

MEMO

<b>Project:</b>	Alberton Wind Farm	<b>Document No.:</b>	Mm 006
<b>To:</b>	Synergy Wind Pty Ltd	<b>Date:</b>	24 July 2017
<b>Attention:</b>	Coralie Spitzner	<b>Project No.:</b>	2015590ML
<b>From:</b>	Alex Morabito	<b>No. Pages:</b>	12
		<b>Attachments:</b>	No
<b>Subject</b>	Predicted noise levels – Alternative Turbine Types		

This memo details predicted noise levels for the Alberton Wind Farm in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS6808:2010) as required by the Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria*, dated June 2015.

**APPLICABLE NOISE LIMITS**

The following base noise limits have been used for this assessment:

- NZS6808:2010 base noise limit of 40 dB  $L_{A90}$  for non-stakeholder properties
- ETSU-R-97 base noise limit of 45 dB  $L_{A90}$  for stakeholder properties with a noise agreement

**SITE LAYOUT**

**Turbines**

The predictions have been undertaken on the basis of a total of thirty-four (34) turbines with a number of candidate models, as detailed in Table 1.

**Table 1: WTG manufacturer specifications**

Detail	SWT-3.15-142	SWT-3.6-130	G132-3.465	V136-3.6
Make	Siemens	Siemens	Gamesa	Vestas
Model	SWT-3.15-142	SWT-3.6-130	G132	V136-3.6
Rated power (MW)	3.15	3.6	3.465	3.6
Rotor Diameter (m)	142	130	132	136
Hub Height (m)	109	115	114	112
Orientation	Upwind	Upwind	Upwind	Upwind
Highest sound Power $L_{WA}$ dB	105.9*	107.0*	107.3*	106.5*
Tonality <sup>+</sup>	Information not available	Information not available	Information not available	Information not available

\* Guaranteed sound power level, including a 1 dB margin to account for uncertainties (See Section Sound power levels)

+ See Section Tonality

The coordinates of the wind turbines are tabulated in Appendix A.

**Receivers**

A total of ninety-nine (99) receivers have been included in the prediction model, including nineteen (19) stakeholder properties and eighty (80) non-stakeholder properties.

The coordinates of the residential properties included in this assessment are tabulated in Appendix A.



## TURBINE DATA

### Sound power levels

Sound power levels used in the assessment have been sourced from the documents presented in Table 2, for each of the candidate turbine models.

Table 2: Reference documents

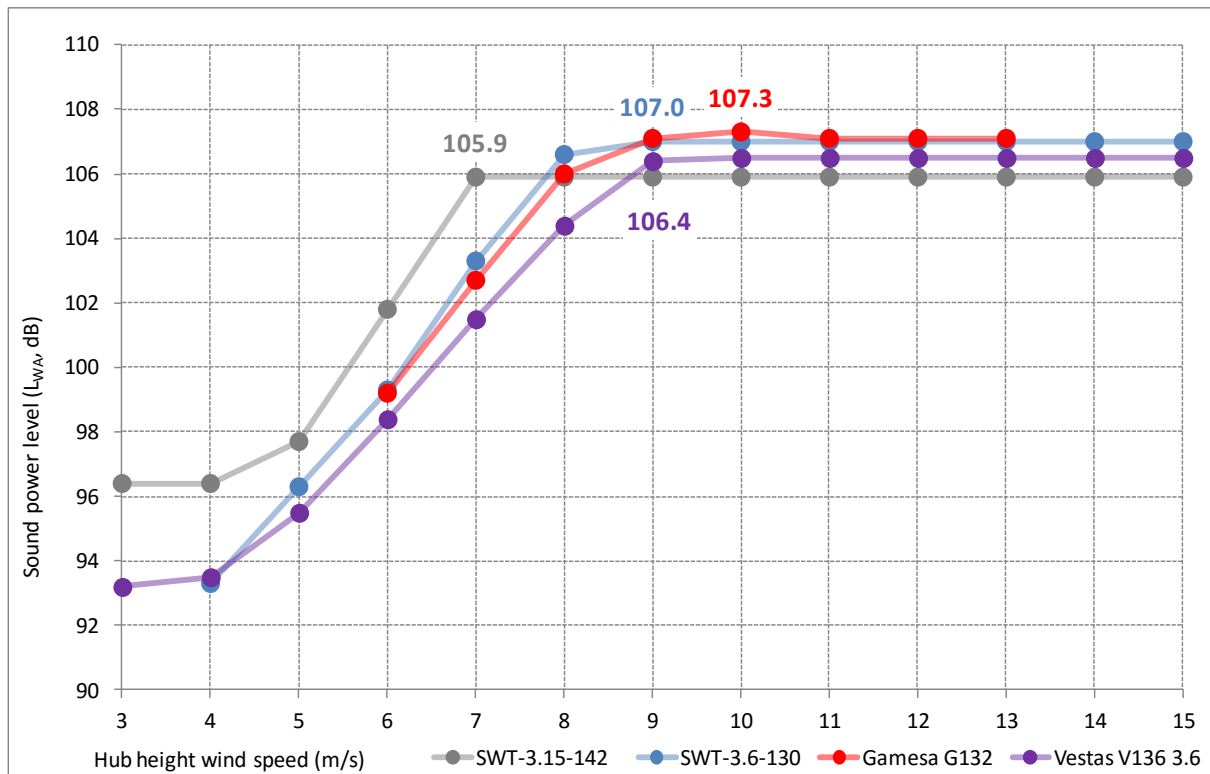
Model	Reference document
SWT-3.15-142	<i>Standard Acoustic Emission, SWT-3.15-142, Rev. 0</i> Document ID: WP ON PLM&EN EN GS-40-0000-G669-00 2016.05.12
SWT-3.6-130	<i>Standard Acoustic Emission, SWT-3.6-130, Rev. 1</i> Document ID: WP ON PLM&EN EN GS-40-0000-G955-00 2016.06.15
G132-3.465	<i>G132-3.465MW POWER CURVE AND NOISE.</i> dated 26/02/17; and <i>MCG G132-3.465MW NOISE SPECTRUM,</i> dated 26/02/17
V136-3.6	<i>Performance Specification V136-3.60 MW 50/60 Hz</i> Document no.: 0056-6306 V02 2017-04-21; and <i>V136-3.6 MW Third octave noise emission</i> Document no. 0064-2970_01 2017-02-16

Note: the assessment has been based on the turbine fitted with blades with serrated trailing edge

The sound power level values used for this assessment have been derived from the above documents with the inclusion of a 1 dB margin to account for uncertainties.

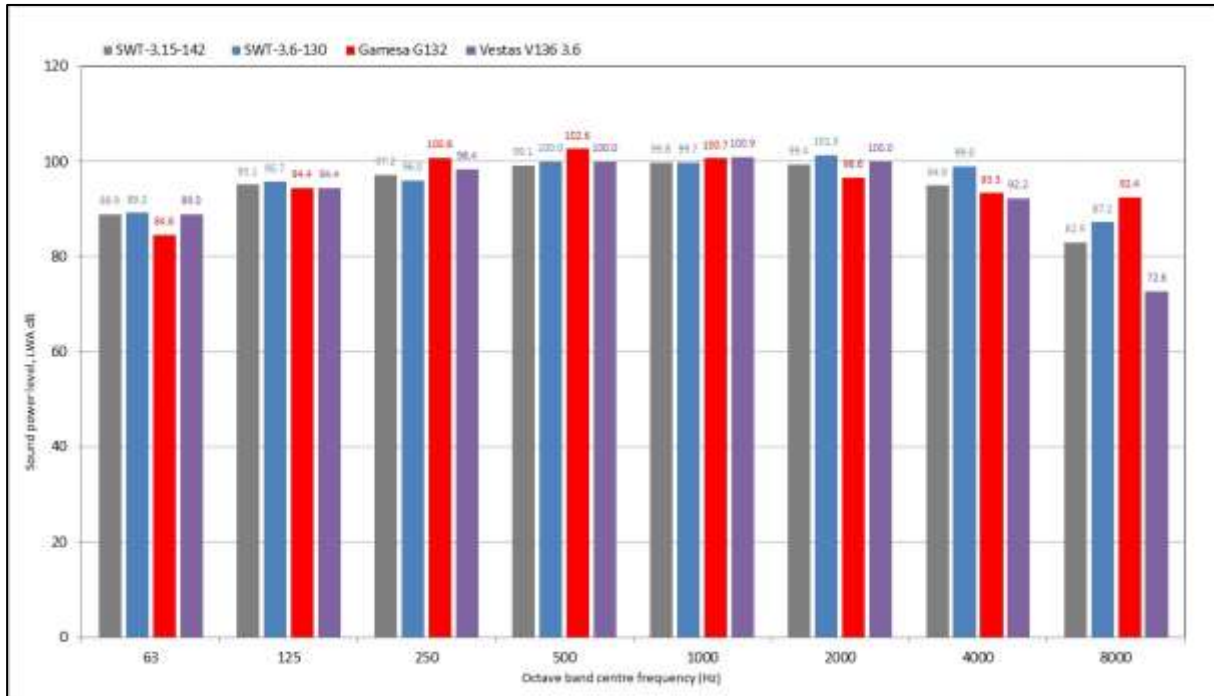
The profile of A-weighted sound power levels as a function of hub height wind speed, detailed the documents listed in Table 1, are presented in Figure 1, for the candidate turbine models.

Figure 1: Sound power level vs. hub height wind speed



The octave band values provided in the reference documents have been adjusted to the highest sound power level detailed in Figure 1 and are presented in Figure 2, for the candidate turbine models. Tabular values are also presented in Appendix C.

Figure 2: A-weighted octave band sound power level spectra



## Tonality

Tonal audibility values ( $\Delta L_{a,k}$ ) were not available for the turbine models at the time of preparing this document.

Notwithstanding the above, we envisage that the procurement contract for the site would stipulate that the turbines must not produce emissions which would attract a penalty for tonality when assessed in accordance with the relevant noise criteria and any associated conditions of consent.

## NOISE PREDICTION METHOD

Noise from the Alberton Wind Farm has been predicted using ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO 9613-2:1996) as implemented in version 7.4 of SoundPLAN.

The following key details are noted:

- Turbine hub height: As detailed in Table 1
- Receiver heights: 1.5 m
- Ground characterisation:  $G = 0.5$
- Atmospheric conditions:  $T = 10^\circ\text{C}$  and  $\text{RH} = 70\%$
- Terrain elevation provided by Synergy Wind Pty Ltd

A full summary of the prediction methodology is provided in Appendix B.

## RESULTS

Predicted noise levels, corresponding to the highest sound power levels detailed in Figure 1 are provided in Table 3 and Table 4 for the various turbine models.

**Table 3: Highest predicted noise levels at non-stakeholder properties, dB L<sub>A90</sub>**

Receiver	Applicable base noise limit	SWT-3.15-142	SWT-3.6-130	G132-3.465	V136-3.6
D01	40	27.2	27.4	28.4	27.6
D02	40	28.5	28.7	29.9	29.0
D03	40	29.3	29.5	30.8	29.8
D04	40	29.6	29.8	31.0	30.1
D05	40	29.8	30.0	31.3	30.3
D06	40	28.5	28.7	29.9	29.0
D07	40	27.0	27.2	28.2	27.4
D08	40	27.7	27.9	29.0	28.2
D09	40	29.4	29.6	30.9	30.0
D10	40	32.7	32.9	34.3	33.3
D11	40	29.9	30.1	31.4	30.4
D12	40	31.5	31.8	33.1	32.1
D13	40	36.5	36.7	38.1	37.2
D14	40	30.3	30.5	31.8	30.8
D15	40	27.6	27.8	28.7	28.0
D16	40	29.1	29.3	30.4	29.6
D17	40	25.9	26.0	26.7	26.1
D18	40	29.1	29.3	30.4	29.5
D19	40	28.9	29.1	30.1	29.3
D20	40	30.6	30.8	32.0	31.1
D21	40	32.3	32.5	33.8	32.9
D22	40	36.1	36.3	37.7	36.7
D23	40	25.6	25.8	26.4	25.9
D24	40	34.3	34.5	35.9	34.9
D25	40	32.3	32.5	33.8	32.8
D26	40	26.2	26.4	27.1	26.5
D27	40	31.6	31.8	33.0	32.1

Receiver	Applicable base noise limit	SWT-3.15-142	SWT-3.6-130	G132-3.465	V136-3.6
D28	40	26.0	26.2	26.9	26.3
D29	40	35.4	35.6	37.0	36.0
D30	40	37.3	37.6	38.9	38.0
D31	40	36.2	36.5	37.9	36.9
D32	40	29.8	29.9	31.0	30.2
D33	40	36.3	36.6	38.0	37.0
D34	40	34.1	34.3	35.7	34.7
D35	40	36.7	37.0	38.3	37.4
D36	40	30.2	30.3	31.4	30.6
D37	40	30.6	30.7	31.9	31.0
D38	40	30.9	31.1	32.3	31.4
D39	40	30.2	30.4	31.5	30.6
D40	40	31.3	31.4	32.6	31.7
D41	40	30.5	30.7	31.9	31.0
D42	40	32.0	32.2	33.4	32.5
D43	40	30.4	30.6	31.9	31.0
D44	40	30.9	31.1	32.4	31.4
D45	40	33.1	33.3	34.6	33.7
D46	40	36.0	36.2	37.7	36.6
D47	40	36.1	36.3	37.8	36.7
D48	40	36.3	36.5	37.9	36.9
D49	40	36.2	36.4	37.8	36.8
D50	40	33.1	33.4	34.7	33.7
D51	40	37.6	37.9	39.3	38.3
D52	40	34.6	34.9	36.2	35.2
D53	40	34.4	34.6	36.0	35.0
D54	40	35.1	35.3	36.7	35.7
D55	40	34.9	35.1	36.5	35.5
D56	40	34.9	35.2	36.5	35.5
D57	40	36.9	37.1	38.5	37.6

Receiver	Applicable base noise limit	SWT-3.15-142	SWT-3.6-130	G132-3.465	V136-3.6
D58	40	35.3	35.6	36.9	36.0
D59	40	35.3	35.5	36.9	35.9
D60	40	38.0	38.2	39.6	38.6
D61	40	33.7	33.9	35.3	34.3
D62	40	37.7	37.9	39.3	38.4
D63	40	33.0	33.2	34.6	33.6
D64	40	34.3	34.5	35.9	34.9
D65	40	35.2	35.5	36.8	35.8
D66	40	35.0	35.3	36.7	35.7
D67	40	34.1	34.3	35.7	34.7
D68	40	33.0	33.3	34.6	33.6
D69	40	32.2	32.4	33.7	32.7
D70	40	32.1	32.3	33.6	32.7
D71	40	32.3	32.5	33.8	32.8
D72	40	35.0	35.2	36.6	35.6
D73	40	35.1	35.4	36.7	35.7
D74	40	34.2	34.5	35.8	34.8
D75	40	33.4	33.6	34.9	33.9
D76	40	32.7	32.9	34.2	33.2
D77	40	32.3	32.5	33.8	32.8
D78	40	31.9	32.1	33.4	32.5
D79	40	31.3	31.5	32.8	31.9
D80	40	31.2	31.4	32.7	31.7
D81	40	36.7	37.0	38.3	37.4
D82	40	33.5	33.7	35.0	34.1
D83	40	33.6	33.8	35.1	34.2
D84	40	34.9	35.1	36.5	35.5
D85	40	35.1	35.3	36.7	35.7

The predicted noise levels from the Alberton Wind Farm comply with the base limits at all non-stakeholder properties, for each of the turbine types.

**Table 4: Highest predicted noise levels at stakeholder properties, dB LA90**

Receiver	Applicable base noise limit	SWT-3.15-142	SWT-3.6-130	G132-3.465	V136-3.6
R01	45	37.4	37.7	38.9	38.1
R02	45	45.5	46.0	46.7	46.2
R03	45	39.8	40.1	41.2	40.5
R05	45	39.3	39.6	40.9	40.0
R06	45	29.4	29.6	30.7	29.9
R08	45	40.1	40.4	41.7	40.8
R09	45	39.6	39.9	41.3	40.3
R10	45	35.5	35.8	37.1	36.2
R11	45	35.8	36.1	37.4	36.5
R12	45	41.9	42.2	43.3	42.6
R13	45	43.0	43.4	44.5	43.7
R14	45	44.9	45.3	46.2	45.6
R15	45	41.4	41.8	42.8	42.1
R16	45	40.7	41.0	42.1	41.4
R17	45	44.0	44.5	45.4	44.7
R18	45	37.8	38.1	39.4	38.4
R19	45	36.4	36.7	38.0	37.1

Note: Shaded cell(s) exceed the applicable base noise limit

The following is evident from Table 4:

- Predicted noise levels from the Alberton Wind Farm exceed the base limit at one (1) stakeholder property (R02) by 0.5 dB, using the Siemens SWT-3.15-142 turbine
- Predicted noise levels from the Alberton Wind Farm exceed the base limit at two (2) stakeholder properties, R02 and R14 by 1 dB and 0.3 dB respectively, using the Siemens SWT-3.6-130 turbine
- Predicted noise levels from the Alberton Wind Farm exceed the base limit at three (3) stakeholder properties, R02, R14 and R17 by 1.7 dB, 1.2 dB and 0.4 dB respectively, using the Gamesa G132 turbine
- Predicted noise levels from the Alberton Wind Farm exceed the base limit at two (2) stakeholder properties, R02 and R14 by 1.2 dB and 0.6 dB respectively, using the Vestas V136-3.6 turbine

**APPENDIX A WIND FARM LAYOUT**

**A1 Turbine Coordinates – WGS84 Zone 55**

<b>Turbine</b>	<b>Easting</b>	<b>Northing</b>	<b>Turbine</b>	<b>Easting</b>	<b>Northing</b>
T01	458853	5721594	T18	466207	5723430
T02	458685	5722082	T19	466293	5722824
T03	458756	5722567	T20	466711	5729705
T04	459518	5721714	T21	466771	5730287
T05	459584	5722157	T22	466804	5723380
T06	459637	5722587	T23	466912	5730979
T07	459708	5723054	T24	466630	5726724
T08	462198	5723499	T25	467223	5726089
T09	462340	5724695	T26	467278	5724773
T10	462791	5723439	T27	467403	5723331
T11	463408	5723282	T28	467414	5729117
T12	465069	5723430	T29	467662	5725331
T13	465102	5722990	T30	467551	5730153
T14	465248	5723919	T31	467683	5724225
T15	465606	5723479	T32	467964	5723825
T16	465616	5722934	T33	468258	5723514
T17	466758	5726258	T34	468632	5724068

**A2 Dwelling coordinates WGS84 Zone 55 – Stakeholder properties**

<b>Property</b>	<b>Easting</b>	<b>Northing</b>	<b>Distance to nearest turbine (m)</b>	<b>Property</b>	<b>Easting</b>	<b>Northing</b>	<b>Distance to nearest turbine (m)</b>
R01	458025	5721403	850	R12	466861	5725604	605
R02	458511	5721773	355	R13	467098	5724123	594
R03	459349	5723517	586	R14	467310	5724158	379
R05	464013	5723672	720	R15	467727	5729528	517
R06	464619	5729290	2,133	R16	468091	5725646	533
R08	465556	5724498	656	R17	468272	5724349	457
R09	466041	5724449	954	R18	468387	5725686	808
R10	466058	5727464	935	R19	469205	5724777	912
R11	466580	5728555	1,006				



A3 Dwelling coordinates - WGS84 Zone 55 – Non-stakeholder properties

Property	Easting	Northing	Distance to nearest turbine (m)	Property	Easting	Northing	Distance to nearest turbine (m)
D01	456219	5721293	2,589	D44	465058	5729122	1,753
D02	456468	5721683	2,253	D45	465158	5726702	1,472
D03	456636	5722500	2,091	D46	465557	5725302	1,417
D04	456675	5722351	2,028	D47	465624	5725326	1,456
D05	456731	5722471	1,992	D48	465662	5725284	1,426
D06	456782	5720820	2,211	D49	465666	5725357	1,416
D07	456947	5719936	2,526	D50	465711	5728791	1,355
D08	456961	5720204	2,348	D51	465724	5724867	1,061
D09	457354	5720365	1,938	D52	465957	5727564	1,076
D10	457420	5721301	1,463	D53	466440	5728061	1,350
D11	457910	5720036	1,821	D54	466491	5727792	1,077
D12	458209	5720224	1,514	D55	466729	5728009	1,289
D13	458737	5723585	1,018	D56	466778	5728057	1,236
D14	458998	5719763	1,837	D57	466848	5721988	1,003
D15	460039	5719125	2,641	D58	466928	5727796	1,113
D16	460111	5719590	2,205	D59	467134	5728108	1,047
D17	460407	5718517	3,318	D60	467278	5722331	1,008
D18	461192	5720028	2,376	D61	467900	5727786	1,417
D19	461907	5720276	2,788	D62	468021	5722533	1,009
D20	462027	5721045	2,460	D63	468183	5727934	1,411
D21	462521	5721661	1,798	D64	468186	5727032	1,348
D22	463348	5724709	1,008	D65	468397	5729317	1,003
D23	463770	5731358	3,165	D66	468579	5722356	1,202
D24	463822	5725019	1,517	D67	468582	5730329	1,046
D25	463843	5725711	1,814	D68	468737	5730295	1,194
D26	463853	5730988	3,001	D69	468860	5726875	1,816
D27	463917	5726014	2,056	D70	468913	5730054	1,366
D28	463929	5731320	3,002	D71	469019	5726564	1,834
D29	463958	5724677	1,496	D72	469159	5725201	1,250
D30	463373	5724339	1,058	D73	469510	5724603	1,028
D31	464056	5724474	1,315	D74	469711	5724415	1,133

Property	Easting	Northing	Distance to nearest turbine (m)	Property	Easting	Northing	Distance to nearest turbine (m)
D32	464260	5727382	2,460	D75	469822	5724534	1,278
D33	464278	5724560	1,163	D76	469938	5724573	1,400
D34	464339	5721714	1,487	D77	470008	5724610	1,479
D35	464393	5724553	1,064	D78	470094	5724521	1,531
D36	464402	5727287	2,298	D79	470239	5724441	1,650
D37	464632	5727402	2,110	D80	470251	5724509	1,678
D38	464746	5727334	1,980	D81	467680	5726999	1,018
D39	464816	5729479	1,908	D82	465354	5727002	1,306
D40	464838	5727269	1,873	D83	465338	5726904	1,304
D41	464925	5729257	1,841	D84	460504	5723858	1,131
D42	464933	5726951	1,712	D85	465384	5725596	1,525
D43	464967	5730568	1,826				

## APPENDIX B PREDICTION METHODOLOGY

Detail	Description
Software	Proprietary noise modelling software SoundPLAN version 7.4 (current release)
Method	<p>International Standard ISO 9613-2:1996 <i>Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation</i> (ISO 9613-2).</p> <p>Adjustments to the ISO 9613-2 method are applied on the basis of the guidance contained in the UK Institute of Acoustics publication <i>A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise</i> (UK good practice guide).</p>
Source characterisation	<p>Each wind turbine is modelled as an incoherent point source of sound positioned at the proposed hub height of the turbines.</p> <p>The total sound of the wind farm is then calculated on the basis of simultaneous operation of all wind turbines and summing the contribution of each.</p>
Terrain data	Elevation contours provided by Synergy Wind.
Terrain effects	Adjustments for the effect of terrain are determined and applied on the basis of the UK good practice guide.
Ground conditions	<p>Ground factor of <math>G = 0.5</math></p> <p>The ground around the site corresponds to acoustically soft conditions (<math>G=1</math>) according to ISO 9613-2. The adopted value of <math>G = 0.5</math> assumes that 50 % of the ground cover is acoustically hard (<math>G = 0</math>) to account for variations ground porosity and provide a cautious representation of ground effects.</p>
Atmospheric conditions	<p>Temperature <math>10^{\circ}\text{C}</math> and relative humidity 70 %</p> <p>This represents conditions which result in relatively low levels of atmospheric sound absorption and is chosen on the basis of the UK good practice guide.</p> <p>The calculations are based on sound speed profiles<sup>1</sup> which increase the propagation of sound from each turbine to each receiver location, whether as a result thermal inversions or wind directed toward each calculation point.</p> <p>The primary consideration for wind farm noise assessment is wind speed and direction. The noise level at each calculation point is assessed on the basis of being simultaneously downwind of every wind turbine at the site. Other wind directions in which part or the entire wind farm is upwind of the receiver will result in lower noise levels. In some cases, it is not physically possible for a receiver to be simultaneously downwind of each turbine and the approach is therefore conservative in these instances.</p>
Receiver heights	1.5 m AGL

<sup>1</sup> The sound speed profile defines the rate of change in the speed of sound with increasing height above ground

**APPENDIX C SOUND POWER LEVEL DATA**

**C1 Guaranteed sound power levels +1 dB uncertainty vs. hub height wind speed**

Turbine Type L <sub>WA</sub> dB	Hub height wind speed m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
SWT-3.15-142	96.4	97.7	101.8	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9
SWT-3.6-130	93.3	96.3	99.3	103.3	106.6	107.0	107.0	107.0	107.0	107.0	107.0	107.0
G132-3.465	-	-	99.2	102.7	106	107.1	107.3	107.1	107.1	107.1	-	-
V136-3.6	93.5	95.5	98.4	101.5	104.4	106.4	106.5	106.5	106.5	106.5	106.5	106.5

**C2 Octave band sound power levels**

Turbine Type L <sub>WA</sub> dB	Octave Band Centre Frequency Hz									
	63	125	250	500	1000	2000	4000	8000	A	
SWT-3.15-142	88.9	95.1	97.2	99.1	99.8	99.4	94.9	82.9	105.9	
SWT-3.6-130	89.2	95.7	96.0	100.0	99.7	101.3	99.0	87.2	107.0	
G132-3.465	84.6	94.4	100.8	102.6	100.7	96.6	93.3	92.4	107.3	
V136-3.6	89.0	94.4	98.4	100.0	100.9	100.0	92.2	72.6	106.5	