2000	4000	8000
$L_{WA,P}$	83,15	91,41	97,03	98,7	96,73	91,01	84,3	81,09

These specifications do not substitute the above mentioned full test report (particularly for noise immission prognosis).

Comments:

Measured by: WINDTEST Grevenbroich GmbH
Frimmersdorfer Str.73
D-41517 Grevenbroich

Schallemission FGW 2007 Konformitätssiegel

Date: 25.05.2007

REpower Dokumenten-Nummer	Rev.
D-2.9-VM.SM.03-D	A-GB
Freigabe	Datum
	25.05.2007

Dipl.-Met. Klaus Hanswillemenke Dipl.-Ing. Thomas Fischer

Sound Power Level

REpower 3.XM104

[3.XM/104/50Hz]

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Table of Contents

Applicable Documents

The following documents are mentioned within this document without being subject matter of this product description.

Title	Document no.

* Depending on the project specific selection of REpower products the respective documents will appear in each case as separate amendments of the contract in their actual version.

List of Abbreviations and Units

Abbreviation/Unit	Description

1 Sound Power Level *REpower 3.XM104*

1.1 Sound Power Level according to IEC for different Hub Heights

HH*	V_{10}[1] [m/s]	5,0	6,0	7,0	8,0	9,0	10,0	11,0	12,0
78m	L_{WA} [dB(A)]	101,8	105,7	106,5	106,6	106,6	106,6	106,6	106,6
80m	L_{WA} [dB(A)]	101,9	105,7	106,5	106,6	106,6	106,6	106,6	106,6
98m	L_{WA} [dB(A)]	102,4	105,9	106,5	106,6	106,6	106,6	106,6	106,6
100m	L_{WA} [dB(A)]	102,5	105,9	106,5	106,6	106,6	106,6	106,6	106,6

* 78/80m and 98/100m depending on foundation design

All sound power levels above are based on wind speeds of V_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: Wind turbine generator systems – part 11.
The calculation of the wind speed in 10m height is based on a roughness length of 0.05m, equivalent to a vertical wind shear coefficient of 0.14.

1.2 Sound Power Level according to FGW Guideline at 95% of rated power

The sound power level measured according to the Technical Guideline "Fördergesellschaft Windenergie e.V. (FGW)" at 95% of the rated power is independent of the hub height:

$$\mathbf{L_{WA,\,95\%} = 106.6\ dB(A)}$$

[1] Wind speed in a height of 10 meters