REPORT 40-1487

Revision 5

Silverton Wind Farm
Noise Impact Assessment

PREPARED FOR

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Silverton Wind Farm

Noise Impact Assessment

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EXECUTIVE SUMMARY

Heggies Pty Ltd (Heggies) has been engaged by Silverton Wind Farm Developments Pty Ltd as the acoustical consultants for the proposed Silverton Wind Farm. Operational and construction noise levels have been predicted and assessed.

Existing baseline noise levels were monitored at three locations surrounding the proposed site for over two weeks from November to December 2007. Operational noise criteria have been determined in accordance with the *South Australia EPA Noise Guidelines for Wind Farms (February 2003).* A more conservative approach was adopted for receivers in Silverton, where criteria based upon night-time data only were established.

Noise modelling was conducted using ISO 9613-2 and adopted appropriate conservative input assumptions.

Stage 1 will consist of 120 turbines that have been noise modelled. Predicted noise levels comply with criteria at all locations.

Final Stage 2 will bring the total number of WTGs up to 600. A layout of 598 turbines has been noise modelled. Predicted noise levels comply with criteria at all locations.

Transformer noise levels have been predicted for both stages and will comply with minimum Industrial Noise Policy limits under 'worst case' meteorological enhanced propagation conditions.

Construction noise levels, including on-site concrete batch plants, rock crusher and blasting are predicted to comply with appropriate limits.

Traffic noise generated by the project will be greatest during construction. The use of on-site concrete batch plants will significantly reduce the number of total vehicle movements to and from the site, with a projected 'peak' construction period generating approximately 250 vpd. Traffic noise impacts are not likely to be significant, as the main site access route is remote from any dwellings, and heavy vehicle routes through Broken Hill will be minimised and on appropriately designated roads that already carry significant traffic. Similarly possible night-time traffic movements through Broken Hill have the potential to cause disturbance, however, appropriate management would minimise possible impacts.

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1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been engaged by Silverton Wind Farm Developments Pty Ltd as the acoustical consultants for the proposed Silverton Wind Farm.

1.1 Objectives

This report describes the methodology and findings of the Noise Impact Study (NIS) and forms part of the Environmental Impact Assessment for the proposed Silverton Wind Farm.

This report details the main aspects of the proposed wind farm project, the acoustic criteria, the background noise measurements and the predicted noise level at all potentially impacted receivers from the operation of the proposed wind farm.

It also addresses the acoustic impact of the wind farm during the construction phase, including blasting and transportation noise.

1.2 Methodology

1.2.1 Acceptability limit criteria

The methodology and acceptability limit criteria that have been applied to this study are based upon the *South Australia EPA Noise Guidelines for Wind Farms (February 2003)* (SA Guidelines). The principal acceptability limit criteria is that the wind farm $L_{A90(10\ min)}$ noise should not exceed the greater of an amenity limit of 35 dBA or the pre-existing background noise by more than 5 dBA (for any given wind speed).

The project requirements and wind farm acceptability limit criteria are discussed in more detail in **Section 6**.

1.2.2 Wind farm noise level prediction

The noise emission model used in this study to predict wind farm noise levels at sensitive receptors is based on ISO 9613 as implemented in the SoundPLAN computer noise model. The model predicts noise levels through spherical spreading and includes the effect of air absorption (as per ISO 9613), ground attenuation and shielding.

Predicted L_{Aeq} noise levels are based on sound power levels determined in accordance to the recognised standard IEC-61400-11 (*Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques*), where available, for the wind range 3 to 10 m/s.

The noise character of Wind Turbine Generator (WTG) noise emission is also assessed for any special audible characteristics, such as tonality or low frequency content, which would be deemed more annoying or offensive. If characteristics such as tonality were identified, then the predicted noise level would be penalised by the addition of 5 dBA. It should be noted that the characteristic noise level modulation of WTGs, commonly referred to as 'swishing', is considered to be a fundamental part of wind farm noise and is taken into account by the SA Guideline assessment procedure.

1.2.3 Ambient noise monitoring

In order to establish the intrusive noise limit, background noise monitoring is required to establish the pre-existing ambient noise environment as a function of wind speed. As wind speed increases, the ambient noise level at most receivers generally also increases as natural sources, such as wind in trees, begin to dominate. The variation of background noise with wind speed is usually quite site specific and related to various physical characteristics such as topographic shielding and the extent and height of exposed vegetation.

Noise monitoring is completed for a period of approximately two weeks and then correlated to synchronous wind speed and direction data for a reference height of 10 m at the wind farm monitoring mast. The captured data is screened for validity, with data monitored during periods of rain or where the average wind speed at the microphone position likely exceeded 5 m/s being discarded from the data set. Other data that was obviously affected by external noise sources (eg pond pumps, grass mowing, birds at dawn) was also removed from the data set. A regression analysis of all valid data is used to determine a line of 'best fit' from which the noise limit is established.

1.2.4 Assessment procedure

In general, the assessment procedure contains the following steps:

1. Predict and plot the L_{Aeq} 35 dBA noise level contour from the wind farm under reference conditions. Receivers outside the contour are considered to be within acceptable wind farm noise levels.
2. Establish the pre-existing background noise level at each of the relevant assessment receivers within the L_{Aeq} 35 dBA noise level contour through background noise monitoring.
3. Predict wind farm noise levels at all relevant assessment receivers for the wind range from cut-in to approximately 10 m/s.
4. Assess the acceptability of wind farm noise at each relevant assessment receiver to the established limits.

Furthermore, where the assessment of a receiver has shown unacceptable resulting wind farm noise levels, a process of noise mitigation and alternative wind farm layouts is considered.

A brief explanation and description of acoustic terminology is included in **Appendix D.**

2 WIND TURBINE OPERATIONAL NOISE CRITERIA

2.1 Introduction

The NSW Government Department of Planning has issued information on the required inputs into the Environmental Assessment.

The Director General's Requirements highlighted a number of specific issues, including an assessment of the noise impacts to be undertaken in accordance with *Wind Farms – Environmental Noise Guidelines* from the South Australia Environment Protection Authority (February 2003) with consideration, where appropriate, to *Wind Farms – Environmental Noise Guidelines (interim),* 2007.

Furthermore, DECC has highlighted a number of requirements in relation to noise for the proposed Silverton Wind Farm, based on the NSW *Industrial Noise Policy* and *Environmental Noise Control Manual* (EPA, 2004).

2.2 SA EPA Noise Guidelines for Wind Farms

The South Australia EPA Noise Guidelines for Wind Farms (SA Guidelines) recommends the following noise criteria for new wind farms:

The predicted equivalent noise level ($L_{Aeq,\ 10min}$), adjusted for tonality in accordance with these guidelines, should not exceed:

- *35 dBA, or*
- *the background noise level by more than 5 dBA,*

whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.

These guidelines also provide information on measuring the background noise levels, locations and requirements on the number of valid data points to be obtained and the methodology for excluding invalid data points. It also outlines the process for determining lines of best fit for the background data, and determination of the noise limit.

The SA Guidelines explicitly state that the 'swish' or modulation noise from wind turbines is a fundamental characteristic of such turbines, however, it specifies that tonal or annoying characteristics of turbine noise should be penalised.

A 5 dBA penalty should be applied to the measured noise level if an 'authorised' officer determines that tonality is an issue and that tonality should be assessed in a way acceptable to the EPA.

The SA Guidelines do not provide an assessment for the potential of low frequency noise or infrasound, but do state that recent turbine designs do not appear to generate significant levels of infrasound as the earlier turbine models did.

2.3 NSW Industrial Noise Policy (INP)

The NSW Department of Environment and Climate Change requirements for the proposed Silverton Wind Farm Environmental Assessment are based on the NSW INP.

The INP requirements include site selection for background measurements, description of the site, the equipment used, graphing of results and amenity noise criteria during each of the three periods (Day, Evening and Night) as per the INP.

The proposed site for the Silverton Wind Farm is in a remote rural area and therefore the Amenity Criteria for rural residential receivers, as detailed in Table 2.1 in the NSW INP, is applicable.

The criteria vary as a function of time of day. The day, evening and night periods are defined as:

Day period	7:00 am – 6:00 pm 8:00 am – 6:00 pm (Sundays and public holidays)
Evening period	6:00 pm – 10:00 pm
Night period	10:00 pm – 7:00 am 10:00 pm – 8:00 am (Sundays and public holidays)

The amenity criteria (L_{Aeq} level) for the residential noise sensitive locations for the Silverton Wind Farm project are:

Day period	50 dBA
Evening period	45 dBA
Night period	40 dBA

The intrusiveness criterion in the INP is based on the rating background level (RBL), where the criterion is:

$$L_{Aeq,\ 15\ min} \leq RBL + 5\ dBA$$

This is almost identical to the SA Guidelines (Section 2.2), the difference being the measurement interval (15 and 10 minutes) and the determination of the background noise level (rating level, based on 10th percentile of measured background levels, or using a line of best fit through the data points).

The INP states where the measured RBL is less than 30 dBA, then the RBL is considered to be 30 dBA.

In summary, it is evident that the non-project related residential receivers assessed under the *SA EPA Wind Farm Guideline* will generally comply with INP amenity criteria. Furthermore, intrusiveness is covered by the *SA EPA Wind Farm Guideline.*

2.4 World Health Organisation

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.

The appropriate guideline limits are listed in **Table 1.**

Table 1 WHO Guideline values for environmental noise in specific environments

Specific environment	Critical health effect(s)	LAeq (dBA)	Time base (hours)	LAMax (dBA, fast)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance – window open, night-time	45	8	60

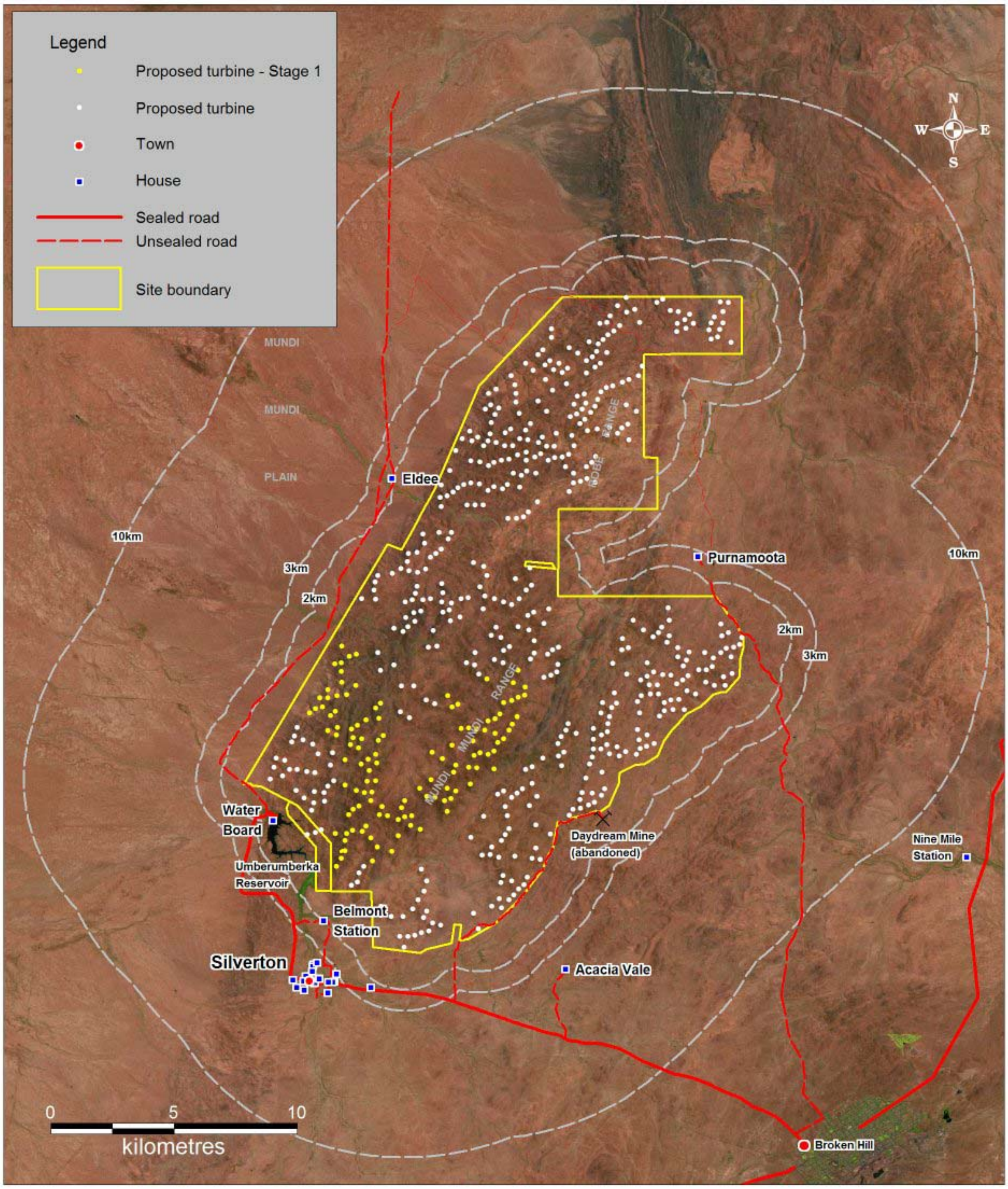
3 GENERAL SITE DESCRIPTION

The proposed Silverton Wind Farm site is located to the north of the township of Silverton on the Mundi Mundi ranges, approximately 25 km northwest of Broken Hill in far western NSW. The final proposed layout will stretch approximately 30 km from north to south and 20 km from east to west.

The wind farm is to be developed in stages, with the initial Stage 1 consisting of up to 120 WTGs concentrated in the south of the project area. The final Stage 2 layout will contain up to 600 WTGs. The actual layouts noise modelled include 120 WTGs for Stage 1 and 598 WTGs for the total, including Stage 1 and Stage 2.

The location of the proposed wind farm is shown in **Figure 1.**

Figure 1 Location of proposed Silverton Wind Farm



3.1 Characteristics of the site

The proposed site incorporates the farming properties Purnamoota Station, Belmont Station, Eldee Station and Nine Mile Station.

An assessment has been carried out to ensure any noise impact from the wind farm will comply with SA EPA Guidelines.

Figure 2 View of Mundi Mundi Range as seen from Mundi Mundi Plains

Topographically, the proposed site broadly includes a number of steeply undulating hills and ridges that run in an approximately north–south direction including, Mount Umberumberka, Mount Mundi Mundi, the Mundi Mundi Range, Mount Robe, Lakes Knob and Mount Frank. To the west of the range is the contrasting flat Mundi Mundi plains. The region is rocky and arid with only limited vegetation cover. The district was once used for mining but currently it is primarily used for limited agricultural (grazing) purposes.

Only limited car traffic travels in the district and therefore the ambient background noise environment is determined by predominantly natural sources such as birds or vegetation that is wind influenced.

The prevailing wind is from the southeast and the district receives only marginal rainfall.

3.2 Dwelling locations

A limited number of residential dwellings surround the proposed site with the majority located to the south of the site in the township of Silverton.

Nine Mile Station is approximately 12 km from the nearest WTG. An abandoned (uninhabitable) dwelling on the Nine Mile property, Acacia Vale, is approximately 9 km from WTG's. Both have been left out from the assessment.

The assessment locations include all dwellings located within 10 km of a proposed WTG, indicated on the map in **Figure 1**. **Table 2** lists the on-site and off-site receiver locations and their position.

Table 2 Surrounding receivers

Location	East (m)	North (m)
S10 Silverton	520508.4	6472376
S11 Silverton	520663	6472010
S12 Silverton	520975.8	6471892
S14 Silverton	521947.2	6472277
S15 Silverton	520956.2	6472316
S16 Silverton	521243.3	6472275
S17a Silverton	521024.6	6472557
S17b Silverton	521064.8	6472551
S18 Silverton	521169	6472417
S19 Silverton	521304.6	6472779
S20 Silverton	521310.4	6473016
S21 Silverton	521349.4	6473120
S22 Silverton	521490.5	6473190
S24a Penrose Park 1, Silverton	521565.8	6472440
S24b Penrose Park 2, Silverton	521584.6	6472431
S25a Silverton	521376.1	6472210
S25b Silverton	521402.9	6472255
S27 Silverton	522282.4	6472652
S28a Silverton	522121.8	6472266
S28b Silverton	522185.8	6472304
S29 Silverton	521917.5	6471763
SL2 Eldee Station	524750.1	6496054
SL34 Purnamoota Station	536946.1	6492457
SL35 Limestone Station	535924.9	6469159
SL6 Umberumberka	519709.1	6479956
SL9 Belmont Station	521763.2	6475177

4 PROPOSED WIND FARM LAYOUT

The proponent has proposed the project be developed in stages. The actual proposed turbine locations are listed in full in **Appendix E.**

The horizontal distance between each of the assessment locations and the nearest ten WTGs to each location has been calculated and is shown in **Table 3.** It can be seen that Umberumberka is the closest assessment location from proposed WTG's at 1.6 km.

Table 3 Distance between the assessment location and nearest ten WTGs

	Closest WTGs	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
S11 Silverton	WTG #	B44	B35	B39	B36	B46	B33	B28	B51	B42	B29
	km	4.8	4.8	4.8	5.1	5.1	5.1	5.3	5.4	5.4	5.5
S14 Silverton	WTG #	B44	B39	B35	B46	B36	B51	B33	B42	B54	B28
	km	3.5	3.6	3.8	3.8	4.0	4.1	4.1	4.3	4.4	4.6
S15 Silverton	WTG #	B44	B35	B39	B36	B33	B46	B28	B51	B42	B29
	km	4.4	4.4	4.4	4.6	4.7	4.7	4.9	5.0	5.0	5.1
S18 Silverton	WTG #	B44	B35	B39	B36	B46	B33	B28	B51	B42	B29
	km	4.1	4.2	4.2	4.4	4.5	4.5	4.7	4.7	4.8	5.0
S19 Silverton	WTG #	B35	B44	B39	B36	B33	B46	B28	B42	B51	B29
	km	3.8	3.9	3.9	4.1	4.1	4.2	4.3	4.5	4.5	4.6
S22 Silverton	WTG #	B35	B39	B44	B36	B33	B46	B28	B42	B29	B51
	km	3.4	3.6	3.6	3.7	3.7	3.9	3.9	4.1	4.1	4.2
S24a Penrose Park	WTG #	B44	B39	B35	B46	B36	B33	B51	B42	B28	B54
	km	3.8	3.8	3.9	4.1	4.1	4.2	4.4	4.5	4.6	4.7
SL2 Eldee Station	WTG #	E55	E51	E52	E58	E48	E53	E54	E56	E45	E60
	km	1.9	2.0	2.2	2.2	2.2	2.4	2.6	2.8	2.8	2.8
SL34 Purnamoota	WTG #	P58	P54	P51	P49	P46	P44	P43	P45	P53	P48
	km	2.8	3.3	3.5	3.7	3.9	4.0	4.0	4.0	4.0	4.2
SL35 Limestone Station	WTG #	B82	B86	B88	B72	B90	B91	B74	B79	B92	B87
	km	9.5	9.6	9.6	9.6	9.7	9.7	9.9	9.9	9.9	10.2
SL6 Umberumberka	WTG #	WB1	B13	B9	B15	B17	WB2	B1	B21	B4	B18
	km	1.6	1.6	1.6	1.6	1.8	1.9	1.9	2.0	2.1	2.1
SL9 Belmont Station	WTG #	B28	B29	B35	B33	A13	B30	B36	A16	B31	B39
	km	2.0	2.3	2.3	2.4	2.6	2.6	2.7	3.0	3.0	3.2

4.1 WTG type and details

The current proposed and investigated wind turbines are REpower MM92 – three bladed, upwind, pitch-regulated and active yaw turbines. The rotor diameters for this model are 92 m and they are all proposed to be mounted at a hub height of 100 m.

Table 4 summarises the relevant turbine input data used for noise level prediction.

Table 4 WTG manufacturers data

Make, model, power	REpower, MM92 Evolution, 2 MW
Rotor diameter	92 m
Hub height	100 m
Cut-in wind speed	3.5 m/s
Rated wind speed	13 m/s
Rotor speed	7.8–15 rpm
Sound power level, $L_{WA,ref}$	105.0 dBA

Noise emission for the proposed alternative turbines has been independently tested according to International Standard IEC 61400-11. Copies of the certification test that give the sound power level variation with wind speed, frequency spectra and tonality assessment are contained in **Appendix B.**

A sensitivity analysis was conducted for alternative WTG hub heights. Predictions indicate that the difference in received noise level between 80m hub height and 100m hub height are only approximately 0.2 dBA.

At the request of the DECC a further iteration of the noise model is presented where the largest WTG listed in the EA (worst case) for which measurement data exists, a Vestas V90 3MW at 80 metre hub height and a Sound power level, $L_{WA,ref}$ of 109.4 dBA, was modelled. The results of this iteration are for comparative purposes only as should this WTG model be selected there would be minor modifications to the layout presented and some of the WTG's causing non-compliance would be removed or de-rated. Given the greater generating capacity of the V90 3MW WTG it is expected that fewer WTG's would be required. The results from this iteration are presented in **Appendix F,** including an indication of the areas that would require mitigation.

5 OPERATIONAL NOISE LEVELS

5.1 Introduction

As discussed in **Section 1.2.2**, a three-dimensional computer noise model was used to predict L_{Aeq} noise levels from all WTGs at all surrounding residential dwellings.

The ISO 9613 noise model incorporates a 'hard ground' assumption and includes one-third octave band calculated effects for air absorption, ground attenuation and topographic shielding. It is noted that ISO 9613 equations predict for average downwind propagation conditions and also hold for average propagation under a well-developed moderate ground-based temperature inversion.

The estimated accuracy of the prediction model is approximately ±3 dBA.

Further discussion with regards to ISO 9613 and the noise predictions of wind farms is included in **Appendix G.**

While $L_{A90(10\ min)}$ noise levels are used for compliance monitoring, the assessment utilises predicted L_{Aeq} noise levels as prescribed by SA Guidelines, inferring a degree of conservatism that assists in other uncertainties in the noise prediction and assessment process.

5.2 Wind turbine noise levels

For indicative purposes, the WTG noise levels from the proposed wind farm were calculated for the reference wind condition of 8 m/s at all surrounding residential receivers. The resulting WTG noise levels are listed in **Table 5** for all layouts at 8 m/s wind speed, measured at the reference height of 10 metres, which is the condition that WTG sound power levels are typically quoted.

Predicted noise contour plots resulting from proposed Stage 1 are depicted in **Figure 3,** the final Stage 2 600 WTG layout is depicted in **Figure 4**.

Furthermore, noise levels from the proposed wind farm were calculated for all integer wind speeds in the range of 3–12 m/s at all surrounding assessment receivers within 10 km of a turbine. While the rated wind speed of the WTGs is typically 13–14 m/s, published manufacturers sound power level test data (IEC 61400-11) has only been generated as high as 12 m/s. It should be noted that noise produced by WTGs begins to plateau at higher wind speeds and because of the higher masking background noise level at higher wind speeds, noise impacts and compliance are a non-issue at these speeds. The covered wind range sufficiently covers the most noise-critical operational conditions.

The predicted levels are displayed on the assessment graphs presented in **Appendix A.**

Table 5 WTG LAeq noise level (dBA) at V_{ref} = 8 m/s

	Coordinates			
Receiver/property	**X**	**Y**	**Stage 1**	**Final Stage 2 – 600 WTG**
	m	**m**	**dBA**	**dBA**
S10 Silverton	520508	6472376	25.3	30.3
S11 Silverton	520663	6472010	24.8	29.9
S12 Silverton	520976	6471892	24.8	30.1
S14 Silverton	521947	6472277	25.9	31.9
S15 Silverton	520956	6472316	25.5	30.8
S16 Silverton	521243	6472275	25.6	31
S17a Silverton	521025	6472557	25.9	31.2
S17b Silverton	521065	6472551	25.9	31.2
S18 Silverton	521169	6472417	25.8	31.2
S19 Silverton	521305	6472779	26.4	31.9
S20 Silverton	521310	6473016	26.9	32.2
S21 Silverton	521349	6473120	27	32.4
S22 Silverton	521491	6473190	27.3	32.8
S24a Penrose Park 1	521566	6472440	26	31.7
S24b Penrose Park 2	521585	6472431	26	31.7
S25a Silverton	521376	6472210	25.5	31.1
S25b Silverton	521403	6472255	25.6	31.2
S27 Silverton	522282	6472652	26.7	33
S28a Silverton	522122	6472266	26	32.1
S28b Silverton	522186	6472304	26	32.3
S29 Silverton	521918	6471763	25.1	31
SL2 Eldee Station	524750	6496054	19.9	37.9
SL34 Purnamoota Station	536946	6492457	9	34.1
SL35 Limestone Station	535925	6469159	9	22
SL6 Umberumberka Reservoir	519709	6479956	33.3	39.6
SL9 Belmont Station	521763	6475177	31.1	36.3

Shaded cells indicate predicted noise level exceeds minimum SA EPA criteria of 35 dBA, however comply with the background + 5dBA requirement, refer to **Appendix A.**

Figure 3 Stage 1 layout – LAeq noise contour map at V_{ref} = 8 m/s

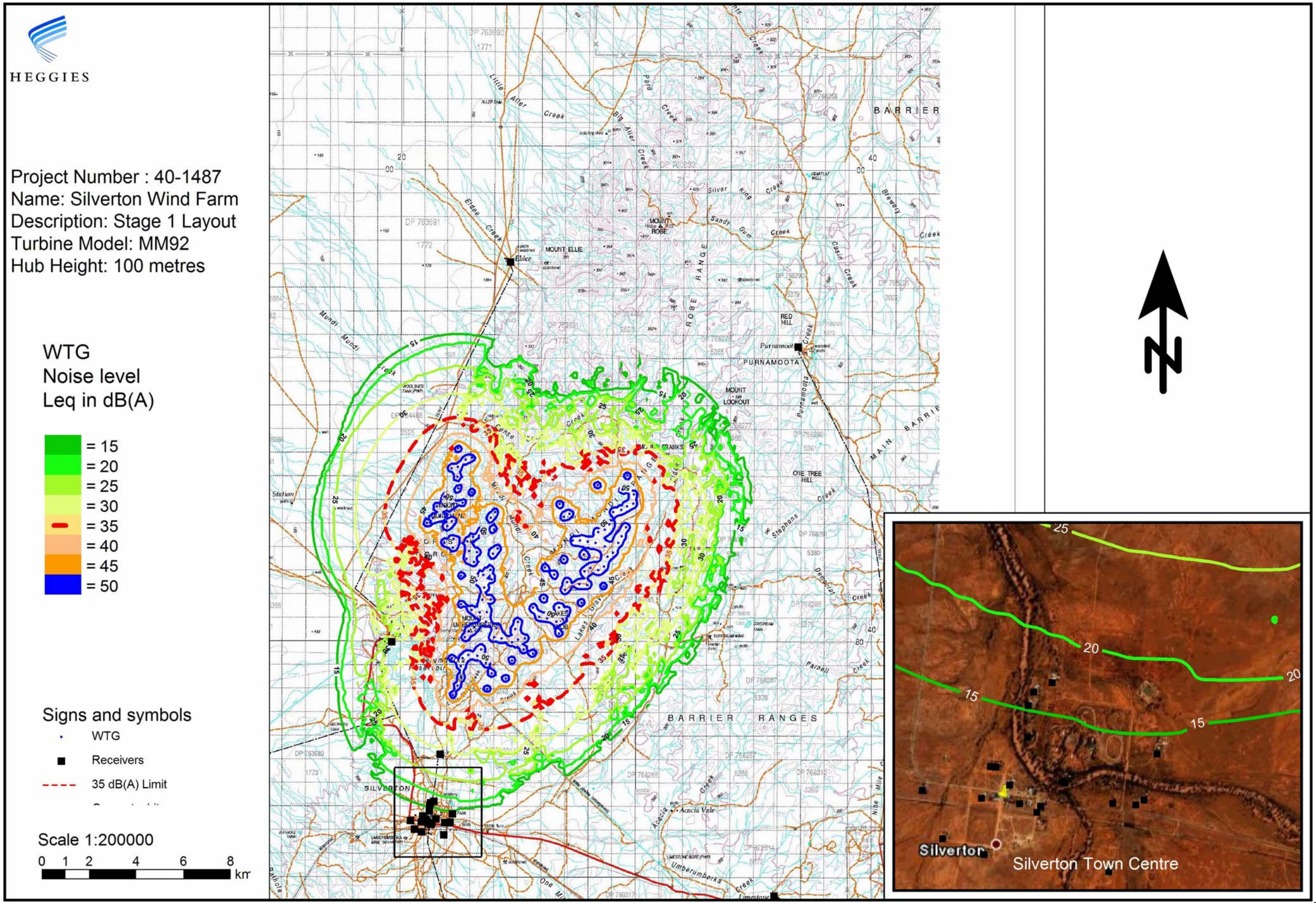
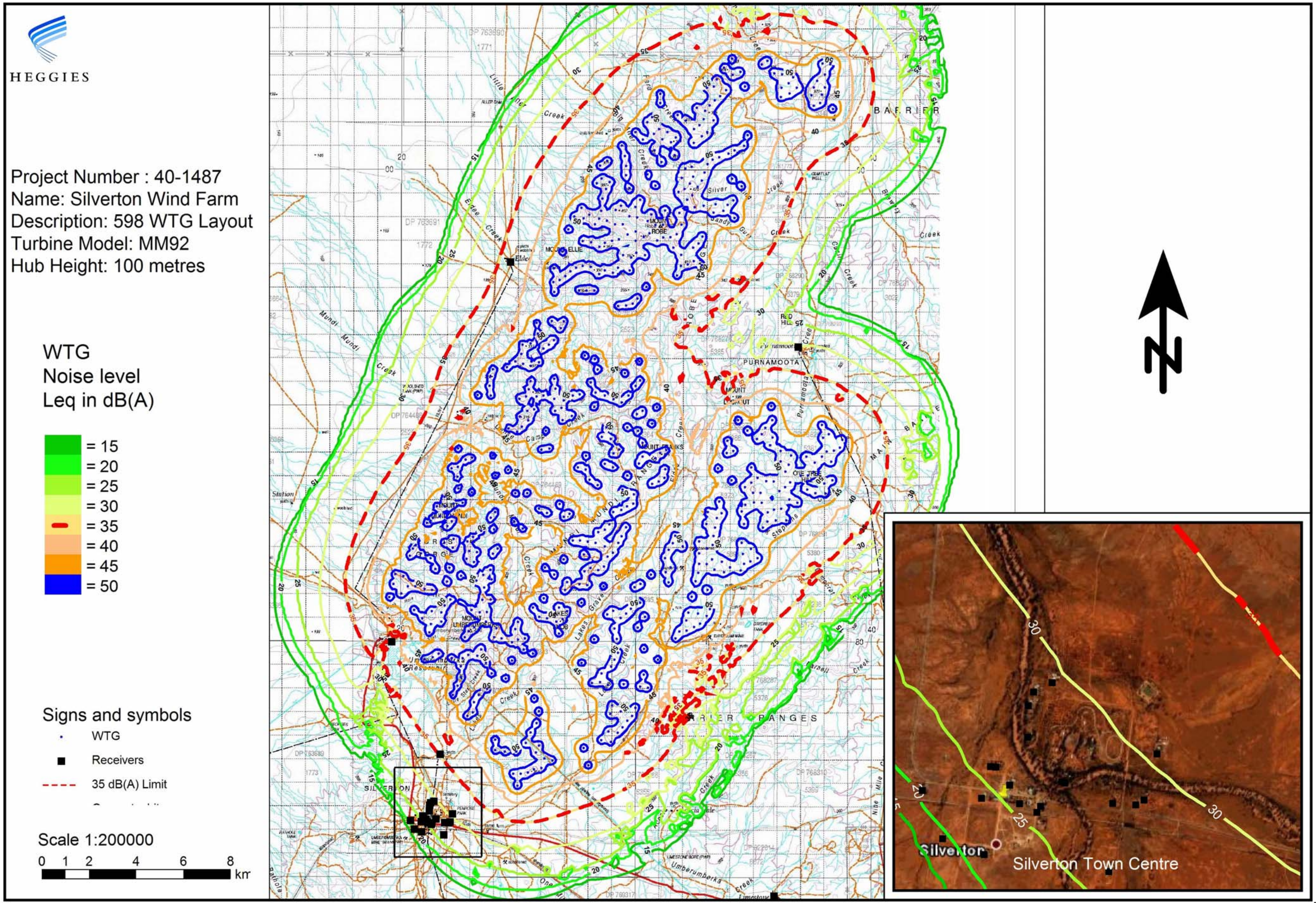


Figure 4 Final Stage 2 layout – L_{Aeq} noise contour map at V_{ref} = 8 m/s



5.3 Transformer noise levels

The proposed location of the Stage 1 substation is approximately GDA94 E522044 N6481722 and will include up to 2x300 MVA transformers.

Blast protection walls may enclose the substation transformers, in which case they will also serve as noise walls. These have not been included in the predictions at this stage.

The substations would 'step up' the voltage from the incoming 22–66 kV voltage to the 220 kV voltage of the transmission line.

Australian Standard AS 2374 Part 6 1994: *Power Transformers – Determination of Transformer and Reactor Sound Levels* indicates that transformers of the capacity required (ie 2x300MVA) may produce sound power levels up to 112 dBA. The dominant frequency of such a transformer is 100 Hz.

Noise predictions for transformer substations has been made using CONCAWE algorithms assuming an absolute 'worst case' meteorology enhancement condition of downwind 3 m/s and Pasquill Stability Class F temperature inversion.

For Stage 1, the predicted noise levels from the transformer installation are expected to be less than 24 dBA in the township of Silverton, up to 27 dBA at Belmont Station and up to 12 dBA at Umberumberka Reservoir, which is well below the existing ambient background and predicted future WTG levels and as such will not effect the compliance assessment of the proposed wind farm.

For Final Stage 2 a further 4 transformer substations could be implemented. These have been modelled in their proposed respective locations.

For Final Stage 2, the predicted noise levels from the transformer installations are expected to be less than 25 dBA in the township of Silverton, up to 27 dBA at Belmont Station and up to 17 dBA at Umberumberka Reservoir, which is well below the existing ambient background and predicted future WTG levels and as such will not effect the compliance assessment of the proposed wind farm. The highest predicted transformer noise level is for Purnamoota Station, with a worst-case noise level of 34 dBA, which would comply with the minimum INP criteria limit.

5.4 Transmission line noise (corona noise)

Corona noise is caused by the partial breakdown of the insulation properties of air surrounding the conducting wires. It generally only occurs in humid conditions, as provided by fog or rain. A minimum line potential of 70 kV or higher is generally required to generate corona noise depending on the electrical design. Corona noise does not occur on domestic distribution lines.

Corona noise has two major components: a low frequency tone associated with the frequency of the AC supply (100 Hz for 50 Hz source) and broadband noise. The tonal component of the noise is related to the point along the electric waveform at which the air begins to conduct. This varies with each cycle and consequently the frequency of the emitted tone is subject to great fluctuations. Corona noise can be characterised as broadband 'crackling' or 'buzzing' and is generally only a feature during fog or rain.

We have previously measured corona noise (reference *GEHA Report 045-109/2* dated 9 November 2004) at a site near Officer in outer Melbourne, Victoria. We found it possible to measure corona noise at close distances at high frequencies only, as other noise sources such as traffic and birds caused some interference. A 500 kV line was measured during damp, foggy conditions.

At a distance of 30m along the ground from the line a L_{eq} noise level of approximately 44 dBA was measured. At a distance of 100m, the corona noise was calculated to be approximately 39 dBA.

Assuming a minimum RBL value of 30 dBA, the minimum intrusive criteria as determined by the NSW Industrial Noise Policy (INP) would be 35 dBA. The proposed 220 kV line is likely to generate less corona noise than that measured of a 500 kV line. We therefore conservatively estimate that the minimum criteria level of 35 dBA would be complied with at a distance of 240 metres.

The proposed route for Stage 1 transmission lines from the wind farm to Broken Hill and then in Stage 2 from Broken Hill south to Red Cliffs will traverse largely remote and sparsely habited land. Corona noise is not easily predictable. This general assessment is based upon larger transmission lines in a different location. The semi arid conditions of the project area and smaller capacity transmission lines may lead to lower noise levels and reduced frequency of occurrence.

It is anticipated that sufficient buffer distances will render the occasional corona noise inaudible at residential receivers.

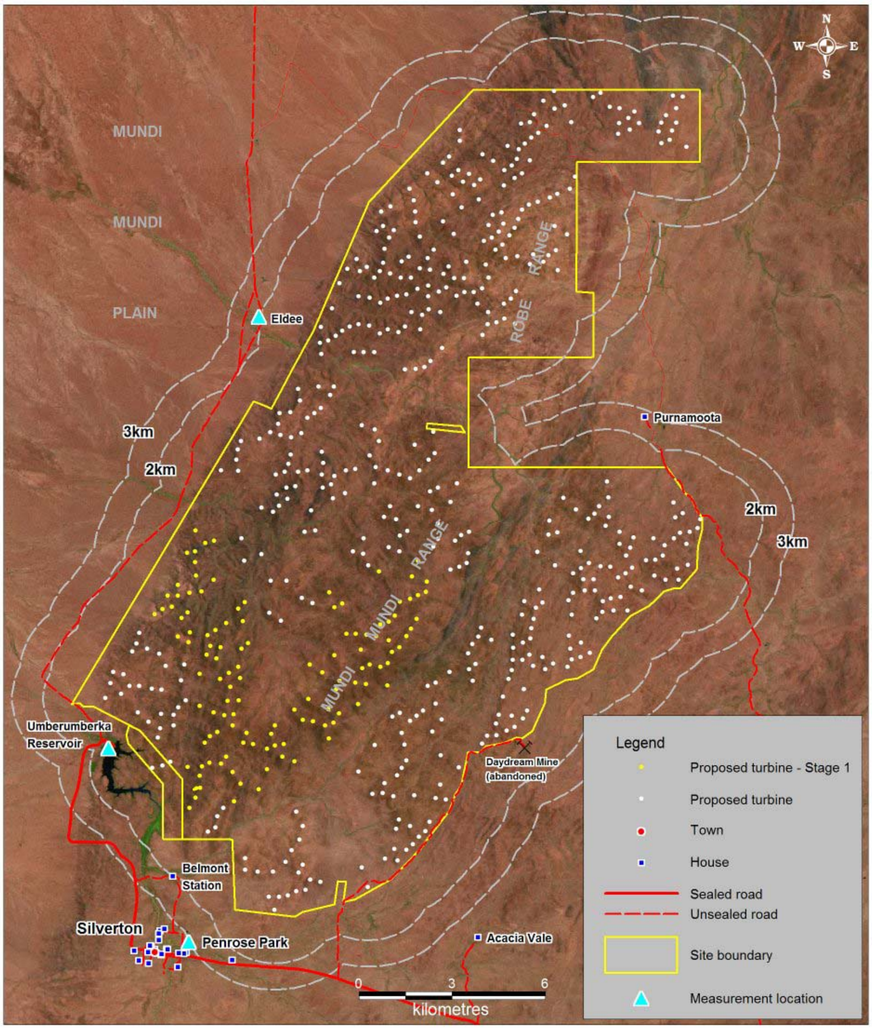
6 BACKGROUND LEVELS AND NOISE LIMITS

6.1 Measurement locations

The locations for the background noise measurements were chosen based on the potential for acoustic impact to the nearest receivers, as recommended by Table 3.1 of the NSW INP. The SA 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.

Figure 5 Background noise monitoring locations



Background noise monitoring locations were selected based on the predicted wind farm noise level from preliminary investigations at reference conditions. Noise monitoring was undertaken at three sites. These are listed in **Table 6**.

Generally a selected monitoring location was used to provide an indicative background for other nearby locations in that vicinity. The relative proximity of some receiver locations to one another as well as their similar wind exposure and surrounding vegetation meant that background noise monitoring was conducted at only one of the locations and the result was considered indicative of the adjacent locations.

It is anticipated that further baseline background noise monitoring may be conducted before project commissioning at additional sites, such as within Silverton, and to assist in understanding the seasonal variation of background noise in the area.

A total of three locations were monitored around the proposed wind farm site.

Table 6 Measurement locations

Location	Address	Indicative of	Similar characteristic for wind induced noise
SL2	Eldee Station	SL34 Purnamoota	Similar vegetation, exposure
SL6	Umberumberka Reservoir		
S24	Penrose Park	Silverton, SL9 Belmont	Geographic proximity, exposure to wind

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.

Meteorological data for the monitoring period was sourced from the nearest Bureau of Meteorology station in Broken Hill. 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 dry and as a result no data points were rejected due to rain.

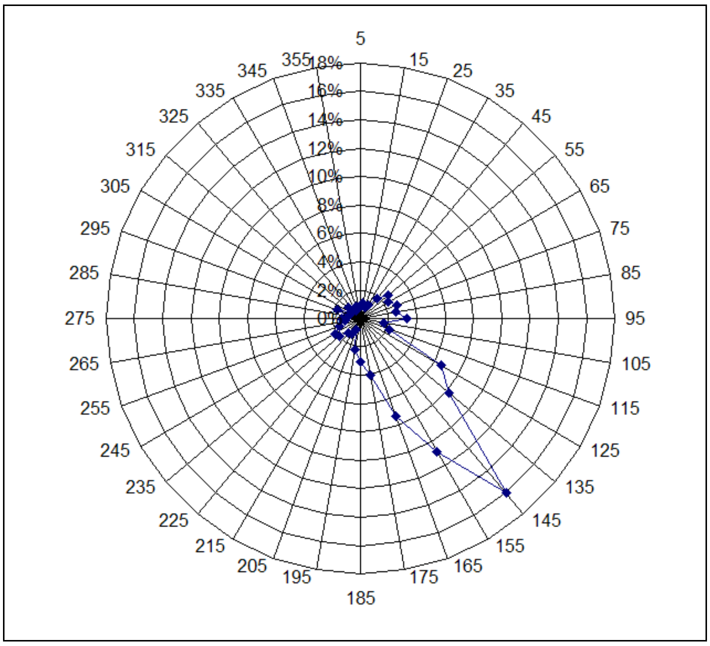
The SA Guidelines require measurements to be conducted in 10-minute intervals, while the NSW INP request 15-minute interval data. Given that almost all wind data, including the wind farm site monitored data, is in 10-minute intervals, this period was used for all measurements.

Noise monitoring for the three baseline sites was conducted from the period 29 November 2007 through to 17 December 2007.

The specific equipment used at each site, site descriptions including photographs and data obtained are shown in the following sections.

The local noise data is correlated to the wind speed at a reference wind data location. It is usual for this location to be at 10 metres above ground level. The reference wind tower at the proposed Silverton Wind Farm has wind monitoring equipment located at 10 metres, 30 metres and 50 metres above ground level. During the survey period, wind was predominantly from the southeast as depicted in **Figure 6.**

Figure 6 Percentage occurrence of wind direction during survey period



6.2 Measurement details

The monitoring period, equipment type and serial number of the noise logger are summarised in **Table 7.**

The SA 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 3–4 m/s. The number of valid data points for each location is also shown in **Table 7.**

The measured background noise levels (L_{A90}) are then plotted against the reference wind tower 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 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 Guideline does not specify a minimum acceptable correlation coefficient.

Table 7 Measurement details for each location

Measurement location	Measurement period	Noise logger	No. of monitoring intervals	No. of valid data points	Correlation coefficient (R^2)		
					Linear	Quad.	Cubic
Eldee Station	29/11/07 13:00 17/12/07 13:20	ARL EL 315 SN 15-203-499	2606	2100	0.4579	0.4696	0.4959
Umberumberka Reservoir	29/11/07 10:10 17/12/07 18:40	ARL EL316 SN 16-207-039	2643	2247	0.4087	0.4087	0.4267
Penrose Park	29/11/07 13:00 17/12/07 13:10	ARL EL316 SN 16-004-033	2610	(all) 2064	0.0337	0.0346	0.035
				(night) 637	0.4167	0.4168	0.451

The Rating Background Level (RBL) as determined by the methodology defined in the NSW Industrial Noise Policy (INP) for each location during each time period is shown in **Table 8**.

Table 8 RBL for each period at each location

Location	Day	Evening	Night
SL2 Eldee Station	34.8	31.6	31.9
SL6 Umberumberka Reservoir	33.2	31.0	31.1
S 24 Penrose Park	42.6	28.6	28.2

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.**

6.3 Location G11 – Eldee Station

The property of Eldee Station is located on the Mundi Mundi Plains to the west of the proposed wind farm. The homestead residence is surrounded by a garden, working sheds and a newly built accommodation wing and is surrounded by flat, largely arid plains. The measurement location was near the northern boundary fence line of the house paddocks.

The monitoring location is shown in **Figure 7.**

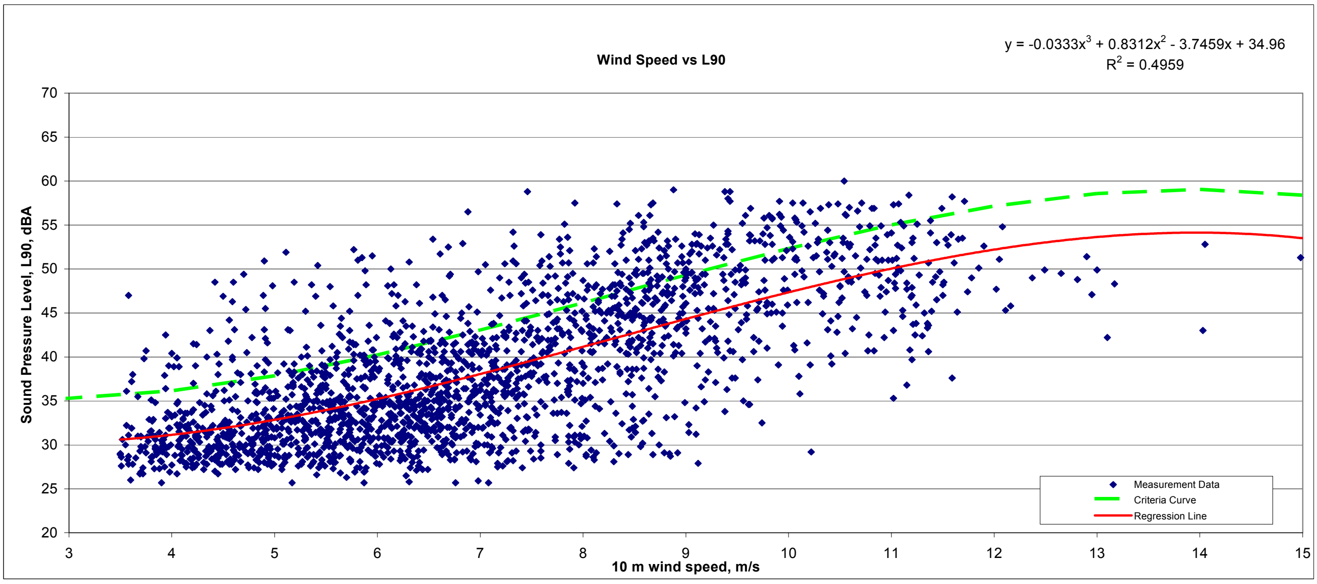
Figure 7 Eldee Station measurement location

The results of the background noise monitoring 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 C**. A limited amount of noise-monitoring data was affected by an extraneous noise source on four days, being an airconditioner, which has been removed from the analysed data set.

The average daytime background level, determined for construction noise impact assessment purposes, was 36.4 dBA.

Figure 8 Background noise measurements and noise criteria curve – Eldee Station



6.4 Umberumberka Reservoir measurement location

The Umberumberka Reservoir pumping station provides water to Broken Hill. It is manned and operated by a caretaker who lives in a nearby residence overlooking the reservoir. The caretaker residence is sufficiently far and well shielded from the pumping station that noise from the pumping station is only audible at the residence under certain conditions.

The measurement location was in a garden bed beside the house. Background noise levels at this location will be influenced by ambient sources such as birds, wind in trees and the pumping station.

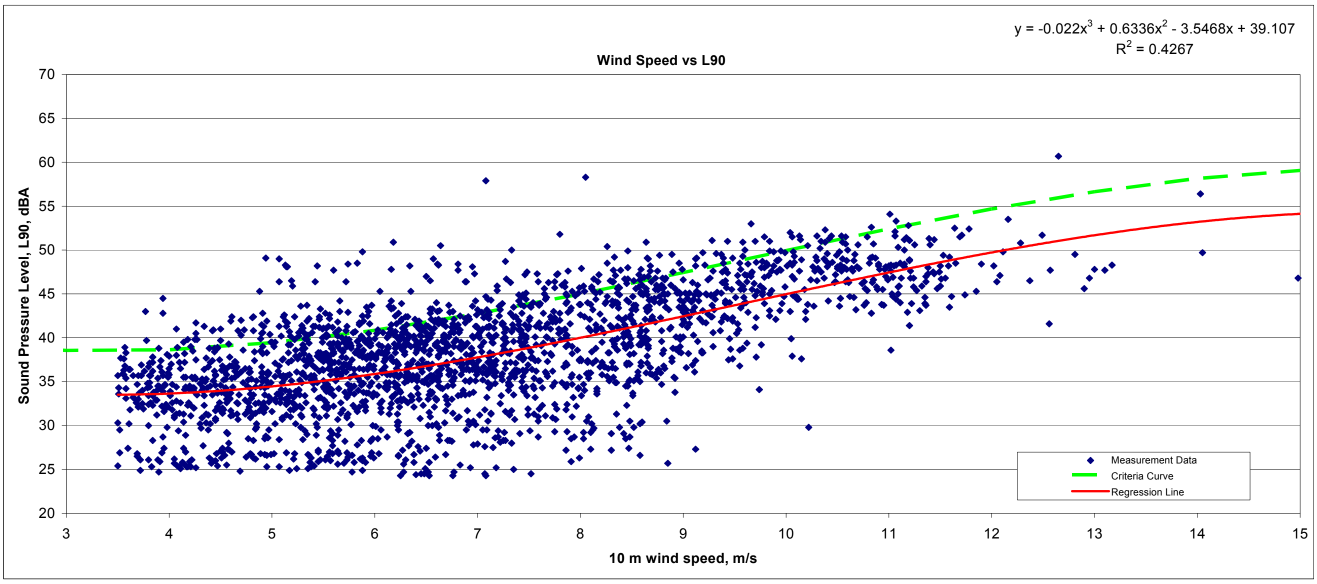
Figure 9 Umberumberka Reservoir monitoring location

The results of the background noise monitoring 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 C**.

The average background level, determined for construction noise impact assessment purposes, was 39.0 dBA.

Figure 10 Background noise measurements and noise criteria curve – Umberumberka



6.5 Penrose Park measurement location

Penrose Park is located in the township of Silverton, to the north of the town centre. It is a recreational park that includes camping, sporting and other facilities. Noise monitoring was undertaken beside the caretaker residence. The property is covered with many large trees and abundant bird life (cockatoos etc) were observed during the site visit.

Figure 11 Penrose Park monitoring location

Graphically represented noise statistical indices together with wind speed are presented in **Appendix C**. It is clear that high noise levels, most likely the high bird population, were experienced on all days at dawn and dusk. This data has been excluded from the analysis. Furthermore, it can be observed that the background noise level during the night periods at this location is significantly lower than during the daytime periods.

The results of the background noise monitoring showing the retained measured data points (excludes data from the dawn and dusk bird chorus) and resulting line of best fit are shown in **Figure 12.**

The same data dissected into day, evening and night is presented in **Figure 13**. It is clear that data collected at this site displays a distinct difference between trends for data collected during the day (07:00–18:00) and that collected during the night (22:00–07:00). Consequently, the noise limits for Silverton will be conservatively based on the night-time data only.

The average background level, determined for construction noise impact assessment purposes, was 48.5 dBA.

Figure 12 Background noise measurements and noise criteria curve – Penrose Park

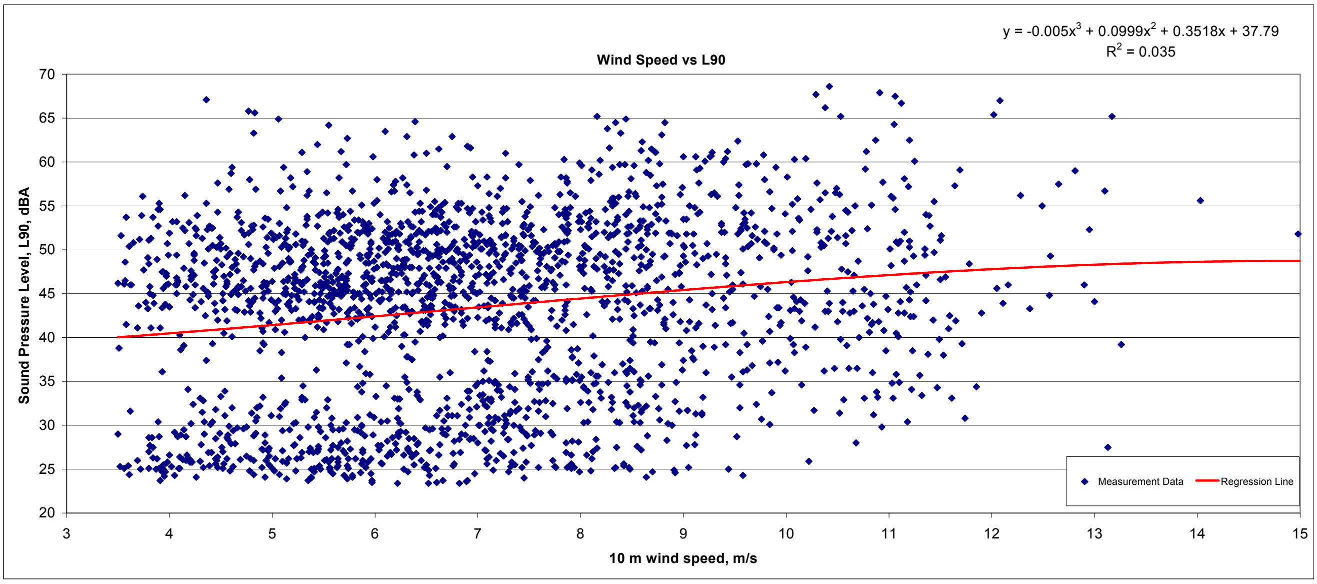
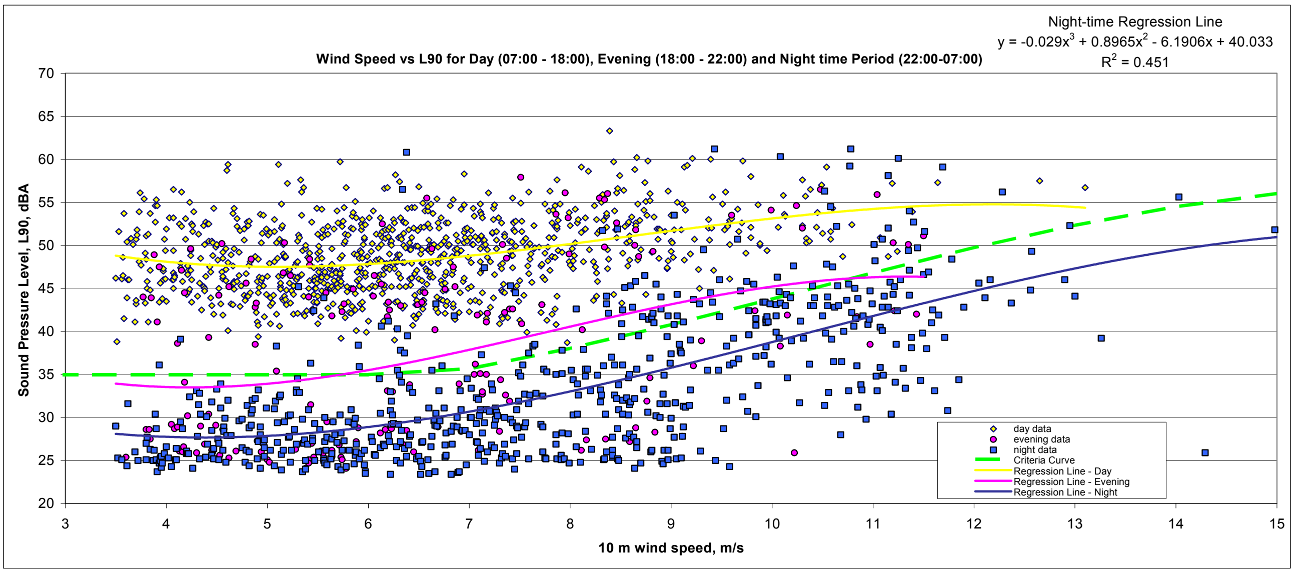


Figure 13 Background noise measurements and noise criteria curve – Penrose Park



7 ACOUSTIC ASSESSMENT OF PROPOSED WIND FARM

7.1 Predicted noise levels

An assessment of the acceptability of wind farm noise levels at all assessment receivers located within a distance of 5 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**. The assessment figures are contained in **Appendix A.**

7.1.1 Stage 1 layout

Appendix A contains the predicted WTG noise level curves for the Stage 1 layout of 120 WTGs, superimposed over SA EPA Guideline Criteria based limits. The predicted curves show that all locations comply.

7.1.2 Final Stage 2 layout

Appendix A contains the predicted WTG noise level curves for Final Stage layout of 598 WTGs, superimposed over SA EPA Guideline Criteria. The predicted curves show that all locations comply.

7.2 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 tonal audibility data ΔLa,k values were determined.

Table 9 Audible tonality assessment to IEC 61400-11

Wind speed m/s	Manufacturer/WTG – ΔLa,k value – audible tonality
	REpower MM92
5	-13.73
6	-110.22
7	-11.72
8	-10.49
9	-9.58

For the wind speed range analysed (5–9 m/s), 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.

7.3 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 50 m to 100 m 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 WTGs is therefore not typical of other sources.

WTGs for the Silverton Wind Farm project are located on top of the Mundi Mundi Range. The hub height (assumed acoustic centre of the WTG) is located between 150 m and 180 m higher than receiver locations on the surrounding area. It is therefore unlikely that conventional temperature inversion conditions, in the lower 100 m 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 3 m/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.

7.4 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 to require sound power data to be measured coincidentally with reference wind speed measurements at an altitude of 10 metres. This is then applied at a specific site (eg at Silverton) by using a reference wind speed altitude of 10 metres (as measured at the monitoring tower positioned on top of the range) to relate background noise levels to wind conditions present at the same time. The turbine noise power can then be applied and compared with background data at those same conditions of wind speed at 10 metres above ground level with good accuracy.

The assessment procedure inherently assumes a fixed relationship between the 10 metre reference altitude and that at which the WTG operates, and that the relationship is the same during IEC 61400-11 test conditions. In practice, as discussed above, the wind velocity profile will vary as a result of ground roughness and atmospheric (stability) effects. The varying profile will likely result in variation in WTG noise emission levels, however, the extent to which levels will vary is difficult to quantify, as the IEC 61400-11 wind profile test conditions are not made available to allow comparison with the subject site.

Accordingly, 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.

7.5 Adaptive Management

If undue WTG noise impacts are identified during operations due to temperature inversion, atmospheric stability or excessive level 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.

8 ASSESSMENT OF CONSTRUCTION NOISE LEVELS

The *Environmental Noise Control Manual (ENCM 1994)* Chapter 171, which remains the sole guideline for construction noise by DECC (formerly NSW EPA), recommend noise level goals and hours for work.

The standard hours of work for construction sites is limited from 7:00 am to 6:00 pm weekdays and 7:00 am to 1:00 pm on Saturdays, with no construction taking place on Sundays or public holidays.

We note, however, that due to the extreme hot weather it is not uncommon for workers in the far west to begin as early as 5:00 am. Where this practice is to take place it will be shown, prior to commencement, that the construction activity is inaudible at residential locations.

For shorter construction periods (less than four weeks), it is considered acceptable for construction noise levels to exceed background noise levels by up to 20 dBA. For construction periods of less than 26 weeks (six months), it is considered acceptable for construction noise levels to be up to 10 dBA above background noise levels.

The ENCM guideline does not stipulate a methodology for establishing background noise levels, however, as the assessment is based upon intrusion above the 'typical' background a commonly adopted interpretation is to use an average background. It should be noted that the ENCM predates the Industrial Noise Policy (INP) by approximately 6 years and as such the use of a 10^{th} percentile RBL methodology is deemed inappropriate as the result would lead to unnecessarily conservative acceptability limits for the significant majority of time.

8.1 Construction noise

Construction activities include:

- construction of access roads
- establishment of turbine tower foundations and electrical substation
- establishment, operation and removal of concrete batching plants
- digging of trenches to accommodate underground power cables and
- the erection of turbine towers and assembly of WTGs.

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

- excavator/grader, bulldozer, dump trucks, vibratory roller (combined SWL 119 dBA)
- bucket loader, rock breaker, drill rig, excavator/grader, bulldozer, dump truck, flat bed truck, concrete truck, (combined SWL 130 dBA)
- excavator, flat bed trucks (combined SWL 111 dBA)
- cranes, fork lift and various 4WD and service vehicles. (combined SWL 111 dBA)

Portable concrete batching plants (combined SWL 115 dBA) may be required to supply concrete onsite. Up to six 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.

It is possible a portable rock crusher plant, including screens (combined SWL 120 dBA) may be implemented for the project. It is anticipated that the crushing plant would be located nearby the concrete batching plants. The contribution from the nearest potential batching plant or rock crusher site to each receiver has been predicted.

The construction period is anticipated to be approximately 18 months for Stage 1, with civil works expected to span approximately 12 months. Stage 2 construction activities are likely to span approximately three to four years, which may extend directly after Stage 1 or be some period after.

Due to the very large area of the wind farm site, intensive works will be located within a distance of potential impact for each surrounding receiver for only relatively short (less than six months) and intermittent periods of time. Intensive works would continually re-position to other areas of the wind farm. It is therefore considered appropriate that construction noise levels up to 10 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. It is more typical during construction for mobile equipment to be operated intermittently with periods of high, medium and low load operations, stationary idling and periods when the equipment is not operating.

Noise monitoring experience of large earthmoving projects and mining ventures shows that received noise levels can be approximately 5 to 8 dBA below the theoretical maximum calculated level. In this case a de-rating factor of 5 dBA was selected to convert modelled full load simultaneous operation to typical operations of multiple mobile construction vehicles.

Four worst case area of works were chosen:

- for the southern area of the site, closest to Silverton
- for the northwest area, nearest Eldee Station
- for the central west of the site, nearest to Umberumberka Reservoir
- for the east area of the site, closest to Purnamoota Station

The resulting predicted construction noise level for the relevant worst-case scenario is detailed in **Table 10** together with typical background noise levels obtained during the background noise monitoring campaign.

Table 10 Worst case construction LA10 noise levels (dBA)

			Construction in worst case Location of wind farm nearest receiver					
	Typical (average) background LA90 dBA	Short-term (<6 months) construction noise limit dBA	Portable concrete batching plant dBA	Rock crusher & screen dBA	Trench excavation dBA	Access road construction dBA	Turbine foundation establishment dBA	WTG erection dBA
Silverton Township	48.5	59	0	10	10	29	41	12
Belmont Station	48.5 *	59	5	14	12	21	43	6
Purnamoota Station	36.4 *	46	10	19	23	30	43	24
Eldee Station	36.4	46	0	8	19	26	49	21
Umberumberka Reservoir	39.0	49	28	37	22	41	51	21

* assumed from monitoring at alternative location

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

Some nearby receivers are anticipated to receive elevated construction noise levels when turbine foundation civil works, specifically the rock breaker, are located nearby. However, due to the anticipated short period of localised works would likely be considered satisfactory.

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

If impacts were to be identified during construction then an appropriate mitigation measure may be to position the vehicle or other vehicles such that they screen noise emissions or to re-schedule the works to occur during a more appropriate weather condition.

It is possible that some limited amount of night-time construction activity may be required, specifically WTG erection during periods of light wind. This will involve the lifting of WTG towers, nacelles and blades into position with a crane. This activity involves the least amount of mobile equipment compared to others such as access road establishment, trenching or foundation establishment. The predicted 'worst case' position noise level for WTG erection in the township of Silverton is 12 dBA which is significantly below the existing ambient background noise level. It is unlikely the activity would be audible or cause an impact in this instance.

8.2 Blasting

8.2.1 Applicable criteria

The ground vibration and airblast levels that cause concern or discomfort to residents are generally lower than the relevant building damage limits.

The NSW EPA advocates the use of the ANZECC guidelines for assessing potential residential disturbance arising from blast emissions. The ANZECC guidelines for control of blasting impact at residences are as follows:

- The recommended maximum level for airblast is 115 dB Linear. The level of 115 dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dB Linear at any time.
- The recommended maximum for ground vibration is 5 mm/s, Peak Vector Sum (PVS) vibration velocity. It is recommended, however, that 2 mm/s (PVS) be considered as the long-term regulatory goal for the control of ground vibration. The PVS level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 9:00 am to 5:00 pm Monday to Saturday. Blasting should not take place on Sundays and public holidays.
- Blasting should generally take place no more than once per day.

The Australian Standard 2187.2-1993 *Explosives – Storage, Transport and Use. Part 2: Use of Explosives* does not present human comfort criteria for ground vibration from blasting. It does, however, make mention of human comfort level for airblast in saying 'a limit of 120 dB for human comfort is commonly used'. This is consistent with the ANZECC guidelines.

AS 2187.2-1993 nominates building damage assessment criteria as presented in **Table 11**.

Table 11 Blast emission building damage assessment criteria (AS 2187)

Building type	Vibration level	Airblast level (dB re 20 µPa)
Sensitive (and heritage)	PVS 5 mm/s	133 dB(Linear) Peak
Residential	PVS 10 mm/s	133 dB(Linear) Peak
Commercial/industrial	PVS 25 mm/s	133 dB(Linear) Peak

8.2.2 Blasting assessment

As part of the civil works, it is expected that infrequent blasting may be required to clear obstacles and prepare WTG foundations.

The proposed wind farm site is a green field site where no previous 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%) = 1140 $(SD_1)^{-1.6}$

Airblast SPL(5%) = 165.3 - 24 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:

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

and,

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

Based on the blast emissions site laws, calculations were also conducted to indicate the allowable MICs 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 1600 metres (location Umberumberka Reservoir and WTG #WB1). At this distance the predicted maximum MIC of up to 2000 kg is likely to produce an airblast overpressure below the acceptable level of 115 dB Linear. It should be noted that typically an MIC of 50 to 100 kg is sufficient for blasts with a typical hole size and spacing and overburden.

It is evident that the anticipated blasting is likely to meet all human comfort limits and building damage assessment criteria will be easily met.

8.3 Traffic Noise

Construction of the proposed wind farm will generate considerable traffic, with construction personnel and deliveries, to and from the site. The use of on-site concrete batch plants will significantly reduce the number of total vehicle movements to and form the site

Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependant upon the construction activities being conducted, which will vary during the construction period. For the purposes of assessing the potential construction traffic noise impact typical volumes expected during peak construction activity have been used.

Currently there are no guidelines or mandatory requirements for assessing construction traffic noise impacts. The Roads and Traffic Authority of NSW (RTA) has produced *Environmental Criteria for Road Traffic Noise (ECRTN) 1999*, which establishes an assessment methodology and criteria for acceptable noise levels for a variety of road types, upgrades and developments which may generate traffic. The ECRTN criteria are intended to be applied under normal, long term, traffic conditions.

Notwithstanding the above the applicable ECRTN targets will be introduced in order to evaluate the likely noise impact or potential for adverse community reaction resulting from periods of elevated traffic due to construction.

The relevant ECRTN daytime (7 am – 10 pm) criteria are;

- Collector road, (ie Silverton Road), $L_{Aeq(1\ hour)}$ = 60 dBA
- Local road, (ie Daydream Mine Road), $L_{Aeq(1\ hour)}$ = 55 dBA

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

Decisions on the final road routes to the site entrance would be the subject of negotiations between the haulage contractor and the road authorities, however, it is anticipated that the main site access will be along Silverton Road from Broken Hill, with a turnoff to the site along Daydream Mine Road, some 5 kilometres before the township of Silverton. This route will account for 95% of site access requirements with only limited requirements for project traffic to continue through Silverton.

The traffic study calculations indicate that the maximum daily rate of traffic at any point in the project's road network during the construction phase would likely be in the order of 250 vehicles per day. For the purposes of the noise assessment it is assumed that the during the highest 'peak' hour of traffic approximately 20% of total daily traffic and project traffic will be approximately 50% heavy vehicles.

Table 12 summarises predicted road traffic noise levels associated with the anticipated peak generated traffic volumes.

Table 12 Construction Traffic

Route	Current traffic volume	Projected maximum construction traffic	Number of affected receivers	Increase in road traffic noise from project	'peak hour' Leq(1 hour) at receiver approximately 10 m from roadside
Silverton Road	210 vpd	250 vpd	1 possible	Greater than 2 dBA	63 dBA total
Vehicle routes through Broken Hill e.g. Brookfield Av, Barrier Hwy, Silver City Hwy etc	Varies (assume from 300 to >10,000 vpd)	250 vpd	50-100	Generally less than 2 dBA	58 dBA project only

The greatest increase in traffic volumes as a consequence of the project will be on Silverton Road with current traffic set to more than double during peak construction period. The road is isolated with only a single potential receiver affected along the road.

It is anticipated that most of the project construction personnel will be accommodated in Broken Hill and will therefore be relatively dispersed and cause negligible traffic impacts.

Deliveries of heavy equipment, WTG blades, nacelles and towers etc. are likely to come from Adelaide via the Barrier Highway to the project site. This route will see minimal impacts to residents of Broken Hill with approximately 50 residential receivers along it. Some deliveries may come from the South via the Silver City Highway and through Broken Hill via the appropriate heavy vehicle route. It is anticipated that this may have the potential top impact approximately 100 or so receivers. In both cases project related construction traffic through Broken Hill is unlikely to cause increases in the existing traffic noise level in excess of 2 dBA.

8.3.1 Night-time deliveries

There will 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 is likely to be limited to Broken Hill, as there are not any receivers along Silverton Road or Daydream Road that would be affected.

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 to 40 dBA and as such maximum noise levels from pass-bys may have the potential for sleep disturbance. However, the Barrier Highway is already a significant route (~820 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 goals where appropriate.

Stage 1 layout, which includes 120 REpower MM92 Evolution WTGs, was predicted to comply with all relevant noise criteria, SA EPA Guideline and WHO limits, at all respective receivers.

The final Stage 2 layout, which includes 598 REpower MM92 Evolution WTGs, was predicted to comply with all relevant noise criteria, SA EPA Guideline and WHO limits, at all respective receivers.

It is noteworthy that the compliance of Stage 1 and Stage 2 in the township of Silverton is based on a conservative approach using the night-time background noise profile, which therefore gives a greater confidence in the assessment.

Construction noise impact has been assessed and the worst-case scenarios modelled were found to be acceptable. This includes the operation of ion-site concrete batch plants and a medium sized rock crushing plant with screen.

Blasting impact has been assessed and found to be acceptable. With a maximum MIC of up to 2000 kg, the airblast overpressure is anticipated to be below the acceptable level of 115 dB Linear for all existing residences. A more typical MIC value of 100 kg would yield airblast overpressure of approximately 105 dB Linear.

Transformer noise has been predicted and transmission line corona noise evaluated and both assessed and shown that the minimum noise limits defined by the Industrial Noise Policy will be complied with even under ‘worst case’ meteorological enhanced propagation conditions.

Traffic noise generated by the project will be greatest during construction. The use of on-site concrete batch plants will significantly reduce the number of total vehicle movements to and from the site, with a projected ‘peak’ construction period generating approximately 250 vpd. Traffic noise impacts are not likely to be significant, as the main site access route is remote from any dwellings, and heavy vehicle routes through Broken Hill will be minimised and on appropriately designated roads that already carry significant traffic. Similarly possible night-time traffic movements through Broken Hill have the potential to cause disturbance, however, appropriate management would minimise possible impacts.