TE UKU WIND FARM

NOISE MANAGEMENT PLAN

Report No 8655

Prepared for:
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RAGLAN
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1 INTRODUCTION

Meridian Energy Limited has been granted consent to construct the Te Uku Wind Farm, which is located on the Wharauroa Plateau about 3km from State Highway 23 at Te Uku. As part of the conditions of consent for the wind farm the consent holder is required to prepare and implement a Noise Management Plan to manage the potential effects of noise[1] from the ongoing operation of the wind farm.

Condition 5.8 of the Conditions of Consent requires a Noise Management Plan to be prepared by an appropriately qualified acoustic consultant. This report addresses the noise requirements of the resource consent conditions and how the wind farm will be managed to satisfy those conditions.

[1] See Appendix A for a Glossary of Noise Terms used in this report.

2 RESOURCE CONSENT REQUIREMENTS

Condition 5.8 of the resource consent sets the following requirements for a Noise Management Plan[2]:

5.8 prior to commencement of operation of the wind farm the consent holder shall prepare and implement a Noise Management Plan to manage the potential effects of noise from the wind turbine generators. The Noise Management Plan shall be prepared by an appropriately qualified acoustic consultant and submitted to the Waikato District Council Environmental Services Group Manager for approval. The Noise Management Plan shall include, but not be limited to:

(a) An assessment of the contribution to the overall sound levels from individual wind turbine generators;

(b) Procedures for ensuring compliance with the noise conditions of this consent, including noise compliance testing, methods for addressing non-compliance; and

(c) Procedures for addressing wind turbine malfunctions that cause noise beyond typical operational noise.

Conditions 5.3 to 5.5 relate to the operation of the turbines. These conditions state:

Operation Noise (Turbines)

5.3 The wind turbines shall be designed, constructed, operated and maintained so that within the notional boundary of any rural dwelling existing at the date of issue of consent, the sound level from the wind turbine generators shall not exceed the background sound level L_{95} by more than 5dBA, or a level of 40dBA L_{95}, whichever is the greater.

5.4 The measurement and assessment of noise effects from the wind turbines is to be conducted in accordance with NZ Standard NZS 6808:1998 Acoustics - The Assessment and Measurement of Sound from Wind Turbine Generators

Pre-Instalment Assessment

5.5 A Pre-Instalment Noise Assessment shall be prepared demonstrating that the intended numbers, layout and type of wind turbine generators to be utilised for the wind farm will result in the noise limits specified in

[2] A copy of the Environment Court decision is attached as Appendix B

condition 5.3 above being met. The Pre-Instalment Noise Assessment shall be prepared by an appropriately qualified acoustic consultant, and submitted to the Waikato District Council Environmental Services Group Manager for approval, prior to the installation of any wind turbine generator.

3 OPERATIONAL NOISE (NON-TURBINE)

There will be very few non-turbine related noise sources at the proposed wind farm; the only activity will be when staff members visit the site. The only other noise likely to be heard off site will be the turbines operating. The transformers will generate relatively low levels of noise with typical substation transformer noise being approximately 50dBA at 25m. As these transformers are well clear of all residential locations they will not be heard by the neighbours.

The only off-site noise would be from vehicle movements as operators' arrive and depart each day. The noise from these vehicles will be minimal although staff will be advised to drive in a responsible manner to minimise vehicle noise.

There may be occasions when it is necessary to undertake significant maintenance activities, which could include cranes and other heavy vehicles on site. This noise would be controlled by NZS 6803:1999 Acoustics – Construction Noise.

4 OPERATIONAL NOISE (TURBINES)

4.1 BACKGROUND INFORMATION

The successful operation of this wind farm is dependent on installing wind turbines that are within the predicted noise levels, the location of the turbines being as designed, the turbines being operated in accordance with the manufacturers design specifications and any other requirements that may be identified during compliance monitoring for day to day operations. This information forms the basis of the management of noise from the wind farm.

Siemens SWT-2.3-101 wind turbines that have a maximum power output of 2.3 MW and rotor diameter of 101m are being installed at the Te Uku site. In order to confirm that the noise output from these turbines will comply with the noise limits specified in condition 5.3, the noise levels have been predicted for these turbines using the sound power level information provided by Siemens. The levels predicted for the SWT-2.3-101 turbines are shown in Appendix C and the final wind farm layout is shown in Appendix D. The location of the houses where the noise levels have been predicted is shown in Appendix E.

The wind farm design limits have been determined by monitoring the existing noise environment before any wind farm construction work commenced to determine the existing background sound in accordance with the requirements of consent condition 5.3. The locations monitored have been managed by selecting the sites that are representative of the higher predicted noise levels and in some cases where specific noise requests for measurements have been made. No further monitoring of the existing noise environment is necessary to comply with the requirements of NZS6808.

Field measurements over a ten day period were undertaken at the houses expected to be the potentially most affected in each direction from the proposed wind farm. The location of these houses is shown on Figure 1.

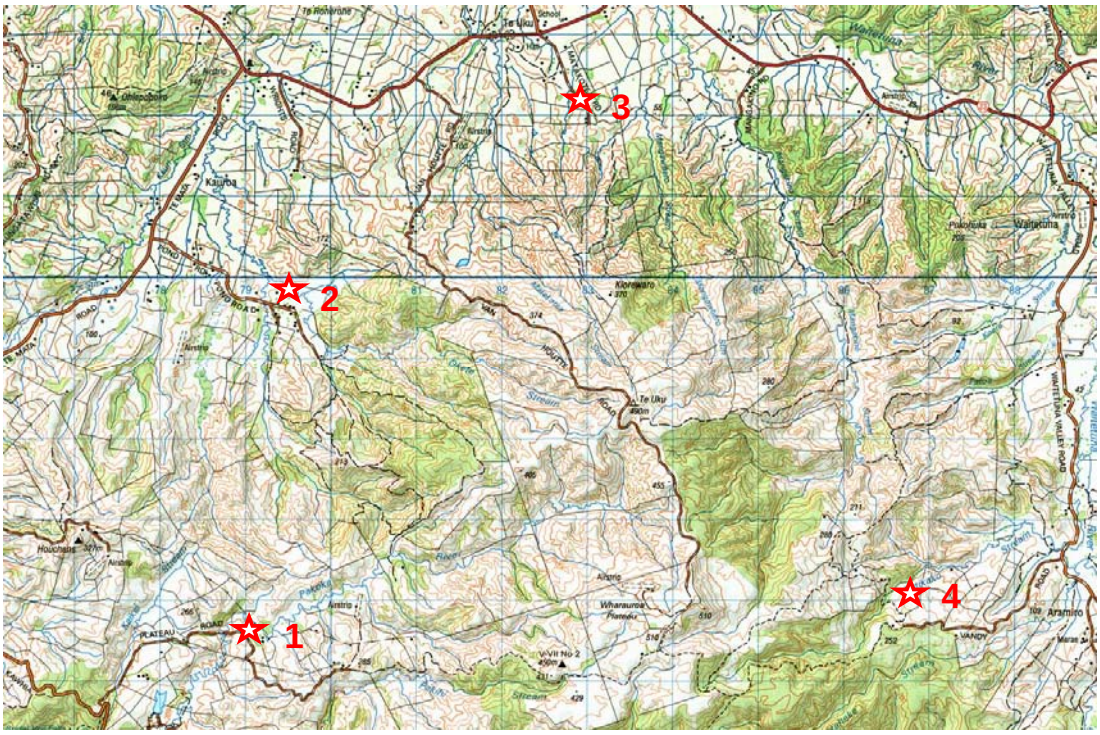


Figure 1. Background Noise Measurement Sites

In addition, measurements were undertaken at the following five sites, all of which are beyond the limits of the Map shown on Figure 1.

Site 5	371 Maungatawhiri Road, Raglan
Site 6	201 Ohautira Road, TeUku
Site 7	126 Waitetuna Valley Road
Site 8	103 Parker Access Road, Waitetuna
Site 9	821 Waitetuna Valley Road

4.2 MONITORING OF WIND FARM NOISE

As required by condition 5.4 of the consent conditions all monitoring will be undertaken in accordance with the requirements of *NZS6808:1998 Acoustics - The Assessment and Measurement of Sound from Wind Turbine Generators.*

4.3 ADDRESSING UNUSUAL EFFECTS OF MONITORING

When monitoring is undertaken there is always the potential for unusual events to occur, such as a low background sound at the dwelling but wind at the wind farm that generates noise in the wind turbines. This situation could result if a wind is blowing at the wind farm but the receiver location is screened from the wind for some reason which could result in a particularly low background sound when there is sufficient wind at the wind farm to generate noise. The audibility of the wind farm will depend on the wind speed and direction at the time and the background noise level at the receptor location.

To investigate this effect it is necessary to identify any periods when these conditions may occur and determine the level of the wind farm noise at these times. Examples of the management methods that will be in place to determine and investigate any such effects are set out below.

As set out above, the wind speed at the wind farm has already been measured and plotted against the noise levels received at the selected monitoring sites. Once operating, monitoring will be undertaken at the same sites and the background sound plotted against the wind speed again. From the monitoring undertaken before and after the wind farm development, the difference in the noise level is used to determine the contribution of noise from the wind farm. Any unusual differences will be reviewed and if necessary a real time noise trace, spectrum analysis and time varying effects will be measured to help identify the noise effects.

In order for the noise from turbines to have any potential effect for residents, even if there is no wind at the receiver position, there needs to be at least a 4m/s wind blowing, as the turbines do not generate power and hence noise at wind speeds below 4m/s as shown on Figure 2.

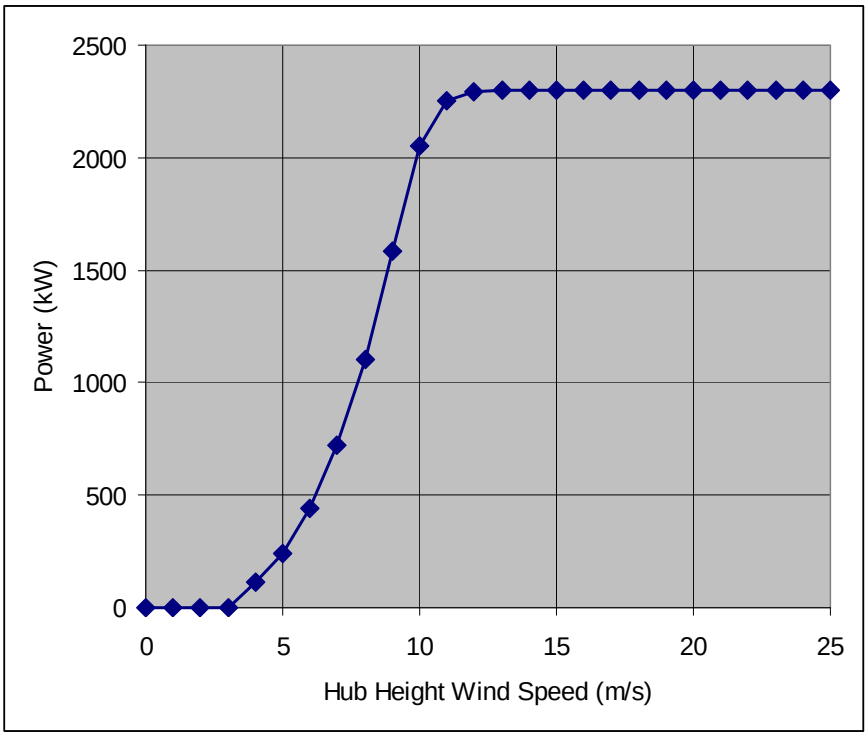


Figure 2. Siemens SWT-2.3 Power Curve

5 SPECIAL AUDIBLE CHARACTERISTICS

The above analysis only addresses the absolute noise level received. In addition, there is the potential of either a tonal component to the noise (as defined in NZS 6808:2010 Acoustics – Wind Farm Noise and given below) or the turbine noise modulation.

B4.3 Simplified test method for tonality

A test for the presence of a prominent discrete-frequency spectral component (tonality) can be made by comparing the levels of neighbouring one-third octave bands in the sound spectrum. An adjustment for tonality shall be applied if the L_{eq} in a one-third-octave band exceeds the arithmetic mean of the L_{eq} in both adjacent bands by more than the values given in table B2.

Table B2 - One-third octave band level differences

One-third octave band	Level difference
25 - 125 Hz	15 dB
160 - 400 Hz	8 dB
500 - 10000 Hz	5 dB
NOTE - At frequencies below 500Hz the criterion could be too severe and tones might be identified where none are actually audible. For complex spectra the method is often inadequate and the reference method should be used.	

B2.3 Reference test method

The reference method shall be that prescribed as Annex C to ISO 1996-2:2007 or an equivalent method.

CB2.3 An example of an alternative method is the DIN 45681 method.

When ordering the wind turbines the manufacturer advised the turbines would not generate any tonal component in terms of the requirements of NZS6808 that would attract a tonal penalty to the measured sound. Some attended spectral measurements will be made at receiver locations once the wind farm is fully commissioned to ensure there is no tonal component to the sound. Should a complaint be received about possible tonal character to the noise, this will be

checked at the receiver position of concern under the wind conditions considered to be applicable by the resident. The method that would be adopted is to undertake the analysis in terms of the Joint Nordic Method - Version 2 – 1999 as recommended in NZS6808:1998, Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators.

6 MODULATION NOISE

As set out in section *B3 Amplitude modulation* of NZS 6808:2010 Acoustics – Wind Farm Noise

> *B3.1 Assessment*
> *No appropriate objective test for amplitude modulation has been standardised. If a local authority enforcement officer or an acoustics advisor to a local authority considers that a wind farm creates sound with a clearly audible amplitude modulation at a noise sensitive location, an adjustment of +5 dB shall be applied to the wind farm sound level at that location for the wind conditions under which the modulation occurs.*
>
> *B3.2 Interim test method*
> *In making an assessment under B3.1, modulation special audible characteristics are deemed to exist if the measured A-weighted peak to trough levels exceeds 5 dB on a regularly varying basis, or if the measured third-octave band peak to trough levels exceeds 6 dB on a regular basis in respect of the blade pass frequency. Consideration should also be given to whether the sound of the modulation is reasonable under section 16 of the Resource Management Act.*

Any concern expressed about modulation would be investigated using noise monitoring equipment that allows the noise to be logged at 0.1 second intervals over a number of days if necessary. The results would be plotted along with the one third octave spectrum analysis, which would also be plotted if necessary. This would establish if there was any modulation to the sound under a full range of wind conditions. Modulation assessments will also be made at the time of any attended tonal measurements.

7 DE-RATING TURBINES

Field testing will be undertaken once the turbines have been commissioned to demonstrate that the turbines comply with the consent conditions. Noise predictions made for the wind farm show the greatest predicted levels at neighbouring properties to be 32dBA. Based on these predicted levels it is highly unlikely that the conditions of consent will be exceeded. In the unlikely event the wind farm noise limits are exceeded it is noted that the turbines being installed can be de-rated in a manner so as to reduce the noise levels.

De-rating the turbines can be achieved by programming them so under a predefined wind condition (wind speed and/or direction and time of day) the performance of a turbine is able to be controlled. This will allow any individual turbine noise to be controlled if necessary. Any such controls would be implemented automatically by the wind farm control system should the predefined conditions be present.

8 COMMUNITY INVOLVEMENT

Liaison with neighbours is an important aspect of minimising any concerns that may arise. Condition 11.6 of the consent states:

> *The consent holder shall use its best endeavours to ensure that meetings of the Community Liaison Group are held for the duration of the consent from the commencement of the consent:*
>
> *a) At least once every six months during the construction period; and*
>
> *b) At least annually pre and post the construction period (unless the Community Liaison Group determines that meetings should be held less frequently or are no longer required and advises the consent holder and Waikato District Council accordingly)*

Meridian Energy will further encourage dialog with interested parties to the consent, landowners, and Council staff to discuss any matter relating to the exercise of this resource consent

All residents are aware of (or will be made aware of) the telephone number for Meridian Energy should they wish to contact the company. In the event of any major changes (and none are envisaged) the immediate neighbours would be advised.

9 COMPLAINTS

Conditions 11.1 and 11.2 state:

> *The consent holder shall establish and publicise a local telephone number so that members of the public have a specified and known point of contact to raise any of the matters that may arise during the construction and operation of the wind farm.*
>
> *The consent holder shall maintain and keep a complaints register for any complaints about construction activities and operation of the wind farm received by the consent holder in relation to traffic, noise, dust, TV reception, or other environmental effects of the activity. The register shall record, where this information is available, the following:*
>
> *a) The date, time and duration of the incident that has resulted in a complaint;*
>
> *b) The location of the complainant when the incident was detected;*
>
> *c) The possible cause of the incident; and*
>
> *d) Any corrective action taken by the consent holder in response to the complaint, including timing of that corrective action.*
>
> *The complaints register shall be available to the consent holder and the community liaison group at all reasonable times on request. Complaints received by the consent holder that may infer non-compliance with the conditions of this consent shall be forwarded to the Waikato District Council Environmental Services Group Manager within 48 hours of the complaint being received.*

To minimise the potential of receiving complaints it is proposed to take a proactive role with the management of the wind farm. Once the wind farm has been commissioned it is proposed to:

- Undertake noise measurements at the closer dwellings where background monitoring was undertaken prior to constructing the wind farm;
- Establish wind farm sound level;

- Determine if wind farm broad band levels comply with conditions of consent;
- Undertake some selected attended tonal measurements and determine if there is tonal character to the sound;
- Provide a report on the status of noise compliance to Council;
- In the event of complaints, undertake further specific tonality tests and assessments of modulation;
- Assess whether any modifications need to be made to the wind farm operation. If so, measure wind farm under modified operational regime; and
- Provide final report on noise compliance status to Council.

In the event there is any noise complaints the above wind farm analysis will supply sufficient information to provide a basis for any further evaluation. The above work will enable any noise complaints to be initially evaluated and form part of the assessment in determining if the complaint is valid.

Any valid complaint will be addressed, the noise measured, including the sound spectrum if appropriate, and the outcome reported back to the complainant. Any necessary remedial work will be implemented as soon as practical and the resident kept informed on all steps being undertaken.

10 SUMMARY

Based on the existing noise environment as measured and the predicted wind turbine noise, the noise from the installation of the proposed turbines will comply with the resource consent conditions with a factor of safety.

The Noise Management Plan puts in place methods of addressing any noise issues and/or complaints that may arise in the future and how the community would be involved with any activity that may affect them.

The aim of Meridian Energy is to operate the wind farm so it will comply with the consent conditions at all times and avoid a noise nuisance for residents.

* * *

APPENDIX A
GLOSSARY OF TERMS USED

The following sets out an explanation of the acoustic terms that will be referred to throughout this report. The aim is not to necessarily provide technical definitions, but to enable a basic understanding of what is meant.

The setting of specific noise levels to control any adverse effects does not necessarily mean that noise will not be heard. Audibility depends on the level of a sound, the loudness of the background sound and any special frequency composition or characteristics that a sound may have.

Research suggests that a small number of people (approximately 10%) will find any noise not of their own making unacceptable. Conversely, there are approximately 25% of the population that are essentially immune to any noise. Neither of these two extremes is normally designed for. In establishing the appropriate noise levels the aim is to try and represent the typical expected community reaction, this will generally be approximately 90% of the people.

In order to reflect community response to noise it is necessary to establish a measure that reflects our attitude to the sounds that we hear. Due to the variability of many sounds (level, tone, duration, intrusiveness above the existing sound, etc) no single descriptor will totally describe the potential community reaction to a sound. For this reason there are a number of terms that need to be understood.

dBA

The basic unit to quantify a sound is the decibel. The A-weighted sound level, or dBA, is a good environmental noise descriptor because of the similarity between A-weighting and the frequency response of the human ear at moderate sound levels. It can also be measured easily. However, it provides no indication of tonal frequency components or unusual frequency distributions of sound that may be the cause of annoyance. Where appropriate, this must be assessed separately.

We can hear a change in sound pressure that varies from 1 (taken as the threshold of hearing) through to 1,000,000,000,000 (taken as the threshold of pain). In order to bring these numbers to a more manageable size a logarithmic scale is normally adopted. This reduces the above values to 0 and 12 respectively. The decibel is then described as 10 times the logarithm of the ratio of the pressure level of interest, to a reference pressure level. Thus the scale becomes 0 to 120dBA.

Some typical subjective changes in noise levels are:

A change of 3dBA is just perceptible
A change of 5dBA is clearly perceptible
A change of 10dBA is twice (or half) as loud

Because we use a logarithmic scale care must be taken when adding sound levels. Two equal noise sources raises the level of one source by 3dBA. It takes 10 equal noise sources to raise the level of one source by 10dBA. ie 60dBA + 60dBA = 63dBA and 60dBA x 10 = 70dBA.

Maximum Sound Level (L_{max})

This unit equates to the highest (maximum) sound level for a defined measurement period. It is adopted in NZS6802:1991 Assessment of Environmental Sound, mainly as a method of protecting sleep.

L_{10}

The sound level which is equaled or exceeded for 10% of the measurement time. This level is adopted in NZS6802:1991 Assessment of Environmental Sound to measure intrusive sound. This level may be considered as the average maximum sound level.

Background Sound L_{95}

The sound level which is equaled or exceeded for 95% of the measurement time. This level is adopted in NZS6802:1991 Assessment of Environmental Sound to measure the background sound. This level may be considered as the average

minimum sound level and is the component of sound that subjectively is perceived as continuously present.

Equivalent Sound Level (L_{eq})

The L_{eq} may be considered as the continuous steady noise level that would have the same total A-weighted acoustic energy as a fluctuating noise over the same time period.

Day Night Level, L_{dn}

The day/night level (L_{dn}) is defined as the time-average sound level in decibels (re 20μPa) over a 24 hour period from midnight to midnight) with the addition of 10dB to nighttime levels during the period from midnight to 07.00 hours and from 22.00 hours to midnight, to take account of the increased annoyance caused by noise at night.

Ambient Sound

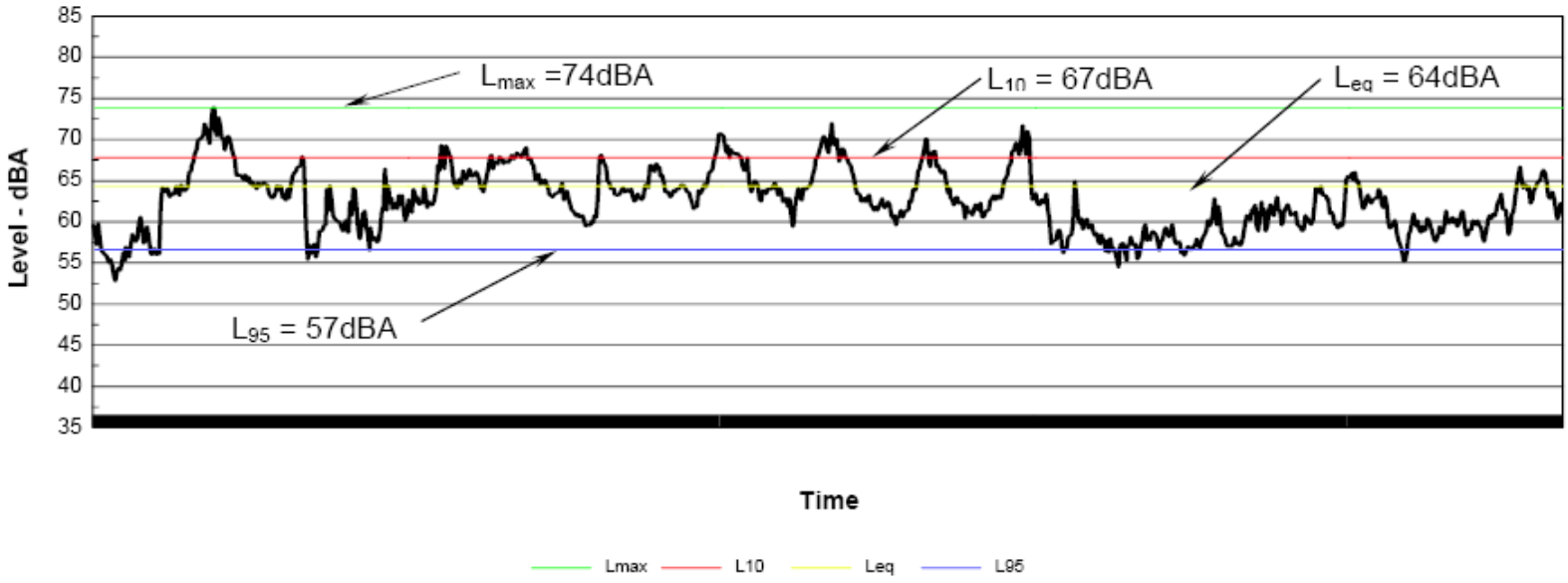
The ambient sound is normally used to describe the total noise environment. The ambient sound is often measured as the 24 hour $L_{eq,}$ which is an average value over the 24 hour period. Shorter times are often used, such as the daytime period

Notional Boundary

The notional boundary is defined as a line 20 metres from the facade of any rural dwelling or the legal boundary where this is closer to the dwelling.

Figure A1 shows a noise trace with the relationship of L_{max}, L_{10}, L_{95} and L_{eq} values when including all events over the 15 minute measurement period and Figure A2 some typical noise levels.

* * *



L_{max} is the maximum noise level
L_{10} is the noise level that is equaled or exceeded for 10% of the measurement period
L_{95} is the noise level that is equaled or exceeded for 95% of the measurement period
L_{eq} is the noise level that contains the same energy as the time varying noise

Figure A1

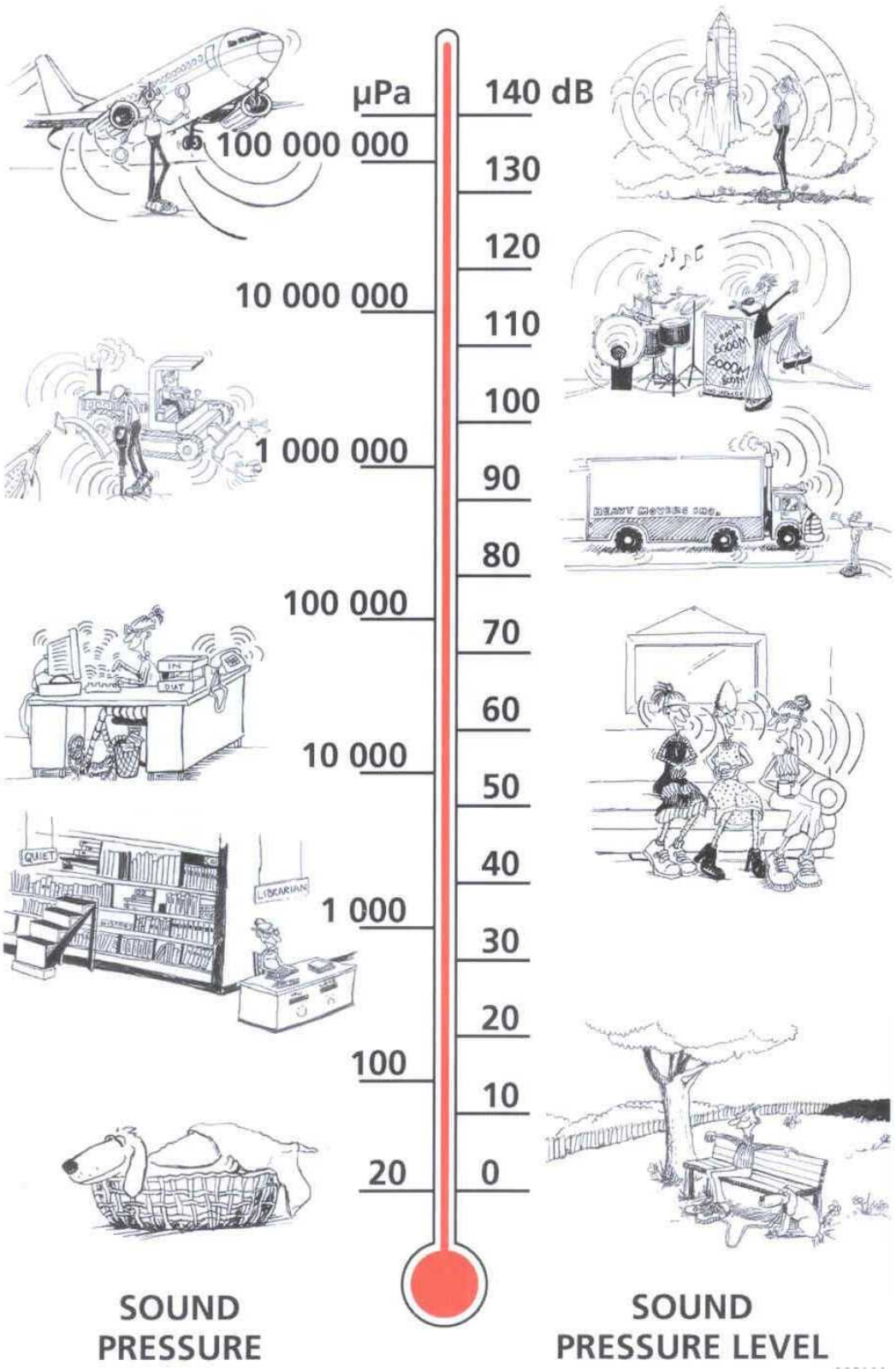

μPa
140 dB
100 000 000
130
120
10 000 000
110
100
1 000 000
90
80
100 000
70
60
10 000
50
40
1 000
30
20
100
10
20
0
QUIET
LIBRARIAN
IN
OUT
SOUND
PRESSURE
SOUND
PRESSURE LEVEL

Figure A2

APPENDIX B

ENVIRONMENT COURT DECISION

APPENDIX C

PREDICTED NOISE LEVELS, dBA L_{10}

House	Level	House	Level	House	Level
1	25	41	27	81	24
2	24	42	27	82	29
3	25	43	26	83	24
4	26	44	26	84	28
5	26	45	26	85	30
6	24	46	26	86	23
7	24	47	26	87	30
8	23	48	28	88	26
9	23	49	28	89	24
10	23	50	27	90	22
11	23	51	29	91	21
12	23	52	29	92	24
13	23	53	27	93	25
14	23	54	28	94	22
15	24	55	27	95	20
16	23	56	27	96	15
17	24	57	25	97	17
18	24	58	25	98	21
19	24	59	27	99	21
20	24	60	27	100	22
21	24	61	28	101	21
22	24	62	28	102	24
23	24	63	24	103	24
24	24	64	27	104	23
25	24	65	25	105	21
26	24	66	25	106	21
27	24	67	25	107	24
28	25	68	27	108	24
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30	27	70	27	110	25
31	27	71	26	111	23
32	26	72	26	112	23
33	26	73	28	113	27
34	26	74	28	114	26
35	25	75	30	115	27
36	25	76	30	116	27
37	25	77	30	117	24
38	25	78	30	118	22
39	25	79	29	119	11
40	26	80	31	120	24

House	Level	House	Level	House	Level
121	25	163	30	205	29
122	26	164	30	206	30
123	27	165	30	207	30
124	25	166	29	208	29
125	26	167	29	209	30
126	28	168	29	210	31
127	28	169	30	211	31
128	28	170	30	212	27
129	28	171	32	213	27
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159	27	201	31	243	29
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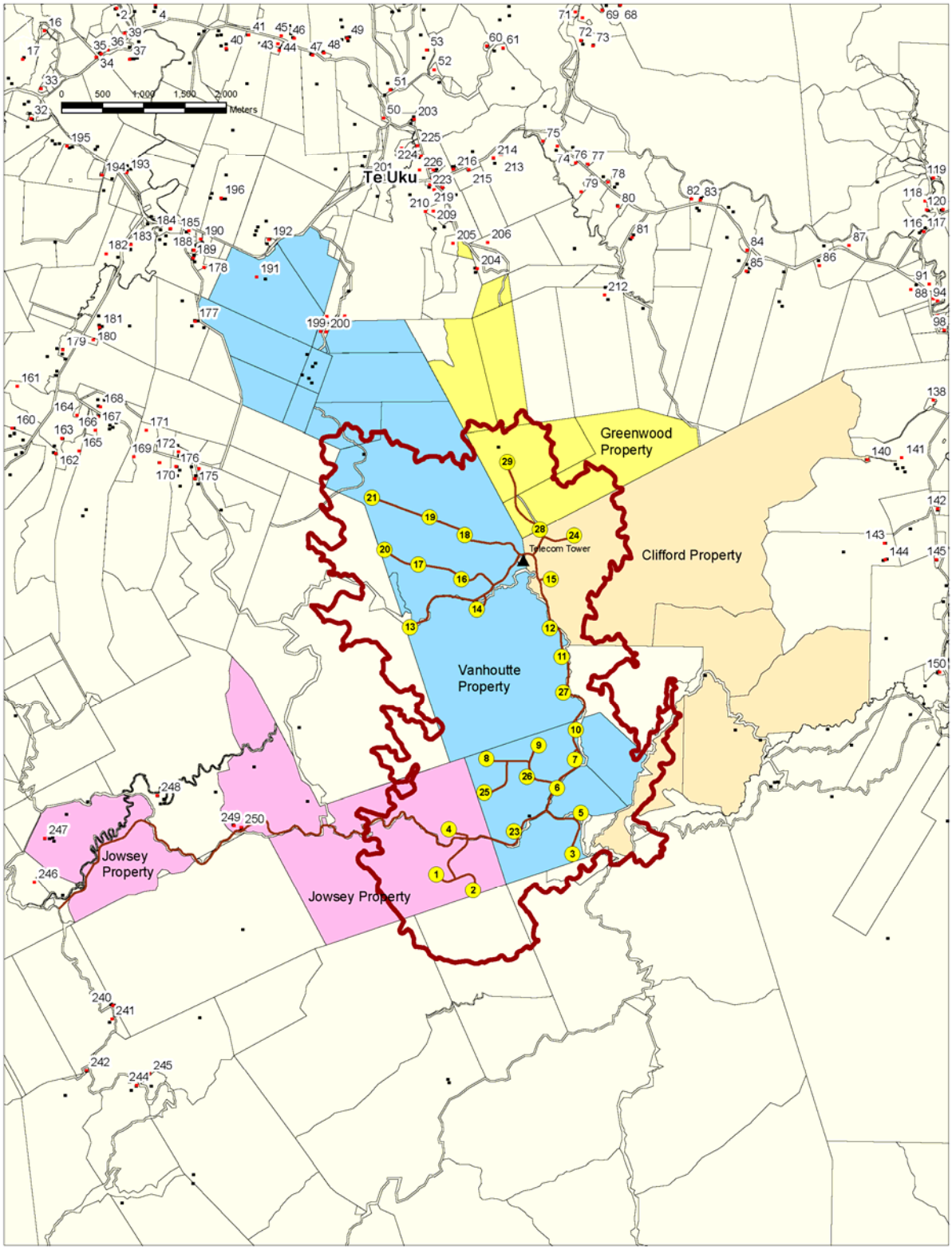
161	29	203	30	245	29
162	29	204	28	246	30

APPENDIX D

LOCATION OF DWELLINGS



APPENDIX E

LOCATION OF WIND TURBINES