From: Peter Pattison [redacted]@trc.qld.gov.au]
Sent: Tuesday, 30 August 2011 4:07:22 PM
To: Sch. 4@noisemeasurement.com.au'
CC: Kylie Coutts
Subject: MCU/11/0024 Mt Emerald Wind Farm noise assessment

Dear Sch. 4(

Please find attached our letter of appointment. An order number will follow.

The following points/queries came to mind after a brief read of the noise report:

- there appears to be no/loose correlation between background noise at the sensitive receptor, and wind speed at the SR, & wind speed at the turbines. Are there any implications?
- Given the large number of identified SR, is there sufficient background noise data?
- The wind profile appears to be very seasonal (compared to HRWF). Does this affect ecomonic viability?
- Is 10m/s the highest noise output for the turbines, or should there be further predictive noise contours provided?

As per the brief, the first requirement is any further information requirements for an Information Request. By way of information, a separate (and unrelated) resubdivision application has been lodged by Port Bajool (which is also part of the wind farm joint venture) over land immediately adjacent to the wind farm site (see attached proposal plan - Lots 7, 8, 39 & 40).

Please contact me if you have any queries, or require further info or maps.

regards

Peter Pattison
Senior Planner
Urban and Regional Planning Group, Planning and Development
Tablelands Regional Council
Phone: Sch. 4(4)(6) - Disclosing personal inform **Fax:** 07 4096 5086
Email: [redacted]@trc.qld.gov.au | **Website:** www.trc.qld.gov.au
31 James Street | PO Box 3, Malanda, Queensland, Australia, 4885

Tablelands Regional Council

Atherton Service Centre
PO Box 573, Atherton QLD 4883
Telephone: 1300 362 242

Urban & Regional Planning Group
Peter Pattison, Senior Planner
Telephone: Sch. 4(4)(6) - Disclos
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30 August 2011

File Ref: MCU/11/0024
Our Ref: BN:PP:hi

Noise Measurement Services
PO Box 2127
BROOKSIDE CENTRE Q. 4053

Attn: Sch. 4(4)(6) - Disclo

Dear Sir

RE: REVIEW OF NOISE ASSESSMENT FOR MT. EMERALD WIND FARM DEVELOPMENT APPLICATION

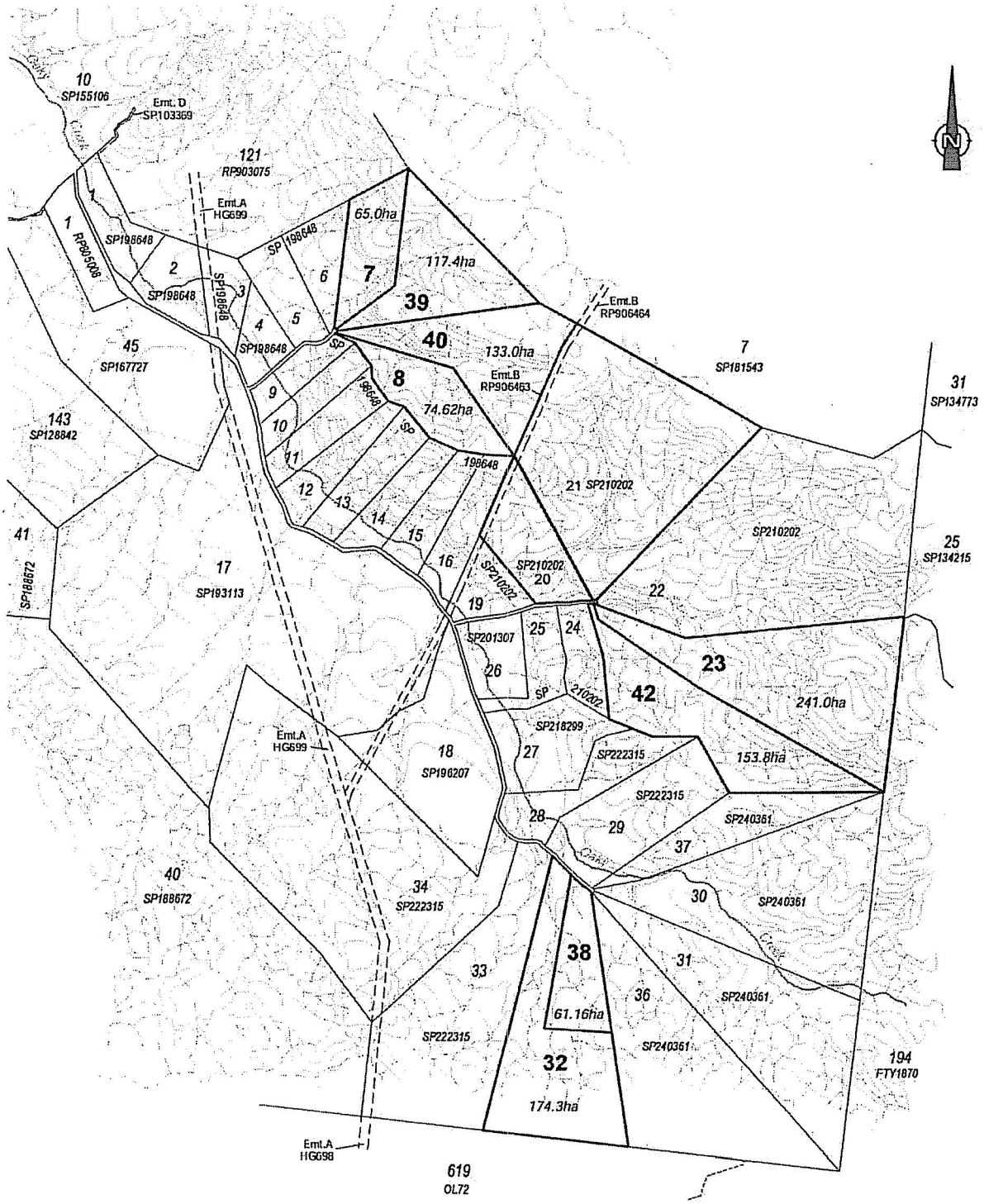
I refer to your submission in relation to the above commission.

Council has considered the offers received for the project and we are pleased to advise that your firm's offer for the amount of $ 5 400 (plus GST) was successful. Would you therefore please proceed with the required noise assessment at your earliest convenience.

Yours faithfully

Sch. 4(4)(6) - Disclosing personal informatio

PETER PATTISON
SENIOR PLANNER



RPS

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IMPORTANT NOTE

This plan was prepared as a concept plan only and accuracy of all aspects of the plan have not been verified.
All lots, areas and dimensions are approximate only, Subject to relevant studies, Survey, Engineering and Government approvals.
No reliance should be placed on the plan and RPS Australia East Pty Ltd accepts no responsibility for any loss or damage suffered howsoever arising to any person who may use or rely on this plan.

RECONFIGURATION OF A LOT

PROPOSED LOTS 7, 8, 23, 32, 38, 39, 40 & 42

PR105500-1 SCALE: 1:40000 9/8/2011

NOISE MEASUREMENT SERVICES

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Queensland 4053 Australia
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3 October 2011

The Chief Executive Officer
Tablelands Regional Council
Attention: Peter Pattison
Senior Planner, Urban and Regional Planning Group

Dear Peter

Review of Noise Assessment of the Mt Emerald - Arriga Wind Farm.

Thank-you for your instructions.
The documentation supporting the application has been received and I have obtained additional information regarding the 'Temporary Local Planning Instrument' and the response of the Department of Environment and Resource Management. In order to fully answer your queries this report is supplemented with the preparation of perspective maps and a 'helicopter tour' of the proposed wind farm. The report refers to information presented by the Applicant. The primary report considered is the noise impact assessment by Noise Mapping Australia.

This report takes the format of a professional peer-review and is in six parts with two annexures:

1.0 The application
2.0 Wind data
3.0 Noise data
4.0 Noise criteria
5.0 Noise management conditions
6.0 Conclusions and Recommendations
Annex A Perspectives of Mt Emerald Wind Farm
Annex B Revised predicted sound levels at residences

1.0 The Application

1.1 Location

The application is for a wind farm in the vicinity of Mt Emerald – Arriga. The Plates to **Annex A** present our overview of the proposal based on information supplied by the applicant. The Plates illustrate the location of the wind turbines and residences in the locale as well as predicted noise contours for an average wind speed of 10 metres per second at the wind farm.

1.2 Turbines

The proposal is for a maximum of 75 turbines of an unspecified type, with a blade length of up to 50 metres and a hub height of between 80 metres and 90 metres. The Applicant's Noise Report (Appendix H of the application applies the Enercon E-82 E2 2.3 MW capacity turbine with a hub height of 82 metres and a rotor diameter of 'approximately 42 metres'. (The Enercon has a rotor diameter of 82 metres). The Parsons Brinckerhoff Arriga Wind Energy Yield Assessment report applies the Enercon E82 with a 78 metre hub height. The Transfield Shadow Flicker Assessment applies both the Enercon E82 and the Siemens SWT 3.0-101 turbine with a 80 metre hub height and 51 metre blade.

1.3 Planning Information

The application is code assessable for a Rural Zone under the Mareeba Shire Planning Scheme. The applicant states that the application is for a Material Change of Use (Utility installation – Wind farm) and appears to be unsure ("presumes") concerning the status of the application:

> *Despite the current planning scheme omitting specific reference to renewable energy projects, such as wind farms, it has essentially included relevant requirements to assess such a project, by virtue of broader planning statements contained in the Desired Environmental Outcomes, and aspects of the Rural Zone Code (which presumably considered 'Utility Installation' aspects).*

The applicant then considers 'desired environmental outcomes' and the sections of the application applicable to noise are:

- item (j): Threats to public health and safety associated with the natural and built environments, including flooding in the catchments of the Barron River and Mitchell River are minimised;
- item (r): The identification and protection of the amenity of noise sensitive development and liveability of residential areas.

In both cases the application refers to the noise assessment report of Noise Mapping Australia (NMA) [Appendix H of the Applicant's information] which concludes *"that the noise goals outlined in the Environmental Protection Policy (Noise) 2008 are met at all locations"*. I cannot support this statement for reasons stated in this Report.

The Statement of Commitments presented by the applicant under Item 2 of Table 42 is noted. The NMA Noise Report has excluded the Lotus Glen facility and the Springmount Accommodation Village from assessment. My opinion based on the Parsons Brinckerhoff Arriga Wind Energy Yield Assessment report is that the Village and Lotus Glen may both be affected by noise from the wind farm. Item 2.11 of the Statement of Commitments is inadequate to address noise mitigation for these two "urban density" residential facilities as the Item refers only to *"the closest non-involved residences".*

1.4 Temporary Local Planning Instrument

The NMA Noise Report does not, of course, address the Proposed Temporary Local Planning Instrument (Wind Farms) Wind Farm Code submitted to Council by the Department of Local Government and Planning on 15 September 2011. My conclusion is that the instrument applies and extends the Environmental Noise Policy.

Overall outcomes (a), (c), (f) and (h) are strict, and the expressions "minimise potential impacts" in (a) and "acceptable" in (f) are complex hurdles for any assessment to address. The probable solution(s) for noise in Specific Outcome S5 comes back to the noise policy with the new criterion of "does not result in unacceptable levels" of nuisance, risk to human health or wellbeing, or ability to sleep or relax.

If the TLPI is approved and if it applies to this application, the NMA noise report (or such other relevant report) will need to demonstrate compliance with the Environmental Protection (Noise) Policy 2008 so that audible and inaudible noise emissions resulting from the wind farm that potentially impact on existing residences do not result in unacceptable levels (including cumulative impacts) of (i) nuisance, (ii) risk to human health or wellbeing, (iii) ability to sleep or relax.

1.5 Department of Environment and Resource Management

DERM have responded by suggesting the consideration of the following

- The Environmental Protection Act 1994;
- The Environmental Protection (Noise) Policy 2008;
- DERM's *Planning for Noise Control* guidelines;
- DERM's draft guideline *Assessment of Low Frequency Noise*; and
- State Planning Policy 5/10 and Guideline for Air, Noise and Hazardous Materials.

DERM also considered the applicant should provide detailed technical information on the likely noise impacts, consistent with AS1055.1-1997 *Acoustics: description and measurement of environmental noise-general procedures.* (It is probably an oversight but DERM does not suggest AS1055.2 *Application to specific situations* which is just as applicable to this application). The NMA noise report is generally in accord with the standards.

The application of the most relevant Australian Standard, *AS 4959:2010 Acoustics-Measurement, prediction and assessment of noise from wind turbine generators,* has not been considered by either DERM or in the NMA noise report. This is a significant oversight on the part of both parties.

DERM notes the availability of the South Australian wind farm guideline which is applied in the NMA Noise Report. DERM does not appear to know of the Victorian Wind Farm Guidelines published in 2011. The Guidelines (attached) are more comprehensive than the South Australian Guidelines and like SA apply different noise criteria for rural land-uses based on 'high-amenity'. High-amenity is not defined although I understand rural areas "as-such" can be considered high amenity. Victoria also applies a 2000 metre setback between turbines and residences not party to the wind farm.

The NMA report considers the application of the Noise Policy with respect to the application.

The *Planning for Noise Control* guidelines are not addressed by the NMA noise report. The Guidelines are useful as both a planning tool and as a guide to the assessment of the acoustic environment. As a planning tool the Guidelines implements the concept of Planning Noise Levels and applies adjustments for the tonality or impulsiveness of source noise. The Guideline applies a method for assessment of maximum noise level for sleep disturbance. (The Guide applies a general noise reduction outside to inside of 5 dB(A) for a wide-open window). Due consideration must be given to meteorological effects including temperature inversions, drainage-flow winds, and wind effects. These considerations are not addressed in the NMA noise report.

The draft Low Frequency Noise guideline is a DERM work-in-progress and is not, therefore, addressed by the NMA noise report. The NMA report does, however, address issues of low frequency noise.

Council advises that the provisions of the State Planning Policy 5/10 and Guideline for Air, Noise and Hazardous Materials do not apply as the Policy is only triggered by reconfiguration of a lot or a material change of use for a residential use and if the proposed development is within a defined management area. There are no defined management areas north of Townsville. The NMA noise report does not therefore need to address the Policy.

2.0 Wind Data

2.1 The Parsons Brinckerhoff Report

Partial wind data is provided in the Parsons Brinckerhoff Arriga Wind Energy Yield Assessment report (PB Report). The Plates in Annex A show the location of the wind monitoring towers in relation to the proposed turbines and the existing residences. The report also includes data from the 20 metre wind tower at High Roads which is the primary source of

wind data in the noise report. The wind data for the two towers does not cover a full 12 months and is a point of issue in the PB Report which says at Section 4.6:

> *The scope of work for the AWF EYA does not include a detailed uncertainty analysis. However, it is noted that PB generally recommends that an EYA is conducted using, at a minimum, 12 months of on-site monitoring. This allows confidence that any seasonal variation in the wind climate is encapsulated in the wind dataset. The use of datasets with less than 12 months of continuous readings can affect the assessment by not effectively representing those seasonal fluctuations, and by limiting the accuracy of the correlation with a long-term dataset.*

A detailed on-site wind assessment is critical for noise assessment at residences. PB present useful wind data that assists in the assessment of potential noise from the wind farm:

- Tower 9530, to the "eastern" side of the range, has an average wind speed of 10 metres/sec at a height of 80 metres (hub height). The data showed a strong directionality from an east-southeast direction. The wind shear profile has an exponent of 0.04, which PB notes as being comparatively low. The diurnal wind speed pattern shows high wind speeds from 10pm to 7am with lower wind speeds during the day.
- Tower 9531, to the "western" side of the range, has an average wind speed of 8 metres/sec at a height of 50 metres. The data showed a strong directionality from an easterly direction. The wind shear profile has an exponent of 0.24. (PB notes the variation in wind shear between the two sites as highlighting the variability and complexity of the terrain and the roughness at the site). The diurnal wind speed pattern at 9531 has high wind speeds from 10pm to 8am and lower wind speeds during the day.
- In relation to the High Road data the mean wind speed is recorded at 7 metres/sec and shows a similar diurnal pattern of wind speed; higher at night than during the day.

The wind speeds at the turbines will be variable in direction – the closeness of the two towers shows this – and considerable turbulence can be expected. Turbulence data is not provided as such by PB but Table 18 of the report provides the energy yield related to wake efficiency. It is clear that many of the turbines have reduced efficiency; turbines 23 to 25 for example. The yield assessment is important as it allows an insight into turbulence and potential noise emissions from the wind farm. The NMA Noise Report also applies the High Roads dataset but this is for a completely different wind shed and different topography.

2.2 Comments re NMA Noise Report wind data

- The NMA Noise Report has referenced the wind data from High Roads and needs to be re-assessed with the wind data from the on-site towers. The assessment needs to identify the effects of an east-southeast wind and its effects on Lotus Glen and the

accommodation village; and an easterly as it will affect the residences to the west of the wind farm.

- The noise report does not present any wind data at residences and it is not possible therefore to identify the effect of winds at the plateau of the wind farm with wind speed and direction at the same time in the locale surrounding Mt Emerald.
- Stable conditions at night with high wind speeds on the plateau and low or nil wind in the areas surrounding Mt Emerald will enhance the possibility of audible noise at residences.

2.3 Overall conclusions regarding wind data

- There is no on-site long-term measured wind data for residences in the locale.
- There is no correlation between on-site wind data at the towers and actual wind data at a representative number of residences.
- The noise report records a mathematical relationship between background sound level and wind speed at a 10 metre reference height. Validation of this approach is required.
- The wind data supplied by Parsons Brinckerhoff shows clearly that there is a complex weather pattern on the plateau. This has significant implications for noise generation and propagation onto residences surrounding the wind farm.

3.0 Noise Data

3.1 The NMA Noise Report

The approach taken by the NMA Noise Report is to calculate wind farm noise levels at residences around the proposed wind farm; compare the levels to a guideline number from the South Australian wind farm guidelines; and then assess compliance with the acoustic quality objectives of the Environmental Protection (Noise) Policy 2008. This is a standard approach. While I am familiar with the noise prediction methodology applied I do not agree with the assumption that the modelling is 'conservative' as the calculations do not contain measures of uncertainty. This is a critical issue. No noise prediction model is as precise as that given in the report and a variation of at least ±3 dB(A) is expected at 1000 metres. All predictions have measures of uncertainty – if the wind blows towards a receiver the sound level is often higher than if the wind is calm or blowing the other way. This point is also made by Mr Lenchine of the EPA South Australia who developed the guidelines endorsed in the NMA noise report. Mr Lenchine has said (Acoustics Australia, Vol 37 April 2009 No.1):

> *Noise modelling software can incorporate different algorithms to predict wind farm noise. Generally WTGs are represented as elevated point sources. Some researchers state that the ISO9613-2 produces very accurate results for predicting noise impact from the wind farm. However, none of the algorithms can reproduce the peculiarities of the noise emission in the source zone. For example, our recent investigations and other research show that the attenuation rate in close proximity to a wind farm can be 2-4dB/doubling of distance. None of the commercially available noise prediction software,*

which utilises the point source representation of a WTG, can reproduce this effect. Generally, the software accuracy for the noise impact from wind farms is unsatisfactory. In practice, a discrepancy up to 10 dB(A) between predicted results and in situ measurements, is not rare.

The above critiques are fundamental to the review and noise assessment / management for Mt Emerald and require a revision of the NMA noise report to address prediction uncertainty. The premise of the applicant that the wind farm will achieve the requirements of the 40 dB(A) noise criterion under the South Australian wind farm guideline and the statutory requirements of the Noise Policy, are not proven.

The assessed residences are relatively hard to locate on the map in the NMA noise report and some residences are at distances different to the distances in Table 1. The residential locations in **Annex A** have been sourced from local information and the Springmount Primary Fire Brigade Map (undated, but in current use). Residences within (approximately) 2000 – 2500 metres to the west, north and north-east of the wind farm will be affected by noise from the wind farm. The concern with the NMA Noise Report is that the potential effect of the wind farm on the Lotus Glen Centre, the Springmount Accommodation Village and the residences to the west and north-east has not been considered in sufficient detail. To provide a guide to potential effect the Plates in **Annex A** have the 10 metre/sec wind farm LAeq noise contour sourced from the NMA Noise Report and draped over a Google aerial photograph. This approach, plus the 'helicopter tour' video prepared as part of this Report, provides a better understanding of the noise levels predicted near residences due to the ground contours, turbine layout and wind direction (turbulence and wakes). The 10m/s wind speed is from the average data and the PB report shows that higher levels to 12.5 m/s can be expected.

The sound power data in the NMA Noise Report records the Enercon E82 sound power level as 102.9 dB(A) at a wind speed of 10m/s. Enercon data indicates a guaranteed sound power level of 104 ±1 dB(A) for a 78 metre hub-height machine at a wind speed of 10m/s. Siemens AG Germany was contacted for information with respect to the Siemens SWT3.0-101 turbine. At the time of writing this report the company had not responded with any data. However, an independent acoustic report states that the guaranteed sound power is 107 ±1.5 dB(A). It is the duty of the applicant to validate the sound power levels used in the NMA predictions.

The conclusion from an overview of the predictions is that all of the values for residences presented in Table 9 have a potential variation of ± 4 dB(A) (uncertainty of 3 dB and sound power variation of 1 dB) plus an adjustment of 1 dB(A) for the variation in sound power levels. In effect, this is a variation, for assessment purposes, of one full contour in the noise contours. Additionally, if the Siemens SWT3.0-101 turbine is installed instead of the Enercon the sound levels at the residences can vary by a further ± 5 dB(A). Under operational conditions an

additional 5 dB(A) penalty for noise character due, for example, to tonality, impulsiveness or audible or inaudible amplitude modulation (tonal complexes) applies.

Therefore, the sound levels at the residences will not be a single number, as implied by Table 9 of the NMA report, but a range of levels depending on wind speed and direction at the turbines, and wind speed and direction at the residences. This effect can be illustrated by reference to noise contours, for example. If the range of sound levels is ± 5dB and if the contours are presented in 5 dB steps, then the expected noise levels over a period of time and different weather conditions can be expressed as "35 dB with a variation of ± 1 contour" and allows assessment of potential effect based on the perspectives presented in **Annex A.**

My observations at wind farms in New Zealand and Victoria indicate outdoor sound levels over 32 LAeq dB, affected by amplitude modulation, can cause nuisance conditions, sleep disturbance and adverse health effects. **Annex B** presents the range of sound levels calculated with a degree of uncertainty to reflect actual operational conditions.

Recalculating the outdoor levels in indoor levels is a significant problem and in my experience must be undertaken on a house-by-house basis. While it is possible to "model" with "generic" noise reductions these may not be achieved in practice. Secondly, in my experience adverse effects can arise despite achievement of nominal "acceptable" outdoor-to-indoor noise reductions. Therefore, the predicted outdoor or indoor noise levels and background levels in Table 9 of the NMA Noise Report cannot be verified. The NMA noise report does not verify the estimated "outdoor to indoor" noise reduction (10 dB(A)) for residences with windows open, nor the degree of acceptance by residents to keeping doors and windows closed all year round in order to reduce noise from the wind farm (page 8 of the NMA report refers).

3.2 Background sound levels

The approach taken by the NMA Noise Report is to reference a small number of short-term background sound levels surveys and then calculate background sound levels at residences around the proposed wind farm. In view of the size and complex nature of this locale it is concluded that more residential background sound level surveys need to be made, and over a time-frame of 12 months. The reasons for this are three-fold:

- The onsite tower data shows significant variation in wind speed, wind direction and wind shear;
- There is no local data to correlate onsite tower data to residential weather data;
- There is, therefore, no data to prove or disprove the effect of increased noise emissions at residences in the vicinity of the wind farm.

3.3 Low Frequency and Infrasound Noise

The noise report presents the 'G-weighted' infrasound and low frequency sound levels at residences. The levels were calculated based on a GE1.5MW turbine. No data is provided,

however, of the sound power levels for an Enercon 82 or Siemens SWT 3.0-101 wind turbine in the one-third frequency bands 0.25Hz to 315 Hz as required under ISO 7196 for infrasound dB(G). Secondly, no information is provided as to the noise prediction model that was used to calculate the residential levels. The infrasound data and low frequency sound levels of Table 10 can not be confirmed and are not supported. It is emphasised before a turbine is installed its low frequency and infrasound noise generation characteristics must be presented,

3.4 Wake and turbulence interactions

Wake and turbulence interactions between turbines down-wind of each other are the cause of turbine inefficiency and this is well documented in the PB report. These inefficiencies give a guide to potential noise issues caused by turbine interaction but the issue is not as clear-cut as suggested in the noise report. Significant interactions between turbines can increase down-stream noise by more than 3 dB(A), and in some cases as much as 10 dB(A). The data supplied by Parsons Brinckerhoff clearly shows significant yield inefficiencies due to wake and turbulence effects. Consequently the statement on page 33 of the noise report "*As a result wake effects may be discounted"* cannot be supported. On the contrary, wake and turbulence effects as well as amplitude modulation must occur and they will have significant contribution to noise emission and immission at residences.

3.5 Sleep disturbance

Nose from wind farms can be audible and cause sleep disturbance at relatively low levels due to the nature (drone, swish, rumble-thump) of the noise. The environmental values are only described in part by the acoustic quality objectives. The sound heard within the residences is what is significant and the noise report does not make any analysis for this. As part of this report is the author's peer-reviewed paper *'The problems with noise numbers for wind farm noise assessment'* which presents the issues relating to measurement methodologies and background information to noise nuisance due to wind farm noise and adverse health effects.

The issues of noise nuisance due to wind farm noise and adverse health effects, at least partially the result of sleep disturbance, have been canvassed in the (June 2011) Senate Inquiry into Rural Wind Farms and the (June 2011) National Health and Medical Research Council Wind Turbine Forum. Both of these can be stated as presenting comprehensive accounts of national and government recognised scientific knowledge and standards and present the significance, magnitude and extent of both direct and non-direct impacts of wind farm noise on individuals.

The environmental values of the EPP(Noise) are 'protected' by indoor night-time criteria of 30 dB(A) measured as LAeq, adj, 1hour and 40 dB(A) measured as LA01, adj,1hour (fast response). These are maximum values. The unique nature and characteristics of wind turbine noise is such that, in my opinion, the stated values (protect from sleep disturbance, for example) have precedence and the numeric values must be considered on that basis.

3.6 Revised sound levels at residences

Annex B revises the predicted sound levels of Table 9 in the NMA Noise Report to account for measures of prediction uncertainty and variation in turbine sound power. The Enercon E82 NMA predicted sound levels for a wind speed of 10 m/s and a sound power of 102.9 dB(A) are adjusted to show a potential operational variation of ± 4 dB(A) (uncertainty of 3 dB and sound power variation of 1 dB). The sound levels for the Siemens SWT3.0-101 are predicted by reference to the NMA predicted sound levels for the Enercon E82 at a wind speed of 10 m/s (as above) plus an adjustment of a sound power of 102.9 dB(A) to 107 ±1.5 dB(A).

4. Noise Criteria

The noise report sets out the various noise criteria which the noise report considers are applicable. The relationship between the different legal requirements and the relationship of nuisance and environmental harm under the Act to the Environmental Protection (Noise) Policy 2008 is not as clear as that suggested. The environmental values to be enhanced or protected are the qualities of the acoustic environment that:

- Protect health and diversity of ecosystems
- Conducive to protecting the amenity of the community
- Are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following: sleep; study or learn; be involved in recreation including relaxation and conversation

In developing potential noise management conditions consideration is given to:

- **Environmental Nuisance**: unreasonable interference or likely interference with an environmental value
- **Environmental harm**: other than environmental nuisance; establishes risk criteria and thresholds for material or serious harm
- **'Harm'** can be authorised as a development condition of an approval, for example

While an explanation of the inter-relationship between these legal issues is not expected in an acoustic report the assessment does need to provide clear guidance – or discussion - with respect to Queensland legislation. It is debatable whether the Acoustic Quality Objectives are sufficient in their own right to deal with nuisance in the context of wind farm noise. Section 8 of the Environmental Protection (Noise) Policy 2008 is not specific as it prescribes an objective for enhancing or protecting the environmental values; the objectives are not stated as being the only measures or acoustic descriptors that can be applied; the objectives are maximum values. However, this is a legal issue and not necessarily an acoustic issue, even though assigning an appropriate metric or measures are critical to the assessment. To traverse some of the metrics considered in the NMA Noise Report:

- The South Australian wind farm guideline is not supported as there is no peer-reviewed scientific evidence presented in the guideline to support its application. The guideline presents different noise criteria for different land-uses, neither of which are applicable under Council's Rural code. The guideline is not sufficient to address the

environmental values of the Environmental Protection (Noise) Policy 2008. On the contrary, there is good evidence for the application of a lower noise criterion of 35 dB(A) and penalties for audible and inaudible noise.

- There are many "guidelines" available to the applicant and a starting point for assessment should have been Australian Standard *AS4959-2010 Acoustics – Measurement, prediction and assessment of noise from wind turbine generators* that was published at the time of the assessment.
- A relevant guideline in Queensland for low frequency noise is the Department of Environment and Resource Management's Draft Ecoaccess Guideline 'Assessment of Low Frequency Noise', addressed in the NMA noise report. The noise report does not, however, conform to the 'Purpose and Scope' of the guideline which states:

  > *Proponents must identify the environmental values of the receiving environment and demonstrate how they will protect and enhance the environmental values through best practice environmental management.*

- The 'creeping background' criterion under the Environmental Protection (Noise) Policy 2008 would restrict the operation of the wind turbines to the background level due to the stated prevalence of an average 10 minute wind speed of 10 m/s at a hub height of 80 metres. That is, the wind farm can be considered to be a noise source of a variable nature.

5.0 Noise Management Conditions

The noise management conditions applied to the High Roads wind farm are relevant to this application. Due to the complexity of the site, uncertainty relating to the turbines to be installed, true immission sound levels and background levels, it must be concluded that adverse effects due to wind farm generated noise will affect at least some residences. The NMA noise report identifies only sound levels and makes no assessment of adverse effects, potential sleep disturbance or potential nuisance. Therefore noise management conditions must be enforceable with penalties for failure to comply. The High Road wind farm noise management conditions in the Decision Notice of 1 June 2011 are:

"9. Noise Impact Requirements

a) Except for times when the wind farm wind speed and background sound levels are such as to trigger a secondary noise limit, the turbines shall be designed, located, operated and maintained so that the wind farm sound levels measured by (LAeq,adj,10 min) outdoors at any sensitive receptor during the operational lifetime of the wind farm shall not exceed the background sound level of the existing acoustic environment by more than 5dB(A).

b) Where the outdoor wind speed at any sensitive receptor is 6m/s or lower, a secondary wind farm noise limit shall apply under which the turbines shall be designed. located, operated and maintained so that the wind farm sound levels measured by (LA90,10 min) outdoors at any sensitive receptor during the operational lifetime of the wind farm

shall not exceed the background sound level of the existing acoustic environment by more than 5dB(A), or a level of 35 dB(A) (LA90,10 min) whichever is the greater.

c) The secondary noise limit shall apply only between the hours of 10:00pm to 7:00am the next day.

d) The noise from wind farm activity, as measured inside any habitable room of a sensitive receptor dwelling with windows open to represent typical 'worst case' conditions, shall not exceed:

i) during night-time (10:00pm to 7:00am the next day), a noise level of 30 dB LAeq,adj,10 min. and;

ii) at any other time the sound level shall not exceed 35 dB LAeq,adj,10 min.

In addition, perceptible or audible noise from wind farm activity shall not affect human health or wellbeing, including sleep or relaxation.

e) When noise from the wind farm has perceptible or audible characteristics that are perceived by the complainant as being cause for complaint, the measured sound level of the source shall have a 5 dB penalty added. Audible characteristics include tonal character measured as amplitude or frequency modulation (or both); and tonality (where the tonal character/tonality of noise is described as noise with perceptible and definite pitch or tone).

f) Before the use commences, an effective noise monitoring, evaluation and response process that addresses the noise compliance conditions must be submitted to, and approved by, Council's delegated officer. The response measures will include the control, turning off, and/or decommissioning of turbines to alleviate noise breaches, and will be documented in a Wind Farm Noise Operations Manual.

Monitoring must be in accordance with *Australian Standard AS 4959-2010 Acoustics-Measurement, prediction and assessment of noise from wind turbine generators;* the Department of Environment and Resource Management Ecoaccess draft *Guideline Noise-Assessment of Low Frequency Noise*; International Standard ISO 1996-2:2007 *Acoustics-Description, measurement and assessment of environmental noise - Part 2: Determination of environmental noise levels*. The monitoring shall include all the sound levels as required by these noise conditions and shall include monitoring for the characteristics described in Annex A of International Standard IEC 61400-11 *Wind turbine generator systems – Part 11: Acoustic noise measurement techniques*. Wind speed and wind direction shall be measured at the same location as the noise monitoring location.

g) Thereafter, alleged noise breaches by the wind farm must be addressed in accordance with the approved noise monitoring, evaluation and response process as documented in the Wind Farm Noise Operations Manual to the satisfaction of the Council's delegated officer.

h) A post-construction noise monitoring program must be undertaken by the proponent that commences no later than 2 months after the commissioning of the first turbine and which continues for a minimum of 12 months after the commissioning of the last

turbine, to the satisfaction of Council's delegated officer. That monitoring will be undertaken at all existing sensitive receptors and the results will be provided to Council at six monthly intervals commencing from the date of commissioning of the first turbine.

i) An independent specialist noise consultant (other than the company who prepared the predictive acoustical report) will be appointed by the Council and will monitor and verify wind farm noise levels that are the subject of complaint about either environmental nuisance or environmental harm due to noise. For the purposes of these conditions, a specialist noise consultant is taken to be a person qualified in acoustics and eligible for membership of the Australian Acoustical Society.

j) The proponent will lodge a cash bond of $ 40,000 for any costs associated with that monitoring and verification.

k) The wind farm complaint process must provide for an immediate, 24-hour, 7-day response by the wind farm operator to a complaint, and the specified responses will include noise monitoring and noise mitigation. The wind farm operator must notify Council within 24 hours of the receipt of a complaint and the operator must state what action has been taken, or is proposed, to bring the wind farm into compliance. The complaint process will also provide for complaints received by Council.

l) If the post-construction noise monitoring at any existing sensitive receptor identifies wind farm noise that exceeds the noise limit criteria specified in these conditions, or if a valid complaint lodged under the process established under these conditions is received by Council or the operator, the approval holder shall take immediate action to mitigate such noise.

m) Where reasonable and feasible, the applicant/operator may, subject to the owner's agreement and consent, provide that noise mitigation in the form of physical building modifications to an existing dwelling, or to a new dwelling built on any vacant parcel of land. The noise mitigation measures are to achieve a night-time noise level (10:00pm to 7:00am the next day), of 30 dB LAeq,adj, 10 min and daytime and evening noise level of 35 dB LAeq,adj, 10 min inside a habitable room of the dwelling with windows open. The sound inside the habitable room shall have no perceptible or audible noise from wind farm activity.

n) For the purposes and application of these noise conditions, the terms used in the conditions have the same meanings as the Schedule 2 Dictionary within the *Environmental Protection (Noise) Policy 2008,* save that for the purposes and application of these noise conditions

- *background sound/noise level* has the same meaning as AS 4959-2010 Acoustics - Measurement, Predication and Assessment of Noise from Wind Turbine Generators."

Assessment to Condition 9(e)

The assessment procedures and methodologies under condition 9(e) need to be detailed in the Wind Farm Noise Operations Manual. The existing environment is the environment

existing prior to the establishment of the wind farm. There are many different ways to measure audible and inaudible sound and establishing these in the Wind Farm Noise Manual will provide certainty of application. A recent UK Court of Appeal ('Den Brook'), for example, has established measurement procedures relating to amplitude modulated sound. This procedure is being investigated both in the UK (by a wind farm developer) and by ourselves (independent research). It is recommended that Council take a pro-active stance and institute the development of the Wind Farm Noise Manual.

6.0 Conclusions and Recommendations

Conclusions

6.1 The NMA noise report does not establish that the wind farm will achieve the requirements of the Environmental Protection (Noise) Policy to not cause adverse effects to an individual's wellbeing including sleep and relaxation. The applicant has not therefore satisfied item (j): *Threats to public health and safety associated with the natural and built environments, …;* and item (r): *The identification and protection of the amenity of noise sensitive development and liveability of residential areas*.

6.2 The premise of the applicant that the wind farm will achieve the requirements of the 40 dB(A) noise criterion under the South Australian wind farm guideline and the statutory requirements of the Noise Policy are not proven. On the contrary, there is good evidence for the application of a lower noise criterion of 35 dB(A) and penalties for audible and inaudible noise.

6.3 If the Temporary Local Planning Instrument is approved and if it applies to this application, the NMA noise report (or such other relevant report) must demonstrate compliance with the Environmental Protection (Noise) Policy 2008 so that audible and inaudible noise emissions resulting from the wind farm that potentially impact on existing residences do not result in unacceptable levels (including cumulative impacts) of (i) nuisance, (ii) risk to human health or wellbeing, (iii) ability to sleep or relax.

6.4 The wind farm will have a significant noise effect on the surrounding locale. The wind direction will tend to increase noise levels to the west, north and north north-east. From previous studies I conclude that at night residences within 2km – 3km (approximately) of the wind farm will hear wind farm noise on a consistent basis. Individuals susceptible to sleep disturbance and / or low frequency sound pressure variations will be affected. Individuals at greater distances may be affected but this is an unknown extent.

6.5 Additional wind data is required for a full 12 months onsite to verify wind speeds and directions.

6.6 Additional background sound levels are required at representative residential locations for a full 12 months onsite.

6.7 The predicted residential noise levels in the NMA Noise Report cannot be verified and must be updated for the actual turbine to be installed, onsite weather conditions and assessed against measured background sound levels and wind data at representative residential locations for a full 12 months.

6.8 It is concluded that the noise management conditions applied to the High Roads wind farm are relevant to this wind farm application subject to confirmation of methodologies under condition 9(e).

6.9 Due to the complexity of the site, uncertainty relating to the turbines to be installed, true immission sound levels and background levels, it is concluded that adverse effects due to wind farm generated noise will affect at least some residences. Therefore the noise management conditions must be enforceable with penalties for failure to comply.

Recommendations

My recommendation is that Council not approve the application on the grounds that the applicant has not demonstrated compliance with the Environmental Protection (Noise) Policy 2008 with respect to enhancing or protecting the environmental values being the qualities of the acoustic environment that are (a) conducive to protecting the health and biodiversity of ecosystems; and (b) conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following (i) sleep; (ii) study or learn; (iii) be involved in recreation, including relaxation and conversation; and (c) conducive to protecting the amenity of the community.

However if Council is of a mind to approve the application the following minimum conditions should be applied:

1. Require the applicant to demonstrate compliance with the Environmental Protection (Noise) Policy 2008 with respect to enhancing or protecting the environmental values being the qualities of the acoustic environment that are (a) conducive to protecting the health and biodiversity of ecosystems; and (b) conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following (i) sleep; (ii) study or learn; (iii) be involved in recreation, including relaxation and conversation; and (c) conducive to protecting the amenity of the community.
2. When satisfied with compliance with condition (1) above and, if applicable condition (7) below, confirm the noise management conditions and assessment provisions for 9(e) as stated in Section 5 of this report.
3. Institute the immediate development of a Wind Farm Noise Manual.
4. Ensure that the noise management conditions are readily enforceable with penalties for failure to comply.
5. Require the applicant to provide 12 month on-site wind data and 12-month wind data at representative residences in the locale of the wind farm.
6. Require the applicant to provide 12 month background sound level data at representative residences in the locale of the wind farm.
7. If the Proposed Temporary Local Planning Instrument (Wind Farms) Wind Farm Code is approved and if it applies to this application, the NMA noise report (or such other relevant report) must demonstrate compliance with the Environmental Protection

(Noise) Policy 2008 so that audible and inaudible noise emissions resulting from the wind farm that potentially impact on existing residences do not result in unacceptable levels (including cumulative impacts) of (i) nuisance, (ii) risk to human health or wellbeing, (iii) ability to sleep or relax.

Trusting that the above is of assistance,

Yours truly

Sch. 4(4)(6) - Disclosing personal inforr

Sch. 4(4)(6) - Dis PhD, FRSPH

ANNEX A: PERSPECTIVES OF MT EMERALD WIND FARM

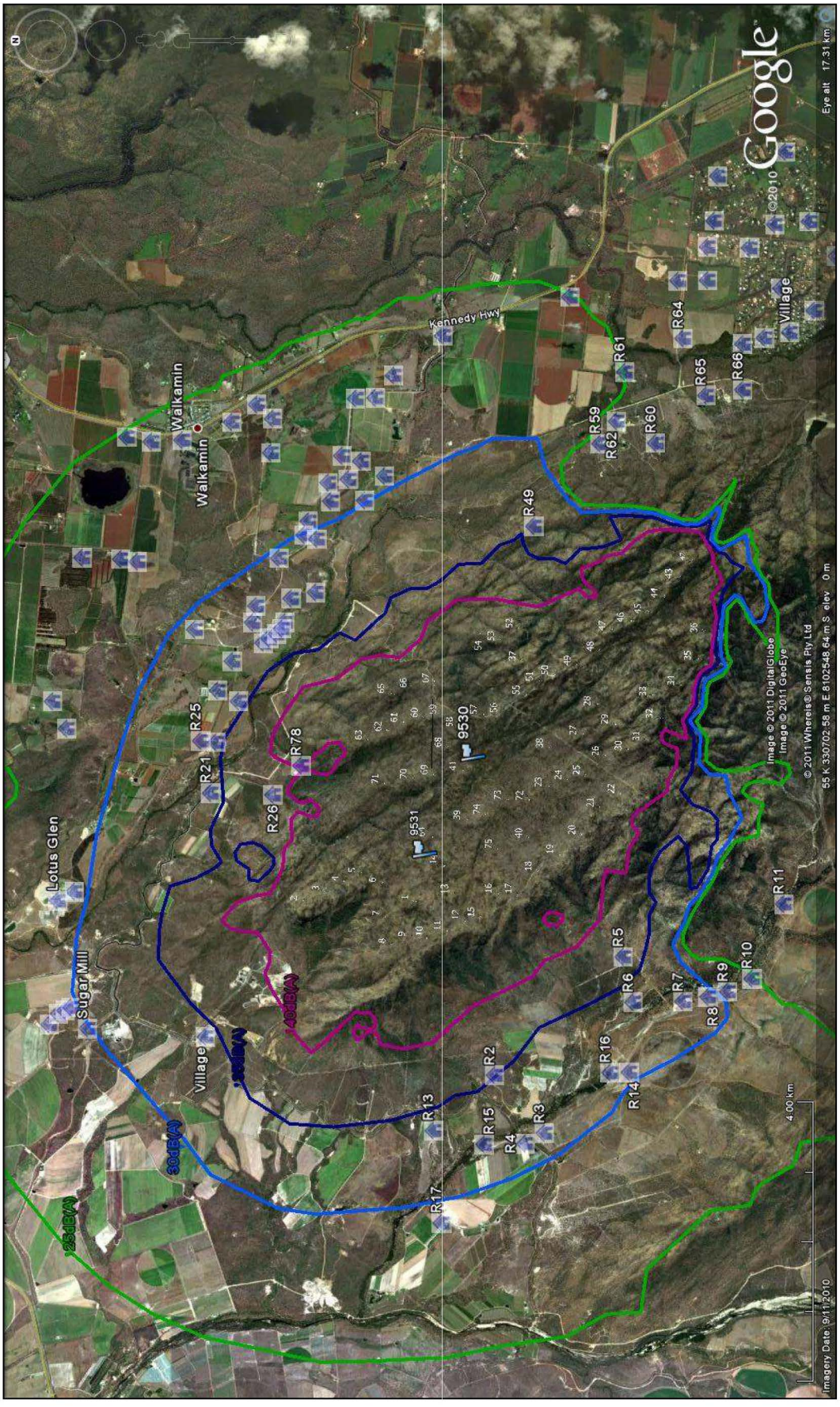

Plate 1: Wind farm showing topography, residences, wind towers and wind turbines.

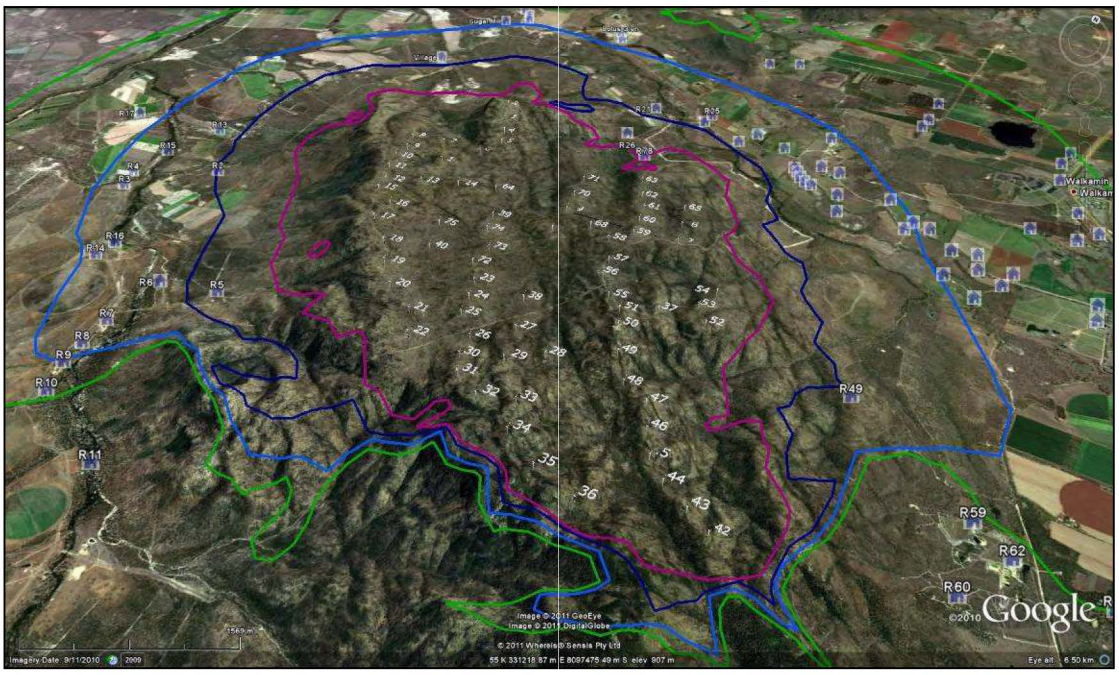

Plate 2: View across Mt Emerald; LAeq noise contours at 10m/s wind from the Noise Report (40 purple; 35 dark blue; 30 light blue). Houses in blue; turbine by number.

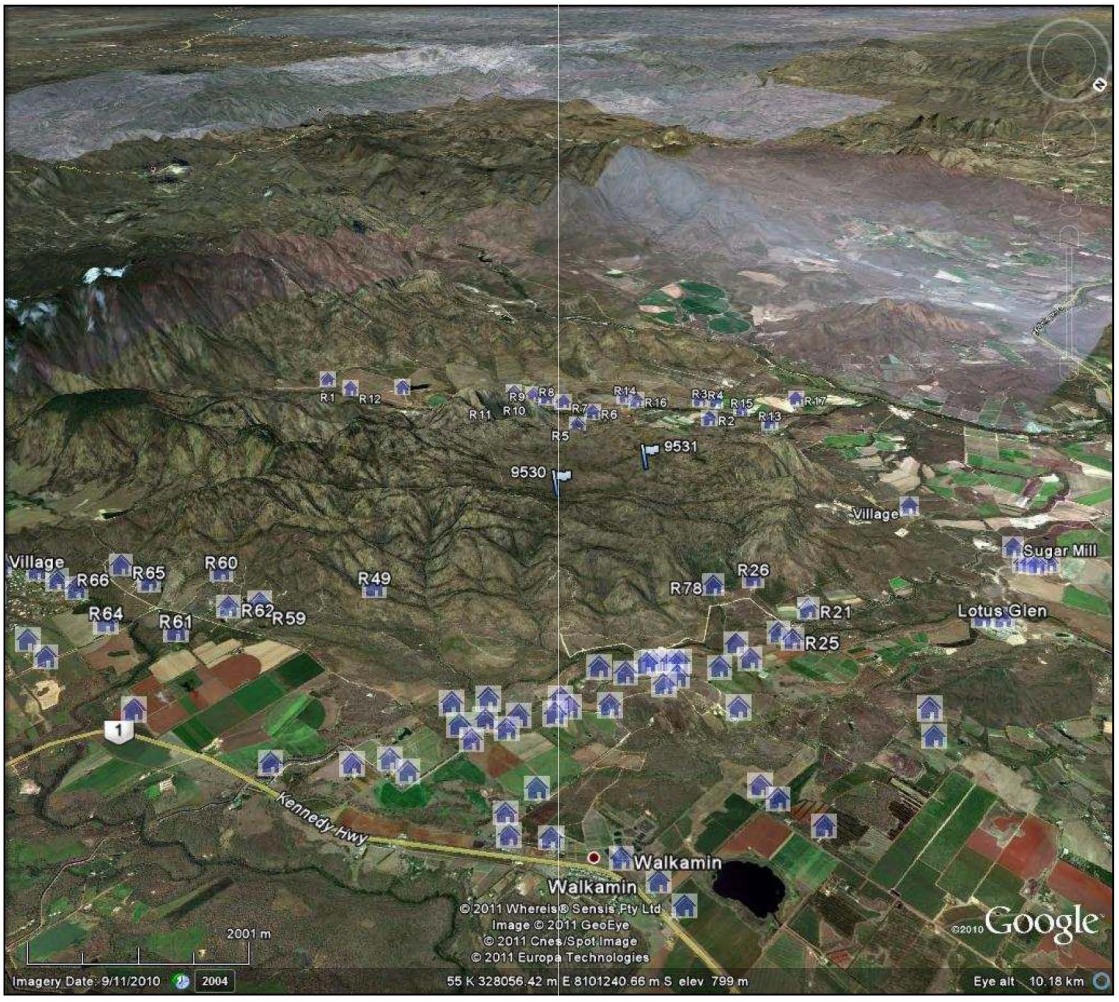

Plate 3: Perspective of the wind farm from the east showing complex ground topography, residences and wind towers.

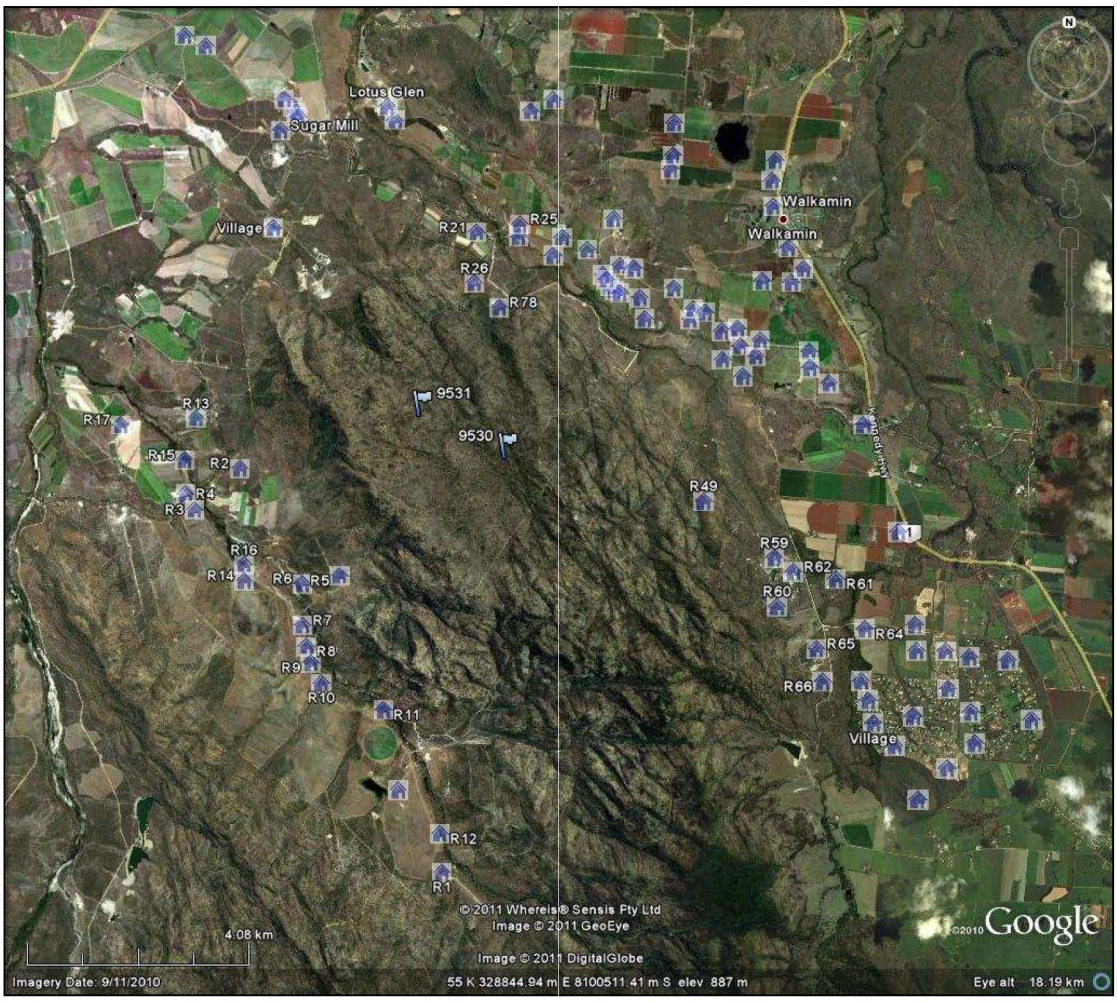

Plate 4: Overview of Mt Emerald showing residences and wind tower locations

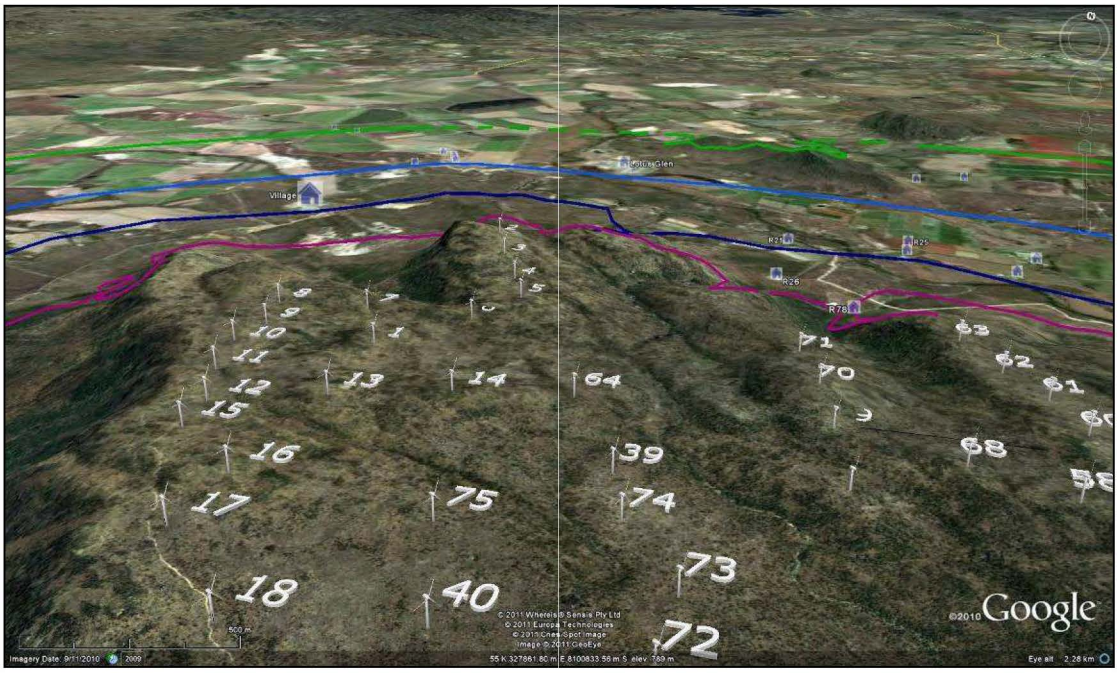

Plate 5: View across Mt Emerald towards Lotus Glen and the accommodation village; LAeq noise contours at 10m/s wind from the Noise Report (40 purple; 35 dark blue; 30 light blue)

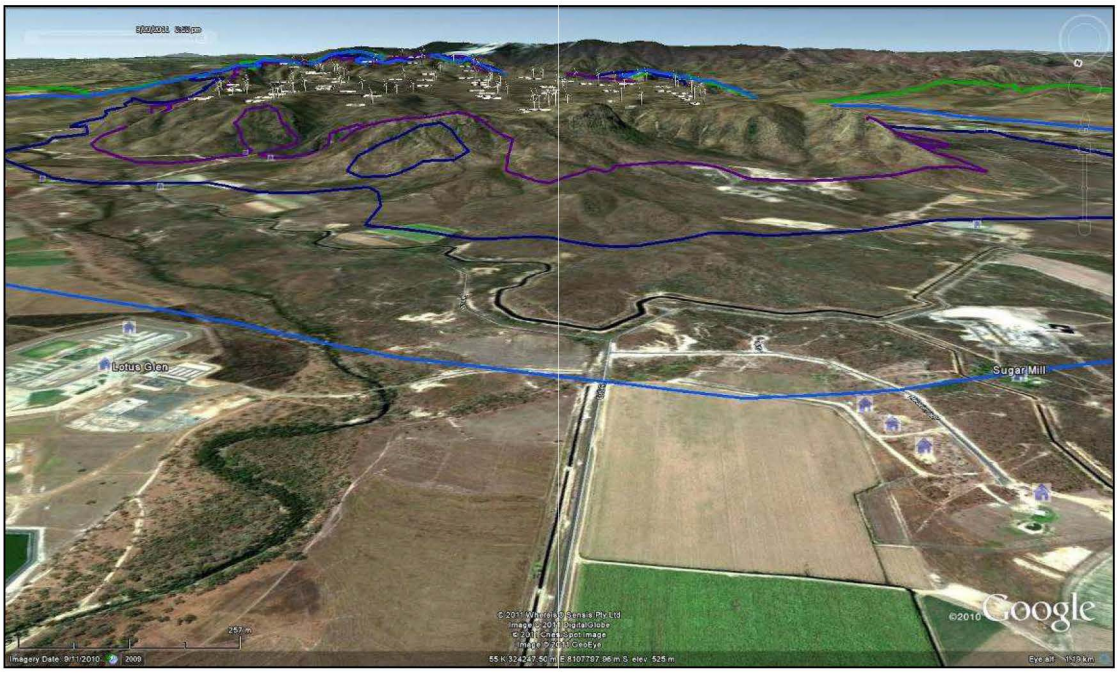

Plate 6: View across Lotus Glen and the accommodation village towards Mt Emerald; LAeq noise contours at 10m/s wind from the Noise Report (40 purple; 35 dark blue; 30 light blue)

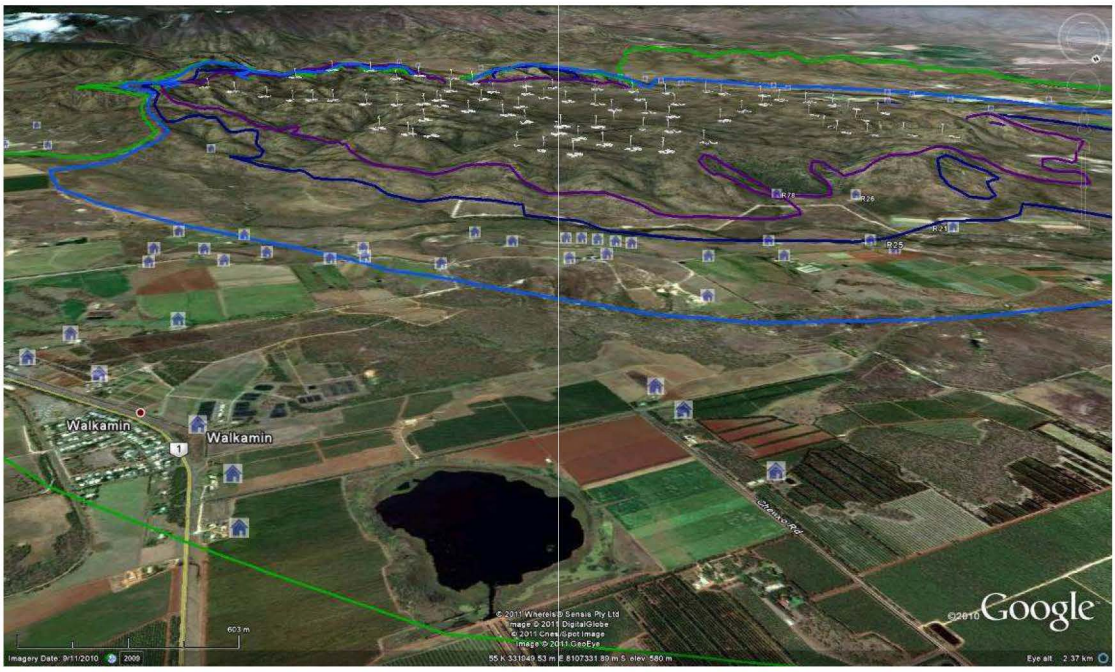

Plate 7: View from east (Walkamin) towards Mt Emerald; LAeq noise contours at 10m/s wind from the Noise Report (40 purple; 35 dark blue; 30 light blue)

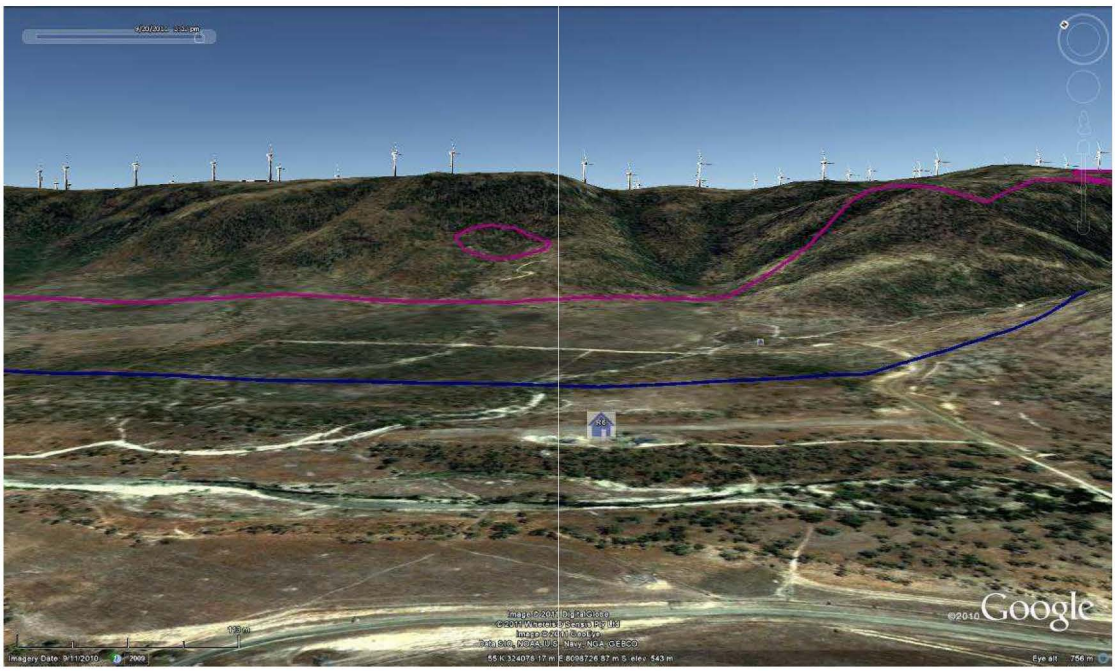

Plate 8: View from west towards Mt Emerald; LAeq noise contours at 10m/s wind from the Noise Report (40 purple; 35 dark blue; 30 light blue)
Note: the turbines are to scale relative to topography

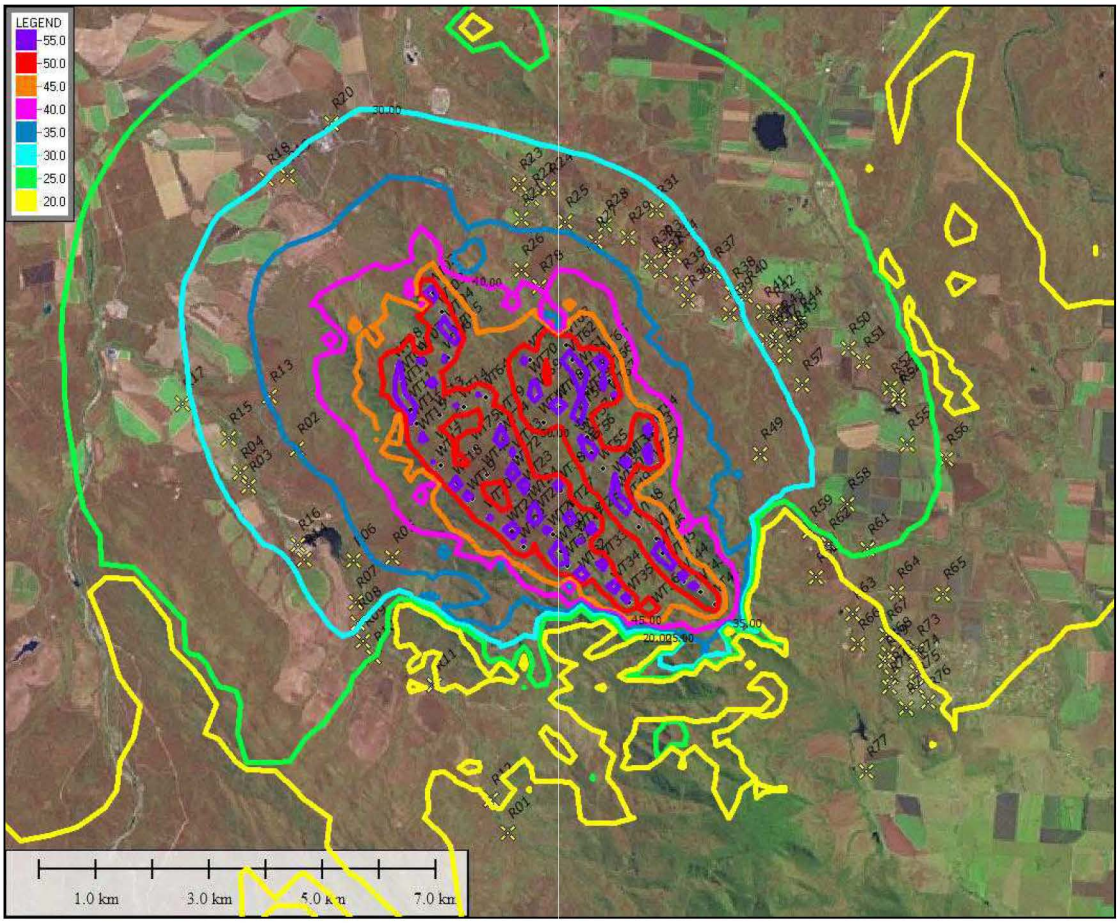

Plate 9: Figure 20 from the Noise Mapping Australia noise report. The contours are the LAeq sound levels for a wind speed of 10m/s (referenced to a height of 10 metres)
Note: the house numbers on Plate 10 may not correspond exactly to the house numbers in the perspectives

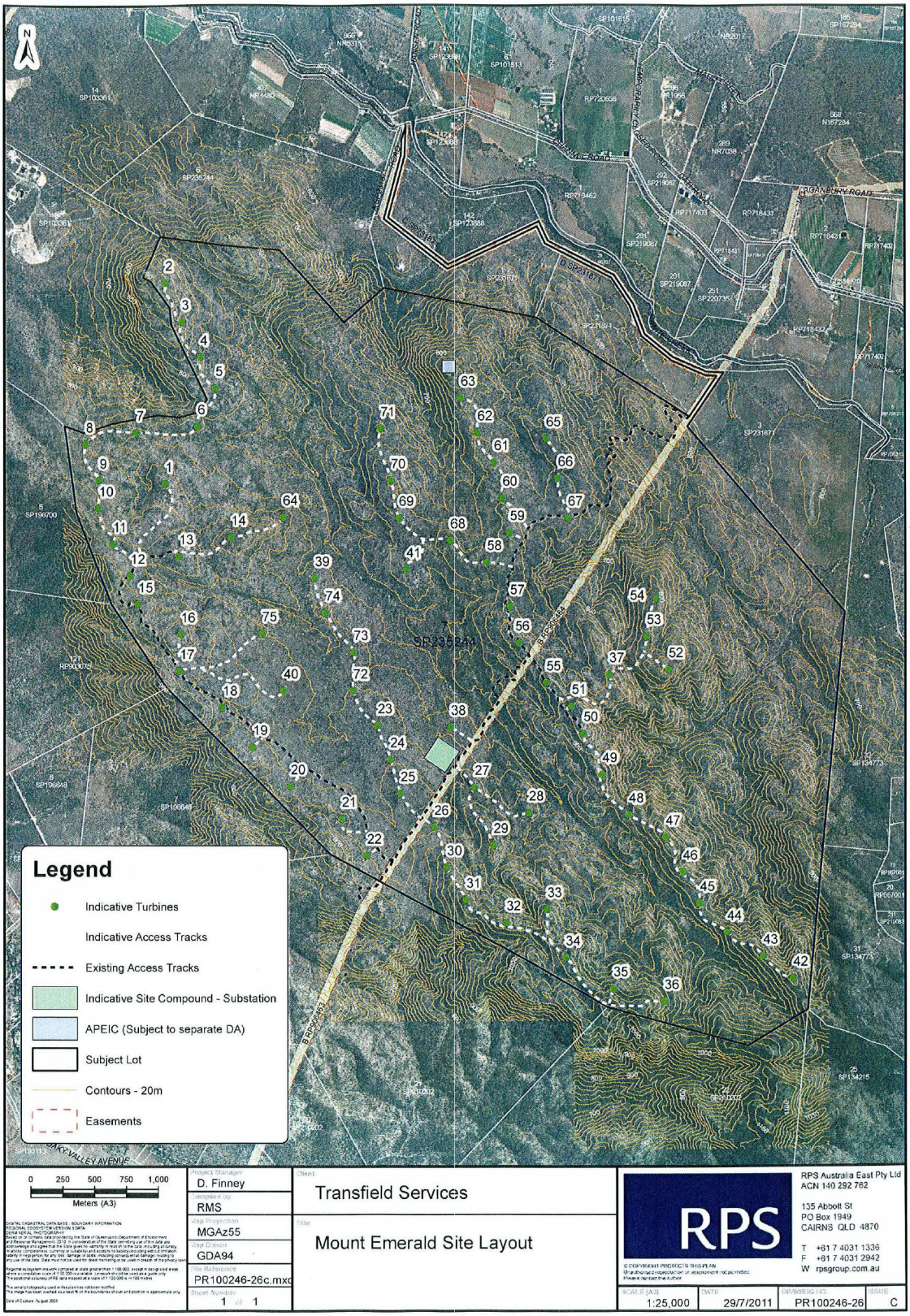

Plate 10: Mount Emerald Site Layout - Plan from applicant prepared RPS Australia East Pty Ltd dated 29/7/2011

ANNEX B: REVISED SOUND LEVELS AT RESIDENCES

Table 9 NMA Noise Report revised according to section 3.6						
Calculated Average LAeq(10 minute) Noise Levels,						
at Each Noise Sensitive Receptor For Wind Speeds at 10 m/s at Reference Height of 10m						
Residence	Enercon E82	Enercon E82		Siemens 3.0	Siemens SWT3.0-101	
	NMA av. level	Variation Hi	Variation Lo	Est. Av. Level	Variation Hi	Variation Lo
1	20	24	16	24	29	19
2	35	39	31	39	44	34
3	31	35	27	35	40	30
4	31	35	27	35	40	30
5	32	36	28	36	41	31
6	34	38	30	38	43	33
7	32	36	28	36	41	31
8	31	35	27	35	40	30
9	28	32	24	32	37	27
10	25	29	21	29	34	24
11	20	24	16	24	29	19
12	20	24	16	24	29	19
13	36	40	32	40	45	35
14	31	35	27	35	40	30
15	32	36	28	36	41	31
16	31	35	27	35	40	30
17	30	34	26	34	39	29
18	30	34	26	34	39	29
19	31	35	27	35	40	30
20	30	34	26	34	39	29
21	34	38	30	38	43	33
22	33	37	29	37	42	32
23	32	36	28	36	41	31
24	32	36	28	36	41	31
25	34	38	30	38	43	33
26	38	42	34	42	47	37
27	35	39	31	39	44	34
28	33	37	29	37	42	32
29	33	37	29	37	42	32
30	33	37	29	37	42	32
31	33	37	29	37	42	32
32	33	37	29	37	42	32
33	32	36	28	36	41	31
34	32	36	28	36	41	31
35	32	36	28	36	41	31
36	33	37	29	37	42	32
37	30	34	26	34	39	29
38	30	34	26	34	39	29
39	31	35	27	35	40	30
40	30	34	26	34	39	29
41	29	33	25	33	38	28
42	29	33	25	33	38	28
43	29	33	25	33	38	28
44	28	32	24	32	37	27
45	29	33	25	33	38	28
46	30	34	26	34	39	29
47	29	33	25	33	38	28
48	29	33	25	33	38	28
49	27	31	23	31	36	26
50	27	31	23	31	36	26

Table 9 NMA Noise Report revised according to section 3.6						
Calculated Average LAeq(10 minute) Noise Levels,						
at Each Noise Sensitive Receptor For Wind Speeds at 10 m/s at Reference Height of 10m						
Residence	Enercon E82	Enercon E82		Siemens 3.0	Siemens SWT3.0-101	
	NMA av. level	Variation Hi	Variation Lo	Est. Av. Level	Variation Hi	Variation Lo
51	27	31	23	31	36	26
52	26	30	22	30	35	25
53	26	30	22	30	35	25
54	26	30	22	30	35	25
55	26	30	22	30	35	25
56	25	29	21	29	34	24
57	29	33	25	33	38	28
58	28	32	24	32	37	27
59	18	22	14	22	27	17
60	6	10	2	10	15	5
61	25	29	21	29	34	24
62	23	27	19	27	32	22
63	18	22	14	22	27	17
64	23	27	19	27	32	22
65	23	27	19	27	32	22
66	17	21	13	21	26	16
67	19	23	15	23	28	18
68	18	22	14	22	27	17
69	17	21	13	21	26	16
70	15	19	11	19	24	14
71	6	10	2	10	15	5
72	11	15	7	15	20	10
73	20	24	16	24	29	19
74	20	24	16	24	29	19
75	19	23	15	23	28	18
76	18	22	14	22	27	17
77	13	17	9	17	22	12
78	40	44	36	44	49	39
Village*	34	38	30	38	43	33
Lotus Glen*	28	32	24	32	37	27
*note: level estimated from noise contour						

Notes to table

- The environmental values of the EPP(Noise) are 'protected' by indoor night-time criteria of 30 dB(A) measured as LAeq, adj, 1hour and 40 dB(A) measured as LA01, adj,1hour (fast response).
- LA01-1 hour is the sound level exceeded for 36 seconds in an hour
- The criteria are maximum values of noise
- The criteria are adjusted for tonal character or impulsiveness
- The adjustment is nominally 5 dB added to the measured sound level (ref AS1055)

Observation by author

- Individuals sensitive to the variable noise from wind turbines are known to need windows closed and residence treated for noise reduction at levels of around LAeq 20 to 25 dB indoors

The Problems With "Noise Numbers" for Wind Farm Noise Assessment

Bob Thorne

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Bob Thorne[1]

Abstract

Human perception responds primarily to sound character rather than sound level. Wind farms are unique sound sources and exhibit special audible and inaudible characteristics that can be described as modulating sound or as a tonal complex. Wind farm compliance measures based on a specified noise number alone will fail to address problems with noise nuisance. The character of wind farm sound, noise emissions from wind farms, noise prediction at residences, and systemic failures in assessment processes are examined. Human perception of wind farm sound is compared with noise assessment measures and complaint histories. The adverse effects on health of persons susceptible to noise from wind farms are examined and a hypothesis, the concept of heightened noise zones (pressure variations), as a marker for cause and effect is advanced. A sound level of LAeq 32 dB outside a residence and above an individual's threshold of hearing inside the home are identified as markers for serious adverse health effects affecting susceptible individuals. The article is referenced to the author's research, measurements, and observations at different wind farms in New Zealand and Victoria, Australia.

Keywords

wind farms, human perception, noise

Wind Farms Are a Unique Source of Noise

Wind farms and wind turbines are a unique source of sound and noise. The noise generation from a wind farm is like no other noise source or set of noise sources. The sounds are often of low amplitude (volume or loudness) and are constantly shifting in character ("waves on beach," "rumble-thump," "plane never landing," etc.). People who are not exposed to the sounds of a wind farm find it very difficult to understand the problems of people who do live near wind farms (Thorne, 2007). Some people who live near wind farms are disturbed by the sounds of the farms, others are not. In some cases adverse health effects are reported, in other cases such effects do not appear evident. Thus, wind farm noise is not like, for example, traffic noise or the continuous hum from plant and machinery. Wind turbines such as those proposed are large noise sources relative to dwellings, and like aircraft, sound emissions are transmitted via the roof and windows. Noise barriers at ground level are generally ineffective in screening or mitigation such sound (Thorne, 2011).

Wind has audible and subaudible characters. That is, measurement of wind sound will always present sound levels in the audible, low-frequency, and infrasonic frequencies. Sound in the low frequencies and infrasound frequencies can be heard if the sounds are loud enough. The sounds, however, may be perceptible rather than heard at relatively lower levels of "loudness."

Evidence produced in New Zealand concerning the West Wind and Te Rere Hau wind farms indicate that the adverse effects of wind farm noise are well documented. West Wind has recorded 906 complaints over a 12-month period. Te Rere Hau has recorded 378 complaints over an 11-month period. Waubra (Victoria, Australia) has a less well documented complaint history but, as recorded in this article, sufficient to identify issues.

Wind farm sound analysis presents three distinct issues:

- The identification of sound that can be directly attributed to the sound of the wind farm/turbines, measured as a background sound level, compared with the sound of the ambient environment without the presence of the wind turbines
- The sound of any special audible characteristics of the wind farm/turbines, such as distinct tonal complexes and modulation effects (amplitude and frequency) that may affect human health through sleep disturbance, for example
- The presence of any sound characteristics that may affect human health

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Sound from modern wind turbines is primarily due to turbulent flow and trailing edge sound, mechanical sound, and variations in infrasound (air pressure variations). Sound character relates to blade characteristics, blade/tower interaction, and mechanical noise and can be grouped into four main bands. The sound can be characterized as being impulsive and broadband, audible and inaudible (infrasonic):

- Infrasound below, 20 Hz (perceptible, normally inaudible)
- Low frequencies, 20 to 250 Hz
- Mid frequency, 250 to 2,000 Hz (broadly, although the higher level could be 4,000 Hz)
- High frequency, 2,000 to 20,000 Hz

Not all these frequencies can be heard by a person with "normal" hearing, as hearing response is unique to an individual and is age dependent as well as work and living environment dependent. It is important to note that infrasound can be "audible" to people with sensitive hearing (Thorne, 2011). Evidence briefly summarized in this article allows the conclusion that there is the potential for adverse health effects for individuals due to wind farm activity while living in their residences and while working on their farms within 3,500 meters of large-scale turbines. Wind farm activity that causes adverse health effects such as sleep disturbance, anxiety, stress, and headaches is a health nuisance, is objectionable, and is unreasonable.

Research indicates that "ordinary" wind has a laminar or smooth infrasound and low-frequency flow pattern when analyzed over short periods of time. Wind farm activity appears to create a "pulsing" infrasound and low-frequency pattern. These patterns are illustrated in sonograms in this article. The hypothesis derived from my research is that wind farm sound has an adverse effect on individuals due to this pulsing nature as well as audible noise due to the wind turbines. These effects may be cumulative.

The Problems With "Noise Numbers" for Wind Farm Noise Assessment

Analysis of "single-value" A-weighted wind farm background levels in the presence of ambient background levels (the real world) is extremely difficult to impossible. This observation is made on the basis of 5 years of monitoring wind turbines at different locales under widely different weather conditions. Figure 1 illustrates the issue: there are the separate sets of sound sources—local ambient, the turbines, and distant sources. It is not possible to separate out the contribution of each source once it is recorded as a single-value (e.g., the "background LA95" sound level or "time-average LAeq" sound level) at a specific location, such as a residence.

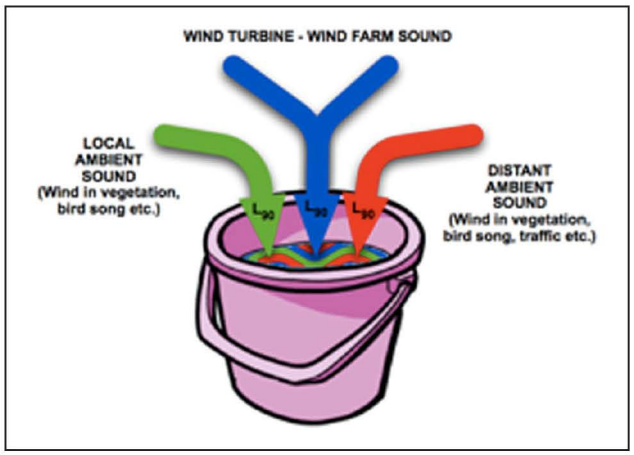


Figure 1. "Bucket of mixed sound" from different sources

By way of example, pour a glass of milk (noise specifically from wind farm activity) into a glass of water (the ambient sound around a residence). Add some extra water for distant sound (wind in trees, distant water pumps, etc.) that affects the background. Now remove the milk. Difficult? Impossible. The three components are completely intermingled. Unfortunately, the example holds true for whatever combination of "single-value" acoustical descriptors are used to describe wind farm mixed with ambient sound levels. A practical alternative is to identify a set of sounds that are specific to the wind farm that are not a characteristic of the receiving environment and reference these sounds. The levels are recorded as, for example, unweighted (*Z*) sound levels in third octave or 1/12 octave bands. Still difficult, but not impossible.

Obviously, loud levels of sound from a wind farm in excess of LAeq 35 dB may be measurable but still very difficult to prove as being the source of sound when mixed into sound from vegetation (wind in trees, for example).

Conversely, it is easy for people to hear wind farm noise within "ordinary" ambient sound.

It is on this fundamental issue that any standard or condition requiring a wind farm to comply with a specific compliance level will fail. The only possible way is to turn the turbines off, measure the ambient levels, turn the turbines on, measure the wind farm and ambient sound levels together, assess the variation and then come to some decision as to compliance. This procedure only applies to an audit process and fails, of course, if noise complaints are being investigated when the wind farm noise and the ambient sound are completely mixed together and the wind farm sound is not clearly dominant.

The problems with understanding the potential effects of the wind farm start with the sound level predictions often used to assess compliance against some form of guideline or legislation.

Prediction of Wind Farm Sound Levels

Sound level predictions are not "accurate"; they do not present the sound levels that will be heard at any one location at any one time. Rather, a prediction is a mathematical equation referenced to a lot of assumptions and uncertainties. Because of this, the predicted levels are also "uncertain." The art in prediction is to identify all the assumptions and uncertainties to present a realistic assessment under realistic daily conditions. This is extremely difficult to do and cannot be done with certainty using simple prediction methods such as ISO 9613-2:1996 *Acoustics-Attenuation of sound during propagation outdoors; Part 2 General method of calculation*.

Conversely, the prediction method can be used to provide an indication of expected sound levels over a long term of 12 months, for example.

To gain an initial understanding of the potential noise levels from a wind farm, it is common practice to prepare a noise map of the locality based on the 9 m/s turbine sound power information and residents living in the locale. Noise predictions do not tell the whole story, however. Meteorological conditions, wind turbine spacing, and associated wake and turbulence effects, vortex effects, turbine synchronicity, tower height, blade length, and power settings all contribute to sound levels heard or perceived at residences. In addition to this, the method of prediction has what is known as "uncertainty."

That is, the predicted values are given as a range, ±3 dB(A) at 1,000 meters for the most common prediction method with the predicted value being the "middle" of the range. The uncertainty increases with distance and the effect of two or more turbines operating in phase with a light/strong breeze blowing toward a residence. A variation of 6 to 7 dB(A) can be expected under such adverse conditions. Thus, on any given day the wind farm background LA95 or "source" time-average (LAeq) sound levels—assuming the wind farm is operating—could vary significantly in comparison with the predicted sound level. This is without the additional effect of any adverse wind effects or weather effects such as inversions.

A typical view from a residence toward the nearest towers approximately 1,800 to 2,200 meters to the south is shown in Photo 1. This shows the turbines side-on to the residence. The side-on angle of the blades allows the effect known as vortex shedding affect the residence. If the blades are full-on, as would be the case with a southwest breeze, the residence is affected by cumulative sound as well as wake and turbulence effects. The effects are potentially more noticeable on the land as there is no screening effect from the pressure changes that can occur. The wake effects are observable when the wind blows from one turbine to the other; the effects are not dependent on the direction of the turbines to the observer. The effect of the turbines at night can be seen in Photo 2.

Photo 1. Wind turbines as seen from a residence

Photo 2. Warning lights and visual effects, a local wind farm

Shepherd and Hubbard (1986) suggest that turbines "shift" from line source to point source decay characteristics at a separation distance of approximately 900 meters. Thus, a wind farm can be considered as a discrete line source consisting of multiple sources that can be identified by distance and spacing (blade swish, blade past tower, wake and turbulence interference effects, and vortex shedding). These sources are identifiable (see Photos 3 and 4). The imaging in Photo 3 shows the different sound levels from the blades of the two turbines.

The pattern in Photo 4 shows clearly the vortex shedding from the blade on the downstroke. The dominant source of sound is from the blades with an overall sound variation in the order of 2 dB(A). The measurements are taken at approximately 150 meters behind the turbine. Frequencies below 300 Hz can also be measured.

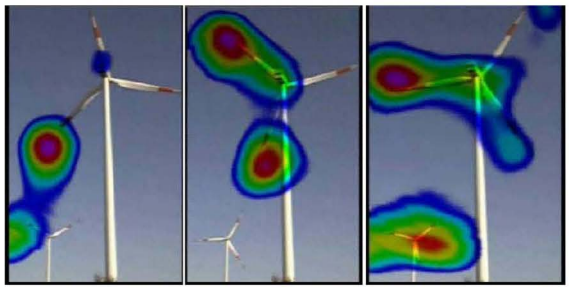


Photo 3. Acoustic photograph of sound sources from two turbines
Source. Acoustic Camera, "Multiple sources wind turbines 300Hz – 7kHz. avi" by permission from HW Technologies, Sydney.

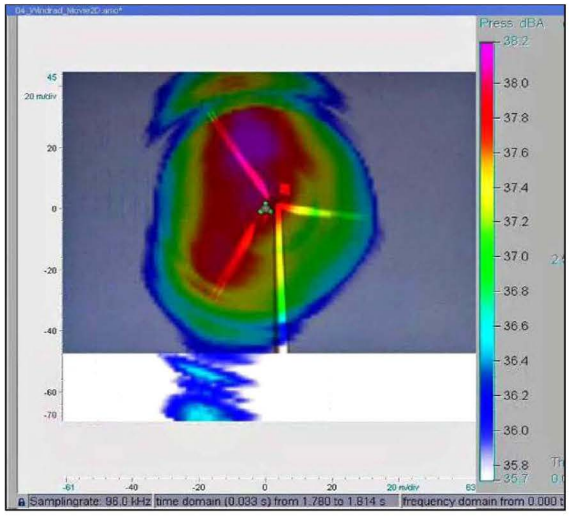


Photo 4. Acoustic photograph of sound sources from a turbine
Source. Acoustic Camera, by permission from HW Technologies, Sydney.

Wake effects are always created as highly turbulent air leaving a turbine interacts with lower speed air. A major wind turbine manufacturer recommends a distance of at least 5 rotor diameters between the wind turbines. Wake effects with pockets of lower speed air are present within 3 rotor diameters downwind and mostly dissipated at a distance of 10 rotor diameters. If a second turbine is situated within 10 rotor diameters of the first turbine, the blades of the second turbine can suddenly enter into a pocket of slower air in the wake caused by the first turbine. I. Shepherd (personal communication, 2010) concludes that increased sound levels will occur and the propagation distance in meters to a defined "criterion" or sound level can be calculated.

The vortex travels downwind in the form of a helix, rotating about its axis with each vortex replacing the previous one in space at approximately 1-second intervals—sometimes more, sometimes less depending on the speed of rotation and number of blades. The practical effect is to create heightened noise zones (HNZs).

It is hypothesized that an HNZ is the combined effect of directional sound and vibrations (wave trains) from the towers, the phase between turbines' blades, lensing in the air or ground, and interference between turbines' noise (audible) and vibration causing very localized patches of heightened noise and/or vibration. The wave train travels in time and the heightened peaks and troughs create a HNZ at an affected residence. The effect has been consistently measured at a residence 1,400 to 2,000 meters downwind from a row of turbines. The HNZ is directly affected by the design and operation of the wind farm (location and type of turbines, phase angles between blades) and wind conditions. These variables and the effects of wind shear are confounding factors that must also be taken into account when predicting the potential for noise from a wind farm.

The HNZs can be small in extent—even for low frequencies and infrasound—leading to turbine sounds "disappearing" and "appearing" in areas spaced only a few meters apart. The concept of HNZ goes a long way in explaining the problem of wind farm noise and its variability on residents. The other factor is the variability of the background sound levels as affected within the HNZs. The turbine sound levels have the effect of lifting the background (when in phase or acting together). The background drops when in the trough between the crest of the HNZ levels. However, this effect can change quite quickly depending on wind direction, temperature conditions, and turbine activity.

In summary, the prediction of wind farm sound levels at a receiver depends on a whole range of different assumptions and uncertainty, for example:

- The true sound power level of the turbine(s) at the specified wind speed
- The reduction in sound level due to ground effects
- The increase or reduction in sound level due to atmospheric (meteorological) variations and wind direction
- The variation due to modulation effects from wind velocity gradient
- Increase and reduction in sound levels due to wake and turbulence modulation effects due to turbine placement and wind direction
- Increased sound levels due to synchronicity effects of turbines in phase due to turbine placement and wind direction
- Building resonance effects for residents inside a dwelling

Wind farm noise level predictions can therefore be considered as only approximations of sound levels and cannot be given any weight other than this. The reasons are due to the highly complex nature of the sound created by each individual turbine and the cumulative effects of a number of turbines. Unfortunately, noise predictions are often taken as

Table 1. Average LA95 Sound Levels Recorded at Residence (Levels Rounded)

Date	LA95 Day, 7 a.m. to 6 p.m.	LA95 Evening, 6 p.m. to 10 p.m.	LA95 Night, 10 p.m. to 7 a.m.
October 15	—	35	—
October 16	37	40	32
October 17	34	32	36
October 18	29	26	27
October 19	29	29	25
October 20	34	31	29
October 21	34	29	31
October 22	30	31	33
October 23	32	25	36
October 24	33	35	26
October 25	38	—	—

being 100% true by naïve approving authorities. This sense is often bolstered by consultants claiming their predictions are "conservative" when in fact they are nothing of the kind. A conservative set of predictions includes all assumptions and uncertainties for different times of day/night, different weather/wind conditions, and the cumulative influence of the whole wind farm.

The situation becomes worse when the predicted levels are referenced to background sound levels as is the case with many wind farm guidelines, standards, and compliance requirements. These conditions are often called "background-plus" criteria where the compliance levels are determined against measured or predicted background sound levels.

Background Sound Levels

Background sound levels are the cornerstone of many acoustical standards dealing with wind farm noise. But what are background levels and how are they measured? Are they constant? Can anyone say with certainty that a background level measured at one location will be the same as in another nearby location? Does the wind affect the levels of background sound? How can wind turbine sound be identified in background sound?

These questions are answered by observations for a case study, "The Dean Report" (Thorne, 2010), taken at two different times in 2009 under different weather conditions. Although the residence is affected by wind turbine noise, a series of ambient and background sound levels were recorded in order to gain an indication of the levels within the locale. Ambient recordings were taken over the period October 15-30, 2009. Ambient A-weighted sound levels were measured generally in accordance with Australian Standard AS1055.1:1997. The ambient sound levels were recorded at 10-minute intervals over a 10-day period (see Table 1). Weather data (wind speed and direction, temperature, and humidity) were recorded for the same time period. Nighttime is recorded as from 10 p.m. the previous day to 7 a.m. on the nominal day.

Table 1 shows the wide range in sound levels at the residence. The levels, at approximately 2,000 meters from the turbines, show the impossibility of determining when or if the wind farm is exceeding a background level of 35 or 40 dB(A). It can be inferred that for some of the time the wind farm is in compliance but at other times it might not. The situation becomes more difficult if there is sufficient breeze to cause a significant lift in background levels.

Finally, if compliance depends on the presence—or not—of audible tones or modulation, then determination becomes near impossible without people to describe the character of the sound. Due to the nature of an operational turbine, modulation is a continuous feature of the wind farm under normal operational conditions—but the sound may not always be audible. In this case the residence is not occupied and the character of the sound—audible modulation in particular—cannot be determined "all the time" on the basis of personal physical observation. The background sound levels are often adjusted for special audible characteristics such as modulation or tonality. Modulation can, however, be determined from sound recordings from a calibrated sound level meter at a relevant time and place investigating the sounds of the wind farm.

The important compliance issue is, "How can special audible characteristics be measured in real time." The answer is, "With difficulty." Either of these two criteria requires full-time real-time monitoring in order for compliance to be proven or not proven at any affected residence.

Sound propagation varies significantly under different wind conditions and influences both the background levels and the character of the sound, especially:

- When there is a strong breeze at the turbines but no or little breeze at the residence
- When the prevailing breeze is blowing from the wind farm to the residence
- Under conditions of cool, clear evenings/nights/mornings when a mist (inversion) covers the ground

This latter condition is sometimes (in Australia) called the "van den Berg effect." It is a common condition and is explained further in this article. My own observations at operational wind farms at distances of around 1,400 meters show that sound levels are higher under calm or inversion conditions (cold clear night) at the observer than under unstable conditions (e.g., light breeze during the day). Sound levels under inversion conditions are often louder and clearer at observer locations. The effects of temperature inversion in the locale supports inversion (fog) conditions and enhanced and elevated sound levels at the residences are expected. Under stable or inversion conditions sound levels do not decay as quickly compared with unstable conditions.

Thus, the real sound levels from the wind farm may vary considerably within any 24-hour period, due to weather conditions. As with special audible characteristics, measurement

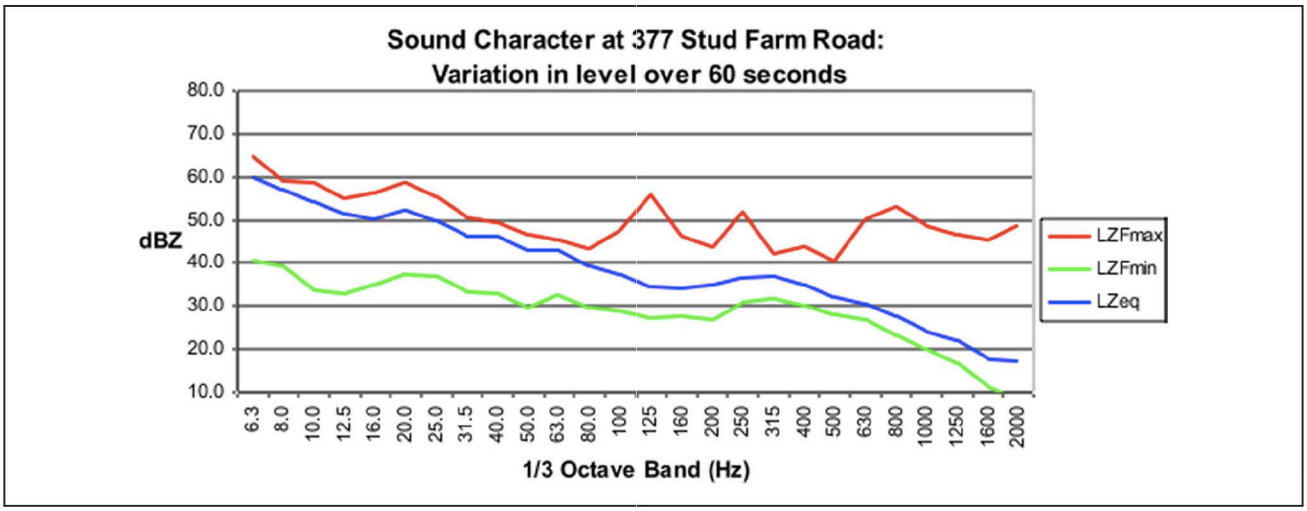


Figure 2. Variation in sound character over 60 seconds

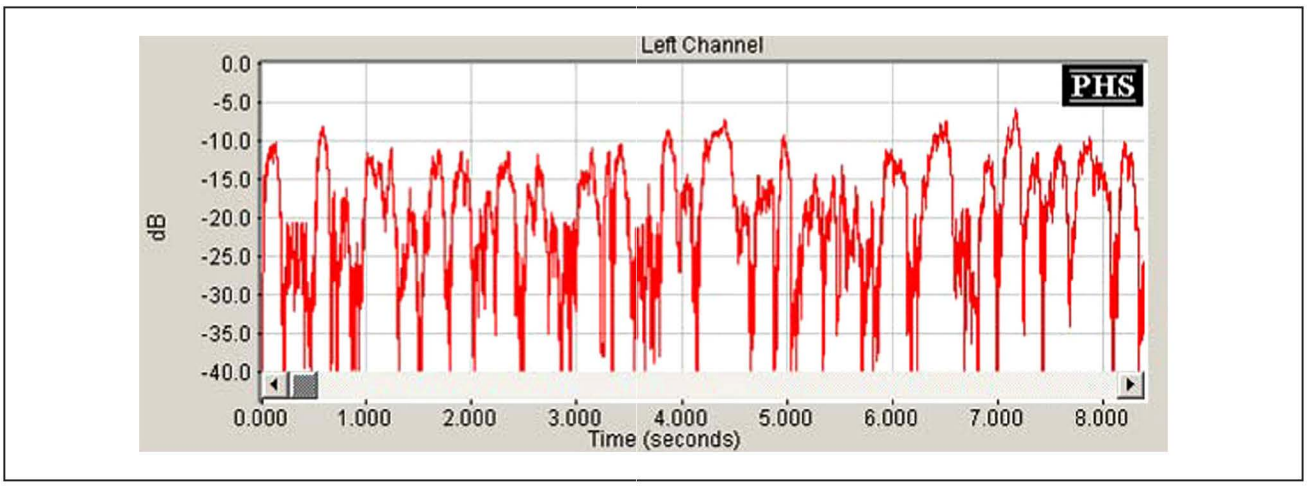


Figure 3. Pulse pattern from an operational wind farm

of wind farm noise for compliance requires full-time real-time monitoring in order for compliance to be proven or not proven at any affected residence. This applies to both audible and inaudible sound.

Audible Sound Character

The operation of the turbines to the southwest of the residence can be clearly heard at the residence. The sound on Thursday evening at 9:40 p.m., October 15, 2009, can be described as a steady rumble with a mixture of rumble-thumps. Wind in the trees or vegetation is not intrusive. Figure 2 presents the variation between maximum, minimum, and average (Leq) unweighted sound levels. Unweighted ("Z" weight sound levels) are referenced to assess the audibility of the sound.

In 60 seconds the sound character varies regularly by more than 20 dB; this level of variation will be audible. The generally accepted variation for a clear sense of audibility is 3 dB. Far finer detail is available by analyzing the sound into amplitude variation over the 60 seconds (see Figure 3). The figure shows the regular pulsing or modulation that is typical of blade passing the tower.

The background ambient sound levels for the assessment in Figure 2 references ambient levels recorded at the residence when the turbines were not operating. To confirm that a sound is audible to a person of "normal" hearing, an analysis of broadband sound such as the sounds recorded on the Thursday and illustrated in Figure 2 can be further analyzed for audibility. The higher the orange line is above the green line in Figure 4, the more clearly the signal can be heard. As a guide, a 3 dB shift can be readily heard. The sound is also compared against the hearing threshold level for a "normal" person.

From just this short survey it can be concluded that the wind farm was in noncompliance with a 40 dB(A) background criterion that includes a penalty for special audible characteristics. Sound from wind farms can be easily heard

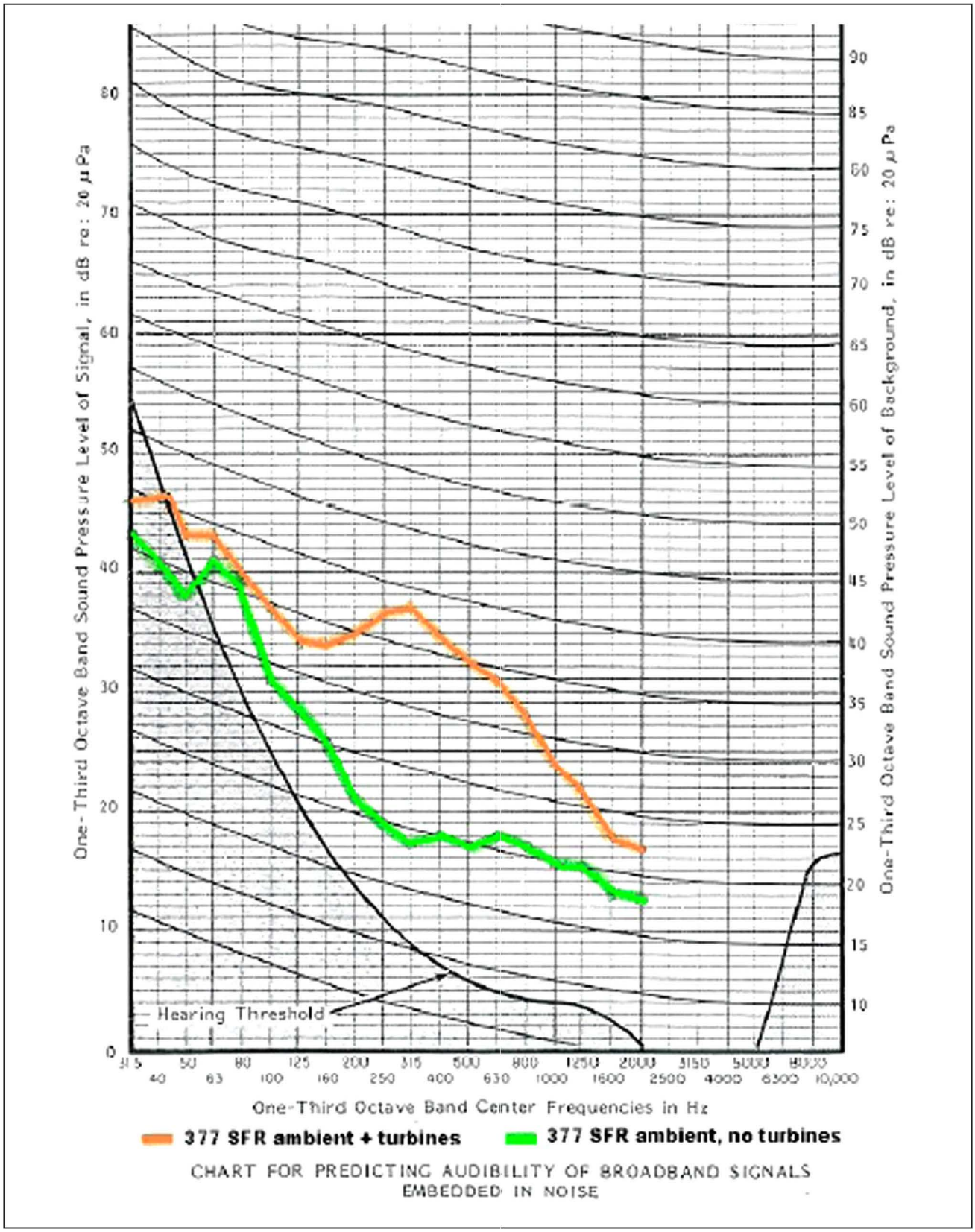


Figure 4. Audibility of wind turbines at a residence

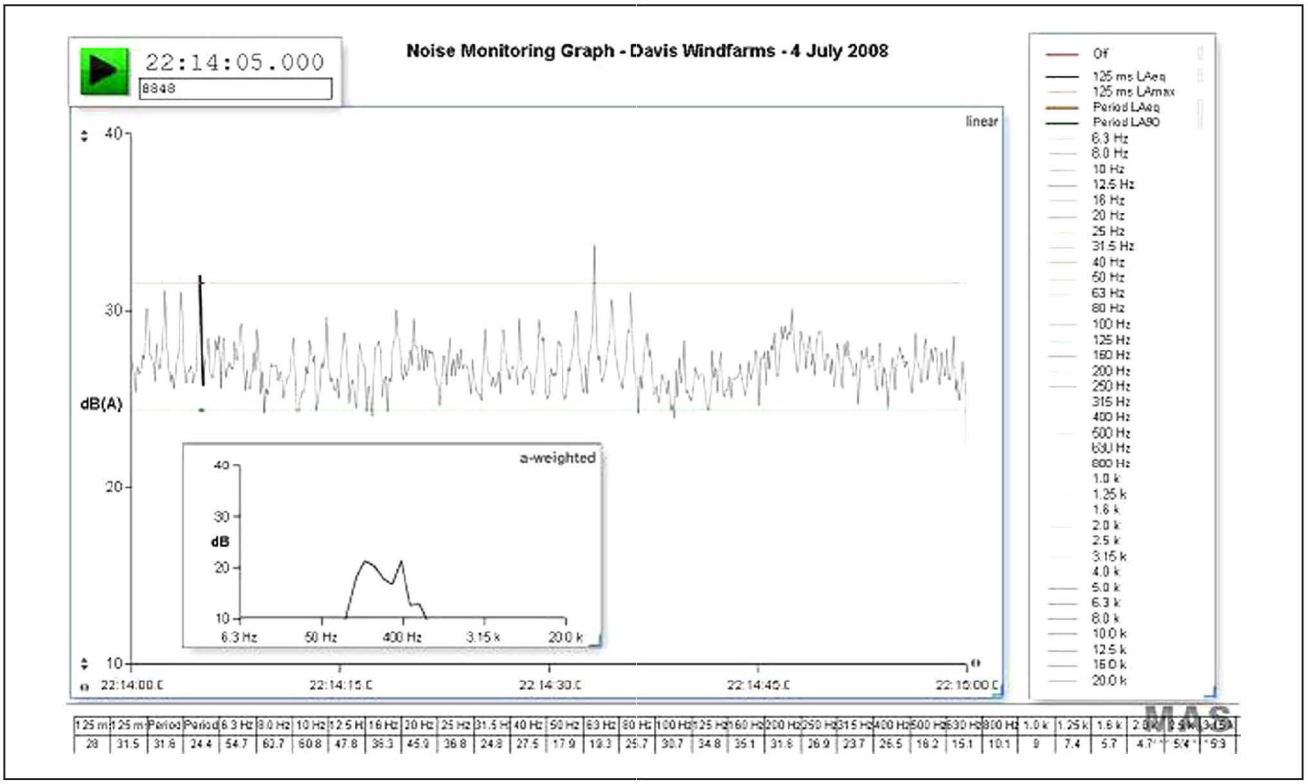


Figure 5. Sound of wind turbines at 930 meters, inside residence

at distances of 2,000 meters; such sound was measured as the background level over the range 29 to 40 dB(A) with conditions of calm to light breeze. The sound was modulating and readily observed and recorded. The sound can be defined as being both unreasonable and a nuisance. But in this case the sound is also causing adverse health effects to exposed residents. It is concluded that the reason for this is the effects of audible nuisance noise and infrasound.

Low-Frequency Sound and Infrasound

The issue of low-frequency sound and infrasound has been a controversial topic for many years. Figure 5 illustrates audible sound as well as both low-frequency and infrasound as heard inside a bedroom approximately 930 meters from a set of wind turbines. The modulating character of the sound is clearly defined in the first 5 seconds as a pattern of three spikes. The chart shows that low levels of sound are clearly audible inside a dwelling. The interior level for the 60 seconds is LAeq 31.6 dB. There are clear and distinctive audible, low-frequency, and infrasound levels. The residents (the United Kingdom) have vacated the dwelling.

In the Waubra case study, the sounds of the wind turbines were recorded at the residence and in the locale. Figures 6 and 7 illustrate the sound levels and character of the sound, including ambient wind, outside the residence. The initial survey was only for the time period 19:40 October 15, 2009, to 01:40 October 16, 2009. The wind dropped after 20:10 and the sound levels decreased.

The outdoor sound levels indicate fluctuating background (LA90, LA95) sound levels with significant variations in the "time-averaged" level, LAeq. The variations are not unusual. The LA95 level for the time period is 33.9 dB(A). The overall sound character shows slight variation between the time-averaged level, LZeq, and the maximum levels, LZmax, in each third octave band. The variation, however, is in the order of 6 dB or more in each band and this is audible.

The initial survey recorded the sound levels inside the residence. Figures 8 and 9 illustrate the sound levels and character of the sound, including ambient wind.

Figure 8 represents a time slice for the beginning of the survey when the sound of the turbines was audible outside. The inside background (LA90, LA95) sound levels are compared with the `time-averaged' level, LAeq. The consistency in level is not unusual for inside a home. The LA95 level for the time period is 17.4 dB(A). The average level is LAeq 32.5 dB. At 8 p.m., the wind dropped and the sound levels within the home decreased, with an average sound level of LAeq 18 dB, just above the background level.

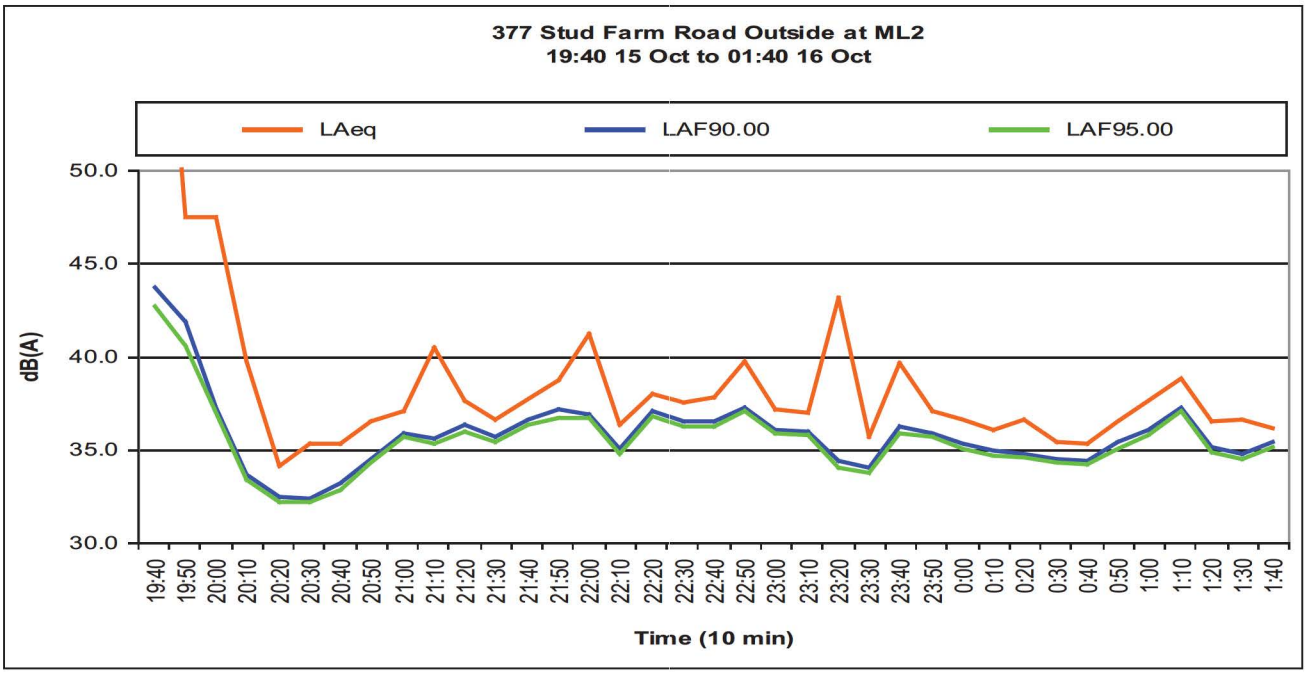


Figure 6. Outdoor sound levels for the initial survey

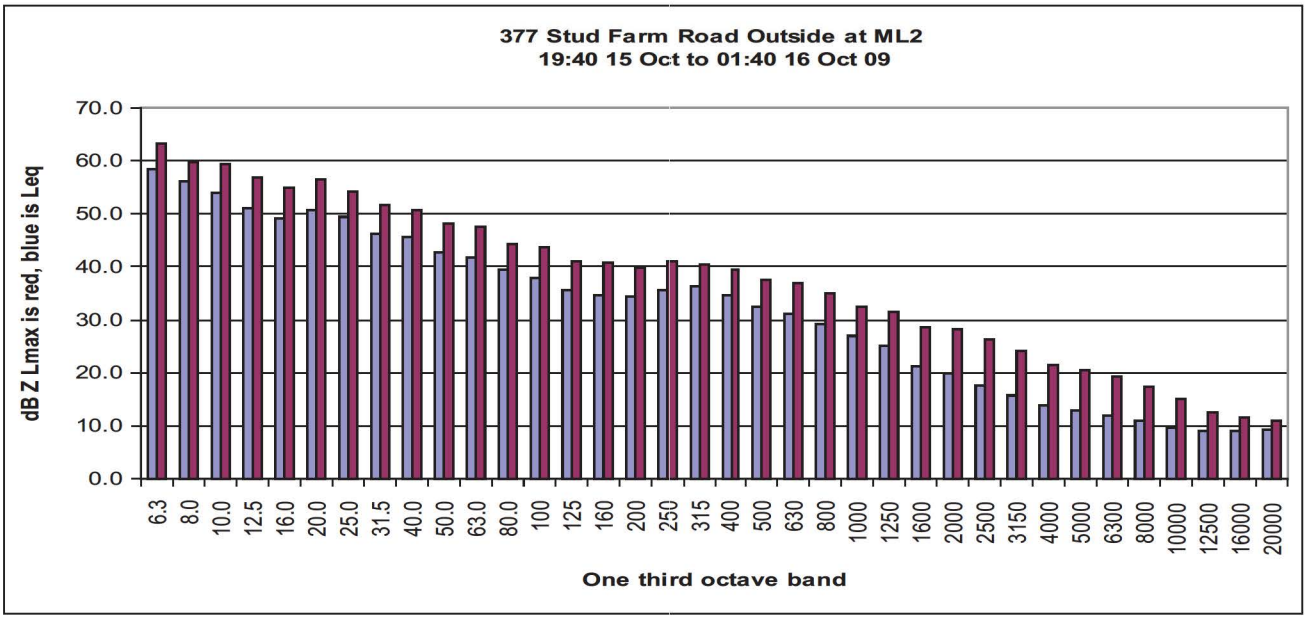


Figure 7. Outdoor sound character for the initial survey

The caution here is that sound levels vary significantly over very short (10 minutes, for example) periods of time. Thus, an assessment on an average longer-term level (Figure 8) may not truly represent the short-term effect of varying sound character (Figure 9).

The observation from Figure 9 is that the overall sound character shows substantial variation between the minimum level, LZmin, and the maximum levels, LZmax, in each third octave band. The variation is significant above 20 Hz because this is when the difference in sound levels becomes audible. The levels show the failure of A-weighted statistical levels in presenting the true sound character.

Sound levels were recorded inside the residence main bedroom over the time period 9:12 a.m. October 12, 2009, to 10:02 a.m. October 13, 2009 (see Figure 10). The wind farm was in operation at this time. The sound levels were

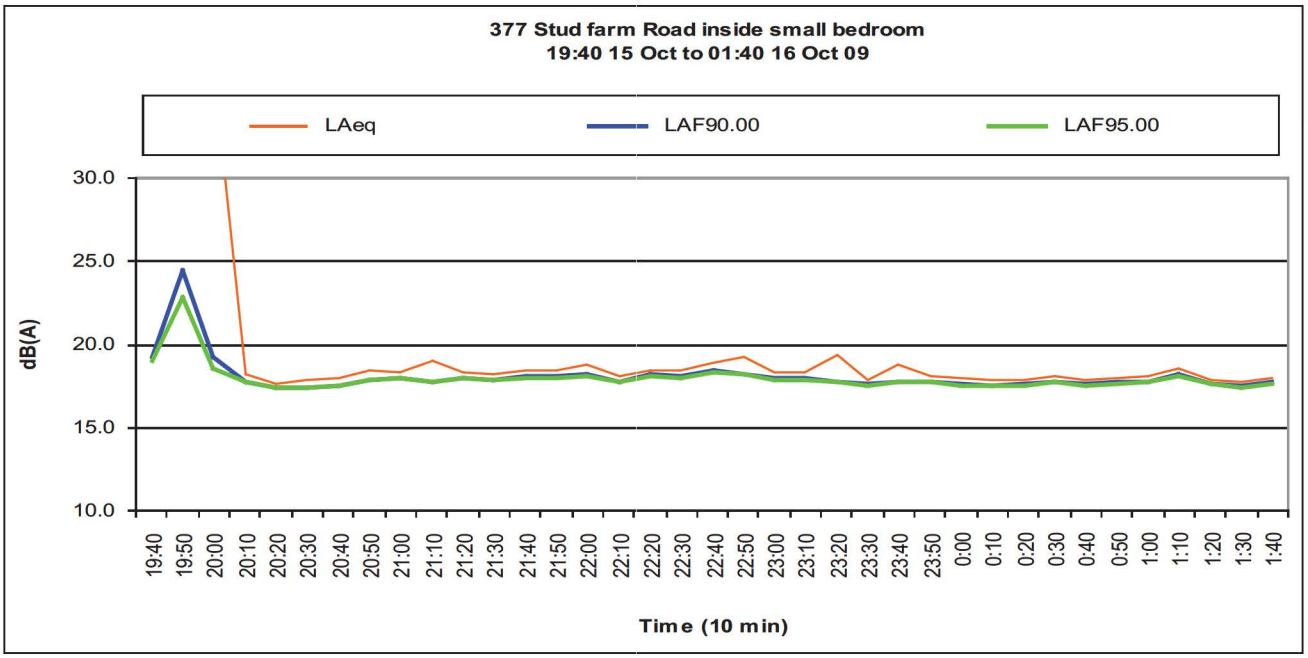


Figure 8. Indoor sound levels for the initial survey

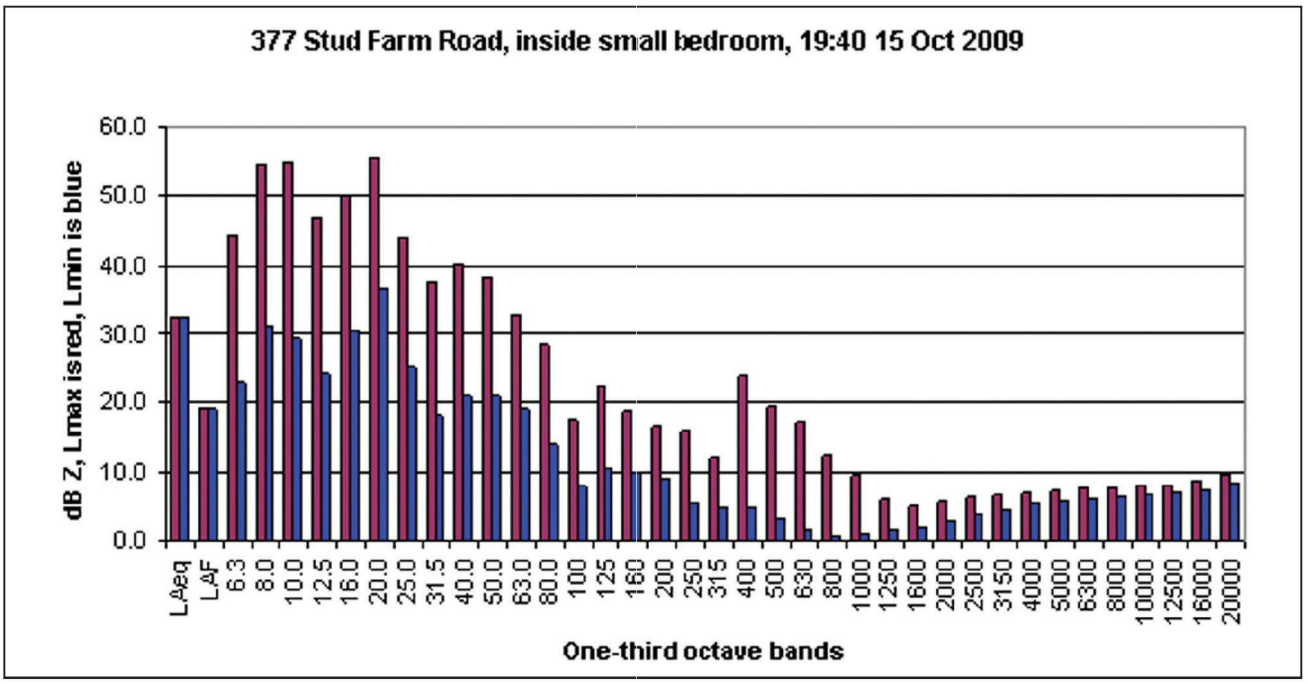


Figure 9. Indoor sound character for the initial survey

recorded in third octave bands every 30 seconds and the average levels for this time period are presented in the following. The SVAN sound level meter is able to record to a lower frequency compared with the Larson Davis 831 meter.

The character of the sound levels is similar to the time-average level *outside*, but there is significant variation between the levels in the two bedrooms. The point is to show that rooms in a residence can and will show significantly different characteristics. What may be inaudible or not perceptible in one room can be easily heard or perceived in another room on the same side of the house. The other concern is that the main bedroom appears to have little sound reduction from outside to inside. The recorded levels are with turbine activity and it is concluded that ambient and wind farm activity will be audible within the bedrooms.

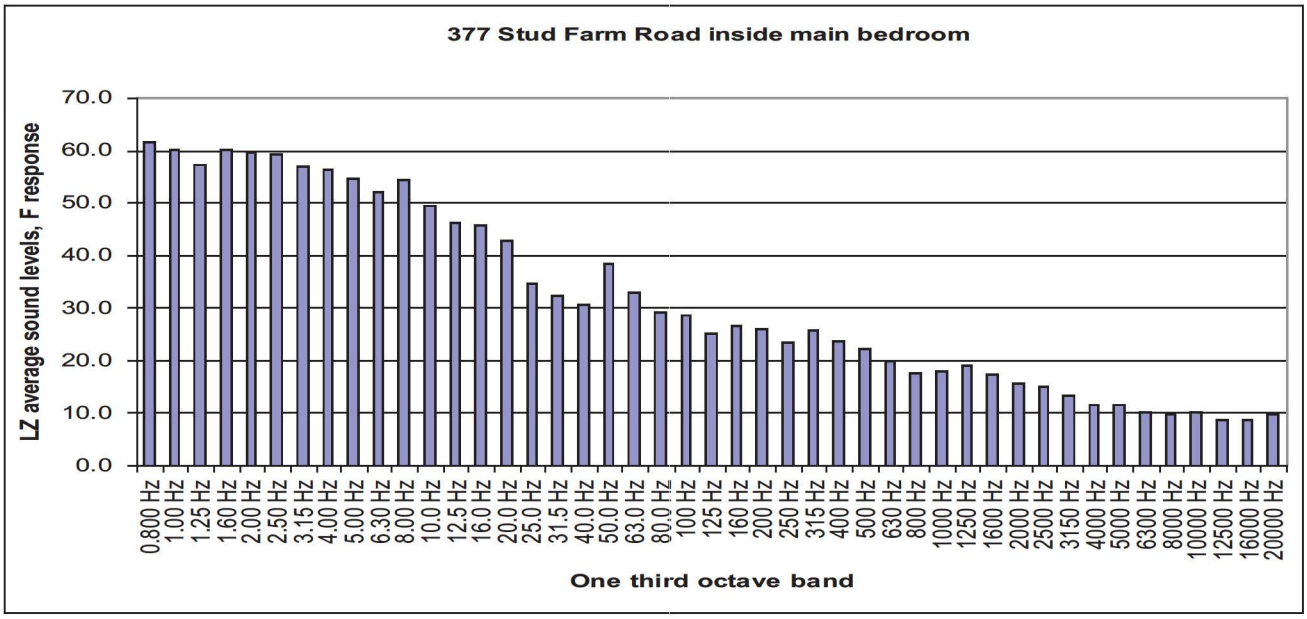


Figure 10. Indoor sound character (main bedroom)

Sonograms are presented to illustrate specific locations with and without turbine activity. The sonograms illustrate the presence of turbines even though the activity may not be audible. Different time segments are used to illustrate the effects. The important features are the following:

- The significant amount of sound energy in the low-frequency and infrasonic ranges.
- The variation of 20 dB between high and low values in the sonograms between the yellow bands and the purple bands. This variation is audible under observed conditions.

The overall levels in one third octave band charts are provided to illustrate the difference between maximum and minimum sound levels in the measurement time period. These correspond to the peak and trough values and give a "first-cut" assessment of whether or not audible modulation, audible tonality, perceptible modulation, or perceptible tonality may exist. Charts are provided as examples of the sound character. The sonograms are taken from recorded audio files that are 60 or 30 seconds in length. Hence, the displayed sonogram charts can differ from the one third octave band charts, which are calculated over a full 10 minutes.

The case study illustrates the difficulties in measuring and assessing wind turbine sound. Sound level criteria referenced to an A-weighted sound descriptor do not accurately describe the sound or perception of a wind turbine or a wind farm.

The study by Thorne (2010) records that wind turbine sound at the residence is perceptible and can be analyzed and assessed in a meaningful way.

The sound character of the wind farm is clearly different from the locale and indicates the presence of modulating sound. The sonograms and third octave band charts presented are provided to illustrate the character of the sound. The method developed by H. Bakker, Astute Engineering, New Zealand (personal communication, 2010) displays sound character, modulation, tonality, or tonal complexes through sonograms. These show sound at various frequencies over time as shown in Plate 1. They can be thought of like a sheet of music or an old pianola roll; the left axis is frequency—musical pitch—while the bottom axis is time. Amplitude and frequency modulation can be identified in the sonograms by distinctive regular patterning at 1-second (or longer or shorter) intervals. Tonality and tonal complexes can also be identified using sonograms. The color indicates the loudness in unweighted dB (SPL) with the color bar at the right providing a key to the "loudness" in decibels associated with each color. The values (−30 to 20, for example) on the right-hand side of the sonogram are decibel levels. Loud notes appear yellow or while; soft notes would appear purple or black. (In these sonograms, much of the color scale has been made black so that peaks stand out better.) Generally, the sonograms are not calibrated against measured sound level but present a comparison between peak and trough (maximum and minimum) levels in a short period of time. At the time of recording it is possible to include reference sound levels in order to assess the sonogram values against measured values.

There are two types of sonograms shown, one is for audible frequencies (20-1,000 Hz) and the other is for low frequencies (0.8-20 Hz), referred to as *infrasound*. The use of sonograms can show the presence of modulation. The rumble/thump of

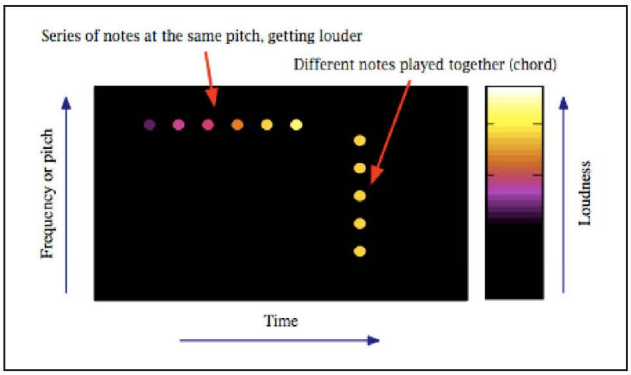


Plate 1. How to interpret a sonogram

wind turbine modulation has been demonstrated to exist in three geographically separate wind farms.

Sound Character at Residence, Plate 2

Plate 2 illustrates the sound of wind farm audible at 7:40 p.m. outside residence, as well as wind in trees, voices, setting-up activity, and a distant vehicle. The sonogram shows a distinctive 50 Hz tone from a nearby electrical source, as well as strong readings at 20 Hz, 16 Hz, and 6.3 Hz. These are indicator frequencies for potential adverse health response. The regular bands or modulations at around 1 Hz indicate wind turbine blade pass frequency. Higher frequency contents (800-5,000 Hz) not evident in the sonogram are evident in the third octave bands.

Sound Character at Residence, Plate 3

The audio file identifies wind and wind farm sounds. There are strong readings at 20 Hz, 16 Hz, and 6.3 Hz. These are indicator frequencies for potential adverse health response. The regular bands or modulations at around 1 Hz indicate wind turbine blade pass frequency. Higher frequency content (800-5,000 Hz) evident in the third octave band chart is not evident in the sonogram. Low-frequency content is evident in both the sonogram and the third octave band chart.

Sound Character at Residence, Plate 4

Wind farm not audible outside residence. The wind pattern is completely different from the previous two sonograms. There is a distinctive 90 Hz tone from an aircraft. Animal and bird noise provide the character. The strong readings at 20 Hz, 16 Hz, and 6.3 Hz have gone. The previous regular bands or modulations at around 1 Hz indicate wind turbine blade noise has gone and instead there are smooth bands of sound from "ordinary" wind flow.

Sound Character Between Two Sets of Turbines, Plate 5

The wind farm was audible at the measurement location as a distant rumble and some of the nearest visible turbines approximately 500 to 1,500 meters distant were moving slowly, as though they were starting up. The sound is similar to an aircraft overhead, although the sound was not from a plane. There are strong readings at 20 Hz and below on a regular basis although there was little or no breeze. The regular bands or modulations at around 1 Hz indicate wind turbine blade pass noise.

Sound Character Inside Residence, Plate 6

Sound levels measured inside a small bedroom. The audible sound character (200-400 Hz) is from distant voices within the house. Wind farm not audible outside residence: turbines to the north turning slowly, turbines to the south not turning. There are strong readings at 20 Hz and below on a regular basis. There was no ground-level breeze outside during the recording. There is evidence of normally nonperceptible infrasound and audible midrange frequencies within the bedroom.

Responses of Residents Living Near Wind Farms

Community noise exposure is commonly measured in terms of a noise exposure measure. Noise exposure is the varying pattern of sound levels at a location over a defined time period. The time period is most often 1 day (short term) or over weeks, months, or a year (long term).

The practical difficulty in locale measurements is that many of them are needed to describe a neighborhood. It is customary, therefore, to use a suitable single-number evaluation for community neighborhood noise exposure. Individuals, however, are different in their tolerance to specific sounds: there is a distinct duration-intensity relationship that varies depending on the character of the sound (Thorne, 2007).

There is no defined relationship that can predict when a noise is reasonable or unreasonable; for this to happen, the sound must be audible or perceptible to cause an adverse response in the person affected.

Previous wind farm investigations in New Zealand and Victoria, Australia, indicate that residences within 3,500 meters of a wind farm are potentially affected by audible noise and vibration from large turbines, such as those proposed. Residences within 1,000 to 2,000 meters are affected on a regular basis by audible noise disturbing sleep. Adverse health effects are reported and as these effects did not occur before the wind farms became operational a reasonable hypothesis is that the wind farm activity has a causal relationship (Thorne, 2007, 2011).

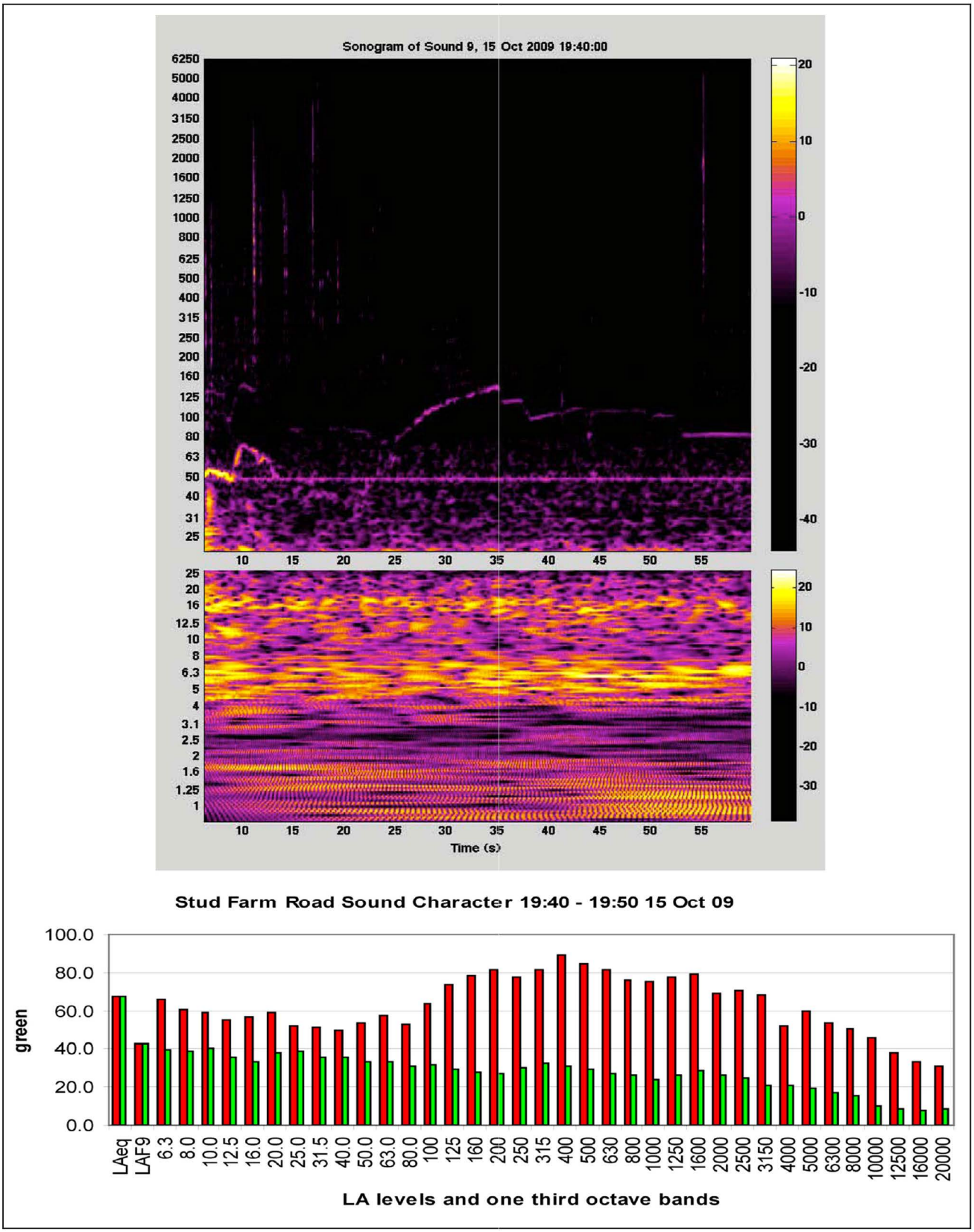


Plate 2. Sound of wind farm audible outside residence

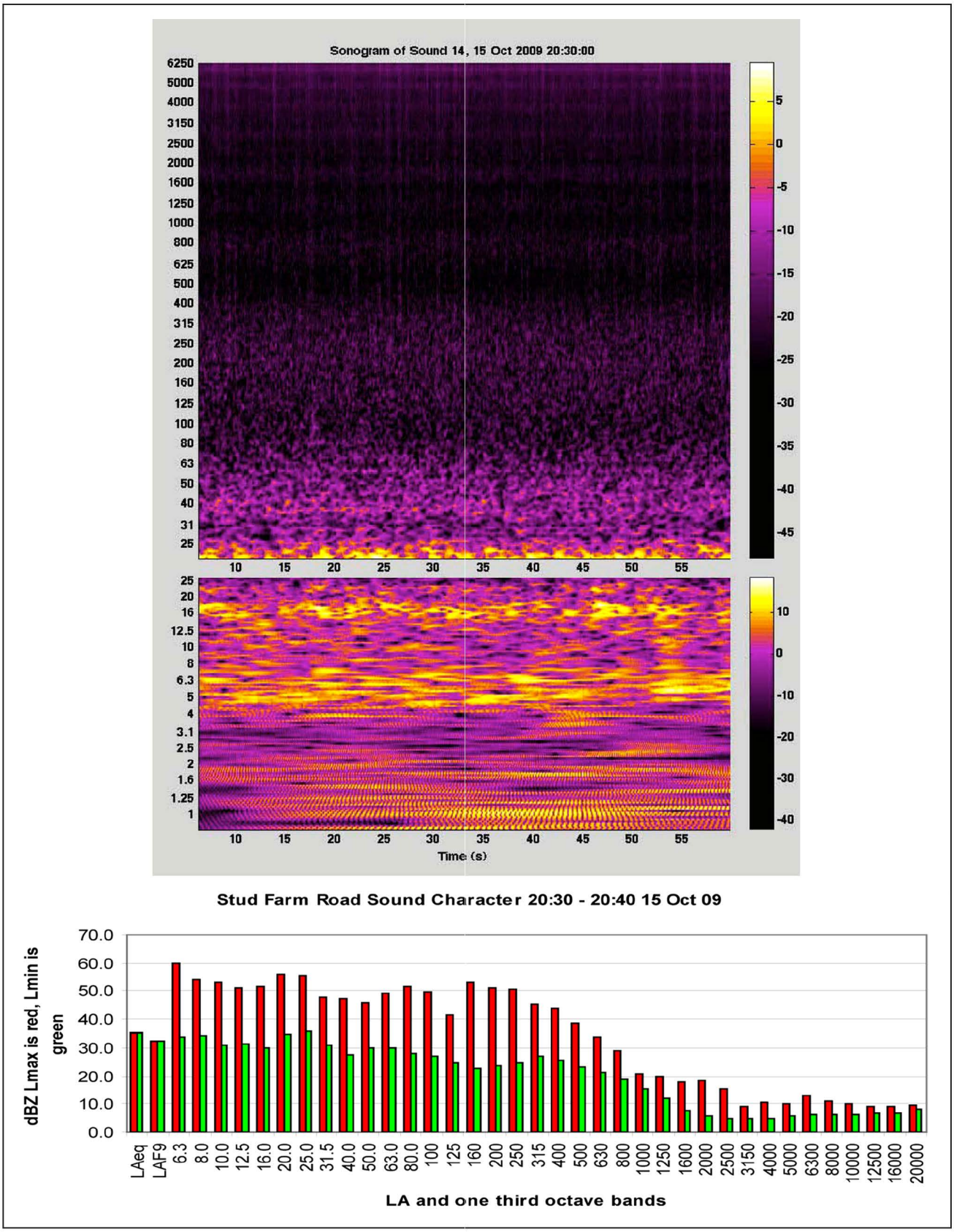


Plate 3. Sound of wind farm audible outside residence (low frequencies identified)

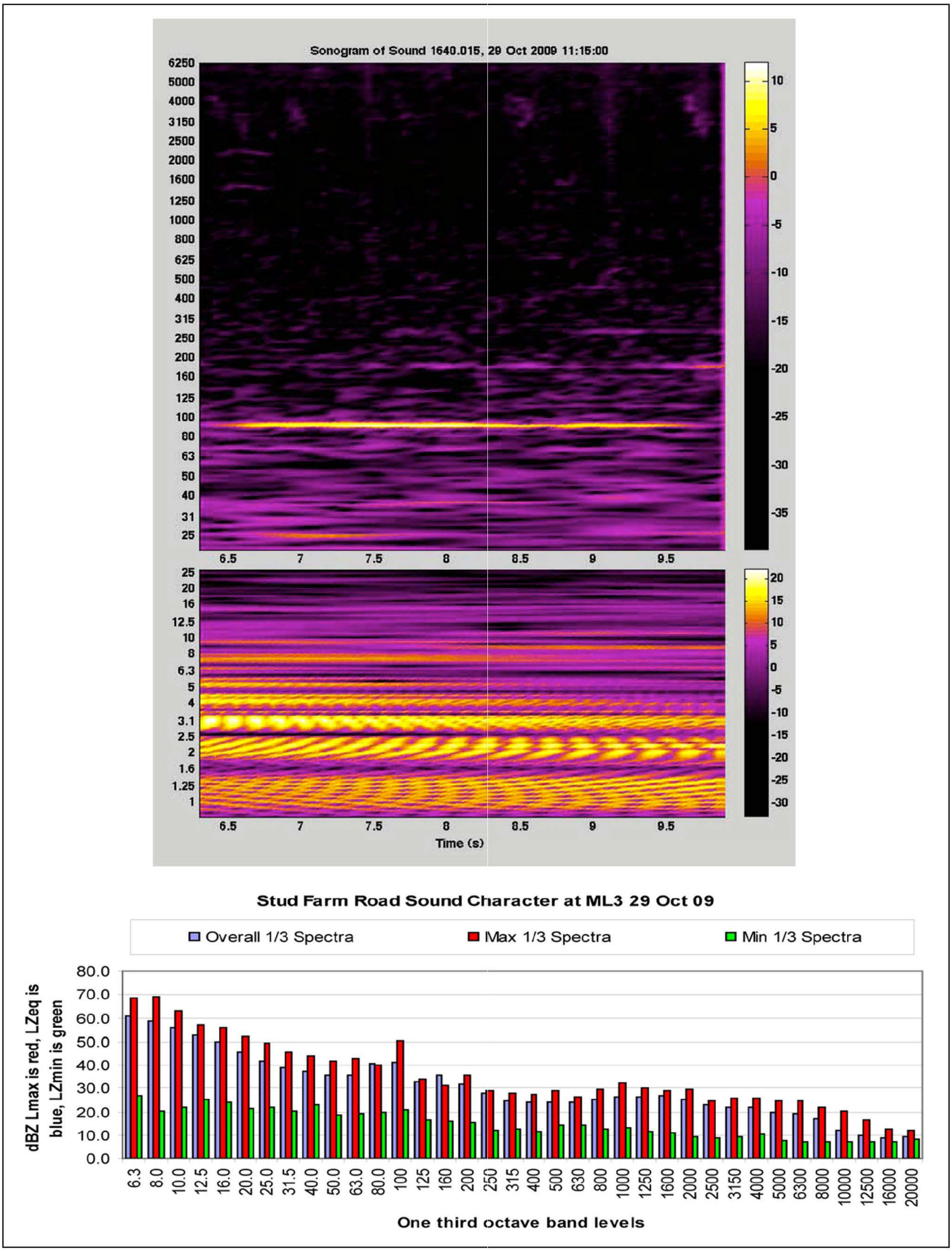


Plate 4. Sound of wind farm not audible outside residence

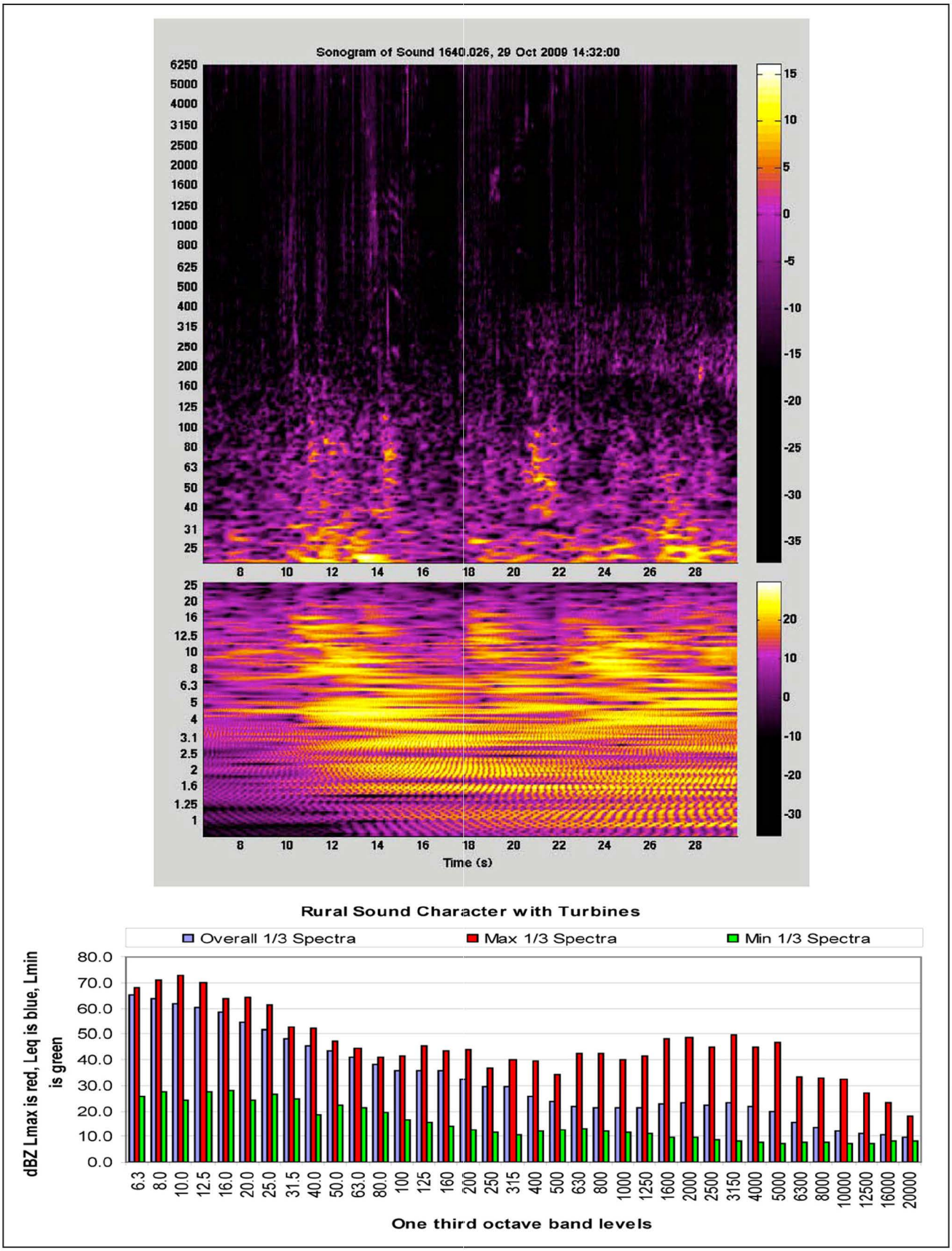
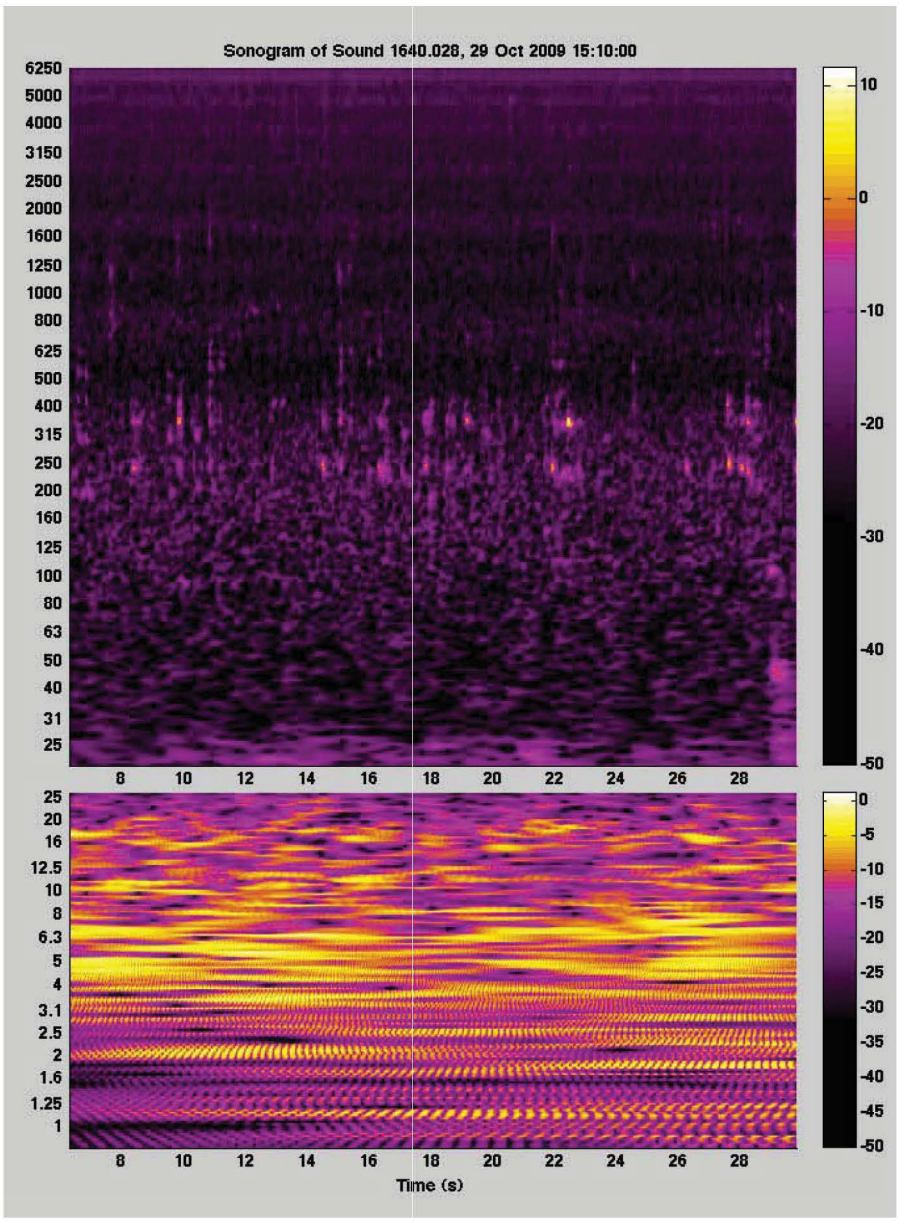


Plate 5. Sound character of wind farm turbines



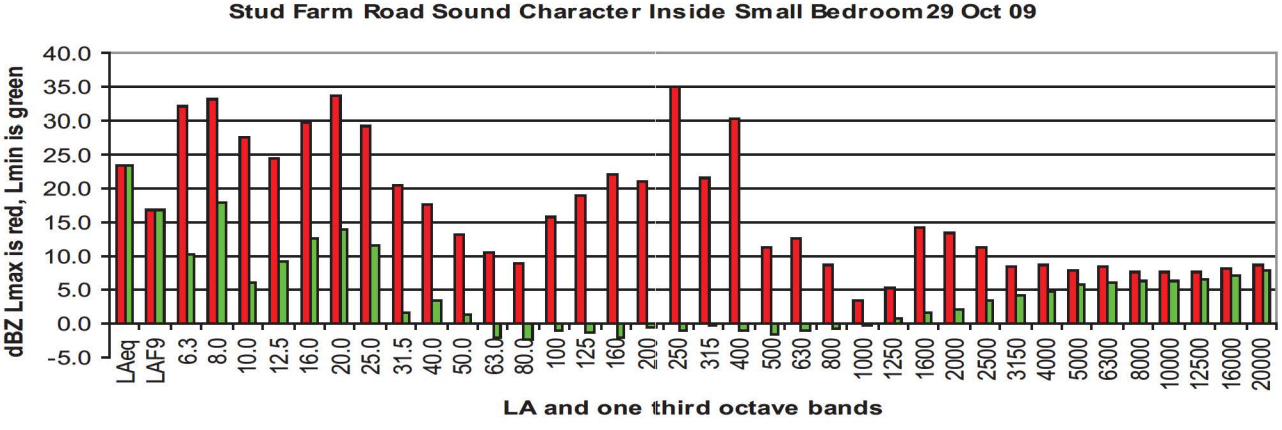


Plate 6. Sound character of wind farm inside a dwelling

The following three examples illustrate the effects of wind farms on residents living within the locale.

The Effects on People Living Near the Waubra Wind Farm, Victoria, Australia

The Waubra wind farm commenced operation in March 2009 in the Ballarat section and in May 2009 in the northern Waubra section. Within a short time nearby residents were becoming concerned about noise. By August 2009 adverse health effects were being reported. In September-October I interviewed five different families near the northern section of the wind farm, all of whom indicated some adverse reaction since the commissioning of a nearby wind farm earlier in the year. The families are all within approximately 1,000 to 2,000 meters of turbines and had at least two sets of turbines near to them. Under these circumstances, the residences are affected by wind farm activity over a range of wind directions. The interviews were preliminary in nature and standard psych and noise sensitivity tests were not conducted, nor were detailed health notes recorded.

Family A indicated headaches (scalp and around the head pressure), memory problems, and nausea when the turbines are operating. Symptoms include an inability to get to sleep and sleep disturbance, anxiety and stress, pressure at top and around head, memory problems, sore eyes and blurred vision, and chest pressure. When the turbines are stopped the symptoms do not occur. A difference in severity is recorded with different wind directions. A personal comment made states the following:

> I am having problems living and working indoors and outdoors on our property . . . problems include headaches, nausea, pain in and around the eyes, sleep disturbance, pain in back of head; we feel this is coming from generation of wind from wind farm as it is OK when turbines are stopped.

Family B indicated tinnitus, dizziness, and headaches since the turbines have started operating. The family also indicated sleep disturbance at night with the sound of the turbines interrupting sleep pattern, vibration in chest at times, and tiredness and trouble concentrating during the day. The family did not have problems sleeping when not at Waubra overnight.

Family C indicated that the noise coming from the turbines at night disturbed sleep. During the day there was noise that causes bad headaches, sore eyes causing impaired vision, earache, and irritability.

Family D indicated suffering from sleep disturbance, headaches, nausea, and tachychardia (rapid heart rate) since the turbines started operating.

Family E indicated that when the turbines were operating symptoms included feeling unwell, dull pains in the head (acute to almost migraine), nausea, and feeling of motion sickness. Symptoms at night when the turbines were in motion included sleep disturbance from noise and vibration (unable to get any meaningful deep sleep) and sleep deprivation leading to coping problems. The problems were reported as follows:

> Some days when the wind is in the north-east my eyes feel swollen and are being pushed out of the sockets. I have a buzzing in my ears. On these days I feel it very difficult to summon memory and difficult to concentrate.
>
> The sound of the turbines when functioning is on most days so intrusive that it affects my concentration and thought processes when performing complex tasks. I suffer from sleep interruption as a direct result of the noise, which then affects my ability to function at 100% the following day. One is aware of a throbbing in the head and palpitations that are in synchrony with the beat of the turbines and to a degree the flashing of the red lights. Because of this impact on my everyday life it causes me great stress and in turn great irritability.

Two families identified blade glint/flicker and the red warning lights on the top of each tower as an additional source of annoyance.

Statutory declarations (June 2010) concerning noise issues have been declared by residents affected by the Waubra wind farm. Noise from the turbines is being experienced by residents within approximately 1,000 meters of the nearest turbines and at distances of approximately 3,000 to 4,000 meters distant from the nearest turbines. The locales where the residents experience noise are shown in Plate W1. The noise and health effects experienced by residents are presented in Table W1.

The Waubra north and Ballarat locales are rural in nature with relatively low hills and rolling countryside. The northern section of the wind farm is illustrated in Plate W2. The locale is affected by southwest winds at turbine level but can be relatively calm at residences. The prevailing winds at Ballarat airport are shown in Figure W1. The measured wind directions are given to illustrate the importance of accurate wind data in predicting or assessing complaints.

The Effects on People Living Near the "West Wind" Wind Farm, New Zealand

The "West Wind" wind farm commenced operation in May 2009. From my observations at Makara, New Zealand, at a residence situated approximately 1,200 to 1,300 meters from 5 turbines and within 3,500 meters of 14 turbines there is known probability that the wind farm will exhibit adverse "special audible characteristics" on a regular basis resulting in sleep disturbance, annoyance, and stress.

The observations and measurements being recorded at Makara involve the residents taking notes of the noise heard when they are awakened. At the same time, a fully automated monitoring system records exterior audio as well as exterior and interior sound level data in summary levels and third octave band levels. This allows the generation of tracking

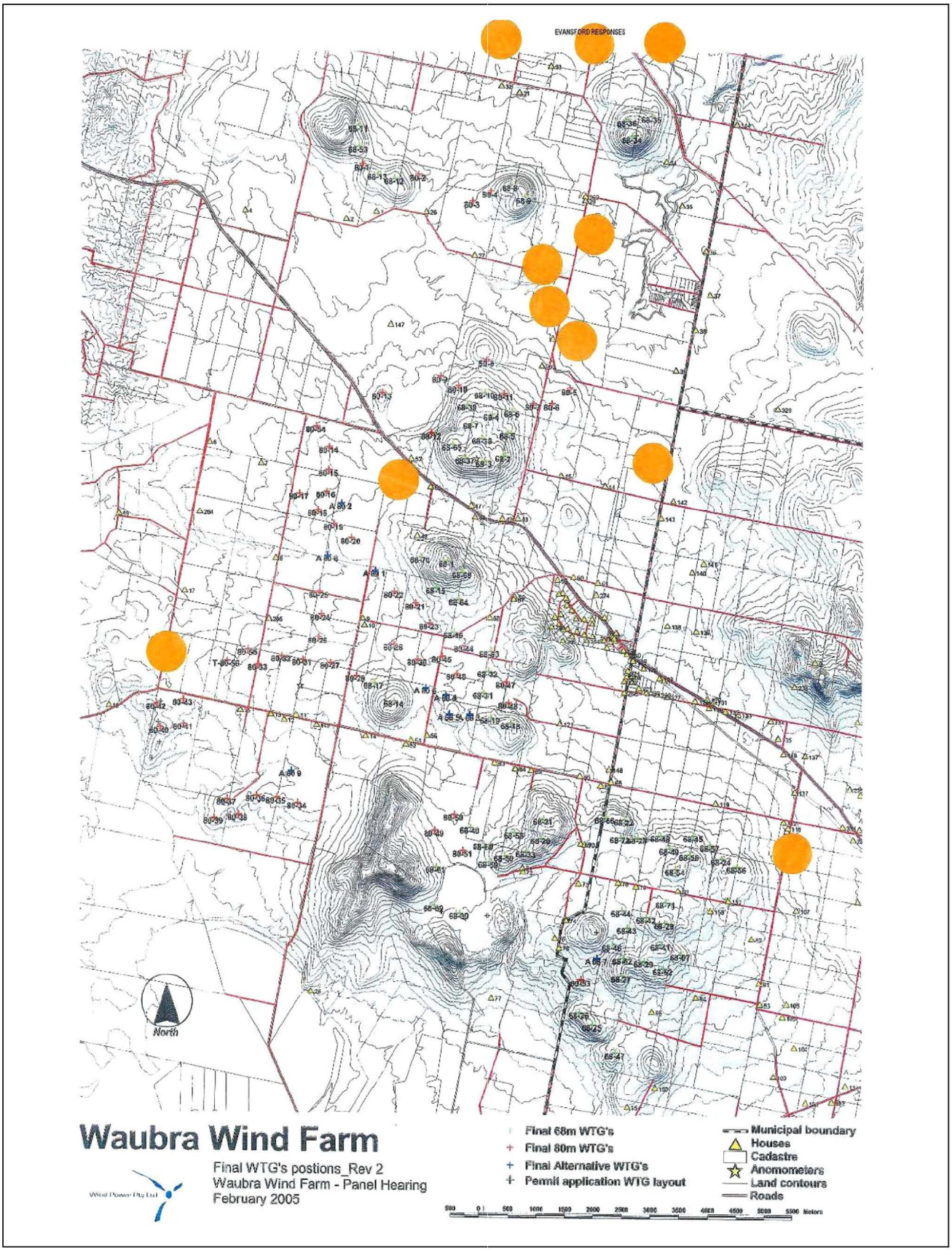


Plate W1. Locales in Waubra affected by Waubra wind farm turbine noise
Note. The locales affected by wind farm noise are identified by the orange circles.

Table W1. Waubra Wind Farm Perception and Complaint Analysis

Locale	Distance	Effects of Noise
1	1,500-2,500	Sleep disturbance, headaches, affects eyes and back of head, tinnitus. Worst affect is while working the farm. Heart pressure changes.
2	1,000	Sleep disturbance, headaches, high blood pressure.
3	1,000-1,300	Sore eyes and headaches when the turbines are operating.
4	1,250-3,000	Sleep disturbance. Affects people working on the farm. Headaches, earaches, blood pressure changes, and poor eye sight.
5	1,300-2,200	Insomnia, headaches, sore eyes, dizziness, tinnitus, and heart palpitations. Deteriorating health due to lack of sleep and stress levels. Unable to sleep through the night. Affects while working outside on the farm.
6	2,000-2,300	Headaches and pressure in ears when working on the farm.
7	550-1,400	Sleep disturbance, windows vibrate. Affects while working on the farm. Headaches, lack of sleep, major problem with flicker. Excessive noise under a strong southwest wind.
8	1,000-3,500	Headaches when working farm within 1500 meters of turbines. Dizziness when two turbines inline and in sync, effect went when approximately 300 meters out of alignment. Sleep awakenings and disturbed by pulsating swish. Heart palpitations, vibrating sensation in chest and body. Headaches while at home. Stress and depression.
9	3,500-4,300	Frequently suffer from headaches, tinnitus, irritability, sleepless nights, lack of concentration, heart palpitations. Turbines exhibit a loud droning noise and pulsating whoosh.
10	3,400-3,800	Headaches, ringing in ears when turbines are operating. Pressure in ears, heart palpitations, and anxiety attacks. Awaken at night, sleep disturbance.
11	3,000-4,600	Elevated blood pressure, heart palpitations, ear pressure and earache, disrupted sleep, increasing frequent headaches, head pressure, vibration in body, mood swings, problems with concentration and memory. Awaken at night, sleep disturbance.
12	1,000-1,200	Headaches, sickness, frequent sleep disturbance, very stressed. Affects personal life. Lights on turbines cause extreme distress. Ear pressure and loss of balance while working on the farm. Enormous pressure and stress on home and work.

Note. "Distance" is the distance in meters between the locale and the nearest turbines. The distances vary where turbines are in different directions surrounding the locale. Each locale contains one or more affected families. A common observation is that the adverse health effects noted did not exist before the wind farm commenced operation or diminish/disappear when not in the district affected by turbines.

data and sonograms for compliance and unreasonable noise assessment. The complaint data are retained by the City Council. Statistical data are retained by the wind farm operator and summarized for the Council. Audio data for real-time analysis of special audible characteristics are not recorded by either the Council or the wind farm operator. Audio data are recorded, however, by one affected resident.

In the period April 2009 to March 31, 2010, a total of 906 complaints were made to the Wellington City Council, New Zealand, concerning noise from the wind farm at Makara. These complaints were made by residents living near to and affected by the wind farm. An analysis of the complaint history was made by acoustical consultants working for the wind farm company. From 64 households in a population of approximately 140 occupied residences, 57% of the complaints were from 10 households and 79% were from 20 households.

The character of the 650 complaints was sorted by an independent researcher. Rumble, with 252 mentions, was the most common characteristic. Hum and thump are the next most common annoying sounds. In comparing complaints of noise outside to inside, of 650 complaints, only 23 specifically mentioned the noise as being outside.

In personal interviews at Makara, some residents identified nausea as a problem. In the most severely affected cases known, the residents have bought property and moved away from their farm.

Low-frequency sound and infrasound are normal characteristics of a wind farm as they are the normal characteristics of wind, as such. The difference is that "normal" wind is laminar or smooth in effect whereas wind farm sound is non-laminar and presents a pulsing nature. This effect is evident even inside a dwelling and the characteristics are modified due to the construction of the building and room dimensions. Of the indoor complaints, 4.5% specifically mentioned sleep disturbance.

The Makara complaints were limited to a small locale. Complaints were from the whole of the district, that is, a distance of approximately 12 km. The turbines are situated in both clusters and rows. The locale "Makara" is a small village and school affected by a cluster of approximately 14 turbines within 2,000 meters; the locale "South Makara" is a line of residences facing a line of 25 turbines within 2,000 meters over approximately 5 km. The issue is that turbine noise is known, it can be defined by character and distance, and it does have significant impact on a large number of people.

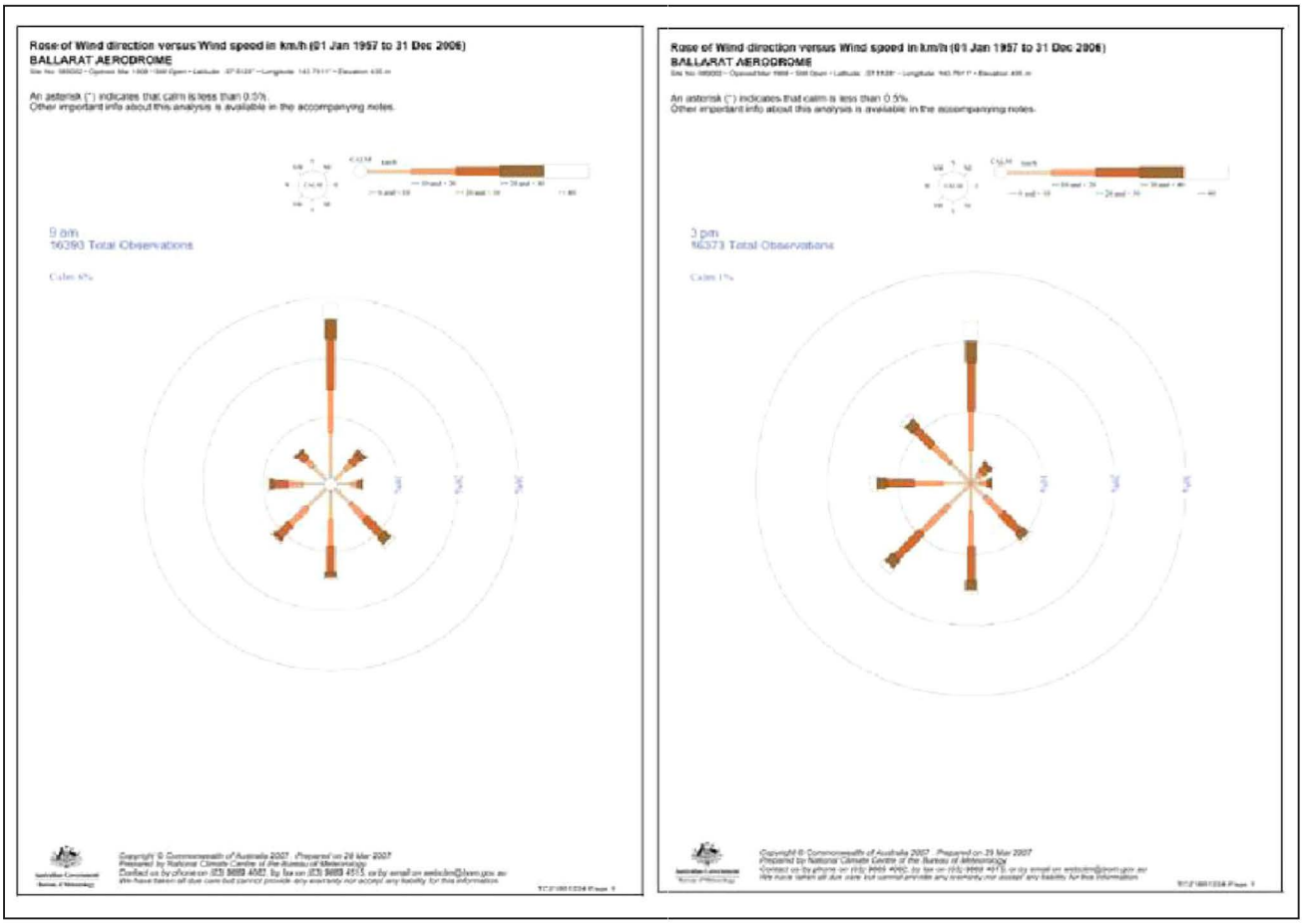


Figure W1. Wind rose, Ballarat Aerodrome, mid-morning and mid-afternoon

The turbines are Siemens 2.3 MW machines situated approximately 1,200 to 2,200 meters from residences.

Nausea and sleep disturbance were reported by one visitor to a residence 2,200 meters from the nearest turbine. The residents also complained about the visual nuisance caused by blade glint and flicker, as well as the red glow from the warning lights on top of each tower. A complaint (March 2010) about the operation of the wind farm expressed the following:

> We have had a persistent level of disturbance noise now for several hours throughout the evening that is now preventing us sleeping since 11:15 p.m. The predominant noise is a continuous loud booming rumble that is even more noticeable after a gust at ground level. When the wind noise drops, the background noise from the turbine continues and is also felt as a vibration being transmitted through the ground. Even with wind noise the vibrations in the house continue. The varying wind speed also causes a beating noise from the blades that occurs in cycles creating yet another form of noise disturbance.

A second resident said the following:

> We are 2 km away to the east and the thumping also penetrates our double glazing. The reverberation is somehow worse inside the house.

And a third resident said the following:

> We . . . get the low-frequency thump/whump inside the house, is very similar to a truck driving past or boy racers sub woofer 100 meters away . . . we have no line of sight turbines and the closest one in 1.35 km away. There are however 27 turbines within 2.5 km (which would apply for the whole village). The sound is extremely "penetrating" and while we have a new house with insulation and double glazing, the low-frequency modulation is still very evident in the dead of night. It is actually less obvious outside as the ambient noise screens out the sound.

The valley is affected by strong winds at turbine level but can be relatively calm at residences. The prevailing wind at

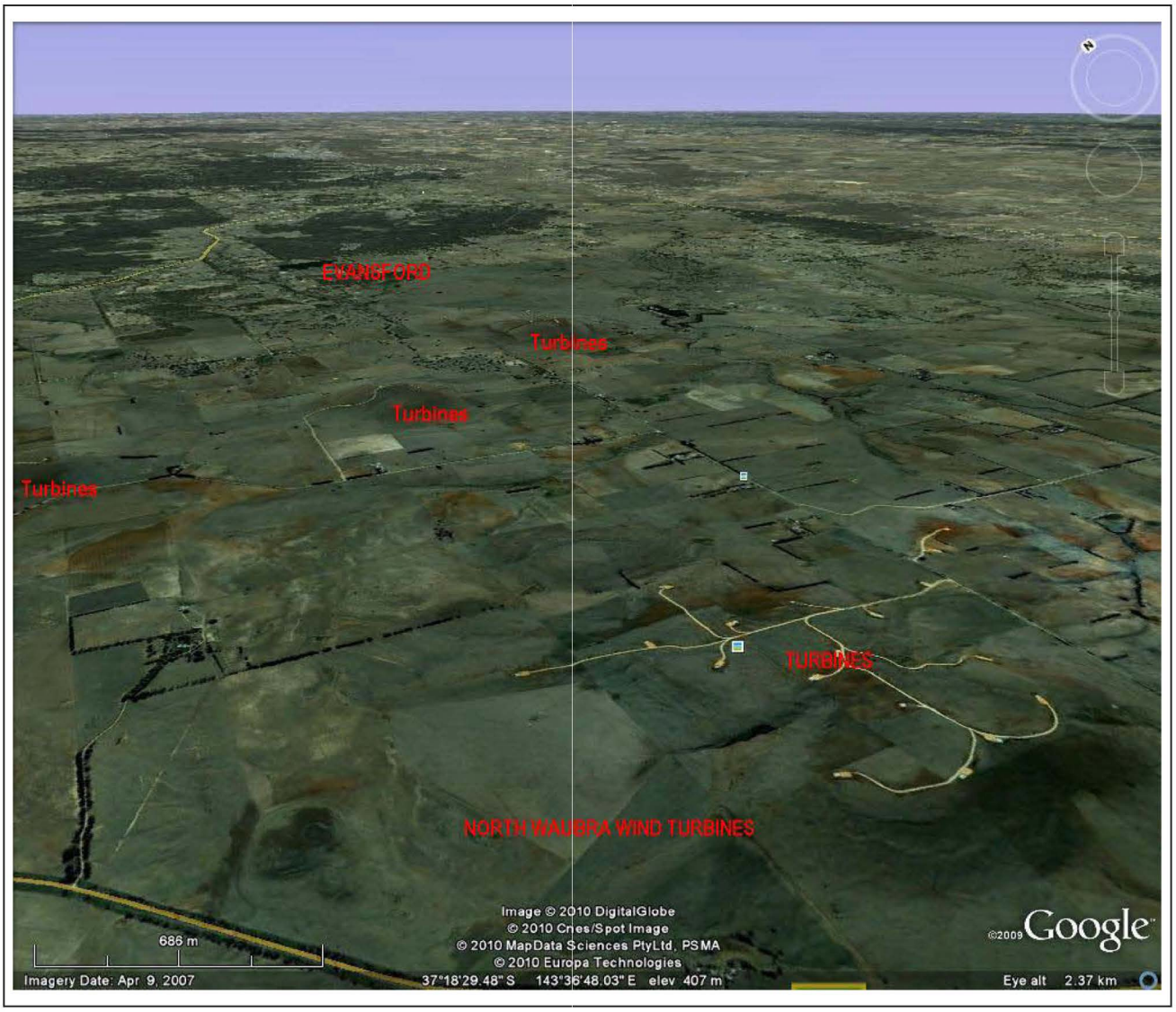


Plate W2. North Waubra locale, residents and the Waubra wind farm

the turbines' mast at 40 meters above ground is shown in Figure WW1. The measured wind directions are given to illustrate the importance of accurate wind data in predicting or assessing complaints.

The Effects on People Living Near the "Te Rere Hau" Wind Farm, New Zealand. In the period from May 2009 to March 31, 2010, a total of 378 complaints about noise were made to Palmerston North City Council, New Zealand, concerning the Te Rere Hau wind farm. The complaints were made by persons within approximately 2,300 meters south, 3,100 meters southwest, and 2,100 meters to the north of the center of the "97"-turbine wind farm. Complaints concerned both the loudness and character (grinding, swishing) of the sound from the turbines, a two-blade 500 kW design.

The Te Rere Hau wind farm complaints are important as they reflect the concerns of a rural community with relatively few people living within 3,500 meters of the center of the wind farm. Te Rere Hau is a densely packed design with wind turbines arranged in a grid pattern. In the 10 months for which records have been seen, 21 different residents complained about noise, with 2 residents logging more than 40 complaints each and a further 8 logging more than 10 complaints each. This indicates issues with wind farm placement and design that can be mitigated by careful consideration of turbine choice, turbine siting design, and

Table WW1. West Wind Perception and Complaint Analysis Till November 2009

Locale	Distance	Effects of Noise
1	1,200-1,300	Kept awake with turbine noise pulsing in bedroom. Sleep disturbance. Sounds not masked by wind in trees or stream.
2	1,200-1,300	Possible to hear and feel the turbines (20 of them) over usual household noises during the day and evenings. At night disturbs sleep patterns and affects health and well-being. Can hear the noise through the bed pillow. Sounds like a tumble dryer.
2	1,200-1,300	Can hear the turbines inside and outside the house during the day and at night. Disturbs sleep and affects health (tiredness). Family is stressed.
3	1,700	Sound is a rhythmic humming heard inside and outside the house during the day and at night. Northwest wind brings noise, southerly does not. Noise is highest when it is calm at the house but windy at the turbines. Turbines audible inside the home with TV on. Noise is a low hum.
4	1,750	When the wind is from the north to northwest the noise penetrates into the home. Persistent deep rumbling around 1-second interval and lasts for 10 to 20 seconds and then abates. Awakens and disturbs sleep. Generates annoyance and irritability.
4	1,700	Disturbs sleep. Turbines are heard when it is calm at the house and windy at the turbines. Annoyance, nausea, earaches, and stress.
5	2,100	Turbines audible in bedroom. Awaken and disturbs sleep. Creates pressure in head and headache. Feeling tired and distressed.
6	2,000	Northwest wind brings noise and disturbs sleep.
7	1,250	Northwest sound is constant thumping, pulsing. Cannot stand being in the house or around the property, sick feeling, headaches, tight chest. Can be heard at night cannot sleep, get agitated, and wound-up. Has ruined peace and tranquility.
7	1,250	Northwest wind, mild to wild, sound is constant thrumming. Noise is intensified in the house and more noticeable at night. Feeling of nausea precludes sleep. Disturbed and sleepless nights.
8	1,500-2,000	Turbine noise heard within the home. Severe sleep deprivation from interrupted sleep and lack of sleep. Fear of causing an accident on the farm due to lack of sleep. Noise at night is a southerly with a grinding rumbling sound. Noise from the northwest grinding a "plane takeoff" noise. Lot of ringing in ears. Easily heard above the background noise. Depression due to noise at night and lack of sleep.
9	750	Noise from the southerly winds rumbling, grinding all day and night. Trouble sleeping.
10	2,200	Regular sleep disturbance, sound like a plane. Louder inside the home than outside. Northwest wind thumping or rumbling sound, noise and vibration in the home (double glazed). Headaches. Low-frequency humming. Awakenings and sleep deprivation.

Note. "Distance" is the distance in meters between the locale and the nearest turbines. Each locale contains one or more affected families.

consideration of neighbors and long-term meteorological conditions. Plate TRH1 presents the impact of the wind farm on nearby residences. The number of complaints lodged by the residents is indicated in the plate. Table TRH1, for a single residence, illustrates the common thread of the noise problems found and the relationship to weather conditions. The residence is approximately 1,200 meters from the nearest row of wind turbines. The position of the wind farm on a plateau above the residences is illustrated in Plate TRH2. The measured wind directions are given in Plate TRH3 and illustrate the importance of accurate wind data in predicting or assessing complaints. The complaint numbers are very high for wind farms that supposedly are complying with their approval conditions. While the background levels may be achieved and this has yet to be proven, the wind farms are a significant source of unreasonable noise. The number and history of the complaints emphasizes the importance of buffer zones and wind farm design so noise can be mitigated by careful consideration of turbine choice, turbine placement, consideration of neighbors, and long-term meteorological conditions.

Real-World Noise Compliance Problem at a Wind Farm

The Te Rere Hau wind farm in New Zealand is presently the subject of a legal review of its compliance and the methodologies applied to measure background sound levels and compliance levels (*PNCC v. NZ Windfarms*, 2010). In brief, it is understood that specific issues raised are the following:

- The Te Rere Hau wind farm is being operated at levels higher than those predicted in the (wind farm) application
- The respondent has substantially underestimated the effects of the wind farm noise on the amenity of the area
- The AEE concluded noise from the wind farm would not exhibit special audible characteristics (i.e., clearly audible tones, impulses, or modulation of sound levels). This conclusion is inaccurate [reasons given]

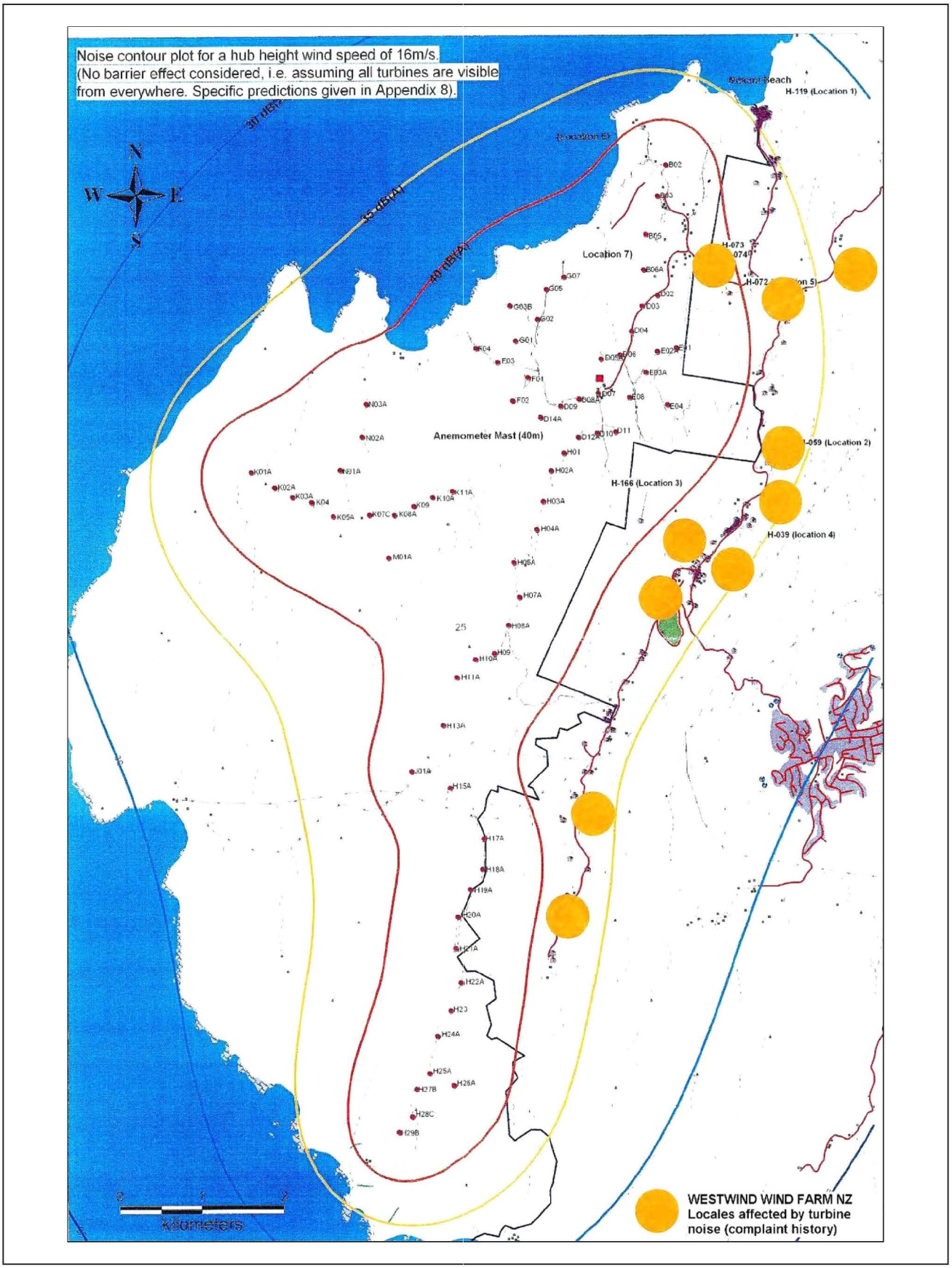


Plate WW1. Locales in Makara affected by "West Wind" wind farm turbine noise

Plate WW2. Makara Valley residents and the "West Wind" wind farm
Note. The turbines (marked in red) are situated on the top of the range and the residents are in the valley (Makara Village and blue squares)

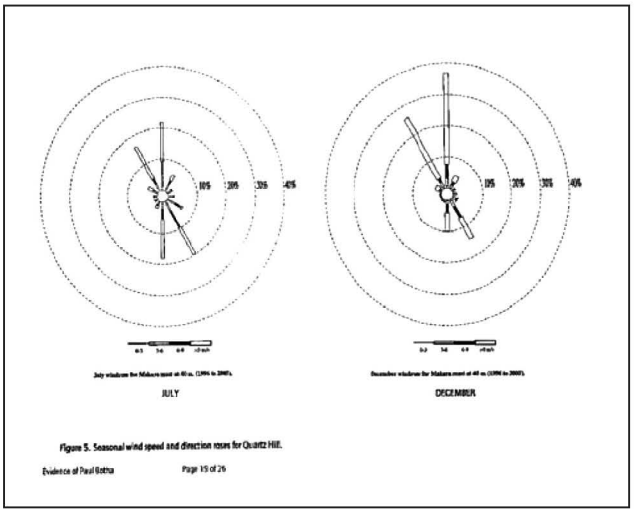


Plate WW1. Prevailing winds for Makara at the wind farm mast (40 meters)

- The actual experience of residents (located up to 2.18 km from the nearest turbines) and the number of complaints made to the Council indicating there are noise effects (which also exhibit special audible characteristics) being experienced at a significant number of local properties
- The actual results reported in the revised compliance report (April 2010) demonstrate the actual sound levels from the wind farm are significantly higher (up to 12.8 dBA higher) at the monitoring location under certain wind speeds and directions than predicted
- While monitored noise included noise from all sounds in the area (not just wind farm noise), the uncertainty as to the actual wind farm noise levels warrants further investigation. A new noise testing specification is the subject of the memorandum of December 21, 2010.

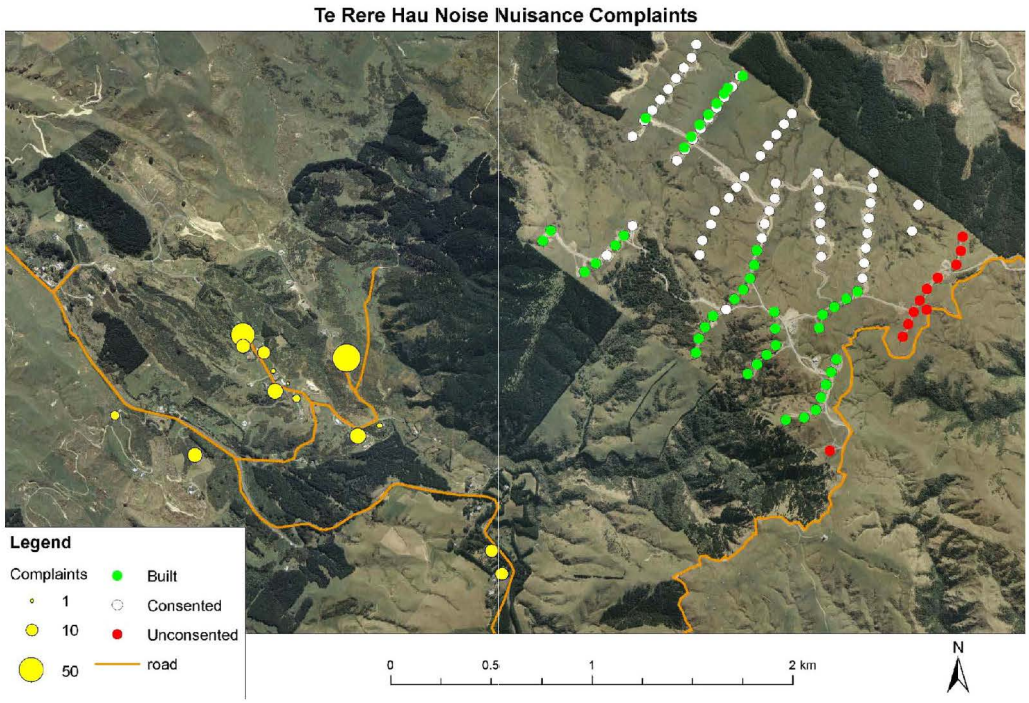


Plate TRH1. Te Rere Hau wind farm complaints by location

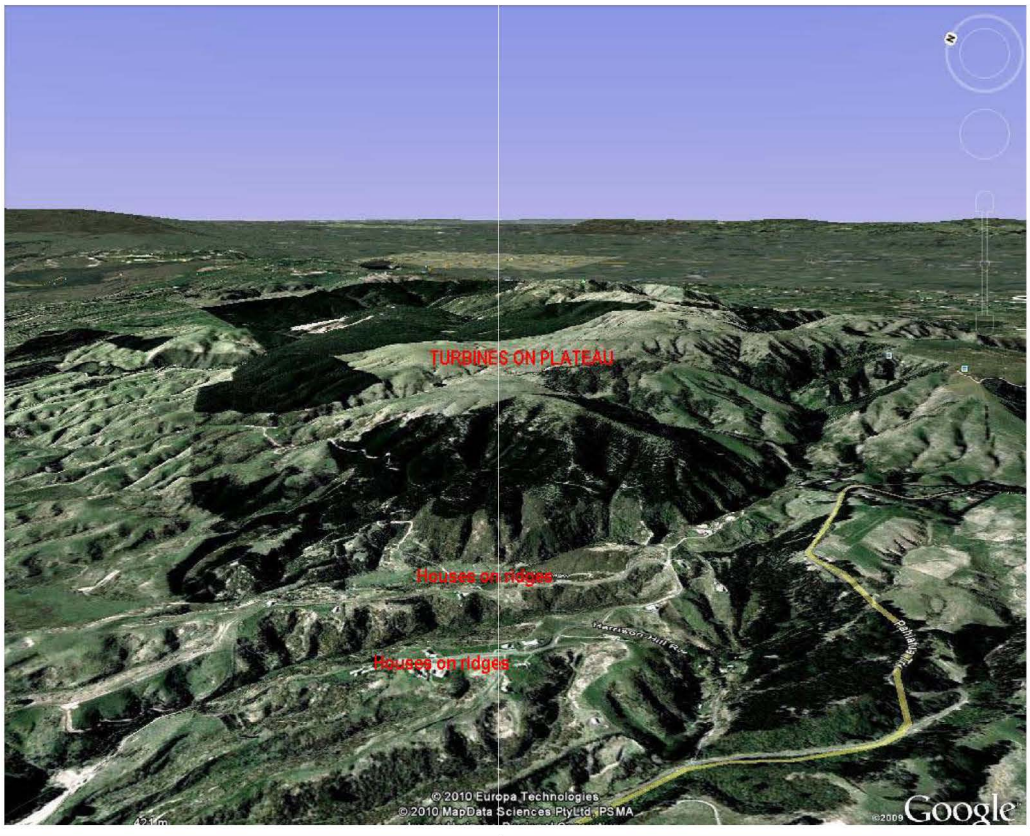


Plate TRH2. Te Rere Hau wind farm in relation to residences

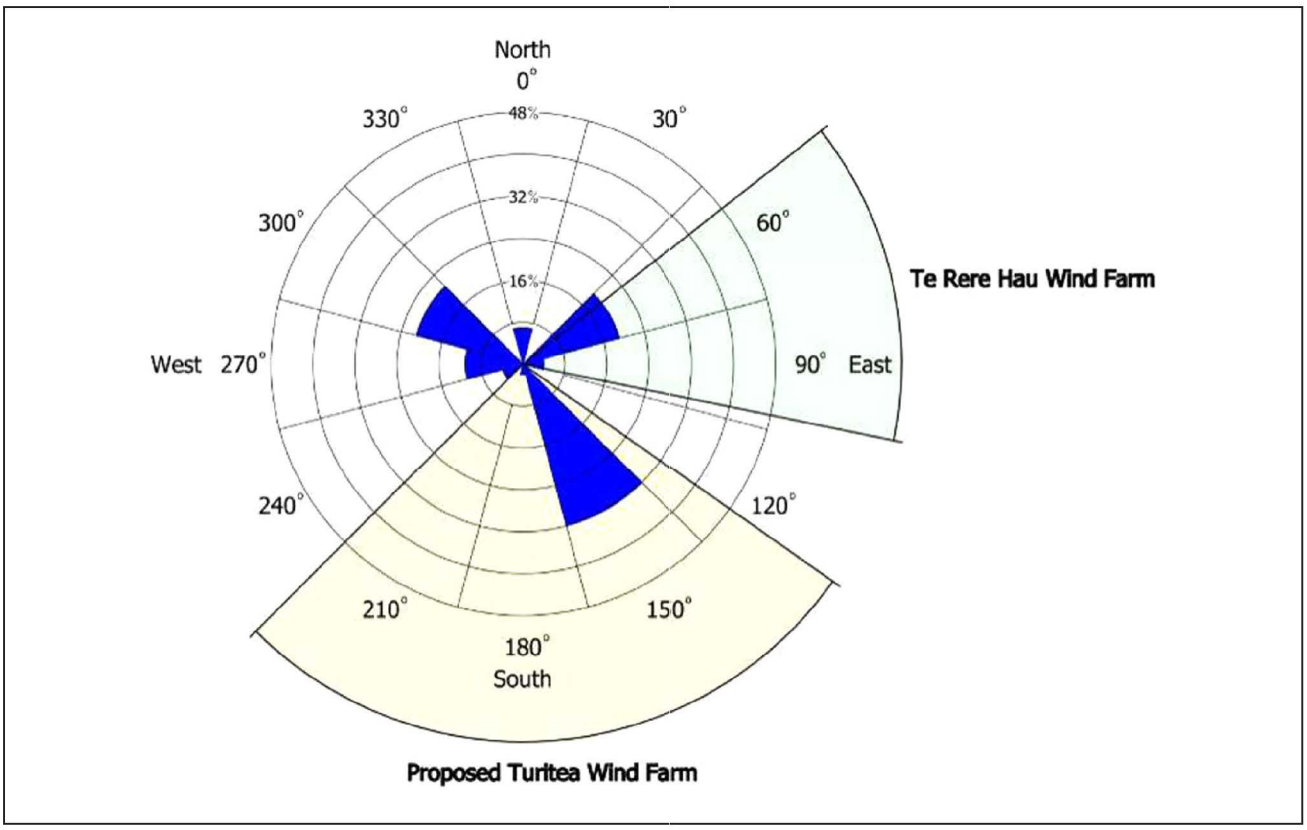


Figure TRH1. Wind Rose for May to September 2009 illustrating existing wind farm (Te Rere Hau) and effect from a proposed wind farm (Turitea) to the south

Conclusions

Personal perception of a sound is investigated through assessment of personal noise sensitivity, personal perception of the characteristics of the sound, and observable adverse health effects. Noise includes vibration in any form that can be "felt" by a person. There is, despite the differences in opinion as to cause, considerable agreement between the parties—residents, clinicians, and acousticians—as to observable health effects from unwanted sound. There are clear and definable markers for adverse health effects before and after the establishment of a wind farm and clear and agreed health effects due to stress after a wind farm has started operation. It is the mechanism of the physical or mental process from one to the other that is not yet defined or agreed between affected persons, clinicians, and psychoacousticians.

- It is concluded that, for the reasons given in this article, compliance criteria of a single value, such as 35 dB(A) measured as the equivalent level, LAeq; 40 dB(A) measured as the background level, LA95; or the "background plus 5dB" sound level, whichever is the greater are not acceptable. This is due to the general failure of approval conditions to provide clear and specific methodologies to measure wind farm sound under compliance testing conditions or under complaint conditions when turbine sound is part of the ambient sound.
- It is concluded that wind farms exhibit special audible characteristics that can be described as modulating sound, impulsiveness, or as a tonal complex. Compliance monitoring must include real-time measurement of special audible characteristics and infrasound.
- It is concluded that frequent short-term variations in air pressure (infrasound) may lead to adverse health effects in individuals.
- It is concluded that meteorological conditions, wind turbine spacing, and associated wake and turbulence effects, vortex effects, wind shear, turbine synchronicity, tower height, blade length, and power settings all contribute to sound levels heard or perceived at residences. Current noise prediction models are simplistic, have a high degree of uncertainty, and do not make allowance for these significant variables.
- It is concluded that noise numbers and sound character analyses are meaningless if they are not firmly linked to human perception and risk of adverse effects.

Table TRH1. Te Rere Hau Noise Complaints, August 2009 to February 2010, Single Residence

Date and Time	Wind Direction	Complaint
07/08/09, 5.45 p.m.		Noise from wind farm
20/08/09 6.55 a.m.	South-southeast	Wind farm loud this morning
20/08/09, 8.45 a.m.	South-southeast	Loud wind mills at 5.00a.m.
21/08/09, 6.32 a.m.	East	Wind farm noise
22/08/09, 12.51 p.m.	East	Medium strength, swooshing, and grinding, only ½ on
29/08/09, 8.45 a.m.	West	Very loud again today
15/09/09, 6.31 p.m.	East	Loud noise coming from wind farm
11/05/09, 10.48 a.m.	West	Light wind, wind farm extremely loud
21/11/09, 5.42 a.m.	West	WF too loud
05/08/09, 7.02 a.m.		Noise from Te Rere Hau this morning
09/08/09, 6.02 p.m.		Excessive noise Te Rere Hau
11/08/09, 1.03 p.m.		Windmills beeping noise every 2 minutes
04/09/09, 8.05 a.m.	East	Continuous noise last half hour
09/09/09, 11.24 a.m.	West	Started turbines 103 and 104, now noisy
11/09/09, 6.21 a.m.	North	Light northerly, noise since he got up
19/09/09, 10.49 a.m.	South	Very noisy again today
20/09/09, 8.13 a.m.	East	Loud noise
28/09/09, 7.15 a.m.	Northeast	Wind farm noise
07/10/09, 5.32 p.m.	West	Light wind, loud noise from wind farm
08/10/09, 7.42 a.m.	West	Light wind, swooshing noise this morning
09/10/09, 7.02 a.m.	Northeast	Light wind, wind farm really loud this morning
10/10/09, 9.59 a.m.	South	Light wind, would like to complain about noise
12/10/09, 7.48 a.m.	North	Light wind loud noise from wind farm
20/10/09, 3.53 p.m.	South	Loud noise at wind farm
08/11/09, 9.36 a.m.		Still, noise today
16/11/09, 7.25 a.m.	West	Lots of noise coming from wind farm this morning
17/11/09, 6.27 p.m.	West	Light wind, very loud tonight
20/11/09, 7.22 a.m.	West	Noise complaint
22/11/09, 7.16 p.m.	East	Light wind, wind farm very noisy
04/12/09, 6.18 a.m.	West	Noisy this morning
07/12/09 6.21 p.m.	West	Loud wind farm
09/12/09, 6.50 a.m.	West	Light wind, droning noise
15/12/09, 7.28 a.m.	South	Noisy wind turbines
19/12/09, 7.04 p.m.	West	Light wind noise from turbines over days whirring
25/12/09 8.59 a.m.	West	Light westerly, very loud today
16/01/10, 9.09 a.m.		Noise
17/01/10, 7.44 a.m.	South	Light-medium southerly wind farm quite loud today
17/01/10, 6.58 p.m.	South	Southerly wind, wind mill noise
18/01/10, 7.26 a.m.	Southeast	Medium wind, wind turbine noise last hour
18/01/10, 6.45 p.m.	East	Noise very bad
18/01/10, 10.54 p.m.	Southeast	Extremely loud
19/01/10, 7.28 p.m.	West	Turbines causing a lot of noise tonight
21/01/10, 8.21 p.m.	East	Loud noise from the turbines
25/01/10, 4.43 p.m.	East	Wind mill noise
26/01/10 8.12 a.m.	East	Medium wind, wind turbines making a lot of noise
28/01/10, 7.27 p.m.	East	Light wind, turbines are noisy again this evening
29/01/10, 10.21 a.m.	East	Loud noise from blades and mechanical noise
29/01/10, 6.12 p.m.	East	Med wind same noise as usual coming from turbines
02/02/10, 6.51 p.m.	East	Loud noise from wind farm
03/02/10, 7.19 p.m.	East	Noise from wind farm
04/02/10 7.01 a.m.	East	Noise loud this morning
05/02/10, 6.22 a.m.	East	Light, loud today
05/02/10, 5.57 p.m.	East	Light wind, same whirring gearbox noise as usual
07/02/10, 12.49 p.m.	Northwest	Excessive noise
08/02/10, 6.58 a.m.		Wind farm very loud this morning
08/02/10, 8.16 p.m.	East	Light wind
10/02/10, 7.11 a.m.	North	Te Rere Hau noisy this morning
15/02/10, 8.14 p.m.	East	Medium wind
16/02/10, 7.50 a.m.	East	Turbine noise in east direction at least hour

- It is concluded that no large-scale wind turbine should be installed within 2,000 meters of any dwelling or noise-sensitive place unless with the approval of the landowner.
- It is concluded that no large-scale wind turbine should be operated within 3,500 meters of any dwelling or noise-sensitive place unless the operator of the proposed wind farm energy facility, at its own expense, mitigates any noise within the dwelling or noise-sensitive place identified as being from that proposed wind farm energy facility to a level determined subject to the final approval of the occupier of that dwelling or noise-sensitive place.

In my opinion, based on my training, experience, measurements, and observations, serious harm to health occurs when a susceptible individual is so beset by the noise in question that he or she suffers recurring sleep disturbance, anxiety, and stress. The markers for this are (a) a sound level of LAeq 32dB outside the residence and (b) above the individual's threshold of hearing inside the home.

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Policy and planning **guidelines** for development of **wind energy** facilities in Victoria

State Government Victoria
Department of Planning and Community Development

August 2011

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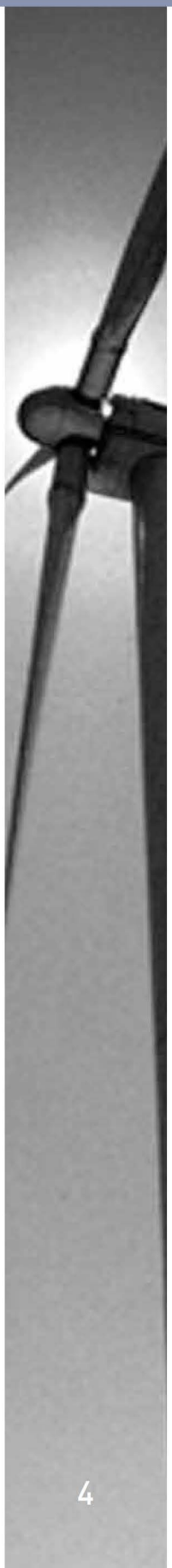
Introduction



Victoria has abundant wind resources, and wind energy facilities have the potential to provide for a significant proportion of Victoria's growth in electricity consumption. Victoria's wind resources are well suited to supporting a large-scale grid of connected wind energy facilities. The Victorian Government supports the development of the renewable energy sector as an important contributor to the sustainable delivery of Victoria's future energy needs.

These guidelines provide the current advice to responsible authorities, proponents and the community to provide guidance about suitable sites to locate wind energy facilities and to inform planning decisions about a wind energy facility proposal.

The purpose of these guidelines is to set out:

- a framework to provide a consistent and balanced approach to the assessment of wind energy projects across the state
- a set of consistent operational performance standards to inform the assessment and operation of a wind energy facility project
- guidance as to how planning permit application requirements might be met.

The guidelines also provide advice about locations in the state that are not appropriate to locate wind energy facilities and provide a framework to ensure proposals for wind energy facilities are thoroughly assessed, including where necessary the need for an Environment Effects Statement (EES).

These guidelines include a glossary where certain terms used in the guidelines are defined.

Section 1

Wind energy facilities

This section defines a Victorian wind energy facility for the purposes of the Victoria Planning Provisions (VPP).

1.1 What is a wind energy facility?

A wind energy facility has the following definition in all planning schemes (refer to Clause 74 (Land use terms) in the VPP):

Land used to generate electricity by wind force. It includes any turbine, building, or other structure or thing used in or in connection with the generation of electricity by wind force. It can include an anemometer.

It does not include turbines principally used to supply electricity for domestic or rural use of the land.

1.1.1 Anemometers, utility installation and electricity grid connections

(a) Anemometer

In Clause 72 (General terms) of the VPP, an anemometer is defined as a 'wind measuring device. It is used to measure the wind speed and direction at a site.

In accordance with Clause 62 of the VPP, a temporary anemometer may be located on a site for up to three years to monitor the suitability of the wind resource for a potential wind energy facility, without requiring a planning permit. At the end of the three-year period, the temporary anemometer must be removed or a planning permit issued for its long-term use.

An anemometer can also be assessed and approved as part of a wind energy facility.

(b) Utility installation

The use of land to transmit or distribute electricity generated by wind, whether or not on the same land title as a wind energy facility, is defined as either a 'utility installation' or a 'minor utility installation' in Clause 74 (Land use terms) of the VPP, depending on the nature and capacity of the transmission or distribution infrastructure.

The transmission or distribution system of power lines necessary to connect a wind energy facility to the electricity grid is a separate land use to that of a wind energy facility. The distribution starting point is defined as the on-site metering point of output from the converter station where the electricity will enter the distribution system.

The wind energy facility and the electricity grid connections are normally subject to separate planning applications. While the applications should generally run in parallel, timelines for approval could differ depending on the nature of the applications. Where they are separate applications, details of the associated transmission infrastructure, electricity utility works and access road options must be provided as part of the wind energy facility application. See section 4.3 (Meeting application requirements) of these guidelines.

1.1.2 Characteristics of a wind energy facility

Wind energy facilities need to be located on sites that have strong, steady winds throughout the year, good road access, proximity to the electricity grid and the capacity of the grid (existing and planned). They can vary considerably in size and scale depending on the physical features of the land, the wind resource available and the amount of energy to be generated.

A wind energy facility typically includes:

- a series of wind turbines
- a substation
- wind monitoring equipment, which can include an anemometer
- temporary or permanent access tracks
- underground cabling connecting the wind turbines to the on-site metered point of output from the converter station where the generated electricity will enter the distribution system. This includes connections from the wind turbines to the on-site substations (i.e. an electricity generation, transmission and distribution system where voltage is transformed from high to low, or the reverse, using transformers).

The wind turbines used in commercial wind energy facilities are generally large, slowly rotating, three-bladed machines that produce between 1.5 and 3.0 MW of electrical output. The most common wind turbine has a generator and rotor blades mounted on top of a steel tower. The rotor blades generally rotate on a horizontal axis and the tower may be 110 metres or more in height.

Turbine height is driven by technological developments including:

- international improvements in technology, leading to larger, higher output turbines with longer rotor blades that require mounting on taller towers
- larger turbine diameters to harvest lower energy winds from a larger inflow area without increasing the cost of the rotor
- taller towers to take advantage of increasing wind speed at greater heights
- more efficient generation equipment and power electronics to accommodate sustained light wind operation at lower power levels without increasing electrical system costs.

The above trends could see turbine height increase in the next five to ten years. As technology develops, other forms of turbines may also be proposed.

Section 2

Wind energy in Victoria

This section describes Victoria's wind energy resource and outlines the broad planning policy and statutory context most relevant to assessment of wind facilities in Victoria.

2.1 Victorian wind resources

Wind speed is the single most important factor affecting the financial viability of a wind energy facility. Even small changes in wind speed due to the siting of individual wind turbines can substantially affect their energy output and therefore the financial viability of a wind energy project.

In Victoria, the prevailing winds tend to blow from the south-west direction and wind speeds vary significantly throughout the state. The highest wind speeds can be found along the coast, in central Victoria and in Victoria's alpine region.

The average wind speed across Victoria is 6.5 metres per second. Approximately two-thirds of Victoria's land area has average wind speed of 5.8 to 7.2 metres per second.

Local topographic conditions and temperature difference between land and sea can have a significant effect on wind speed, with minor changes in location resulting in major variations in speed.

The *Victorian Wind Atlas* (2003) provides detailed information about the wind resource in Victoria based on the results of the CSIRO's modelling and analysis of the wind resources for:

- the state as a whole
- individual local government areas.

The atlas provides information about Victoria's average wind resources at 65 metres above ground level to a resolution of three kilometres.

The modelled wind speed data is presented with a range of other information including:

- land use category
- electricity network
- elevation
- vegetation cover
- reference towns.

The *Victorian Wind Atlas* provides useful information for wind facility developers, councils and communities to assist in determining appropriate locations for a wind energy facility in a particular region. The information is correct to 2003 and for particular projects it will need to be supplemented with more recent site specific data and assessments.

2.2 Identifying suitable locations for wind energy development in Victoria

Wind energy facilities should not lead to unacceptable impacts on critical environmental, cultural or landscape values. Critical values are those protected under Commonwealth or Victorian legislation and assets of state or regional significance, mapped and recognised through planning schemes, including the State Planning Policy Framework (SPPF). In order to identify suitable locations for new wind energy development, the following matters need to be taken into consideration.

2.2.1 Environmental values

Responsible authorities and applicants must consider a range of relevant environmental values and risk factors when identifying suitable sites for wind energy facility development.

These matters are set out in the VPP and include (but are not confined to) the following considerations:

(a) Flora and fauna

Impacts on flora and fauna species and habitat from wind energy facilities and associated infrastructure can be minimised through siting and design measures at the project planning stage. Project specific impacts can vary widely with location and species. The assessment of a proposed development must carefully examine any risk to flora and fauna species and project design and adaptive management measures should be applied where necessary.

Flora and fauna can be protected at the national and state levels.

At the national level, responsible authorities and proponents need to be aware of the following:

- The Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) provides for the protection of matters of national environmental significance, including nationally significant threatened species and wetlands protected under the Convention of Wetlands of International Importance (the Ramsar Convention).
- The habitat values of wetlands and wetland wildlife habitat designated under the Ramsar Convention, or utilised by designated species under the Japan-Australia Migratory Birds Agreement (JAMBA) or the China-Australia Migratory Birds Agreement (CAMBA).

At the state level, responsible authorities and proponents must consider (as relevant) the following:

- The *Flora and Fauna Guarantee Act 1988* which provides protection for species and ecosystems that are of state-wide importance.
- The SPPF which sets out the state planning objectives for protection and conservation of biodiversity - refer to Clause 12.01 (Biodiversity) of the VPP.
- Clause 52.17 (Native Vegetation) of the VPP which provides the relevant decision making framework for native vegetation protection and conservation.

(b) Native vegetation

Losses of native vegetation and habitat could occur as a result of the siting of turbines and associated infrastructure. If native vegetation is proposed to be removed as part of a development proposal, responsible authorities must have regard to *Victoria's Native Vegetation Management – A Framework for Action* (Department of Natural Resources and Environment 2002).

The SPPF sets out the Victorian Government's policy objective and provides relevant strategies and guidelines for native vegetation management in Clause 12.01-2 (Biodiversity) of the VPP. Additional planning provisions are set out in Clause 52.16 (Native vegetation precinct plan) and Clause 52.17 (Native vegetation).

Other environmental values and risk factors must also be considered in identifying suitable sites for wind energy facilities as set out in the SPPF.

2.2.2 Significant landscape values

The Victorian Government recognises that the Victorian community places a high value on landscapes with significant visual amenity due to their environmental, social and economic benefits. Strategic planning plays an important role in identifying and managing these important landscapes.

Responsible authorities and proponents must consider (as relevant) Clause 12.04 (Significant environments and landscapes) of the SPPF.

In addition, strategic landscape studies have been completed for a number of regions across Victoria, including the *Great Ocean Road Region Landscape Assessment Study* (2004) and the *Coastal Spaces Landscape Assessment Study* (2006). These studies identify visually significant landscapes and provide appropriate recommendations for improved planning scheme guidance. Clause 12.02 (Coastal areas) of the SPPF requires these studies to be considered by decision makers.

In planning schemes relevant local strategic studies may also be referenced in the Local Planning Policy Framework, and significant landscapes may be recognised in overlays, such as the Environmental Significance Overlay, Vegetation Protection Overlay or the Significant Landscape Overlay.

To help guide appropriate site selection, design and layout of individual wind turbines, consideration should be given to the significance of the landscape as described in relevant planning scheme objectives, including relevant overlays and strategic studies referenced in the planning scheme.

Suggested mitigation measures to minimise the potential impact of wind energy facilities on a landscape set out in section 5.1.3 of these guidelines should also be considered.

There are also requirements relating to landscape assessment under the state environmental assessment process. For details refer to section 3.4.1 of these guidelines.

2.2.3 Aboriginal cultural heritage values

Wind energy facilities and associated infrastructure have the potential to impact on Aboriginal cultural heritage values. These values are protected under Victoria's *Aboriginal Heritage Act 2006* and Aboriginal Heritage Regulations 2007. It is important that any impacts and the views of relevant Aboriginal people are considered in the early planning stages of a wind energy facility. The Department of Planning and Community Development's practice note *The Aboriginal Heritage Act 2006 and the planning permit process* provides guidance and assistance. The practice note can be obtained at www.dpcd.vic.gov.au/planning/practicenotes.

Where wind energy facilities are located on Crown Land, a range of legal requirements, including the provisions of the Commonwealth *Native Title Act 1993*, may apply.

Responsible authorities and proponents must also consider Clause 15.03-2 (Aboriginal cultural heritage) of the SPPF, which sets out the Victorian Government's policy for the protection and conservation of places of Aboriginal cultural heritage significance.

2.2.4 Exclusion of wind energy facilities in National Parks, State Parks and Coastal Parks and other high quality environmental and landscape locations in the state

Wind energy facilities are not permitted in the following areas, in recognition of their landscape and environmental values:

- National Parks and other land subject to the *National Parks Act 1975*
- Ramsar wetlands as defined under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
- Yarra Valley and Dandenong ranges, Bellarine and Mornington Peninsulas, the Great Ocean Road area within five kilometres of the high water mark, and Macedon and McHarg Ranges
- the area within five kilometres of the high water mark of the Bass Coast, west of Wilsons Promontory.

The specific locations of these areas where wind energy facilities are not permitted are specified in the relevant planning schemes, in Clause 52.32-2 and the schedule to this clause.

2.2.5 Exclusion of wind energy facilities in locations that are likely to be required for future population growth

A wind energy facility is also a prohibited use in an Urban Growth Zone and within five kilometres of major regional cities and centres specified in the Regional Victoria Settlement Framework plan in the SPPF, being:

> Ararat, Bairnsdale, Ballarat, Bendigo, Benalla, Colac, Echuca, Geelong, Hamilton, Horsham, Mildura, Moe, Morwell, Portland, Shepparton, Swan Hill, Traralgon, Sale, Wangaratta, Warrnambool and Wodonga.

These locations are specified in the relevant planning schemes in the schedule to Clause 52.32-2. The five kilometre exclusion areas are proposed to be replaced by more specific locations once the future growth planning for these centres has been completed.

2.2.6 Turbines prohibited within two kilometres of an existing dwelling

If an existing dwelling is located within two kilometres of any turbine that forms part of a proposed wind energy facility, the permit application must be accompanied by evidence of the written consent of the owner of the dwelling. The application is prohibited by the planning scheme where evidence of written consent is not provided.

Section 3

Planning framework for wind energy facility proposals

This section provides a decision-making framework for the assessment of wind energy facility applications.

3.1 Decision-making framework for a planning permit application

The use and development of land for the purpose of a wind energy facility requires a planning permit, under Clause 52.32-2 of the VPP.

All planning schemes include provisions that apply to assessing proposals for wind energy facilities. These provisions include:

- the definition of a wind energy facility in Clause 74 (Land use terms)
- state planning policy for renewable energy in Clause 19.01 of the State Planning Policy Framework (SPPF)
- planning provisions and requirements for planning permit applications set out in Clause 52.32 (Wind Energy Facility)
- planning permit exemptions for anemometers erected for less than three years set out in Clause 62.01.

3.2 Who is the responsible authority?

The local council is the responsible authority for an application for a permit for a wind energy facility, except where a project is designated as being of state significance under Part 9A of the *Planning and Environment Act 1987*.

The local council may consult with Department of Planning and Community Development regional officers in relation to their consideration of a planning permit application for a wind energy facility. The local council may also ask the Minister for Planning to decide an application under section 97C of the *Planning and Environment Act 1987*.

Note: If a project is subject to the requirements of the *Environment Effects Act 1978*, the *Planning and Environment Act 1987* prescribes the planning permit process that will apply. See section 3.4.1 of these guidelines.

3.3 Where can a wind energy facility be constructed?

A permit may be granted for a wind energy facility on any land except land in an Urban Growth Zone and locations identified in Clause 52.32-2 of the VPP and all planning schemes, which include:

- land described in a schedule to the *National Parks Act 1975*
- land declared a Ramsar wetland as defined under section 17 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth)
- land listed in a schedule to Clause 52.32-2 in individual planning schemes, which includes:
    - all land in the Yarra Ranges and Mornington Peninsula planning schemes
    - the Bellarine Peninsula (all land covered by the Queenscliffe planning scheme and land covered by the Greater Geelong planning scheme east of the Surf Coast Highway and south of the Princes Highway)
    - the Great Ocean Road area (all land within five kilometres of the high water mark in the Warrnambool, Moyne, Corangamite, Colac Otway, Surf Coast and Greater Geelong planning schemes between the Bellarine Peninsula and Warrnambool)
    - Macedon and McHarg Ranges (all land within the Macedon Ranges planning scheme, all land west of the Hume Freeway and the Goulburn Valley Highway in the Mitchell planning scheme and all land bounded by the McIvor Highway and the Calder Highway/Freeway in the Greater Bendigo and Mount Alexander planning schemes)
    - land within five kilometres of the high water mark of the Bass Coast in the Bass Coast and South Gippsland planning schemes, west of Wilsons Promontory.
- designated regional population growth corridors – land within five kilometres of major regional cities and centres specified in the Regional Victoria Settlement Framework in the SPPF (i.e. Ararat, Bairnsdale Ballarat, Benalla, Bendigo, Colac, Echuca, Geelong, Hamilton, Horsham, Mildura, Moe, Morwell, Portland, Sale, Shepparton, Swan Hill, Traralgon, Wangaratta, Warrnambool and Wodonga).

3.4 Other statutory approvals

Apart from obtaining planning approval for a wind energy facility, proponents should be aware that there may be other regulatory requirements at both the state level in Victoria and the national level. These include:

- for Victoria:
    - *Environment Effects Act 1978*
    - *Aboriginal Heritage Act 2006*
    - *Flora and Fauna Guarantee Act 1988* (FFG Act)

- for the Commonwealth
  - *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
  - *Native Title Act 1993*

The onus is on the proponent to contact the relevant agency to determine its requirements. Relevant agency contacts and a list of legislation that may impact on a proposed wind energy facility can be found at www.dpcd.vic.gov.au/planning/windenergy.

3.4.1 State environmental assessment

The Minister for Planning is responsible for administering the *Environment Effects Act 1978* and for deciding whether an Environment Effects Statement (EES) is required under that Act. If a proposal is likely to have a significant effect on the environment, it should be referred to the Minister for a decision on the need for an EES.

The onus is on the proponent to refer a proposal to the Minister for Planning to determine whether an EES is required.

The Minister for Planning will require a preliminary landscape assessment to accompany a referral of a proposed wind energy facility. Should an EES be required, then it must include an independently peer-reviewed visual impact assessment by a suitably qualified and experienced person.

The ministerial guidelines for assessment of environmental effects under the *Environment Effects Act 1978* provide guidance on EES processes. More information can be found at www.dpcd.vic.gov.au/planning/environment-assessment.

3.4.2 Commonwealth environmental assessment

A proposal may also need approval under the EPBC Act if it is likely to have a significant impact on matters of national environmental significance, for example, listed threatened or migratory species.

When a person proposes to take an action that they believe may need approval under the EPBC Act, they must refer the proposal to the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities. If the Minister determines that an approval is required, the proposed action must be assessed under the EPBC Act.

Further information on the operation of the EPBC Act is available from the Federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPC), or for help in deciding whether an action should be referred, you should consult the EPBC Administrative Guidelines on Significance at www.environment.gov.au/epbc/publications, including the S*ignificant Impact Guidelines 1.1: Matters of National Environmental Significance* (2009) and the *EPBC Act Policy Statement 2.3 – Wind Farm Industry* (2009).

If approval is required under the EPBC Act, the project may need to be assessed using an assessment process specified under that Act, or an accredited state impact assessment process may be able to be used.

Under the Bilateral Agreement (2009) between Victoria and the Commonwealth, the following Victorian processes can be accredited:

- EES process
- Advisory Committee process
- planning permit process.

The Commonwealth Minister for Sustainability, Environment, Water, Population and Communities will make the final decision under the EPBC Act, even if a project is assessed using an accredited state impact assessment process.

Section 4

Planning permit applications – information for applicants

This section provides information for persons making an application for a permit for a wind energy facility.

4.1 The planning permit application process

The diagram on page 19 sets out the steps in a typical assessment process for a wind energy facility. Section 4.2 of these guidelines provides further details about preparing a planning permit application.

Proponents should also determine if any other parts of the proposal trigger the need for planning permit approval, such as off-site works or native vegetation removal.

Planning scheme zoning and overlay information for any location in Victoria can be obtained from www.dpcd.vic.gov.au/planningschemes.

4.1.1 Pre-application consultation with community and stakeholders

Pre-application consultation with the community and other stakeholders provides an opportunity for information gathering and exchange.

The development of a community and stakeholder communications and consultation plan is highly recommended, as it will help drive an effective and efficient consultative program.

Pre-application consultation is not a formal statutory requirement of the planning process, however effective pre-application consultation offers benefits for proponents and interested parties alike. After a planning permit application is lodged, there are statutory requirements to notify the public of a proposal.

Pre-application consultation provides the proponent with an opportunity to identify and understand any concerns of the community and stakeholders, and to obtain information and feedback on existing conditions and potential issues to address before the public notification phase of the planning permit application. Early consultation will assist in developing a well conceived proposal and contribute to an efficient assessment process.

Some principles to guide consultation include:

- start early
- ensure the consultation is well planned
- provide suitable opportunities for input by particular community and stakeholder groups

- communicate effectively by:
  - listening to what stakeholders and the public have to say
  - listening to what the local council, the Department of Planning and Community Development and other agencies have to say
  - providing sufficient information to enable stakeholders to make a useful contribution
  - providing briefings on progress and further information on request
  - being prepared to make improvements/changes to the proposal in response to stakeholder inputs
  - monitoring stakeholder involvement and inputs to refine and better target the consultation.

The proponent can contact the appropriate council or regional office of the relevant government department for advice regarding pre-application consultation and issues relating to planning and natural resource management.

For further guidance on preparing an appropriate community and stakeholder engagement framework and an effective community and stakeholder communications and consultation plan, refer to the:

- draft *National Wind Farm Development Guidelines* (July 2010), as amended, which are available at www.ephc.gov.au/taxonomy/term/25
- *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (Auswind, December 2006), which are available at www.cleanenergycouncil.org.au
- *Effective Engagement Kit* – DSE (Version 3 September 2005), which is available at www.dse.vic.gov.au/engage

4.1.2 Lodgement and processing of planning permit applications

A planning permit application must be lodged with the responsible authority (usually the local council).

An application will not proceed until the proponent provides all the required information. A planning application must include sufficient information and explanation to allow the responsible authority to come to a sound and timely decision. Clauses 52.32-3 and 52.32-4 contain details of information that must be submitted with an application.

These guidelines will assist proponents in the design and siting of proposed wind energy facilities and in preparing planning permit applications. The draft *National Wind Farm Development Guidelines* (July 2010) and the *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (Auswind, December 2006) also provide guidance on the design and siting of wind energy facilities.

When all the relevant information has been received, the responsible authority will proceed with the public notification and referral requirements. Upon completion of notice and referral, the responsible authority will determine the application. Refer to the assessment process flowchart on page 19.

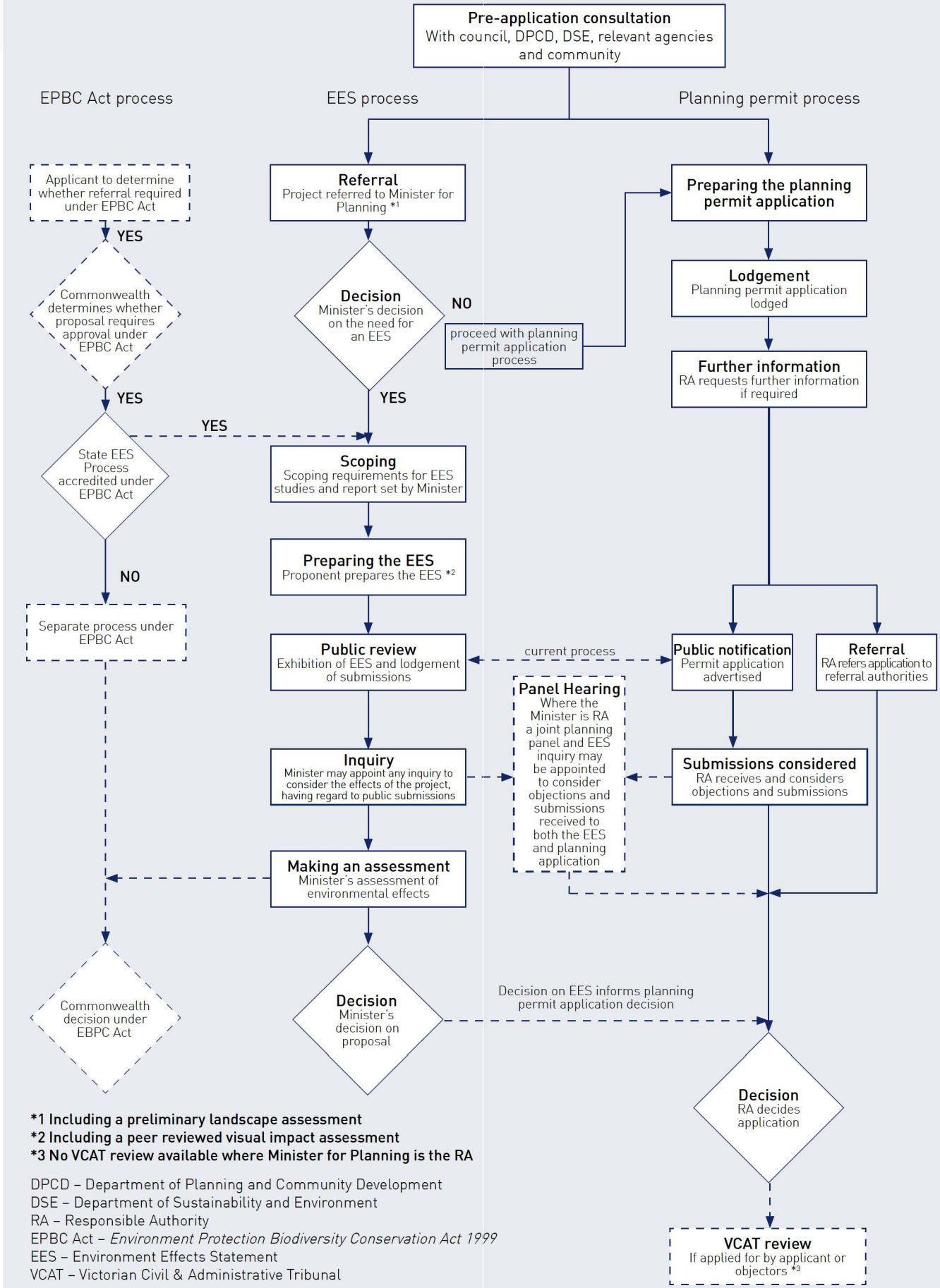
4.1.3 Decision options

The responsible authority may decide to grant a permit, refuse to grant a permit, or where objections have been received, issue notice of decision to grant a permit, giving objectors an opportunity to lodge an application for review at VCAT.

When drafting a permit, a responsible authority must comply with Form 4 of the Planning and Environment Regulations 2005. The manual *Writing Planning Permits* (2007) provides guidance on preparing planning permits. It is available at www.dpcd.vic.gov.au/planning. Model conditions for permits for wind energy facilities have also been developed and are attached to these guidelines (see Attachment B).

If a permit is granted or notice of decision issued for a wind energy facility, it will normally be subject to conditions relating to noise, lighting of turbines, site environmental management, decommissioning and rehabilitation requirements, among other things.

The assessment process flowchart



***1 Including a preliminary landscape assessment**
***2 Including a peer reviewed visual impact assessment**
***3 No VCAT review available where Minister for Planning is the RA**

DPCD – Department of Planning and Community Development
DSE – Department of Sustainability and Environment
RA – Responsible Authority
EPBC Act – *Environment Protection Biodiversity Conservation Act 1999*
EES – Environment Effects Statement
VCAT – Victorian Civil & Administrative Tribunal

4.2 Preparing a planning permit application

4.2.1 Pre-application discussions

Talk to the responsible authority to find out:

- the relevant state and local planning policies, guidelines and other planning scheme requirements that apply to the proposal
- if there are any referral authorities or other agencies that may have an interest in the proposal, it is important at this point to talk to them about what their requirements might be
- who may be affected by the proposal
- information required to accompany the application.

Talk to the Department of Planning and Community Development to find out if the proposal should be referred to the Minister for Planning to determine whether an assessment under the *Environment Effects Act 1978* will be required. If so, a preliminary landscape assessment must be prepared by the proponent and provided to the department.

Talk to the Department of Sustainability and Environment's (DSE) regional biodiversity, flora/fauna officers to determine the likelihood of impact on native vegetation, threatened species, and the type/extent of surveys which may be expected.

Contact the Commonwealth DSEWPC to find out whether the proposal is an action that is likely to have a significant impact on matters of national environmental significance or on Commonwealth land, and should be referred to the Commonwealth for assessment and approval under the EPBC Act.

In addition, contact the Australian Energy Market Operator for early advice about grid connection matters.

Undertake pre-application consultation with the community and stakeholders. While not a formal requirement of the planning process, pre-consultation provides a forum for informal and open consultation to exchange information and gain feedback on the proposal and potential measures to be addressed before public notification of the development application.

4.2.2 Seek expert advice

An application should be accompanied by an assessment of the ecological, visual, noise and other environmental impacts of the proposal prepared by suitably qualified persons.

Expert advice on these matters should be sought early to inform the site selection process and the preparation of the site analysis and design response. The assessments submitted with the application should clearly state the facts, matters and all assumptions on which the assessments were based.

Refer to the draft *National Wind Farm Development Guidelines* (July 2010) and *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (Auswind, December 2006).

4.2.3 Prepare the site analysis

A site analysis is an audit of the subject site and its surrounds. It will comprise a plan, photographs or some other suitable information describing the land and the matters that influence the proposal.

The information requirements for a site analysis for a wind energy facility are set out in section 4.3.2 of these guidelines. If the land is also to be used for other purposes, such as agriculture, the site analysis should include information about this.

4.3 Meeting application requirements

Clause 52.32 (Wind energy facility) in all planning schemes outlines information which must accompany an application for a permit for a wind energy facility.

The following provides assistance to applicants on matters that should be addressed to meet these information requirements. The level of information required to be provided by proponents will vary depending on the size and extent of the proposal, and the requirements of the responsible authority and any referral authorities.

4.3.1 Evidence of written consent

The responsible authority is required to establish if an application for a wind energy facility is discretionary under the planning scheme. Where an application includes a turbine or turbines within two kilometres of an existing dwelling, the responsible authority must be provided evidence of written consent of the owner of that dwelling or dwellings. The application requirements in Clause 52.32-3 require a planning permit application to include:

1. a plan showing all dwellings within two kilometres of a proposed turbine that forms part of the wind energy facility
2. evidence of the written consent of the owner of any existing dwelling located within two kilometres of a proposed turbine that forms part of the wind energy facility.

Evidence of written consent should include:

- a statement of consent that includes
  - the name and address of the owner(s) of the dwelling
  - the address of, and title particulars for, the land on which the dwelling is located
  - a statement that the owner consents to an application being made that includes a turbine(s) located as shown on the attached plan

- a plan showing:
  - the dwelling
  - the proposed location of the turbine(s) within two kilometres of the dwelling
  - the distance between the dwelling and the proposed turbine(s).

The location of the turbine(s) can be a specific site or a more general area in which the turbine(s) will be sited.

The plan should be able to be read and reconciled with the plans of the wind energy facility that form part of the application (including the plan showing all dwellings within two kilometres of a proposed turbine that forms part of the wind energy facility).

The statement of consent and the attached plan should both be signed and dated by the owner of the dwelling.

Attachment A can be used as a statement of consent.

4.3.2 Site and context analysis

(a) A site analysis

A site analysis is an application requirement of the planning scheme. The site analysis may include a site plan, photographs or other techniques to accurately describe:

- in relation to the site:
  - site shape, dimensions and size
  - orientation and contours
  - current land use
  - the existing use and siting of existing buildings or works on the land
  - existing vegetation types, condition and coverage
  - the landscape of the site
  - species of flora and fauna listed under the FFG Act and the EPBC Act
  - sites of cultural heritage significance
  - wind characteristics
  - any other notable features, constraints (e.g. acid sulphate soil, highly erodible soils and land instability) or other characteristics of the site
- in relation to the surrounding area:
  - existing land uses
  - above-ground utilities
  - access to infrastructure

- direction and distances to nearby dwellings, townships, urban areas, significant conservation and recreation areas, water features, tourist routes and walking tracks, major roads, airports, aerodromes and existing and proposed wind energy facilities
- the siting and use of buildings on adjacent properties
- the location of all existing dwellings within two kilometres of the nearest turbine (adopting a precautionary approach, accounting for micro-siting variation in final placement of turbines). Where the proposal includes any turbines within two kilometres of an existing dwelling, the application must be accompanied by evidence of the written consent of the owner of the dwelling. The application is prohibited under the planning scheme where evidence of the written consent is not provided
- the landscape, including any significant landscape features
- views to and from the site, including views from existing dwellings and key vantage points including major roads, walking tracks, tourist routes and regional population growth corridors
- sites of flora and fauna listed under the FFG and EPBC Acts, including significant habitat corridors, and movement corridors for these fauna
- sites of cultural heritage significance
- National Parks, State Parks, Coastal Reserves and other land subject to the *National Parks Act 1975*
- land declared a Ramsar wetland as defined under section 17 of the EPBC Act
- location of any nearby land included in the schedule to Clause 52.32-2 of the planning scheme (i.e specified areas of landscape and environmental significance, specified coastal locations and areas identified to accommodate future population growth of regional cities and centres) showing that the setback requirements are met
- any other notable features or characteristics of the area
- wildfire risks.

(b) A location plan

A plan showing the area around the site including:

- local electricity grid (including capacity)
- access roads to the site.

4.3.3 Design response

(a) A development plan

A development plan comprising:

- detailed plans of the proposed development showing:
  - the layout of the wind turbine generators and associated buildings and works (this can include anemometers)
  - proposed connections to the electricity grid (the on-site metered point of output from the converter station where the generated electricity units will enter the distribution system)
  - access roads on the site
- a concept plan that includes the capacity of new grid connections, network transmission infrastructure, electricity utility works and access road options
- accurate visual simulations showing the appearance of the development in the context of the surrounding area and from key public view points
- measures to manage any fire risks associated with the facility or connections to the electricity grid
- a rehabilitation plan for the site, including plans for revegetation and regeneration works.

(b) Written reports

Written reports including:

- a written response that explains how the proposed design derives from and responds to the site analysis
- a description of the proposal, including:
  - the number, location and specifications of the wind generator turbines (including the height of each turbine to the tip of the turbine blade when vertical above ground level)
  - the amount of electricity to be exported from the site
    - a summary of the contribution of the proposal to:
      - minimising greenhouse emissions
      - increasing Victoria's diversity and security of energy supply
      - economic and social outcomes of the proposal, including local and regional considerations
    - infrastructure requirements, including proposed connections to the electricity grid and vehicle access routes
    - traffic movements

- how the proposal responds to any significant landscape features for the area identified in the planning scheme
- an assessment of the visual impact of the proposal on the landscape, including land that is described in a schedule to the *National Parks Act 1975*, Ramsar wetlands and coastal areas
- an assessment of the impact of the proposal on fauna, including any species (examining particularly birds and bats) listed under the FFG Act or EPBC Act
- an assessment of the noise impact of the proposal prepared in accordance with the New Zealand Standard NZS 6808:2010, Acoustics – Wind Farm Noise (the Standard), including an assessment of whether a high amenity noise limit is applicable, as assessed under Section 5.3 of the Standard (www.standards.co.nz).
- an assessment of the impacts upon Aboriginal and non-Aboriginal cultural heritage
- an explanation of why the site is suitable for a wind energy facility having regard to:
    - the SPPF and the Local Planning Policy Framework, including the Municipal Strategic Statement and any relevant local planning policy
    - the suitability of the site in comparison to other potential sites in the area
    - how the proposal responds to likely amenity effects on the surrounding area, existing dwellings and nearby settlements due to visual, noise and other environmental impacts, and including aviation safety lighting, blade glint, shadow flicker, overshadowing, and electromagnetic interference
    - the extent to which the proposal has been designed to manage any potential adverse impacts
    - the cumulative effects of the proposal having regard to other existing or proposed wind energy facilities in the area and other sources of industrial noise emissions
    - the economic and social impacts of the proposal.

Written reports may include plans, drawings, photographs, computer-based simulations and other documents.

4.3.4 Flora and fauna impacts assessment

In the first instance, proponents should contact the Victorian DSE or the Commonwealth DSEWPC directly for advice regarding whether the proposed wind energy facility may impact species of flora or fauna protected under the FFG Act or the EPBC Act.

Where it is reasonably likely that species listed under the FFG Act or the EPBC Act will be present on or near the site, or using the site as a migratory corridor, applicants for a wind energy facility permit should conduct surveys at the appropriate time for at least 12 months preceding the planning permit application. DSE or DSEWPC (as appropriate) should be consulted on the timing of the surveys. Survey work should determine the species present, any adverse impacts likely to arise from the proposed wind energy facility, and any appropriate mitigation measures.

Potential biodiversity impacts

Possible impacts of a wind energy facility on biodiversity can be considered under six categories set out below. Responsible authorities should consider the following matters in assessing applications and developing permit conditions:

Direct removal of native vegetation and habitat

- May arise for turbine tower footings, tracks and other infrastructure
- May be minimised by layout design and micro-siting
- Address unavoidable losses under Victoria's Native Vegetation Framework

Native fauna casualties resulting from construction activities

- Site induction to minimise risks to wildlife on-site
- Minimise risks to wildlife arising from excavation works

Bird and bat casualties resulting from collisions with moving turbine blades

- Site selection and to an extent layout and micro-siting will impact on risk level, especially for large, slow-flying birds (e.g. waterbirds, raptors)
- As well as direct collision, bats can be killed by barotraumas (lung injury)
- Some bird and bat species may require special consideration due to significance, behaviour or movement patterns

Bird and bat casualties resulting from collisions with stationary infrastructure (e.g. towers, anemometers, fences, powerlines)

- Lighting may disorient birds at night, increasing collision risk
- Fences, wires and transmission lines can be difficult for many species to avoid
- Transmission lines pose a well-documented hazard for many species of large birds

Indirect habitat loss resulting from avoidance

- Some species may avoid turbines by large margins, leading to loss of access to adjacent habitat
- Different avoidance distances may apply to different species or to particular species at different seasons

Cumulative barrier effects

- Migratory or otherwise mobile species may require turbine-free corridors through which to travel between critical sites (e.g. breeding and non-breeding habitats).
- Corridor needs may vary according to relevant species.

In evaluating wind energy facility impacts on birds and bats include cumulative impacts of a number of discrete wind energy developments within a broad area. It is important to place the collision risks inherent in wind farms in context with other anthropogenic collision risks such as fences, windows and motor vehicles. However, potential impacts of specific developments should still be identified, quantified, minimised and where necessary offset to ensure that the net impact of wind farm developments on biodiversity values, especially with regard to threatened species, is at worst neutral.

Further advice is provided in the draft *National Wind Farm Development Guidelines* (July 2010) and species guidelines produced by DSE.

4.3.5 Environmental Management Plan

The preparation of an environmental management plan (EMP) will be required. An environmental management plan details how the site will be managed through construction, and sets out future operational and maintenance requirements. It should include:

- principles of environmental management relevant to the site and nature and scale of the facility
- standards to be met
- environmental mitigation measures
- monitoring requirements
- post-construction adaptive management measures where monitoring shows the proposal may have significant impacts on EPBC Act and FFG Act listed species
- noise complaints registration and response processes
- emergency management and response plan
- decommissioning and rehabilitation requirements.

Further considerations are provided in the draft *National Wind Farm Development Guidelines* (July 2010).

4.3.6 Aircraft safety issues

The height of wind energy turbines can be substantial, resulting in potential impacts upon nearby airfields and air safety navigation. Applicants for a wind energy facility permit should address aircraft safety issues by considering the proximity of the site to airports, aerodromes, or landing strips.

Applicants should consult with the Civil Aviation Safety Authority (CASA) for wind energy facility proposals that:

- are within 30 kilometres of a declared aerodrome or airfield
- infringe the obstacle limitation surface around a declared aerodrome
- include a building or structure the top of which will be 110 metres or more above natural ground level (height of a wind turbine is that reached by the tip of the turbine blade when vertical above ground level).

Section 5

Information for responsible authorities assessing a wind energy facility

This section outlines the key criteria for evaluation of the planning merits of a wind energy facility.

5.1 Assessing wind energy facility proposals – matters for consideration

Proposals for wind energy facilities must be assessed against state planning policy, local planning policy and other matters specified in section 60 of the *Planning and Environment Act 1987*.

These guidelines provide responsible authorities with assistance for the assessment of a wind energy facility. The extent and breadth of issues that arise and require assessment will differ between proposals and will need to be determined on a case-by-case basis. Responsible authorities should endeavour to balance environmental, social and economic matters in favour of net community benefit and sustainable development.

An explanation of matters to be considered by responsible authorities in assessing permit applications for wind energy facilities follows. Some suggested impact reduction measures specific to wind energy facilities are outlined below.

5.1.1 Contribution to government policy objectives

The State Planning Policy Framework (SPPF) in all planning schemes requires that planning authorities make decisions on the basis of fair, orderly, economic and sustainable use and development of land. In this context the SPPF contains a specific policy position regarding renewable energy – refer to Clause 19.01 (Renewable energy). This is the overarching policy statement regarding wind energy development which states:

> **Objective**
>
> To promote the provision of renewable energy in a manner that ensures appropriate siting and design considerations are met.
>
> **Strategies**
>
> In considering proposals for renewable energy, consideration should be given to the economic and environmental benefits to the broader community of renewable energy generation, while also considering the need to minimise the effects of a proposal on the local community and environment. (Paragraph 4 of 5)

More specific provisions relating to assessing wind energy developments are set out in Clause 52.32 (Wind Energy Facility) of the VPP.

Responsible authorities must assess the impact of a wind energy facility on landscape values, flora and fauna, human wellbeing and amenity in a systematic manner. In assessing impacts and appropriate mitigation responses, responsible authorities should reference best practice standards including the draft *National Wind Farm Development Guidelines* (July 2010) and *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (Auswind, December 2006).

5.1.2 Amenity of the surrounding area

A wind energy facility can affect the amenity of the surrounding area due to noise, blade glint, shadow flicker, overshadowing and electromagnetic interference.

(a) Noise

A wind energy facility can create noise due to the:

- mechanical noise produced by the wind turbine generators
- movement of the rotor blades through the air
- construction noise.

The impact of the noise depends on the sensitivity of the surrounding land uses, existing background noise levels, topography and wind speed and direction.

A wind energy facility should comply with the noise limits recommended for dwellings and other noise sensitive locations in the New Zealand Standard NZS 6808:2010 Acoustics – Wind Farm Noise (the Standard).

The Standard specifies a general 40 decibel limit for wind farm sound levels, or the sound should not exceed the background sound level by more than five decibels, whichever is the greater.

Under section 5.3 of the Standard, a 'high amenity noise limit' of 35 decibels applies in special circumstances. All wind farm applications must be assessed using section 5.3 of the Standard to determine if the location warrants application of a high amenity noise limit. Compliance with the higher standard can typically be achieved by a change in the location, number or operating mode of the turbines.

Planning permit conditions should require post installation noise compliance to be monitored and demonstrated to the satisfaction of the responsible authority. Refer to the model permit conditions in Attachment B.

Certification of a whether a wind energy facility complies with the Standard and other applicable noise requirements must be undertaken by an acoustic engineer. The wind energy facility operator must provide the responsible authority with appropriate documentation signed by an independent, appropriately qualified and experienced person. The certifier must be able to demonstrate to the responsible authority appropriate independence, qualifications and experience to carry out the task.

Measurement and compliance assessment methods are set out in the Standard.

(b) Blade glint

Blade glint can result from the sun reflecting from turbine blades.

Blades should be finished with a surface treatment of low reflectivity to ensure that glint is minimised. Further considerations are provided in the draft *National Wind Farm Development Guidelines* (July 2010).

(c) Shadow flicker

Shadow flicker results from the position of the sun in relation to the blades of the wind turbine as they rotate. This occurs under certain combinations of geographical position and time of day. The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the site.

Shadow flicker can be modelled in advance and siting and design can mitigate the problem. This is more likely to be an issue for turbines located to the east or west of a dwelling.

The shadow flicker experienced immediately surrounding the area of a dwelling (garden fenced area) must not exceed 30 hours per year as a result of the operation of the wind energy facility. Further considerations are provided in the draft *National Wind Farm Development Guidelines* (July 2010).

(d) Electromagnetic interference

The effect of wind turbines on electromagnetic waves will usually be relatively limited. Potential electromagnetic interference effects can be calculated from information about affected telecommunications transmitting or receiving stations, local conditions, turbine design and location.

The potential for electromagnetic interference from the generation of electricity from a wind energy facility should be minimised, if not eliminated, through appropriate turbine design and siting.

The siting of wind turbines in the 'line of sight' between transmitters and receivers should be avoided. Further considerations are provided in the draft *National Wind Farm Development Guidelines* (July 2010).

5.1.3 Landscape and visual amenity

The degree of visual impact of a wind energy facility depends on the extent of the change to the landscape caused by the development, taking into account:

- the visibility of the development
- the locations and distances from which the development can be viewed
- the significance of the landscape as described in the planning scheme (including in an overlay, a relevant strategic study or landscape features referenced in the planning scheme)
- landscape values associated with nearby parks described in a schedule to the *National Parks Act 1975* or Ramsar wetlands

- landscape values associated with nearby land included in the schedule to Clause 52.32-2 of the planning scheme, such as specified areas of landscape and environmental significance, specified coastal locations and areas identified to accommodate future population growth of regional cities and centres
- the sensitivity of the landscape features to change.

The visual impact of the development relates to:

- the number, height, scale, spacing, colour and surface reflectivity of the wind turbines
- the quantity and characteristics of lighting, including aviation obstacle lighting (subject to CASA requirements and advice)
- avoidance of visual clutter caused by turbine layout and ability to view through a cluster or array (visually well ordered series) of turbines in an orderly manner
- the removal or planting of vegetation
- the location and scale of other buildings and works including transmission lines and associated access roads
- proximity to sensitive areas
- proximity to an existing or proposed wind energy facility, having regard to cumulative visual effects.

The features of the landscape include:

- the topography of the land
- the amount and type of vegetation
- natural features such as waterways, cliffs, escarpments, hills, gullies and valleys
- visual boundaries between major landscape types
- the type, pattern, built form, scale and character of development, including roads and walking tracks
- flora and fauna habitat
- cultural heritage sites
- the skyline.

Wind energy facilities will have a degree of impact on the landscape.

Responsibly authorities need to determine whether or not the visual impact of a wind energy facility in the landscape is acceptable. In doing so, they should consider planning scheme objectives for the landscape, including whether the land is subject to an Environmental Significance Overlay, Vegetation Protection Overlay, Significant Landscape Overlay or a relevant strategic study that is part of the relevant planning scheme.

The visual impact of a proposal should have regard to relevant state and local government planning policy.

The following measures are suggested to reduce the visual impacts of wind energy facilities:

- siting and design to minimise impacts on views from areas used for recreation and from dwellings
- locating arrays of turbines to reflect dominant topographical and/or cultural features, such as ridgelines, the coastline, watercourses, windbreaks or transmission lines
- using turbine colour to reduce visual impacts from key public view points
- limiting night lighting to that required for safe operation of a wind energy facility and for aviation safety
- reducing the number of wind turbines with obstacle lights while not compromising aviation safety
- mitigating light glare from obstacle lighting through measures such as baffling
- selecting turbines that are consistent in height, appearance and rotate the same way
- spacing turbines to respond to landscape characteristics
- undergrounding electricity lines wherever practicable
- minimising earthworks and providing measures to protect drainage lines and waterways
- minimising removal of vegetation
- avoiding additional clutter on turbines, such as unrelated advertising and telecommunications apparatus.

Further considerations are provided in the draft *National Wind Farm Development Guidelines* (July 2010).

5.1.4 Flora and fauna

Responsible authorities should consider the effects of the proposed wind energy facility on flora and fauna at the site and in the surrounding area. Consideration should be given to:

- whether the species and communities are protected under the EPBC Act or the FFG Act
- the sensitivity of any protected species to disturbance
- the potential loss of habitat of species protected under the EPBC Act or the FFG Act
- measures to minimise the impacts on any native species.

If the proposal is likely to have significant impacts on listed species, the responsible authority should consider whether the applicant has provided appropriate survey work (refer to section 4.3.4 of these guidelines for more detail). Responsible authorities should consider whether to impose planning permit conditions requiring monitoring

of flora and fauna, including further survey work, after construction of the wind energy facility. An environmental management plan may provide for the development of reasonable and cost effective steps to minimise any ongoing risks.

If native vegetation is proposed to be removed, responsible authorities should follow the three-step approach of avoid, minimise and offset, required by *Victoria's Native Vegetation Management – A Framework for Action* (Department of Natural Resources and Environment 2002). In applying the policy, there are three key steps for land managers and owners to address when considering vegetation clearing (as addressed in Clause 12.01-2 of the SPPF of all planning schemes):

- as a priority, avoid the removal of native vegetation
- if the removal of native vegetation cannot be avoided, minimise the loss of native vegetation through appropriate consideration in planning processes and expert input into project design or management
- identify appropriate offset actions.

Details of the Native Vegetation Management Framework can be found on the DSE website at www.dse.vic.gov.au or contact the relevant regional office.

5.1.5 Aircraft safety

The height of wind energy turbines can be substantial, resulting in potential impacts upon nearby airfields and air safety navigation. Responsible authorities should consider the proximity of the site to airports, aerodromes or landing strips, and ensure that any aircraft safety issues are identified and addressed appropriately.

Although the Civil Aviation Safety Authority (CASA) is not a formal referral authority for wind energy facility permit applications, responsible authorities should nevertheless consult with CASA in relation to aircraft safety impacts of a wind energy facility proposal, particularly proposals that:

- are within 30 kilometres of a declared aerodrome or airfield
- infringe the obstacle limitation surface around a declared aerodrome
- include a building or structure the top of which will be 110 metres or more above natural ground level (height of a wind turbine is that reached by the tip of the turbine blade when vertical above ground level)

Other private airstrips may not be identified by consultation with CASA. These may be identified using aerial photographs, discussions with the relevant council, or consultation with local communities.

Responsible authorities should ensure that the proponent has consulted appropriately with CASA in relation to aircraft safety and navigation issues. Refer to section 4.3.6 of these guidelines for more detail.

CASA may recommend appropriate safeguards to ensure aviation safety. These may include changes to turbine locations, turbine heights and/or the provision of aviation safety lighting. Responsible authorities should ensure that any concerns raised by CASA are appropriately reflected in permit conditions.

Aviation safety lighting can have an impact on the amenity of the surrounding area. Responsible authorities may consider the following impact reduction measures (subject to CASA requirements and advice):

- reducing the number of wind turbines with obstacle lights
- specifying an obstacle light that minimises light intensity at ground level
- specifying an obstacle light that matches light intensity to meteorological visibility
- mitigating light glare from obstacle lighting through measures such as baffling.

Further considerations are provided in the draft *National Wind Farm Development Guidelines* (July 2010).

5.1.6 Construction impacts and decommissioning

As outlined above, construction of a wind energy facility and associated infrastructure (access roads and transmission lines) must be managed to minimise on- and off-site adverse impacts on nearby residents and the environment. An environmental management plan (EMP) must be provided as part of every planning application, setting out how environmental impacts will be managed through construction and providing future operational and maintenance specifications. Refer to section 4.3.5 of these guidelines for more detail.

The approved EMP should be endorsed by the responsible authority and form part of the planning permit. Responsible authorities should consider imposing a permit condition requiring that the use and development be conducted in accordance with the endorsed EMP.

The draft *National Wind Farm Development Guidelines* (July 2010) provide a standard expected framework for an EMP covering construction, operation and decommissioning phases of a wind energy facility.

Section 6

Planning permit administration and enforcement

This section describes the role of the responsible authority in administering and enforcing wind energy facility permit conditions.

6.1 Administration of planning permit applications

Section 13(a) of the *Planning and Environment Act 1987* provides that the municipal council is the responsible authority for administration of a planning scheme unless a scheme provides to the contrary.

There are, however, exceptions to this. Councils may request the Minister for Planning to call in and decide an application for a planning permit, in accordance with section 97C of the *Planning and Environment Act 1987*. Councils typically make such a request where the council does not have the necessary technical expertise or capacity to deal with the application itself. The Minister also has the power to direct a council to refer a permit application to the Minister in certain circumstances, under section 97B of the *Planning and Environment Act 1987*. In both cases, a permit may be issued with conditions that require matters to be done to the Minister's satisfaction. For example, additional reports or amended plans may be required to be submitted to the Minister for further approval.

The Minister is responsible for extending, correcting or amending a permit issued by the Minister after a 'call in', but the local council will generally be responsible for enforcement of the permit (see section 6.3 of these guidelines).

6.2 Planning permit conditions

Planning permit conditions must be consistent with provisions set out in Clause 52.32 of the VPP, and should be generally consistent with these guidelines. Model planning permit conditions for wind energy facilities are attached to these guidelines (see Attachment B). These conditions can be customised by the responsible authority to reflect local planning policy and specific project circumstances.

6.3 Enforcement of planning scheme and planning permits

Section 13(a) of the *Planning and Environment Act 1987* states that enforcement responsibilities rest with the local council, unless the planning scheme specifies another person as the responsibility authority. The local council has primary responsibility for enforcement of the planning scheme and planning permits, regardless of whether a wind energy facility permit was issued by the council or by the Minister after a 'call in'.

If a permit has been issued by the Minister after a 'call in', the local council becomes responsible for administering and enforcing a permit, unless the permit conditions state otherwise. For instance, a permit issued by the Minister after a 'call in' may contain conditions that require matters to be done to the Minister's satisfaction. Enforcement responsibilities in relation to these types of conditions may rest with the Minister, rather than the council.

GLOSSARY

TERMS

CASA	The Civil Aviation Safety Authority	
DSE	Department of Sustainability and Environment	Victorian Department administering the FFG Act
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities	Federal Department administering the EPBC Act
EES	Environment Effects Statement	A statement prepared under the *Environment Effects Act 1978* (Vic) assessing the significant environmental effects of proposed works
EMP	Environmental management plan	
EPA	Environment Protection Authority	
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)	Federal legislation dealing with the protection of, and assessment of impacts of activities on, matters of national environmental significance
FFG Act	*Flora and Fauna Guarantee Act 1988*	Victorian legislation dealing with the protection of listed species of flora and fauna
SPPF	State Planning Policy Framework	Contained in the VPP and all planning schemes
the Standard	New Zealand Standard NZS 6808:2010 Acoustics – Wind Farm Noise	The noise standard wind energy facilities applicable under Clause 52.32 of the VPP
VPP	Victoria Planning Provisions	A set of standard provisions on which all Victorian planning schemes are based
Wind energy facility	Land used to generate electricity by wind force. It includes any turbine, building, or other structure or thing used in or in connection with the generation of electricity by wind force. It can include an anemometer. It does not include turbines principally used to supply electricity for domestic or rural use of the land.	This is the definition of a wind energy facility in the VPP

UNITS

W: watt	A unit of power	The power generation capacity of a wind generator is measured in watts
MW: megawatt	A unit of energy	1 megawatt = 1000 watts
Wh: watt hour	A unit of energy	The amount of electricity a wind energy facility generates is measured in watt hours

Attachment A:
Statement of consent

APPLICATION FOR [A PLANNING PERMIT/AN AMENDMENT TO A PLANNING PERMIT] FOR A WIND ENERGY FACILITY

DWELLING LOCATED WITHIN TWO KILOMETRES OF A TURBINE

STATEMENT OF CONSENT

Full details of property on which dwelling is located:

Address: .....

Title Particulars: Volume..... Folio.....

Name(s) and address(es) of the owner(s) of the dwelling

I/we as the owner/s of the existing dwelling on the above property:

- declare that I/we consent to an application for [a planning permit/an amendment to Planning Permit number [insert] for a wind energy facility to be made that includes a turbine or turbines in the location(s) shown on the attached plan
- acknowledge that the proposed turbine(s) will be located within two kilometres from the dwelling.

Signed: .....

Dated:.....

Attached: A plan showing the dwelling and the proposed location of the turbine(s) within two kilometres of the dwelling and the distance between the dwelling and the proposed turbine(s).

This plan should be able to be read and reconciled with the plans of the wind energy facility that form part of the planning permit application. The location of the turbine(s) can be a specific site or a more general area in which the turbine(s) will be sited.

Owner(s) must also sign and date the attached plan.

Attachment B: Model permit conditions to be applied as appropriate

MODEL PREAMBLE

ADDRESS OF THE LAND	**Land generally described as:** [insert a general description of the land e.g. street address, bounded by ...] [insert title details of land] [attach plan of all wind farm land]
WHAT WILL THE PERMIT ALLOW?	**Use [and development] of the land for a Wind Energy Facility and [specify related on-site works – this should not include off-site transmission infrastructure, which is likely to require separate planning permission]**

MODEL CONDITIONS

DEVELOPMENT PLANS

1. Before the development starts, development plans must be prepared to the satisfaction of the responsible authority. When approved, the plans will be endorsed by the responsible authority and will then form part of this permit. The plans must be fully dimensioned, drawn to a scale of [specify scale if possible] and three copies must be provided.

   The plans must be generally in accordance with the application plans numbered [insert number], dated [insert date], prepared by [insert name], but modified to show [insert whichever of the following paragraphs are required]:

   a. the location, setbacks to property boundaries, layout and dimensions of all on-site buildings and works including [select as appropriate from the following list, and include any additional features not in the list if necessary – all turbines, access tracks, underground cables, any temporary concrete batching plant, the substation, the switchyard, any designated car parking areas, and ancillary works such as construction compounds, fire fighting infrastructure and water tanks, as well as off-site road works]

b. the following adjustment to the layout:

   i [specify details of adjustments to siting required to minimise on-site physical impacts, for example disturbance, to native vegetation and fauna habitat. Include as appropriate any siting adjustments arising from findings or recommendations in any surveys undertaken in connection with the application (e.g. flora and fauna surveys)]

   ii [specify details of adjustments to siting required to minimise off-site physical impacts. Include as appropriate any siting adjustments arising from findings or recommendations in any surveys]

   iii [specify any adjustment required in response to an approved cultural heritage management plan]

   iv [specify any other required adjustments e.g. landscaping]

   v no turbines are located closer than [insert] metres from [specify location, e.g. nearby remnant woodland]

c. in relation to the turbines:

   i details of the model and capacity of the turbines to be installed

   ii elevations and dimensions of the turbines, including overall maximum height of turbines to the tip of the rotor blade when vertical, and base diameter at ground level, including tower and concrete base

   iii materials and finishes of the turbines

   iv global positioning system coordinates using WGS84 datum for each turbine

   v distance of each turbine from:

      — each dwelling (if any) within 2 km of the turbine

      — each adjoining property boundary

      — [insert other locations as appropriate, e.g. nearby remnant woodland]

d. in relation to other buildings and works:

   i. locations, elevations and dimensions of the buildings and works

   ii. materials and finishes of the buildings and works

e. the location, size, type and intensity of any lighting (including aviation safety lighting), including any directional screening or baffling of lighting

f. any directional or business identification signage and any required safety signage

g. [specify any other modifications required to the application plans arising from consideration of the application]

h. any staging of the permitted development, including the identification and timetabling of any required pre-construction works.

2. Despite any other condition of this permit, no plans will be endorsed by the responsible authority, and no variation to the endorsed plans will be approved by the responsible authority, which allow a turbine to be located within 2kms of an existing dwelling (measured from closest point of the turbine to closest point of the dwelling) unless evidence has been provided to the satisfaction of the responsible authority that the owner of the dwelling has consented in writing to the location of the turbine.

3. Except as permitted under condition 5, and subject to condition 4, the use and development as shown on the endorsed plans must not be altered or modified without the written consent of the responsible authority.

4. The responsible authority will not consent to an alteration or modification of the use and development as shown on the endorsed plans under condition 3 unless the responsible authority is satisfied that the alteration or modification will not give rise to an adverse change to assessed landscape, vegetation, cultural heritage, visual amenity, shadow flicker, noise, fire risk or aviation impacts.

   Any application for the consent of the responsible authority for an alteration or modification to the endorsed plans under condition 3 must be accompanied by supporting material addressing the matters referred to in this condition, to the satisfaction of the responsible authority.

MICRO-SITING OF TURBINES

5. Subject to condition 6, micro-siting of turbines (as defined in this condition) is permitted with the consent of the responsible authority. Any micro-siting of turbines in accordance with conditions 5 and 6 will be regarded as being in accordance with the endorsed plans, and no amendment to the endorsed plans will be required to reflect the micro-siting of turbines.

   For the purpose of this permit, micro-siting of turbines means an alteration to the siting of a turbine by not more than 100 metres, provided that the turbine is not relocated any closer to:

   a. a boundary of a property that is not part of the land to which this permit applies;

   b. a dwelling within 2km of the turbine (measured from closest point of the turbine to closest point of the dwelling), unless evidence has been provided to the satisfaction of the responsible authority that the owner of the dwelling has consented in writing to the location of the turbine; or

   c. [specify any other locations that turbines cannot be closer to, e.g.].

   Micro-siting of turbines includes any consequential changes to access tracks and electricity reticulation lines.

6. The responsible authority will not consent to micro-siting of turbines unless the responsible authority is satisfied that it will not give rise to an adverse change to assessed landscape, vegetation, cultural heritage, visual amenity, shadow flicker, noise, fire risk or aviation impacts when compared to the site shown on the endorsed plans.

Any application for the consent of the responsible authority to micro-siting a turbine under condition 5 must be accompanied by supporting material addressing the matters referred to in this condition, to the satisfaction of the responsible authority.

SPECIFICATIONS

7. The wind energy facility must meet the following requirements:

   a. the wind energy facility must comprise no more than [specify number] turbines

   b. the maximum wind energy facility capacity must not exceed [insert number] MW

   c. the power output of each turbine must not exceed [insert number] MW

   d. hub height must not exceed [specify number] metres in height

   e. the overall maximum height of the turbines (to the tip of the rotor blade when vertical) must not exceed [specify] metres above natural ground level

   f. turbines must be mounted on a tubular tower with a height of no greater than [specify] metres

   g. each turbine is to have not more than three rotor blades, with each blade having a length of no greater than [specify] metres

   h. the transformer associated with each wind generator must be located beside each tower and pad mounted, or enclosed within the tower structure

   i. the colours and finishes of all buildings and works (including turbines) must minimise the visual impact of the development on the surrounding area, to the satisfaction of the responsible authority

   j. electricity reticulation lines associated with the wind energy facility must be placed underground, provided that clusters of up to [specify number] turbines may be connected together or to the wind farm substation by means of above-ground cabling, with the written consent of the responsible authority.

LANDSCAPING

On-site landscaping plan

8. Before the development starts, an on-site landscaping plan must be prepared to the satisfaction of the responsible authority. The plans must be fully dimensioned, drawn to a scale of [specify scale if possible] and three copies must be provided. When approved, the plan will be endorsed by the responsible authority and will then form part of this permit.

The on-site landscaping plan must include:

a. landscaping to screen the substation, switchyard and associated buildings (other than the turbines)

b. details of plant species proposed to be used in the landscaping, including height and spread at maturity

c. a timetable for implementation of all on-site landscaping works

d. a maintenance and monitoring program to ensure the ongoing health of the landscaping.

9. The landscaping as shown on the endorsed on-site landscaping plan must be completed in accordance with the implementation timetable, and monitored and maintained, all to the satisfaction of the responsible authority.

Off-site landscaping program and plan

10. Within six months after the date of endorsement of the development plans under condition 1, a program of voluntary off-site landscape mitigation works must be prepared, to the satisfaction of the responsible authority.

    The off-site landscaping mitigation works program must provide details of planting or other treatments that will be used to reduce the visual impact of the turbines at:

    a. all dwellings within [specify] kilometres of the nearest turbine

    b. dwellings at [clearly identify any additional specific dwellings to be included in the program].

11. The operator of the wind energy facility must make offers to undertake the off-site landscape mitigation works specified in the program to the relevant landowners within two weeks after the responsible authority confirms that it is satisfied with the program under condition 10.

12. If one or more of the offers to landowners referred to in condition 11 is accepted, an off-site landscaping plan must be prepared, in consultation with the relevant landowners and to the satisfaction of the responsible authority. The plans must be fully dimensioned, drawn to a scale of [specify scale if possible] and three copies must be provided. When approved, the off-site landscaping plan will be endorsed by the responsible authority.

    The off-site landscape plan must include:

    a. details of the properties on which off-site landscaping mitigation works will be undertaken, and the specific locations of the landscaping works on those properties

    b. details of plant species proposed to be used in the landscaping, including height and spread at maturity

c. a timetable for implementation of the landscaping works (with each stage of the landscaping works to be completed not more than 12 months after the completion of the relevant stage of the wind energy facility to which the landscaping works relate)

d. a maintenance and monitoring program to ensure the ongoing health of the landscaping.

13. The landscaping as shown on the endorsed off-site landscape plan must be completed in accordance with the implementation timetable, and monitored and maintained, all to the satisfaction of the responsible authority.

NOISE

Performance requirement

14. The operation of the wind energy facility must comply with New Zealand Standard 6808:2010, Acoustics – Wind Farm Noise (the Standard) as modified by this condition to the satisfaction of the responsible authority. The following requirements apply:

    The operator shall ensure that at any wind speed, wind farm sound levels at sensitive receptors do not exceed:

    a. a noise limit of 40dB L A90 (10 min) provided that the following noise limit shall apply in the circumstances stated in (b) and (c) and where applicable (c) and (d)

    b. when the background sound level is greater than 35 dB L A90 (10 min), the noise limit shall be the background sound level L A90 (10 min) plus 5 dB

    c. where special audible characteristics, including tonality, impulsive sound or amplitude modulation occur, a penalty will be applied in accordance with the Standard up to + 6 dB L90 (as outlined in section 5.4 of the Standard)

    d. a high amenity noise limit, as defined by section 5.3 of the Standard, for specific locations, as determined to be high amenity areas following procedures outlined in clause C5.3.1 of the Standard.

Noise compliance assessment

For the purposes of determining compliance, the following requirements apply:

a. Acoustic compliance reports shall be prepared by a suitably qualified and experienced independent acoustic engineer to demonstrate compliance with the noise limits specified in the Standard.

b. An initial acoustic compliance report must be submitted following completion of the first turbine, and at six monthly intervals thereafter until full operation (following completion of construction and commissioning).

c. A final compliance report must be submitted to the responsible authority after a 12 month period following full operation of the facility.

d. Compliance reports should be publically available.

e. Following facility commissioning, all complaints shall be managed following procedures set out in the noise complaints management plan.

Noise complaints evaluation

a. Post installation sound levels shall, where practical, be measured at the same locations where the background sound levels were determined (GPS coordinates and a map showing these locations is to be provided).

b. If a breach in compliance is detected, or noise complaints are received, an independent assessment report must be prepared by a suitably qualified and experienced independent acoustic engineer to:

- identify the weather or operational conditions associated with the complaint / breach
- analyse the uncertainty and confidence levels in the monitoring, and the steps taken to reduce uncertainty
- target assessment to identify the cause and remediation actions
- submit a remediation plan to the satisfaction of the responsible authority outlining, the investigation process, complainant communications, actions and timelines to resolve the complaint/breach

If the complaint is not resolved through the processes outlined above, the responsible authority may request an independent peer review at the cost of the permit holder and on/off shut down testing to resolve uncertainty.

c. Following the initial post-construction reporting process, additional independent assessment may be requested by the responsible authority at any time, where complaints are received and are considered to reasonably warrant investigation.

d. If investigations indicate special audible characteristics are potentially occurring, procedures outlined in Appendix B of the Standard should be applied.

Noise complaint response plan

Before the commencement of operation, the permit holder must prepare a complaint register, investigation and response plan to the satisfaction of the responsible authority.

The plan shall include:

- how contact details will be communicated to the public
- a toll free telephone number and email contact
- details of the EPA complaints HOTLINE

- a table outlining complaint information for each complaint received, including:
  - the complainant's name
  - any applicable property reference number if connected to a background testing location
  - the complainant's address
  - a receipt number for each complaint which is to be communicated to the complainant
  - the time, prevailing conditions and description of the complainant's concerns including the potential incidence of special audible characteristics
  - the processes of investigation to resolve the complaint.

A report including a reference map of complaint locations, and outlining complaints, investigation and remediation actions is to be provided on an annual basis to the satisfaction of the responsible authority.

The register and complaints response process shall continue for the duration of the operation of the wind energy facility and must be made available to the responsible authority on request.

BLADE SHADOW FLICKER

Performance requirement

15. Shadow flicker from the wind energy facility must not exceed 30 hours per annum at any dwelling existing at [insert date of application].

    Note: Condition 15 does not apply if the operator of the wind energy facility has entered into an agreement with a landowner under which the landowner acknowledges and accepts that shadow flicker may exceed 30 hours per annum at the landowner's dwelling. Evidence of the agreement must be provided to the satisfaction of the responsible authority.

Blade shadow flicker complaint evaluation and response plan

16. Before the first turbine is commissioned, the operator of the wind energy facility must prepare a detailed shadow flicker complaint evaluation and response plan, to the satisfaction of the responsible authority.

    The plan must include the following elements:

    a. a toll free complaint telephone service

    b. a sign on site advising of the complaints telephone number

    c. procedures for assessing any alleged breach of condition 15.

17. The operator of the wind energy facility must implement and comply with the approved shadow flicker complaint evaluation and response plan.

BLADE GLINT

ELECTROMAGNETIC RADIATION

TELEVISION AND RADIO RECEPTION AND INTERFERENCE

18. Before the commencement of construction of the wind energy facility, a pre-construction survey must be carried out to determine television and radio reception strength in the area within 5 km of the site and in which dwellings are located as at [insert date of application], to the satisfaction of the responsible authority.

    The pre-construction survey must include testing at selected locations to enable the average television and radio reception strength in the area within 5 kms of the site to be determined. The specific locations of testing will be determined by an independent television and radio monitoring specialist, to the satisfaction of the responsible authority.

19. If, following commencement of the operation of the wind energy facility, a complaint is received regarding the wind energy facility having an adverse effect on television or radio reception at any dwelling within 5 km of the site which existed at [insert date of application], a post-construction survey must be carried out at the dwelling.

20. If the post-construction survey establishes any increase in interference to reception as a result of the wind energy facility, the operator of the wind energy facility must undertake measures to mitigate the interference and return the affected reception to pre-construction quality to the satisfaction of the responsible authority.

ACCESS TRACKS

21. Access tracks within the site must be sited and designed to minimise impacts on overland flows, soil erosion, the landscape value of the site, environmentally sensitive areas and, where appropriate, the farming activities on the site to the satisfaction of the responsible authority.

22. Access tracks must be surfaced in a manner which does not unduly contrast with the surrounding landscape.

LIGHTING INCLUDING AVIATION OBSTACLE LIGHTING

23. External lighting of infrastructure associated with the wind energy facility is not permitted other than:

    a. low-level, low-intensity security lighting

    b. aviation obstacle lighting in accordance with condition 24

    c. lighting necessary in the case of an emergency or for operational call-outs at reasonable times

    each of which must be to the satisfaction of the responsible authority.

24. Where required, aviation obstacle lighting must meet the following requirements:

    a. for each lit turbine, the lighting must consist of a pair of lights mounted above the nacelle so that at least one light is visible from an aircraft approaching from any direction

    b. each light must be a red, medium intensity, flashing light as required by CASA

    c. each light must be shielded so as to restrict the vertical spread of light to not more than 3.0 degrees and light spread below the horizontal to not more than 1.0 degree

    d. all lights must flash in unison

    e. the duration of the light flash must be the minimum period recommended by CASA and the duration of the period between the flashes must be the maximum period recommended by CASA

    f. the lights are to switch on and off during ambient lighting conditions as recommended by CASA.

25. Before the wind energy facility is commissioned, a lighting maintenance plan must be prepared to the satisfaction of the responsible authority. When approved, the lighting maintenance plan will be endorsed by the responsible authority and will then form part of this permit. The operator of the wind energy facility must implement and comply with the endorsed lighting maintenance plan.

AVIATION SAFETY CLEARANCES

26. Within 14 days after the date of this permit, copies of the development plans endorsed under condition 1 must be provided to the following entities, to enable details of the wind energy facility to be shown on aeronautical charts of the area:

    a. CASA

    b. the Department of Defence (RAAF Aeronautical Information Service)

    c. Airservices Australia

    d. any aerodrome operator within 15 km of the outside property boundaries of the site

    e. the Aerial Agriculture Association of Australia

    f. any organisation responsible for providing air ambulance services in the area.

TRAFFIC MANAGEMENT

Traffic management plan

27. Before the development starts, a traffic management plan must be prepared in consultation with VicRoads and [specify] Council in its capacity as road authority under the *Road Management Act 2004* for local public roads in the vicinity of the

wind energy facility. The traffic management plan must be to the satisfaction of the responsible authority. When approved, the traffic management plan will be endorsed by the responsible authority.

The traffic management plan must include:

a. an existing conditions survey of public roads that may be used in connection with the wind energy facility (for access, pre-construction or construction purposes), including details of the suitability, design, condition and construction standard of the relevant public roads

b. the designation of all vehicle access points to the site from surrounding roads. Vehicle access points must be designed and located to ensure safe sight distances, turning movements, and avoid potential through traffic conflicts

c. the designation of appropriate pre-construction, construction and transport vehicle routes to and from the site

d. engineering plans demonstrating whether, and if so how, truck movements to and from the site can be accommodated on sealed roadways and turned without encroaching onto the incorrect side of the road

e. recommendations regarding the need for road and intersection upgrades to accommodate any additional traffic or site access requirements (whether temporary or ongoing). Where upgrades are required, the traffic management plan must include:

    i. detailed engineering plans showing the required works

    ii. the timing of when the works are to be undertaken

f. [insert any specific requirements regarding road upgrade works that are identified during the application process]

g. a program of regular inspections to be carried out during the construction of the wind energy facility to identify maintenance works necessary as a result of construction traffic

h. the designation of operating hours and speed limits for trucks on routes accessing the site which:

    i. avoid school bus routes and school bus times where relevant

    ii. provide for resident safety

i. measures to be taken to manage traffic impacts associated with the ongoing operation of the wind energy facility on the traffic volumes and flows on surrounding roads

j. [insert any specific requirements regarding traffic management measures that are identified during the application process]

k. a program to rehabilitate existing public roads to the condition identified by the surveys required under condition 27a above:

i. at the conclusion of the construction of the wind energy facility

ii. every [five] years during the operation of the wind energy facility (if required).

Traffic management and road upgrade and maintenance works

28. The traffic management and road upgrade and maintenance works identified in the endorsed traffic management plan must be carried out in accordance with the endorsed traffic management plan to the satisfaction of the responsible authority.

ENVIRONMENTAL MANAGEMENT PLAN

General requirement for an environmental management plan

29. Before the development starts, an environmental management plan must be prepared, to the satisfaction of the responsible authority. When approved, the environmental management plan will be endorsed by the responsible authority and will then form part of this permit.

    The environmental management plan:

    a. must be generally in accordance with [specify name of plan submitted with application]

    b. must be prepared in consultation with the agencies specified in conditions 31 to 38 or any other agency as directed by the responsible authority

    c. may be prepared in sections or stages

    d. must be in accordance with all applicable EPA requirements

    e. must meet the requirements of conditions 31 to 41 below.

30. The use and development must be carried out in accordance with the endorsed environmental management plan, to the satisfaction of the responsible authority.

Construction and work site management plan

31. The environmental management plan must include a construction and work site management plan.

    The construction and work site management plan must include:

    a. the identification of fuels, other hazardous materials and all other potential contaminants stored or used on site during the construction phase of the wind energy facility, and appropriate storage, construction and operational methods to control any identified contamination risks

    b. procedures for managing potential spills and leaks and pollution incidents, including incorporation of appropriate pollution control measures outlined in EPA Publication 480 Environmental Guidelines for Major Construction Sites

c. procedures to suppress dust emissions from construction-related activities. Appropriate measures may include water spraying of roads and stockpiles, stabilising surfaces, temporary screening and wind fences, modifying construction activities during periods of heightened winds and revegetating exposed areas as soon as practicable

d. procedures for managing noise emissions from construction-related activities

e. criteria for the siting of any temporary concrete batching plant associated with the development of the wind energy facility and the procedure for its removal and reinstatement of the site once its use finishes. The establishment and operation of any temporary concrete batching plant must be designed and operated in accordance with EPA Publication 628 Environmental Guidelines for the Concrete Batching Industry

f. appropriate sanitary facilities to be provided for construction and maintenance staff, which must be designed and operated in accordance with EPA Publication 891.2 *Code of Practice – Onsite wastewater management* (December 2008)

g. the identification of waste re-use, recycling and disposal procedures

h. a timetable, where practicable, for the construction of turbine bases, access tracks and power cabling during warmer months, to minimise impacts on ephemeral wetlands, local fauna and sediment mobilisation

i. procedures to ensure that construction vehicles and equipment use designated tracks and works areas to avoid impacts on native vegetation

j. procedures for covering trenches and holes at night, and filling trenches as soon as practical after excavation, to protect native fauna

k. the removal of works, buildings and staging areas on completion of the construction phase of the project.

Sediment, erosion and water quality management plan

32. The environmental management plan must include a sediment, erosion and water quality management plan which must be prepared in consultation with the [specify name] Catchment Management Authority.

    The sediment, erosion and water quality management plan must include:

    a. identification of all construction and operational processes that could potentially lead to water contamination

    b. procedures to ensure that silt from batters, cut-off drains, table drains and road works is retained on the site during and after construction and replaced as soon as possible. To this end:

        - all land disturbances must be confined to a minimum practical working area

- soil to be removed must be stockpiled and separate soil horizons must be retained in separate stockpiles and not mixed, and soil must be replaced as soon as possible in sequence
- stockpiles must be located away from drainage lines

c. the installation of geo-textile silt fences (with sedimentation basins where appropriate) on all drainage lines from the site which are likely to receive run-off from disturbed areas

d. procedures to ensure that steep batters are treated in accordance with EPA Publication 275 Construction Techniques for Sediment Pollution Control

e. procedures for waste water discharge management

f. a process for overland flow management to prevent the concentration and diversion of waters onto steep or erosion prone slopes

g. pollution management measures for stored and stockpiled materials including waste materials, litter, contaminated run-off and any other potential source of pollution to ground or surface waters

h. incorporation of appropriate pollution control measures outlined in EPA Publication 480 Environmental Guidelines for Major Construction Sites

i. an agreed program and appropriate capacity for annual inspection and regular maintenance of any on-site wastewater management system

j. siting of any concrete batching plant and any on-site wastewater disposal treatment fields at least 100 metres from any watercourse

k. a program of inspection and remediation of localised erosion within a specified response time.

Hydrocarbon and hazardous substances plan

33. The environmental management plan must include a hydrocarbon and hazardous substances plan.

    The hydrocarbon and hazardous substances plan must include:

    a. procedures for any on-site, permanent post-construction storage of fuels, lubricants, waste oil or other hazardous substances or potential contaminants to be in bunded areas

    b. contingency measures to ensure that any chemical or oil spills are contained on-site and cleaned up in accordance with EPA requirements.

Wildfire prevention and emergency response plan

34. The environmental management plan must include a wildfire prevention and emergency response plan prepared in consultation with and to the satisfaction of the CFA and DSE.

    The wildfire prevention and emergency response plan must include:

    a. criteria for the provision of static water supply tanks solely for fire fighting purposes, including minimum capacities, appropriate connections and signage

    b. procedures for vegetation management, fuel control and the provision of fire fighting equipment during declared fire danger periods

    c. minimum standards for access roads and tracks to allow access for fire fighting vehicles, including criteria for access to static water supply tanks for fire fighting vehicles

    d. a requirement that, within three months after the commencement of the operation of the wind energy facility, the operator of the wind energy facility facilitates a familiarisation visit to the site and explanation of emergency services procedures for:

        i. the CFA (including headquarters level, the CFA Regional Office and local [insert name] volunteer brigade)

        ii. Rural Ambulance Victoria

        iii. [specify Council name]'s Municipal Emergency Management Committee

        iv. Victoria Police

    e. subsequent familiarisation sessions for new personnel of the organisations referred to in condition 34d on a regular basis as required

    f. if requested, training of personnel of the organisations referred to in condition 34d in relation to suppression of wind energy facility fires.

Blasting management plan (only relevant where blasing is proposed)

35. The environmental management plan must include a blasting management plan.

    The blasting management plan must include:

    a. name and qualification of the person responsible for blasting

    b. a description of the location of where explosives will be used

    c. a plan showing the location of every licensed bore on any property with a boundary within 1 km of the location of the blasting

    d. identification and assessment of any potentially sensitive site within 1 km of the location of the blasting, including the procedure for pre-blast and post-blast qualitative measurement or monitoring of the effects of the blasting on such sites

e. the procedure for site clearance and post-blast re-occupation

f. the procedure for the storage and handling of explosives

g. a requirement that blasting only can occur after at least 48 hours prior written notification of the intention to undertake blasting has been given to the occupants of the properties which are located in whole or in part within 1 km of the location of the proposed blasting

h. a requirement that blasting only be undertaken between the hours of 8am and 4pm.

Vegetation management plan

36. The environmental management plan must include a vegetation management plan to be prepared in consultation with DSE.

    The vegetation management plan must include:

    a. protocols so that net gains will be undertaken if native vegetation disturbance and removal cannot be avoided during the construction, operation and decommissioning stages of the wind energy facility

    b. procedures for the rehabilitation of construction zones with appropriate pasture species.

Pest animal management plan

37. The environmental management plan must include a pest animal management plan to be prepared in consultation with and to the satisfaction of DSE and DPI.

    The pest animal management plan must include:

    a. procedures for the control of pest animals, particularly by avoiding opportunities for the sheltering of pests

    b. follow-up pest animal control for all areas disturbed by the wind energy facility construction works for a period of two years following the completion of the construction of the wind energy facility.

Pest plant management plan

38. The environmental management plan must include a pest plant management plan to be prepared in consultation with and to the satisfaction of DSE and DPI.

    The pest plant management plan must include:

    a. procedures to prevent the spread of weeds and pathogens from earth moving equipment and associated machinery, including but not limited to:

        i. the cleaning of all plant and equipment before transport to the site

        ii. the use of road-making material comprising clean fill that is free of weeds

b. revegetation of disturbed areas

c. a protocol to ensure follow-up weed control is undertaken on all areas disturbed as a result of the construction of the wind energy facility, for a minimum period of two years following completion of the works.

Environmental management plan training program

39. The environmental management plan must include a training program for construction workers and permanent employees or contractors at the wind energy facility site, including a site induction program relating to the range of issues addressed by the environmental management plan.

Environmental management plan reporting program

40. The environmental management plan must include a program for reporting environmental incidents, including:

    a. a register of environmental incidents, non-conformances and complaints, together with corrective actions taken in response to such incidents, non-conformances or complaints

    b. identification of the person to whom reports of environmental incidents, non-conformances and complaints should be made.

Implementation timetable

41. The environmental management plan must include a timetable for implementation of all programs and works referred to in conditions 31 to 40 above.

Review of the environmental management plan

42. The environmental management plan must be reviewed and if necessary amended in consultation with the responsible authority and other authorities as directed by the responsible authority every [five] years, to reflect operational experience and changes in environmental management standards and techniques.

    The amended environmental management plan must be submitted to the responsible authority for re-endorsement. Once re-endorsed, the amended environmental management plan will take the place of the earlier environmental management plan and will form part of this permit.

BATS AND AVIFAUNA MANAGEMENT PLAN

43. Before the development starts, a Bat and Avifauna Management Plan (BAM Plan) must be prepared in consultation with DSE to the satisfaction of the responsible authority. When approved the plan will be endorsed by the responsible authority and will then form part of the permit.

    The BAM Plan must include:

    a. a statement of the objectives and overall strategy for managing and mitigating any significant bird and bat strike arising from the wind energy facility operations

b. a monitoring program [of at least two years duration/on an ongoing basis] that:

   i. commences on the commissioning of the last turbine of the first stage of the use and development approved by this permit or such other time approved by the responsible authority

   ii. requires surveys to be undertaken during breeding and migratory seasons to ascertain:

   - [insert details of any specific species to be monitored]
   - the species, number, age and sex (if possible) and date of any bird or bat strike
   - the number and species of birds and bats struck at lit versus unlit turbines
   - any seasonal and yearly variation in the number of bird and bat strikes
   - whether further detailed investigations of any potential impacts on birds and bats are warranted. Any further detailed investigations required are to be undertaken in consultation with DSE and to the satisfaction of the responsible authority

c. procedures for the reporting of any bird and bat strikes to the responsible authority and to DSE within seven days of becoming aware of any strike, identifying where possible whether the strike was at a lit or unlit turbine

d. information on the efficacy of searches for carcasses of birds and bats, and, where practicable, information on the rate of removal of carcases by scavengers, so that correction factors can be determined to enable calculations of the total number of mortalities

e. procedures for the regular removal of carcasses likely to attract raptors to areas near turbines

f. procedures for periodic reporting, within agreed timeframes, of the findings of the monitoring to the responsible authority, DSE and the local community

g. recommendations in relation to a mortality rate for specified species which would trigger the requirement for responsive mitigation measures to be undertaken by the operator of the wind energy facility, to the satisfaction of the responsible authority and DSE

h. procedures for developing measures, in consultation with the responsible authority and DSE, to offset any impacts detected through the monitoring program, including:

   i. turbine operation management

   ii. on-site or off-site habitat enhancement (including management or improvement of habitat or breeding sites).

44. Following the completion of the monitoring program referred to in condition 43, a report must be submitted to the responsible authority and DSE setting out the findings of the program to the satisfaction of the responsible authority. After consideration of this report, the responsible authority may direct that further investigation of potential or actual impacts on birds and bats is to be undertaken, in which case:

    a. the extent and details of the further investigation must be to the satisfaction of the responsible authority and DSE

    b. the investigation must be carried out to the satisfaction of the responsible authority and DSE.

45. The use and development of the wind energy facility must be carried out in accordance with the endorsed BAM management plan to the satisfaction of the responsible authority.

REFERRAL AUTHORITY CONDITIONS

46. [Include any additional conditions required by referral authorities. Ensure that other conditions do not repeat, and are consistent with, conditions required by a referral authority.]

SECURITY DEPOSIT/BOND (only relevant where deposit/bond is applied)

47. Before the development starts, the operator of the wind energy facility must provide one or more security deposits or bonds to secure:

    a. the performance of any works required under this permit

    b. the maintenance of those works for a period of 12 months after the works are completed.

48. The nature of the security deposit(s) or bond(s), and the terms on which they are provided, must be to the satisfaction of the responsible authority, and:

    a. the amount of the security deposit(s) or bond(s) must be calculated by reference to the value of the works to which the security deposit or bond relates

    b. the security deposit(s) or bond(s):

        i. must remain in place for a period of at least 12 months after the completion of the relevant works to which the security deposit or bond relates

        ii. may only be applied to any works to which the security deposit or bond relates that are not completed in accordance with the requirements of this permit

        iii. will be released at the completion of the maintenance period referred to in condition 47b.

SITE SECURITY

49. All access points to the site and to individual turbines must be locked when not in use and made inaccessible to the general public, to the satisfaction of the responsible authority.

50. All electrical equipment, spare parts and other equipment and materials associated with the wind energy facility must be located in screened, locked storage areas that are inaccessible to the public, to the satisfaction of the responsible authority.

51. Public safety warning signs must be located on all towers, to the satisfaction of the responsible authority.

DECOMMISSIONING

52. Within six months after the construction of the wind energy facility is completed, the operator of the wind energy facility and the owners of the properties which make up the site must enter into an agreement with the responsible authority under section 173 of the *Planning and Environment Act 1987*.

    The agreement must require the operator of the wind energy facility to do the following where any or all turbines have permanently ceased to generate electricity:

    a. notify the responsible authority in writing of the turbine(s) ceasing operation. Such notification must be given no later than two months after the turbine(s) cease operation

    b. undertake the following to the satisfaction of the responsible authority within such timeframe as may be specified by the responsible authority:

        i. remove all above ground non-operational equipment

        ii. remove and clean up any residual contamination

        iii. rehabilitate all storage areas, construction areas, access tracks and other areas affected by the decommissioning of the turbine(s), if those areas are not otherwise useful to the on-going use or decommissioning of the wind energy facility

        iv. submit a decommissioning traffic management plan to the responsible authority and, when approved by the responsible authority, implement that plan

        v. submit a post-decommissioning revegetation management plan, including a timetable of works, to the responsible authority and, when approved by the responsible authority, implement that plan.

53. Application must be made to the Registrar of Titles to register the section 173 agreement on the title to the land under section 181 of the Act within one month after the agreement is executed.

54. The operator of the wind energy facility must pay the reasonable costs of the preparation, execution, registration and enforcement of the section 173 agreement.

STAGING

55. The use and development authorised by this permit may be completed in stages as shown on the endorsed development plans. The corresponding obligations arising under this permit may be similarly completed in stages, except the obligation to prepare and submit the development plans under condition 1.

PRELIMINARY INVESTIGATIVE WORKS

56. For the purposes of this permit, the carrying out of preliminary investigative works, including geotechnical investigations, for the purposes of gathering data or making other assessments necessary or desirable in order to prepare the development plans or other plans specified in this permit, is not considered to be commencement of the development.

EXPIRY

57. This permit will expire if one of the following circumstances applies:

    a. the development is not started within three years of the date of this permit

    b. the development is not completed within six years of the date of this permit.

Date issued: .....

Signature of Responsible Authority: .....

Notes:

1. Any off-site works required under this permit, or any native vegetation removal required in order to implement the use and development allowed under this permit, may require separate planning permission.
2. References in this permit to CASA are references to the Civil Aviation Safety Authority.
3. References in this permit to EPA are references to the Environment Protection Authority.
4. References in this permit to CFA are references to the Country Fire Authority.
5. References in this permit to DSE are references to the Department of Sustainability and Environment.
6. References in this permit to DPI are references to the Department of Primary Industries.

IMPORTANT INFORMATION ABOUT THIS NOTICE

WHAT HAS BEEN DECIDED?

The responsible authority has decided to grant a permit. The permit has not been issued.

This notice sets out what the permit will allow and what conditions the permit will be subject to if issued.

WHAT ABOUT APPEALS?

For the Applicant

- The person who applied for the permit may apply for review of any condition in the notice of decision to grant a permit. The application for review must be lodged within 60 days of the giving of this notice.

For an Objector

- An objector may apply for review of the decision of the responsible authority to grant a permit. The application for review must be lodged within 21 days of the giving of this notice.
- If there is no application for review, a permit will be issued after 21 days of the giving of this notice.

For all applications for review

- An application for review is lodged with the Victorian Civil and Administrative Tribunal.
- An application for review must be made on the Application for Review form which can be obtained from the Victorian Civil and Administrative Tribunal, and be accompanied by the applicable fee.
- An application for review must state the grounds upon which it is based.
- An application for review must also be served on the responsible authority.
- Notice of the application for review must be given in writing to all other parties to the review as soon as practicable after an application for review is lodged. An objector who applies for a review must give notice to the person who applied for the permit.

An applicant who applies for review must give notice to all objectors.

- Details about applications for review and the fees payable can be obtained from the Victorian Civil and Administrative Tribunal.

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Authorised by the Minister for Planning, 1 Spring Street, Melbourne 3000.
These guidelines are an update of editions published in March 2011 and 2009 by the Department of Planning and Community Development and an earlier edition published in 2003 by Sustainable Energy Authority Victoria.

www.dpcd.vic.gov.au/planning

Planning and Environment Act 1987

VICTORIA PLANNING PROVISIONS

AMENDMENT VC82

EXPLANATORY REPORT

Who is the planning authority?

This amendment has been prepared by the Minister for Planning.

The Minister for Planning is the planning authority for this amendment.

What the amendment does

The amendment changes the Victoria Planning Provisions and all Victorian planning schemes by:

- Amending Clause 52.32 - Wind energy facility to:
  - require a permit for the use and develop of any land for a Wind energy facility
  - include a table that identifies locations where a Wind energy facility is prohibited:
    - land where any turbine that forms part of the Wind energy facility is located within two kilometres of an existing dwelling, unless there is evidence of a written consent of any owner of the dwelling in accordance with Clause 52.32-3. With a condition that the prohibition does not apply to a facility that is integrated as part of the development of the land in a residential zone, industrial zone, business zone or special purpose zone.
    - land described in a schedule to the *National Parks Act 1975* with a condition that the prohibition does not apply to a Wind energy facility principally used to supply electricity to a facility used in conjunction with conservation, recreation, administration or accommodation use of the land.
    - land declared a Ramsar wetland as defined under section 17 of the *Environment Protection and Biodiversity Conservation Act 1999*
    - land listed in a schedule to Clause 52.32 in the relevant planning scheme, being
      - all land covered by the Mornington Peninsula and Yarra Ranges planning schemes
      - land described as the Bellarine Peninsula, being the area that is covered by the Queenscliffe planning scheme and that part of the Greater Geelong planning scheme east of the Surf Coast Highway and south of the Princes Highway
      - land described as the Great Ocean Road region, being land within five kilometres of the high water mark of the coast between the Surf Coast Highway in the east and Warrnambool in the west in the Warrnambool, Moyne, Corangamite, Colac Otway, Surf Coast and Greater Geelong planning schemes
      - land in the Macedon and McHarg Ranges, being all land covered by the Macedon Ranges planning scheme, all land west of the Hume Freeway and the Goulburn Valley Highway in the Mitchell planning scheme, and all land bounded by the McIvor Highway and the Calder Highway/Freeway in the Greater Bendigo and Mount Alexander planning schemes
      - land within five kilometres of the high water mark of the coast in the Bass Coast planning scheme and South Gippsland planning scheme west of Wilsons Promontory
      - land within five kilometres of major regional cities and regional centres specified in the Regional Victoria Settlement Framework in the State Planning Policy Framework being Mildura, Swan Hill, Echuca, Shepparton, Benalla, Wangaratta, Wodonga, Horsham, Ararat, Ballarat, Greater Bendigo, Hamilton, Portland,

Warrnambool, Colac, Geelong, Moe, Morwell, Traralgon, Sale and Bairnsdale (the prohibition in these locations does not apply to a Wind energy facility integrated as part of the development of the land where the land is in a residential zone, industrial zone, business zone or special purpose zone).

  - include an additional application requirement for evidence of written consent of any owner of an existing dwelling located within two kilometres of a proposed turbine that forms part of the wind energy facility
  - change the application requirements to consolidate application requirements that were previously included in both Clause 52.32 and the *Policy and planning guidelines for development of Wind energy facilities in Victoria (August 2011)* (Guidelines)
  - introduce a new Clause 52.32-6 that specifies that a permit may be granted for use and develop land for the purpose of wind measurement by an anemometer for a period of more than three years.
- Amending Clause 37.07 – Urban Growth Zone to prohibit a Wind energy facility on land in that zone.
- Amending Clause 36.03 – Public Conservation and Resources Zone to clarify that the condition relates to land described in a schedule to the *National Parks Act 1975*.
- Amending Clause 19.01 – Renewable energy and Clause 52.32 - Wind energy facility to reference the updated guidelines. Also amending Clause 81.01 to alter the status of the Guidelines to a reference document rather than an Incorporated Document in planning schemes.

Strategic assessment of the amendment

Why is the amendment required?

The amendment implements actions proposed by the Government in the *Victorian Liberal National Coalition Plan for Planning* for the 2010 State Election. The amendment implements the Government's policy that a turbine that forms part of a Wind energy facility must not be located within two kilometres of an existing dwelling without the owner's consent, and specifying locations in Victoria where Wind energy facilities are prohibited.

How does the amendment implement the objectives of planning in Victoria?

The amendment meets the objectives of planning set out in the *Planning and Environment Act 1987* (the Act). In particular, it supports the objectives to:

- provide for the fair, orderly, economic and sustainable use and development of land
- provide for the protection of natural and man-made resources
- secure a pleasant, efficient and safe working, living and recreational environment
- balance the present and future interests of all Victorians.

How does the amendment address the environmental effects and any relevant social and economic effects?

The amendment will promote positive environmental, social and economic effects by facilitating a more balanced assessment of the impacts of a Wind energy facility against these factors. The amendment supports greater consideration of local amenity impacts and clarifies locations where Wind energy facilities should be considered, while recognising the importance of providing renewable energy for the broader Victorian community.

Does the amendment comply with the requirements of any applicable Minister's Direction?

The amendment is compatible with all Ministerial Directions under Section 12 of the Act.

The Ministerial Direction on the Form and Content of Planning Schemes under Section 7(5) of the Act is being amended concurrently with this amendment to introduce a schedule to clause 52.32 in relevant planning schemes that describes land where the use and development of a Wind energy facility is prohibited.

How does the amendment support or implement the State Planning Policy Framework?

The amendment is consistent with the State Planning Policy Framework by improving certainty about locations where Wind energy facilities may be appropriate.

Does the amendment have a significant impact on the transport system, as defined by the section 3 of the *Transport Integration Act 2010?*

As the amendment focuses largely on procedural matters for the assessment of Wind energy facilities, it will not have a significant impact on the transport system.

What impact will the new planning provisions have on the resource and administrative costs of the responsible authority?

The amendment will potentially lessen resource and administrative costs of the responsible authority by clarifying locations and circumstances where Wind energy facilities can be considered. The amendment also clarifies the application requirements for a Wind energy facility, and better aligns the application requirements with the guidance material in the *Policy and planning guidelines for development of Wind energy facilities in Victoria*.

Where you may inspect this Amendment

A copy of the amendment can be inspected, free of charge, during office hours, at all municipal council offices in Victoria and at the following offices of the Department of Planning and Community Development (DPCD):

Hume Region
Level 1, 62 Ovens Street
WANGARATTA 3676

Gippsland Region
71 Hotham Street
TRARALGON 3844

Grampians Region
111 Armstrong Street North
BALLARAT 3350

Loddon Mallee
Level 1, 56-60 King Street
BENDIGO 3551

Barwon South West Region
Warrnambool office
25 Liebig Street
WARRNAMBOOL

Barwon South West Region
Geelong office
4th Floor, State Government Offices
Cnr Fenwick & Little Malop Streets
GEELONG 3220

The amendment is also available for public inspection on the DPCD website www.dpcd.vic.gov.au/planning/publicinspection.

NOISE MEASUREMENT SERVICES

18 Lade Street, Enoggera, QLD 4051
Postal: PO Box 2127, Brookside Centre
Queensland 4053 Australia
Email: Sch. @noisemeasurement.com.au

Phone: (61-7) 3355 9707
Fax: (61-7) 3355 7210
ABN: 70 084 643 023

22 August 2011 *proj 1931*

Attention: Peter Pattison

Senior Planner

Tablelands Regional Council

Email: @trc.qld.gov.au

Dear Peter

Fee Proposal to Review Noise Assessment Report for the Arriga Wind Farm

Further to your email of 18 August 2011 I wish to thank-you for the opportunity to provide a fee proposal with respect to advice for the Arriga wind farm.

Noise Measurement Services would be pleased to assist Council with:

a) review the application with respect to noise following the Transfield response to the previous High Road windfarm and the previously commissioned legal opinion regarding wind farms
b) provide specific conclusions about the acceptability or otherwise of the project from a noise perspective
c) identify any perceived deficiencies in the report in relation to meteorological data, background noise data for sensitive receptors, modeling, methodology and conclusions
d) recommendations about appropriate acoustical conditions of approval or acoustical grounds for declining the application.

As mentioned in our recent telephone discussion the High Road Wind Farm reports present much of the detail required in a general assessment for a wind farm.

The report to Council will include reference to my evidence given at other hearings, the Senate Inquiry into Rural Windfarms (2011), the National Health and Medical Research Council Forum (June 2011) and concerns by Council as evidenced in the planning reports for High Road.

I have been to the locale of the Arriga windfarm and have an overview of the potential effects on sensitive receptors. I have also been made aware of concerns of residents with respect to the windfarm. Consequently I need a more detailed locality assessment than that previously made.

Our fee proposal is as follows:

Sch. 4(4)(7)(1)(c) - Disclosing trade secrets, business affairs or research

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Our fees are:

- Sch. 4(4)(7)(1)(c) - Disclosing trade secrets, business affairs or research

Indicative (maximum) fee: $5,400 plus GST

Our professional fee for the above work is Sch. 4(4)(7)(1)(c) - Disclosing trade sec per hour plus GST. Our report is presented in both electronic and printed form.

If Council wishes me to attend Council to present the report this will be at Sch. 4(4)(7)(1)(c) - Disclos Sch. 4(4)(7)(1)(c) - Disclosing trade secr plus actual and reasonable expenses.

If Council wishes me to attend meetings with the Council, developer or other parties outside the preparation of the report this will be at Sch. 4(4)(7)(1)(c) - Disclosing trade secrets, business affairs or re plus actual and reasonable expenses.

Trusting this is of assistance; please feel free to call to discuss.

Yours truly

Sch. 4(4)(6) - Disclosing personal inform

Principal