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IN THE MATTER of the Victorian Civil &
Administrative Tribunal Planning
List Reference No. 3249/2010

STATEMENT OF EVIDENCE CHRISTOPHE FREDERIC DELAIRE

1.0 INTRODUCTION

- 1.1 My name is CHRISTOPHE FREDERIC DELAIRE. I am an Associate in the acoustical consulting practice of Marshall Day Acoustics Pty Ltd. I hold a Masters Degree in Engineering from Ecole Supérieure d'Ingénieurs de Poitiers (France). For over 8 years I have worked in the field of acoustics and noise control. My curriculum vitae is attached in Appendix A.
- 1.2 My company, Marshall Day Acoustics, was commissioned by Future Energy Pty Ltd to prepare a noise impact assessment for the proposed Chepstowe Wind Farm to be located west of Ballarat, Victoria. In preparing this evidence, I have reviewed relevant documentation and performed acoustic calculations.
- 1.3 The noise impact assessment was presented in a letter to Future Energy dated 6 October 2010. I confirm that I am the author of this letter, attached in Appendix B, and I adopt the findings and contents of this letter as evidence for submission to the Tribunal.

2.0 PROPOSED PERMIT CONDITIONS

- 2.1 I have reviewed recent planning permit conditions and propose a set of noise related conditions presented in Appendix C. These are based on the Crowlands Wind Farm planning permit, issued on 18 August 2010 (based on a Panel Report dated 18 June 2008) and a paper I presented to the International; Wind Turbine Noise Conference held in Lyon (France) in 2007.

3.0 SUMMARY

- 3.1 The Chepstowe Wind Farm is proposed to consist of three (3) wind turbines.
- 3.2 The nearest non-stakeholder properties are located approximately 1.1km and 2km from the nearest turbine. It is my understanding that the closest property is derelict.
- 3.3 The nearest stakeholder property is located approximately 900m away from the nearest wind turbine.
- 3.4 A noise impact assessment was undertaken in accordance with the New Zealand Standard 6808:1998 – *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS6808:1998), as required by *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria 2009* (Victorian Wind Energy Guidelines).
- 3.5 It was found that noise emissions from the proposed Chepstowe Wind Farm at all neighbouring properties comply with the lowest possible NZS6808:1998 noise limit of 40dBA at all wind speeds.

SUMMARY OF EXPERIENCE AND PROJECT DETAILS

NAME AND ADDRESS

My name is CHRISTOPHE FREDERIC DELAIRE. I am a Senior Consultant with the acoustic consulting practice of Marshall Day Acoustics Pty Ltd which is located at 6 Gipps Street, Collingwood, 3066.

QUALIFICATIONS AND EXPERTISE

I hold a Masters Degree in Engineering from Ecole Superieure d'Ingenieurs de Poitiers. (France). My curriculum vitae is attached.

AREA OF EXPERTISE

For over 8 years I have worked in the field of acoustics and noise control.

EXPERTISE TO PREPARE THIS REPORT

I have been involved in environmental impact assessments for major projects such as roads, retail developments, wind farms and small developments such as restaurants, residential apartments, service stations, convenience stores, manual car wash developments and night clubs.

INSTRUCTIONS WHICH DEFINED THE SCOPE OF THIS REPORT

I have been commissioned by Future Energy Pty Ltd to assess the noise impact of the proposed Chepstowe Wind Farm.

FACTS, MATTERS AND ASSUMPTIONS RELIED UPON

In the course of my investigations I have:

- Visited the site
- Performed acoustic calculations
- Reviewed relevant documents
- Prepared a letter presenting our findings
- Prepared the statement of evidence.

DOCUMENTS TAKEN INTO ACCOUNT

The following documents have been used for reference:

- *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* (September 2009)
- New Zealand Standard 6808:1998 – *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS6808:1998)
- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS6808:2010)
- Australian Standard 4959:2010 *Acoustics—Measurement, prediction and assessment of noise from wind turbine generators* (AS4959:2010)
- ISO Standard 9613-1:1993 *Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere* (ISO9613-1:1993)
- ISO Standard 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method for calculation* (ISO9613-2:1996)
- Wind turbine sound power level data:
 - WINDTEST Report WT4993/06 dated 6 March 2006
 - REpower document SD-2.9-WT.PC.03-B-B-EN *Power Curve & Sound Power Level REpower MM92 [2050kW]* dated 11 May 2009
- The decision of the Victorian Civil and Administrative Tribunal (VCAT) in the case of *The Sisters Wind Farm Pty Ltd v Moyne SC [2010] VCAT 719* (the Sisters decision) dated 27 April 2010
- EPA Guidelines EPA publication N3/89 *Interim guidelines for control of noise from industry in country Victoria*
- EPA Publication 1316 *Noise from industry in regional Victoria* (NIRV).

SUMMARY OF OPINIONS

A summary of opinions is provided in Section 3.0 of the statement of evidence.

DECLARATION

I have made all the inquiries that I believe are desirable and appropriate and confirm that no matters of significance which I regard as relevant have to my knowledge been withheld from the Tribunal.



Christophe Delaire
Associate

Marshall Day Acoustics
6 Gipps Street
Collingwood Vic 3066

28 January 2011

APPENDIX A

CURRICULUM VITAE – CHRISTOPHE DELAIRE

Name: Christophe Frederic Delaire

Address: 6 Gipps Street,
Collingwood, Victoria, 3066
Australia

Qualifications:
Dipl.Ing. (France) Masters Degree in Engineering
Ecole Supérieure d'Ingénieurs de Poitiers (France)

Experience:
2002 - Present Consultant, Marshall Day Acoustics, Melbourne,
Australia.
Consultants in acoustics and noise control.

Responsibilities include consulting work in
environmental noise impact (including wind farms),
industrial noise control, building services noise control,
architectural sound insulation.

2001 Marshall Day Acoustics, Melbourne, Australia.
(Vacation Employment) Consultants in acoustics and
noise control.

APPENDIX B

LETTER TO FUTURE ENERGY DATED 6 OCTOBER 2010

6 October 2010

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Future Energy Pty Ltd
PO Box 2007
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Attention: Mr Severin Staalesen

Dear Sirs,

CHEPSTOWE WIND FARM
RESPONSE TO COUNCIL'S QUERIES

1.0 INTRODUCTION

Marshall Day Acoustics Pty Ltd (MDA) has undertaken a noise impact assessment of the proposed Chepstowe Wind Farm in accordance with the New Zealand Standard 6808:1998 – *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS6808:1998), as required by *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria 2009* (Victorian Wind Energy Guidelines).

We prepared a brief summary of the results of a noise impact assessment of the proposed Chepstowe Wind Farm, as presented in our memorandum Mm001 R03 2007199 dated 22 March 2010. Further to this memorandum Future Energy Pty Ltd has received queries from the Pyrenees Shire Council, and a noise report prepared by Noise Measurement Services Pty Ltd (NMS) for the Council, regarding the application documents.

We provide herein a more detailed summary of our noise impact assessment which also incorporates a number of recent revisions to the proposed wind farm design. We also address the key items raised by the NMS report.

2.0 SITE DESCRIPTION

The proposed Chepstowe Wind Farm is located in the vicinity of the township of Chepstowe in Victoria. The wind farm is proposed to consist of three (3) REpower MM92 2MW wind turbines.

Since the issue of our memo dated 22 March 2010, the turbine layout has been revised. The current proposed wind turbine locations are presented in Table 1. The proposed layout is presented in Appendix A.

Table 1
Wind turbine locations (MGA94 H54)

Turbine No.	Easting	Northing
1	720081	5836013
2	720375	5836265
3	720472	5835876

Two (2) residential properties are located within 2km of the proposed wind turbines. It is our understanding that one of these two dwellings (House 11) is derelict and the other (House 12) is owned by stakeholder in the project.

A third dwelling (House 76) is located just over 2km away from the nearest proposed wind turbine. This dwelling is the nearest non-stakeholder property to the proposed Chepstowe Wind Farm and has been included within this assessment.

The locations of these three (3) assessed properties are presented in Table 2.

Table 2
Assessed residential properties (MGA94 H54)

House No.	Easting	Northing	Distance from the nearest wind turbine
11 (D)	721338	5836823	1116m
12 (S)	720582	5837128	891m
76	720426	5833836	2041m

Note: (S) stakeholder property
(D) derelict dwelling

3.0 METHODOLOGY

3.1 Noise prediction method

The following equation from Section 4.3.3 of NZS6808:1998 is used to calculate sound pressure levels at residential sites:

$$L_R = L_w - 10 \log(2\pi R^2) - \Delta L_A \quad \text{Equation (1)}$$

where:

L_R = the sound pressure level from a single wind turbine at 1.2m to 1.5m above local ground level in dBA at distance R

L_w = the sound power of the wind turbine at wind speeds referenced at 80m above ground level (AGL) in dBA. Measured according to IEC 61400 *Wind turbine generators systems – Part 11: Acoustic noise measurement techniques* (IEC61400-11:2006).

R = the distance between source and receiver in metres

$\Delta L_A = \alpha_a R$

α_a = attenuation of sound due to air absorption, in dBA/m for broadband sound.

As stated in Section 4.3.3 of NZS6808:1998, it is generally accepted that Equation 1 is slightly conservative (i.e., over-prediction of the sound levels) and we note that it is the same as that used in IEC 61400-11:2006. Section 4.3.3 states:

Equation 1 is based upon hemispherical spreading of the sound from the source and does not take into account attenuation due to screening effects, i.e. where there is no line of sight between the WTG and receiver locations. Acoustic absorption and reflection effects due to vegetation and ground cover are also ignored. The sound level (L_w) predicted at a distance (R) is that at 1.2m – 1.5m above the local ground level, which is assumed non-reflective. Thus, a good estimate can be derived when predicting sound propagation through free space (e.g. across open gullies), and a conservative estimate (i.e. over-prediction), for propagation across flat locations where ground absorption may be significant. For instances where the WTG is not in line of sight from the observation point, there may be an additional attenuation of up to 12dBA. The degree of attenuation will depend upon a number of factors influencing the direct and indirect sound paths between source and receivers.

The determination of uncertainties is not discussed within NZS6808:1998.

3.2 Air absorption

The prediction method outlined in NZS6808:1998, does not consider the spectral content of the wind turbine noise emissions. Spectral content can be important as different wind turbine models emit noise with different amounts of low and high frequency content. Low frequency sound attenuates at a relatively slow rate in air; hence the typical atmospheric absorption coefficient of 0.005dBA/m (5dBA/km) proposed in NZS6808:1998 may, at times, be too great.

For this reason, octave band sound power levels together with the appropriate air absorption coefficient for each octave band, in accordance with ISO9613-1 *Acoustics – Attenuation of sound during propagation outdoors, Part 1: Calculation of the absorption of sound by the atmosphere* (ISO9613-1:1993), have been used to predict noise emissions from the selected wind turbines more accurately. The octave band absorption coefficients used are presented in Table 3.

Table 3
ISO9613-1:1993 air absorption coefficients

Description	Octave band mid frequency								Hz
	63	125	250	500	1k	2k	4k	8k	
Air absorption coefficient	0.12	0.40	1.09	2.11	3.79	9.16	29.91	107.84	dBA/km

The above coefficients have been calculated based on air temperature, air humidity and atmospheric pressure values provided in the Australian Standard 4959:2010 *Acoustics—Measurement, prediction and assessment of noise from wind turbine generators* (AS4959:2010).

The following values have been used:

- air temperature: 15°C
- air humidity: 70%
- atmospheric pressure: 101.325kPa

It should be noted that the noise predictions presented in our memo dated 22 March 2010 were based on an air absorption coefficient of 3dBA/km which is independent of the spectral content of the proposed wind turbine.

3.3 Sound power levels

Since the issue of our previous noise assessment, REpower have provided revised guaranteed sound power level data for the MM92 2MW wind turbine. The revised data has been provided to us in a REpower document SD-2.9-WT.PC.03-B-B-EN *Power Curve & Sound Power Level REpower MM92 [2050kW]* dated 11 May 2009. The revised sound power levels are provided in Figure 1.

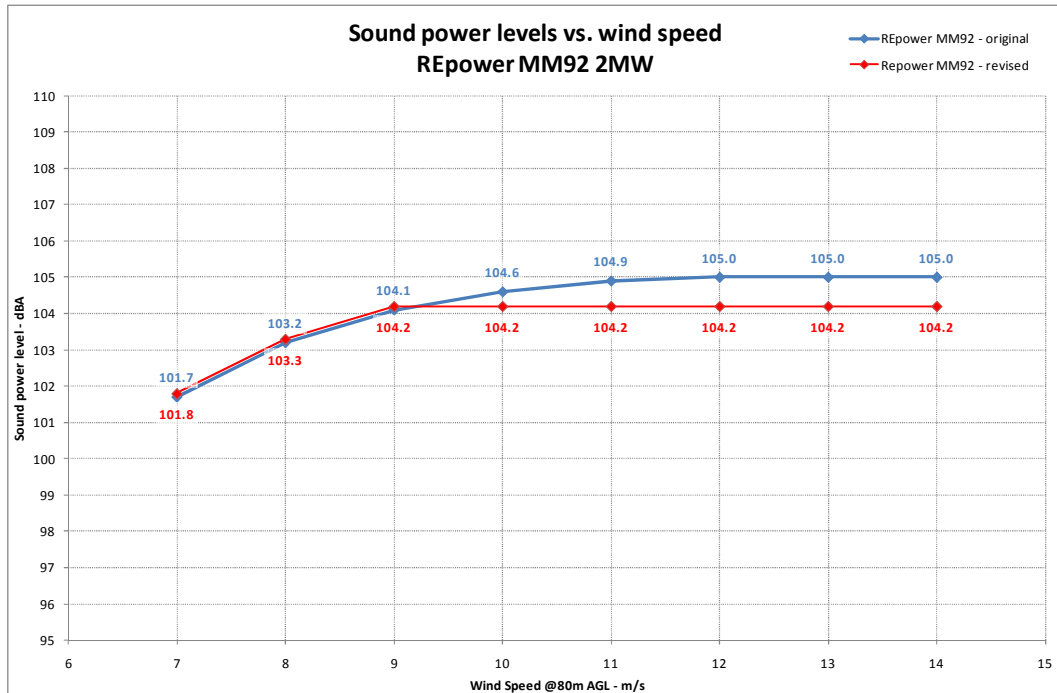


Figure 1: REpower MM92 2MW sound power levels

Octave band sound power data has been provided from independent test report No WT4993/06 dated 6 March 2006 prepared by WINDTEST Kaiser-Wilhelm-Koog GmbH. The test was carried out at the Saint Michaelisdonn Wind Farm in Germany. The reference octave band sound power spectrum of the selected wind turbine is presented in Figure 2.

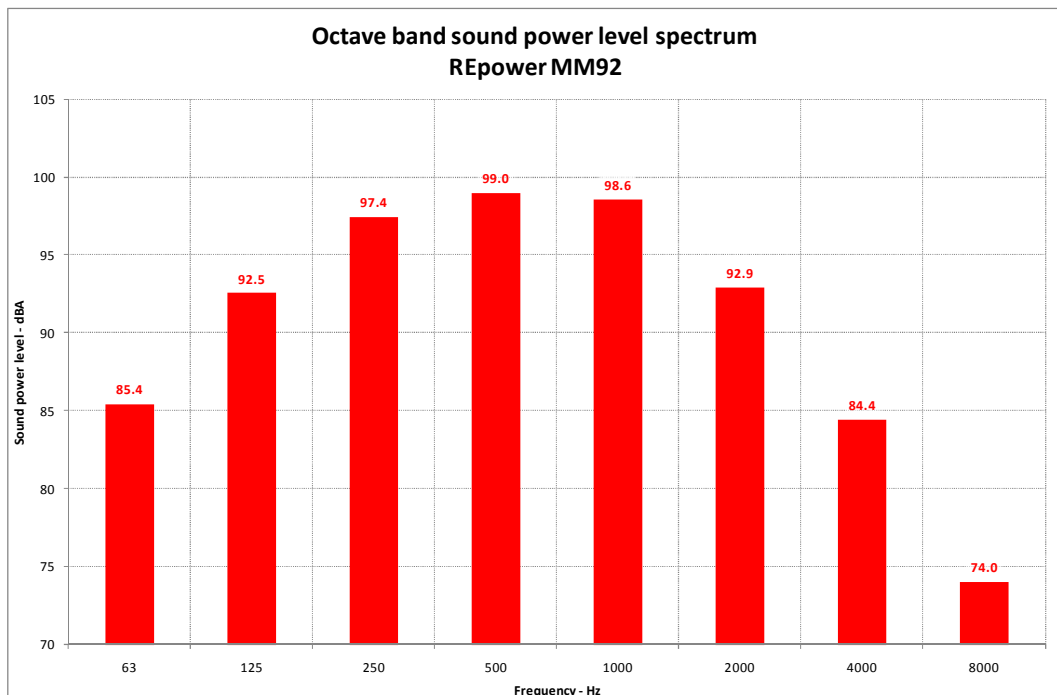


Figure 2: Reference octave band sound power level spectrum

3.4 Background noise monitoring

NZS6808:1998 standard states that the noise level from a wind turbine generator or wind farm at a residential site should not exceed the background noise level (L_{A95}) by more than 5dBA or a level of 40dBA L_{A95} , whichever is greater. Limits can therefore be set using these criteria based on noise measurements of existing ambient levels at a range of wind speeds. .

For the Chepstowe Wind Farm it is proposed that the lowest possible NZS6808:1998 noise limit, 40dBA, is applied to residential properties in the vicinity of the wind farm. This limit is not dependant on background noise levels and, accordingly, background noise monitoring is not required for the establishment of noise limits.

It is noted that background noise level measurements should be undertaken prior to construction of the proposed wind farm as they are required in order to carryout a post-construction noise assessment in accordance with NZS6808:1998.

3.5 Stable air effects and impulsiveness

In 2003, Dr van den Berg undertook a study of the Rhede Wind Park located in the north-west of Germany near the Dutch border. His study set out to explain occurrences of wind park noise emission which were higher than had been expected during the planning phase. The study also included a limited investigation into complaints from adjacent residences of a modulation or impulsive character to the noise emissions during night time hours. He presented his findings in a paper entitled ***Effects of the wind profile at night on wind turbine sound*** published in the ***Journal of sound and Vibration 277 (2004)***.

The results of this study are commonly, and somewhat confusingly, referred to as the "van den Berg effect". We consider that van den Berg's paper addressed two, distinct issues, namely: stable air effects, and; impulsiveness.

With regard to stable air effects, Dr van den Berg found that during periods where the air was highly stable noise emissions from the wind farm increased significantly. During stable air conditions the velocity profile may change. For example, for a given wind speed at 10m AGL the wind speed at hub height may be relatively higher and the wind speed nearer to the ground may be relatively lower than would typically occur. This would in turn cause relatively higher turbine SWLs while, concurrently, the background noise levels at adjacent properties may be relatively lower due to a reduction in wind generated noise from surrounding vegetation, etc. In these circumstances, wind farm noise emission could be more noticeable.

We consider that where a noise assessment uses wind speed data collected at or near the proposed hub height, any potential stable air effects will be better represented in the assessment process.

The predicted noise emissions of the Chepstowe Wind Farm have been referenced to hub height wind speeds. This will reduce the potential effects of air stability on predicted noise levels.

With regard to impulsive character in wind turbine noise emission, van den Berg observed that, on occasion, noise emission from the wind park at selected receivers demonstrated an impulsive character. It was conjectured that this was due to the modulating pattern of noise emission from the nearest cluster of turbines, which operated at approximately the same rotational speed but with the blades being appropriately out-of-phase.

Discussion

It should be noted that the study of the Rhede Wind Park inherently addressed site specific issues including topography and wind turbine type. In particular, around the Rhede Wind Park, stable air most commonly occurred during the night-time hours during summer months. We consider it possible that for an alternative site with different site topography, weather conditions and possibly turbine types, stable air effects and impulsive noise emission may either not significantly affect noise emission or not occur regularly enough to cause significant concern. We are presently not aware of any other published papers which have demonstrated Dr van den Berg's findings at other wind farms.

A recent review of van den Berg's research prepared for the Ontario Ministry of the Environment¹ highlighted the lack of solid scientific data to support the conjecture that stable atmosphere can lead to increased wind turbine noise emission during night-time due to higher than expected hub height wind speeds. Concerning impulsiveness, which is described in this paper as amplitude modulation, it is noted that “***...no strong evidence was provided to show the modulations get worse at night compared to daytime in the summer.***” However, the concluding remarks of this report noted that van den Berg's research should be considered “***as the catalyst that started serious discussion on many aspects of wind farm noise***”.

Given the current state of published information regarding both stable air effects and impulsiveness, we do not consider it appropriate to directly assess either effect as part of the pre-construction planning process. It is considered that, should either effect be present once the wind farm is operational then, measures may be taken to control them.

3.6 Special audible characteristics

NZS6808:1998 requires that 5dBA be added to noise levels from wind turbines with ***known*** special audible characteristics. One of the possible known special audible characteristics is tonality, assessed in accordance with IEC 61400-11 ***Wind turbine generator systems – Part 11: Acoustic noise measurement techniques***. Tonality may be assessed based on information provided by the turbine manufacturer and this data should be provided for review prior to construction of the wind farm.

If any potential special audible characteristics are observed during the operation of the wind farm, an assessment may be carried out during a post-construction noise monitoring program.

¹ Ramani Ramakrishnan – ***Wind turbine facilities noise issues***, Aiolos Report Number: 4071/2180/AR155Rev3 Dec 2007

3.7 Low Frequency Noise and Infrasound

Definition

Although there can be variations between individuals, it is generally accepted that frequencies between 20Hz and 20kHz are audible by humans.

Low frequency noise is generally considered to span between 20Hz and 100Hz and so may be regarded as being within the audible range.

Sound in the frequency range below 20Hz is commonly referred to as infrasound. Despite the inference by the term itself, infrasound can be audible. A Department of Trade and Industry (DTI UK) report *The measurement of low frequency noise at three UK wind farms*² notes that “... frequencies down to a few hertz are audible at high enough levels”. This is also reflected in the introduction to the German standard DIN45680 *Measurement and assessment of low-frequency noise emissions in the neighbourhood* which notes

At frequencies under 20 Hz (infrasound), there is no pronounced auditory sensation because pitch is no longer perceived. Nevertheless, infrasound is not completely inaudible...

Infrasound, perception and annoyance

Human perception of sound energy in the infrasound frequency range is much less acute than other frequency bands. Significant energy is required to produce levels of infrasound which are high enough to be perceived by humans.

However, once low frequency noise or infrasound is perceived, changes in the sound level are more readily observed. Leventhall³ states that an increase in low frequency noise of 5dB can subjectively be perceived as a doubling in loudness. This contrasts with sound at mid and high frequencies where a doubling in loudness is normally associated with a 10dB increase in sound level.

Sources

Infrasound is created by a wide range of different sources including heavy industrial equipment and motor vehicles. Infrasound is also naturally occurring in the environment as a result of meteorological effects such as wind, thunder or ocean waves⁴.

² Department of Trade and Industry 2006, *The measurement of low frequency noise at three UK wind farms* (W/45/00656/00/00), Department of Trade and Industry, United Kingdom

³ Leventhall, G. (2003) *A review of published research on low frequency noise and its effects*. Department for Environment, Food and Rural Affairs, London, United Kingdom.

⁴ Leventhall, G. *Infrasound from Wind Turbines – Fact, Fiction or Deception*, Canadian Acoustics, Vol. 34 No.2 (2006)

Wind industry context

An Acoustics Bulletin article ***Agreement about relevant factors for noise assessment from wind energy projects***⁵ published in March–April 2009 comments as follows:

A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field.

3.8 Assessment of low frequency noise and infrasound in NZS6808:1998

NZS6808:1998 is not designed to assess wind farm noise emissions beyond the audible frequency range. Hence it does not include a methodology to assess low frequency noise and infrasound. In particular, the scope of this Standard includes the following comments:

Reference to overseas studies on infrasound reveals that:

(a) Sound spectra for modern WTGs [Wind Turbine Generators] indicate that compliance with the limits in this Standard (clause 4.4.2) will ensure that infrasound pressure levels will be well below the threshold of perception.

(b) Any potential adverse effect of infrasound would occur at levels greater than the threshold of perception...

Special audible characteristics

Low frequency noise and infrasound can be considered as special audible characteristics. Based on the comments detailed above in Section 3.7 it is not expected that either low frequency noise or infrasound are likely to be problematic and, therefore, that a penalty for special audible characteristics should not apply. In the case of either characteristic being demonstrated as part of the noise emission from a wind farm, a 5dBA penalty would apply.

⁵ Leventhall, G., Bullmore, A., Jiggins, M., Hayes, M., McKenzie, A., Bowdler, D & Davis, B 2009, 'Prediction and assessment of wind turbine noise – Agreement about relevant factors for noise assessment from wind energy projects', *Acoustics Bulletin*, March–April 2009, pp35–37.

4.0 NOISE PREDICTIONS

Noise emissions from the proposed Chepstowe Wind Farm at the assessed dwellings have been predicted in accordance with NZS6808:1998 and compliance with the lowest possible NZS6808:1998 noise limits has been assessed. These predictions are presented in Figure 3.

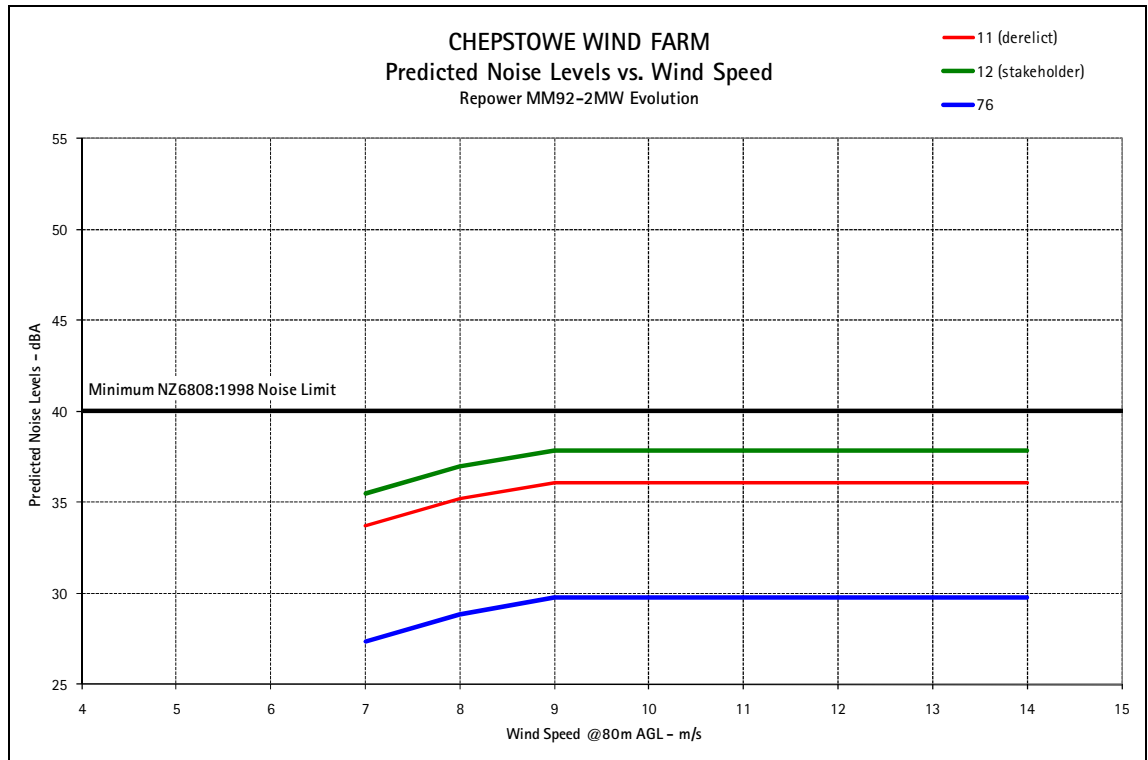


Figure 3: Predicted NZS6808:1998 noise emissions

It can be seen from Figure 3 that noise emissions from the proposed Chepstowe Wind Farm at all three (3) assessed residential properties will comply with the lowest possible NZS6808:1998 noise limits at all wind speeds.

Furthermore, noise emissions from the proposed Chepstowe Wind Farm at all non assessed residential properties are predicted to be below 28dBA and will therefore comfortably comply with the lowest possible NZS6808:1998 noise limits, 40dBA, at all wind speeds.

A noise contour map of predicted noise emissions from the proposed Chepstowe Wind Farm in accordance with NZS6808:1998 is presented in Appendix B.

5.0 CUMULATIVE IMPACT

It is our understanding that the Pyrenees Shire Council has raised concern regarding the potential cumulative noise impact from the proposed Chepstowe Wind Farm combined with the proposed Stockyard Hill Wind Farm. The Stockyard Hill Wind Farm is proposed to be located to the west and south-west of the Chepstowe Wind Farm. An extract of a map provided by the Department of Planning and Community development, showing the location of the proposed Stockyard Hill Wind Farm in relation to the proposed Chepstowe Wind Farm, is presented in Figure 4.

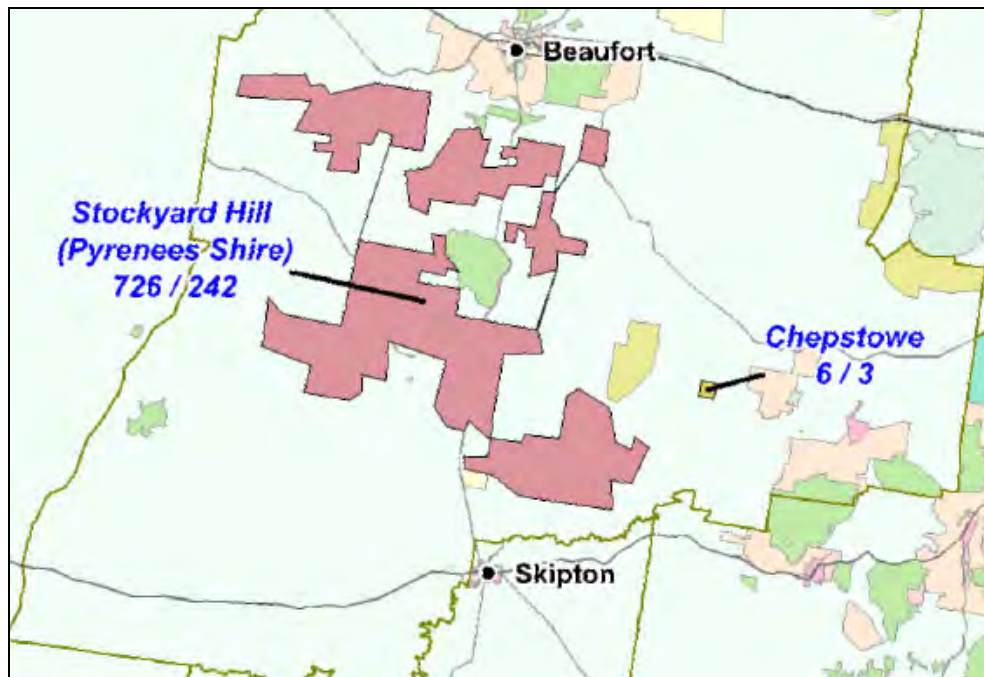


Figure 4: Location of Stockyard Hill Wind Farm and Chepstowe Wind Farm

The nearest wind turbine of the proposed Stockyard Hill Wind Farm is located approximately 5.5km to the south west of the nearest wind turbine from the proposed Chepstowe Wind Farm.

We have sourced details of the Stockyard Hill Wind Farm from the noise impact assessment report (MDA report No. 001 R05 2008222 titled *Stockyard Hill Wind Farm - Noise Impact Assessment* dated 8 July 2009) submitted with the planning permit application presented to a panel hearing earlier this year. Using this information, the noise emissions from the proposed Stockyard Hill Wind Farm have been predicted at the nearest affected residential properties to the proposed Chepstowe Wind Farm. These are presented in Table 4 together with the predicted noise emissions from the proposed Chepstowe Wind Farm.

Table 4
Maximum predicted noise levels at 10m/s (hub height)

House	Chepstowe	Stockyard Hill	Cumulative
11 (D)	36dBA	24dBA	36dBA
12 (S)	38dBA	24dBA	38dBA
76	30dBA	26dBA	31dBA

Note: (S) stakeholder property
(D) derelict dwelling

It can be seen from Table 4 that the noise contribution of the proposed Stockyard Hill Wind Farm would have only a marginal effect on the predicted noise emissions at the nearest affected residential properties to the proposed Chepstowe Wind Farm.

The cumulative noise emissions from the Stockyard Hill and Chepstowe Wind Farms at the three residential properties identified for the Chepstowe Wind Farm noise impact assessment comply with the lowest possible NZS6808:1998 noise limit of 40dBA at all wind speeds.

Similarly, the noise contribution from the Chepstowe Wind farm would have only a marginal effect on the predicted noise emissions at the nearest affected residential properties to the proposed Stockyard Hill Wind Farm and would not affect compliance outcomes.

6.0 RESPONSE TO NMS REPORT

The Conclusion to the NMS report notes three issues identified from their review of the proposed Chepstowe Wind Farm, as follows:

- 1. It is concluded that New Zealand Standard NZS6808:2010 Acoustics – Wind farm noise applied to this application**
- 2. It is concluded that the wind farm will, under southerly and westerly wind conditions, be in non-compliance with a background (L90) level of 35dB(A) at residences 11 and 12.**
- 3. It is concluded that the penalty for special audible characteristics is applicable to this wind farm. With the penalty applied the compliance level at residences 11 and 12 is a background (L90) level of 30dB(A).**

It is our understanding that the turbine layout for the proposed Chepstowe Wind Farm has changed since the planning permit application was lodged and therefore the current proposed layout is different from that assessed by NMS and presented in Plan 1 of their report. We also understand that our memorandum Mm001 R02 2007199 dated 21 July 2008 was made available to NMS for their review. Since the issue of that memorandum a further revision was issued on 22 March 2010. Only a minor change was made as part of this revision which did not affect the outcome of the noise assessment. Notwithstanding these issues, the items raised by NMS have been considered in preparing the following comments.

6.1 Application of NZS6808:2010

Section 4.9.1.3.a of the current Victorian Wind Energy Guidelines, dated September 2009, states the following:

Evaluation by the responsible authority

A wind energy facility should comply with the noise levels recommended for dwellings in the New Zealand standard NZ6808:1998 Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators.

During the assessment phase of the noise impact, particular attention to the following matters within the Standard is required:

- Separate correlation of background sound levels with the wind speed for different wind directions and/or the time of day (Clause 4.5.5 of the Standard), and*
- Wind speed measurements at the hub height of the proposed turbines as - recommended in the Note to Clause 4.5.6.*

These guidelines, which are currently applicable in Victoria, require that the noise impact assessment is to be undertaken in accordance with the NZS6808:1998.

In New Zealand, NZS6808:1998 has been superseded by NZS6808:2010 **Acoustics – Wind farm noise**, dated 1 March 2010.

However, the application of NZS6808:1998 was recently reaffirmed in the decision to approve the Berrybank wind farm in August 2010. The panel report for this project dated May 2010 states the following:

The Wind Farm Guidelines require that wind farm comply with New Zealand standard NZ6808:1998 Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators (NZS 6808:1998).

We have reviewed the decision of the Victorian Civil and Administrative Tribunal (VCAT) in the case of **The Sisters Wind Farm Pty Ltd v Moyne SC [2010] VCAT 719** (the Sisters decision) dated 27 April 2010 and we provide the following comments:

- It is not appropriate to compare predicted noise emissions calculated in accordance with the 1998 version of the NZ Standard with noise limits determined in accordance with the 2010 version of the NZ Standard.
- Predicted noise levels in accordance with the 1998 version of the NZ Standard are generally more conservative than those predicted in accordance with the 2010 version because the earlier version does not include effects such as ground absorption or topographical shielding.
- We believe that the Tribunal has not been properly informed of the content of the NZS6808:2010 in relation to High Amenity Areas.

Section 17 of the Sisters decision states:

We further find that the area impacted by The Sisters proposal is a quiet location as evidenced by the background noise level measurements made by the applicant which were below 35dB(A) at wind speeds up to 6 m/sec.

Sections 5.3.1 and 5.3.2 of NZS6808:2010 recommend that a lower minimum noise limit of 35dBA (instead of 40dBA) be applied at wind speeds below 6m/s during the evening and night periods for High Amenity Areas designated in a planning instrument. Low background noise levels alone are not a justification for the reduced high amenity area noise limit.

It is our understanding that The Sisters decision has been appealed and therefore the final status of the decision is presently uncertain.

6.2 Noise assessment in accordance with NZS6808:2010

Although we believe that using NZS6808:2010 to assess noise emissions from wind farms in Victoria is not accordance with the Victorian Wind Energy Guidelines, we have predicted noise emissions from the proposed Chepstowe Wind Farm in accordance with NZS6808:2010 to respond to the NMS report.

NZS6808:2010 recommends the use of the prediction method detailed in the ISO Standard 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method for calculation*.

The ISO9613-2:1996 prediction method is more complex than the simple prediction method presented in NZS6808:1998 and includes additional parameters such as ground absorption and topographical shielding.

To provide a conservative NZS6808:2010 noise assessment, the following assumptions have been made:

- noise emissions from the proposed Chepstowe Wind Farm have been predicted using ISO9613-2:1996 without any ground absorption
- although the residential properties in the vicinity of the proposed Chepstowe Wind Farm may not be considered as High Amenity Areas, the lower minimum noise limit of 35dBA was used. This lower minimum noise limit is only applicable during the evening and night period for wind speeds below 6m/s.

The NZS6808:2010 predictions are presented in Figure 5 and in the noise contour map presented in Appendix C.

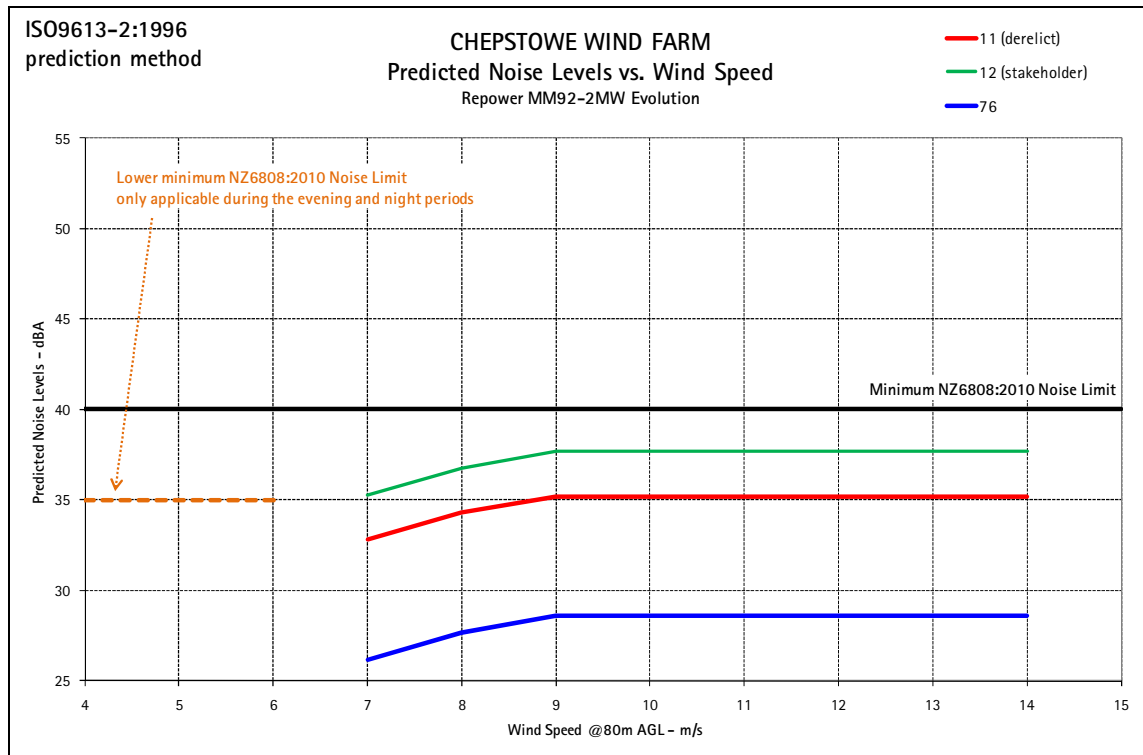


Figure 5: Predicted NZS6808:2010 noise emissions

It can be seen from Figure 5 that the proposed Chepstowe Wind Farm would comply with the lowest possible NZS6808:2010 noise limits. Even if the adjacent dwellings were considered to be within a High Amenity Area, in accordance with NZS6808:2010, the predicted noise emissions from the proposed Chepstowe Wind Farm would comply with the lower noise limits as it only applies for wind speeds below 6m/s during the evening and night periods.

Predicted noise levels presented in Figure 5 are generally consistent with the predictions presented in Item 25 of the NMS report.

6.3 Application of the EPA Guidelines N3/89

The EPA Guidelines EPA publication N3/89 *Interim guidelines for control of noise from industry in country Victoria* are not applicable to wind farms.

In their submission to the Lal Lal Wind Farm panel hearing held in November 2008, the EPA Victoria Southwest Region stated that the N3/89 guidelines were not appropriate for assessing wind farm noise.

The EPA Publication *1316 Noise from industry in regional Victoria* (NIRV) is proposed to replace the N3/89 Guidelines. The introduction of the draft NIRV dated December 2009 state:

This document does not address noise from traffic on road and rail corridors, wind energy facilities, aircraft (while in the air), occupational noise exposure, or nonindustrial noise such as music.

6.4 Effect of meteorological conditions on predicted noise levels

Site atmospheric conditions are not taken into account when assessing wind farm noise emissions in accordance with NZS6808:1998.

The NZS6808:1998 prediction method assumes downwind propagation from all turbines towards each residence.

6.5 Special audible characteristics

NZS6808:1998 requires that predicted noise levels from wind turbine with known special audible characteristics must be adjusted by a 5dB penalty.

Section 4.4 of the Australian Standard 4959:2010 *Acoustics—Measurement, prediction and assessment of noise from wind turbine generators* states the following:

When setting limits of acceptability, the limits should take into account the fundamental characteristics of wind farm noise, including aerodynamic noise from the rotating blades, occasional aerodynamic modulation, the mechanical noise of the gearbox and other components and also other infrequent and short term noises that may occur, such as braking. Should a special audible characteristic (not usual to a correctly functioning wind turbine) such as tonality be present it is recommended that the predicted noise levels from the WTG or wind farm be adjusted by adding a penalty to the predicted level, to take into account the adverse subjective response likely to be generated by the characteristic.

The above indicates that some level of amplitude modulation is a normal characteristic of a correctly functioning wind turbine. During the design stage, the only predictable special audible characteristic is tonality. Information about the presence of audible tones must be provided by wind turbine manufacturers for evaluation.

We trust the above is sufficient for your requirements at this time. Should you have any queries, please do not hesitate to contact me.

Yours faithfully,
MARSHALL DAY ACOUSTICS



Christophe Delaire
Associate

APPENDIX A

PROPOSED SITE LAYOUT



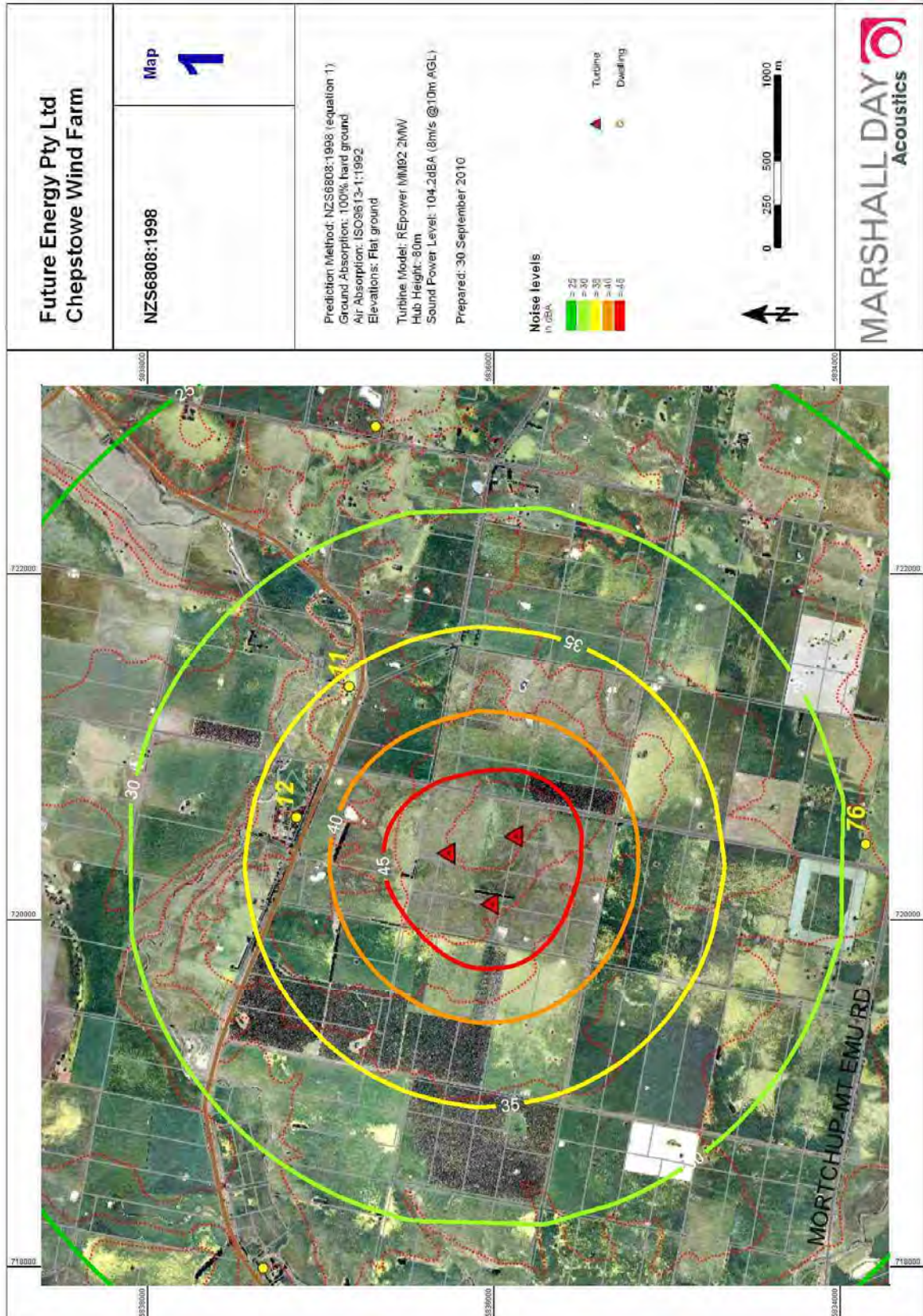
**Chepstowe
Wind Farm**

Site Layout



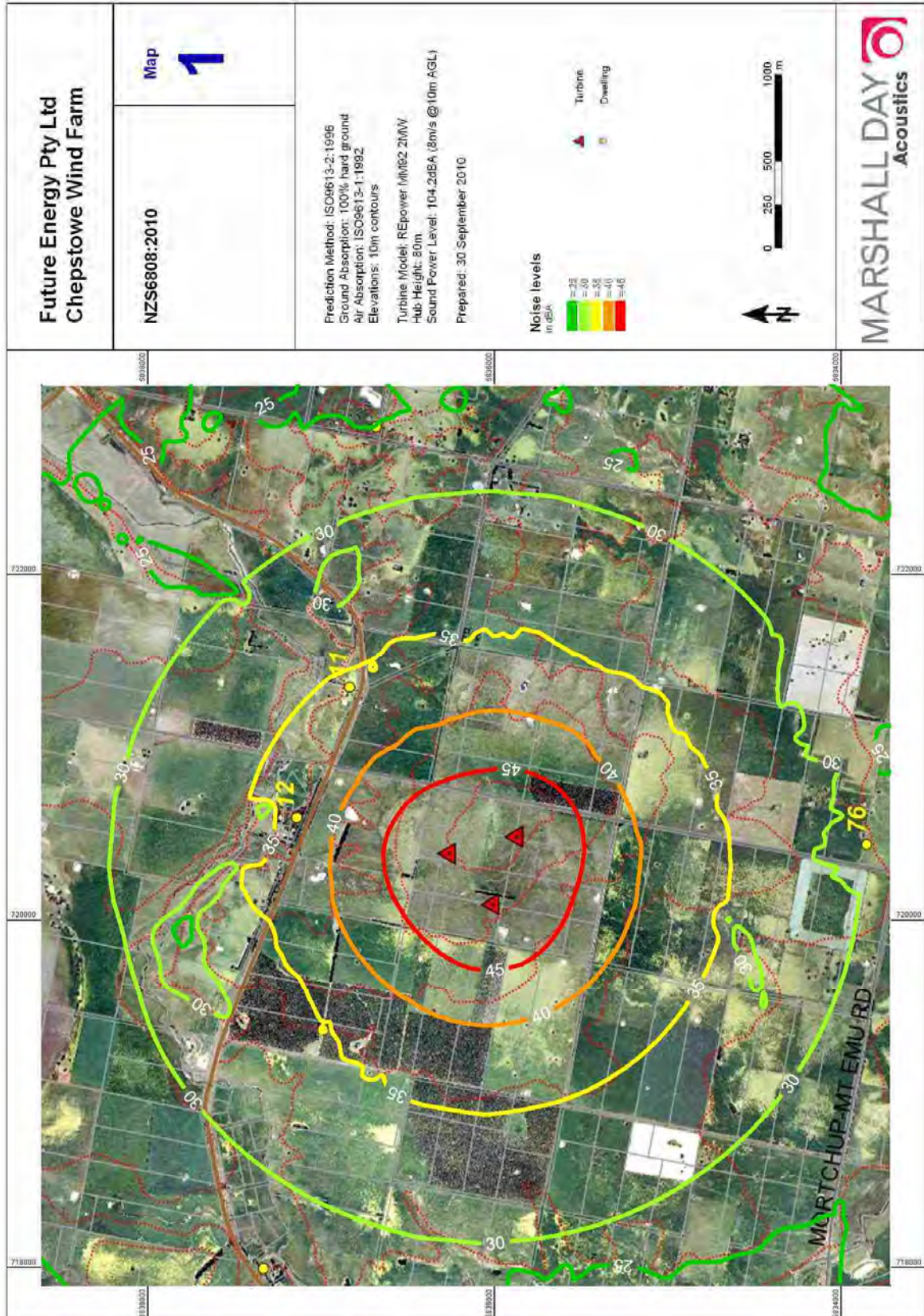
APPENDIX B

NZS6808:1998 NOISE CONTOUR MAP



APPENDIX C

NZS6808:2010 NOISE CONTOUR MAP



APPENDIX C

PROPOSED PERMIT CONDITIONS

1. Except as provided for below in this condition the operation of the wind energy facility must comply with the noise criteria specified in NZS6808:1998 *Acoustics The Assessment and Measurement of Sound from Wind Turbine Generators* at any non participating stakeholder dwelling existing in the vicinity of the wind energy facility at February 2011 when measured by the method specified in that standard. In determining compliance the following shall apply;
 - a) the sound level from the operating wind energy facility when measured outdoors within 10 metres of any such dwelling shall not exceed the background sound level (L_{95}) by more than 5dBA or a level of 40dBA L_{95} , whichever is the greater. Compliance shall be assessed separately for all time data and for night time data. Night time is defined as 10 pm to 7 am; and
 - b) if the sound has a special audible characteristic the measured sound level shall have a penalty of 5 dB applied.

This condition does not apply at any dwelling existing on land on which one or more turbines of the wind energy facility is located ie. a dwelling on participating landowner's land, or at an existing dwelling of a non participating landowner for which an agreement has been reached by which that landowner accepts that noise levels in outdoor areas of the dwelling may exceed the standard.

2. Before the development commences, background noise measurements must be undertaken at all non participating landowner dwellings existing as at February 2011 where predicted noise levels exceed 35dBA when the turbines are operating at full rated power.
3. If background noise measurements cannot be obtained before the development commences, a shut down test should be undertaken to demonstrate compliance at the relevant dwellings.
4. The acceptable noise limits derived from background noise results of Condition 1 shall provide the references at the relevant dwellings for post construction compliance testing. If background noise levels cannot be obtained, and in the interim until such measurements are made, an acceptable noise limit of 40dBA as a presumptive criterion shall apply across the range of operating wind speeds.
5. A post construction noise monitoring and compliance assessment program must be undertaken by the operator under the permit. The initial compliance noise monitoring program must commence within two months of the commissioning of the last turbine in the wind energy facility. The monitoring must be carried out in accordance with the method in NZS6808:1998.

The noise monitoring must be carried out by an independent expert with relevant wind turbine noise experience.

The results of the post construction noise monitoring program and a statement of compliance or otherwise must be provided to the Responsible Authority within 45 days of the end of each monitoring program.

6. Should the results show non compliance, the holder of this permit must submit to the Responsible Authority a detailed program to bring the facility into compliance. On approval, that program shall be implemented and on its completion, the compliance noise monitoring program of Condition 5 shall be repeated to demonstrate compliance and the results provided to the Responsible Authority within 45 days of the completion of the program.
7. Noise monitoring shall be repeated commencing not less than 10 months and not greater than 12 months after the commencement of the program in Conditions 5 or 6 as applicable. Should that further noise monitoring program demonstrate compliance with the noise criteria no further monitoring shall be required unless otherwise determined by the Responsible Authority.
8. Before the use begins the operator under the permit must prepare a detailed noise complaint evaluation and response plan to the satisfaction of the Responsible Authority.