THE ACOUSTIC GROUP PTY LTD
CONSULTING ACOUSTICAL & VIBRATION ENGINEERS

PEER REVIEW OF ENVIRONMENTAL NOISE ASSESSMENT

BODANGORA WIND FARM

42.4998.R1:ZSC

Prepared for: *Bodangora Wind Turbine Awareness Group*
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APPENDICES

1.0 INTRODUCTION

An application has been submitted to the NSW Department of Planning and Infrastructure for the proposed Bodangora Wind Farm to be located near the township of Wellington, in central NSW.

Accompanying the application is a report from Sonus: *Bodangora Wind Farm, Environmental Noise Assessment* dated May 2012 (report ref S3627C8). This report has been posted on the Department's website.

The community has raised concerns in relation to approval of the proposed wind farm, one of the concerns being noise disturbance. The Bodangora Wind Turbine Awareness Group have cited impacts from existing wind farms in Australia as evidence of potential impacts arising from the proposed wind farm and have requested a peer review of the noise report.

The Sonus document refers to the Director-General's Requirements (DRGs") issued on 12 November 2010, and criteria from the noise guidelines for wind farms issued by the South Australia EPA (2003).

2.0 QUALIFICATIONS OF REVIEWER

The nature of actual or perceived noise impacts associated with wind farms is the subject of wide debate throughout communities in proximity to wind farms.

To date there are conflicting arguments or claims as to noise and resultant health impacts due to wind farm operations.

In conducting a peer review it is appropriate to identify the reviewer's technical expertise to undertake such an exercise and to identify any potential conflicts.

I Steven Edwin Cooper am the principal of The Acoustic Group Pty Ltd, Consulting Acoustical and Vibration Engineers.

I have been in practice as an Acoustical Consulting Engineer for 34 years. I hold a Bachelor of Science (Engineering) degree from the University of New South Wales and a Master of Science (Architecture) being a research degree in Acoustics from the University of Sydney and am a Chartered Professional Engineer. I am a Fellow of the Institution of Engineers Australia, a Member of the Australian Acoustical Society and a Member of the Institute of Noise Control Engineering (USA).

In the course of my acoustical consulting practice I have been involved in numerous projects for private, commercial and government organisations requiring expertise in acoustics, noise and vibration issues.

Furthermore as a practising Acoustical Consulting Engineer I am or have been a member of the Standards Association of Australia Committees AV4, AV/10, AV/10/4 and EV/11 dealing with Architectural Acoustics, Whole-Body Vibration, Rail Traffic Noise, and Aircraft Noise respectively. I was a member of the Australian Acoustical Society NSW Membership Grading Committee from 1979 to 1997 and was a member of the Australian Acoustical Society Federal Grading Committee in 1998. My Curriculum Vitae is set out in Annexure A.

It is noted that in the course of my professional career I have been involved in projects where I have appeared for Applicants, Objectors, Councils, Government Departments (State and Federal) and as a Court Appointed Expert. I am not a member of any political party and have not been retained or approached by any wind farm proponents to undertake an assessment of wind farm noise.

I have extensive experience in the measurement and assessment of large industrial premises where there is a requirement to maintain compliance with specified noise limits under all weather scenarios. I have also conducted research into various acoustic issues concerning the propagation of aircraft noise and sound dispersion in enclosed spaces that has questioned the status quo of various Standards or acoustic texts leading to modification/amendments to Australian Standards and International guidelines.

Whilst I have not been engaged by any wind farm applicant to undertake an acoustic assessment or compliance testing of planned or operational wind farms, I was requested late last year by a community group opposing a proposed wind farm at Flyers Creek (in NSW) to review an application.

I prepared a desk top review of the acoustic assessment that had been prepared for the Flyers Creek Wind Farm. My desk top audit was contained in a submission from the Flyers Creek Wind Turbine Awareness Group ("FCWTAG") in relation to the proposed Flyers Creek Wind Farm. The desk top review raised issues as to the ambient background levels, the predicted noise emission levels and the absence of an assessment of the noise impact of the proposed wind farm.

The desk top review was supplemented by preliminary noise testing in proximity to the Capital Wind Farm (in NSW) to experience first-hand wind farm operations and conduct sound level measurements. The preliminary testing highlighted a number of issues with respect to the assessment and evaluation of wind farm noise where currently the predominant acoustic descriptor is the dB(A) level.

I found at times there to be no audible noise inside or outside residential dwellings, whilst on other occasions I was able to detect wind farm noise both outside and inside dwellings.

My testing identified the possibility that noise originating from the wind farm could affect individuals and that further testing/investigations were required as set out in my review of the Flyers Creek Wind Farm application (available on the NSW Department of Planning website).

The NSW Department of Planning issued in late 2011 a draft set of wind farm guidelines for public comment ("the NSW Guidelines). The NSW guidelines are more stringent than the SA wind farm noise guidelines.

As part of my review of the draft NSW guidelines I undertook further measurements and analysis of wind farm noise (Capital, Cullerin and Woodlawn wind farms) to research wind farm noise and assess the practicality of compliance testing as set out in the draft NSW Guidelines.

I prepared a technical submission on the draft NSW Guidelines. I was not engaged by any party to prepare my submission, but as it relied upon previous material prepared for the Flyers Creek submission, my review of the draft NSW Guidelines was added to the Flyers Creek community submissions (available on the NSW Department of Planning website).

As part of my on-going investigations into wind farm noise I have attended residential properties and public roads in proximity to Waterloo and Hallett wind farms (in South Australia) and Cape Bridgewater, Glenthompson and Waubra wind farms (in Victoria) in order to place in context claims of excessive noise/impacts from those wind farms. As experienced for the NSW wind farms I have attended, at some sites in South Australia and Victoria there was clearly audible noise from the wind farm, at other sites some noise was audible, whilst at other sites there was no audible noise.

In the reporting of wind farm noise, there are claims and counter claims as to bias in the presentation of data which is a fundamental issue to be addressed prior to this peer review.

As a Member of the Australian Acoustical Society (the "AAS") and a Fellow of the Institution of Engineers Australia I am required to abide by the Code of Ethics for those two organisations.

Annexure B provides a copy of the Code of Ethics of the Australian Acoustical Society.

If there is potential for an industry to jeopardise the welfare, health or safety of the public, or affect the well-being of the community I am duty bound to identify those issues under the Code of Ethics of the Australian Acoustical Society.

The AAS Code of Ethics requires that the acoustical assessment in relation to a wind farm is accurate and contains all the relevant material. This is the obligation placed on the acoustician. The acoustician has a heavy professional obligation and should be neither pro nor anti wind farm in approach.

I have prepared a technical discussion paper "*Wind Farm Noise – An ethical dilemma for the Australian Acoustical Society?*" that is to be published this month in the society's journal Acoustics Australia.

I approach all my work in accordance with my professional Code of Ethics. Contrary to misleading statement made by some wind industry representatives I make the specific statement in conducting this peer review that **I am not anti-wind farm**.

Any project, be it an industrial application or a wind farm, should operate without giving rise to disturbance, health effects or adverse impacts on the community. If it can do so then, from a noise point of view, it may be permitted.

In relation to the Sonus report that I am peer reviewing there is no indication of the author(s). I am aware of some of the Sonus staff and their professional qualifications who are Members of the Australian Acoustical Society. If however the author(s) of the report are not members of the Australian Acoustical Society then the report is required to accord with the Code of Conduct from the Association of Australian Acoustical Consultants of which Sonus Pty Ltd is identified as a member firm.

3.0 THE SONUS ASSESSMENT

3.1 Outline

The Executive Summary of the document indicates the assessment was undertaken in accordance with the 2003 version of the South Australian EPA wind farm noise guidelines where the base level for noise assessment had been set at 35 dB(A).

The assessment has been based on thirty five 35 (or 37) Vestas V112-3MW wind turbines with a nominal hub height of 80 m. There is a statement that if the selected turbine model is less than or equal to the V112 turbines then the proposed layout can achieve (compliance sic) with the SA Guidelines.

Page ii and 30 of the report identifies 35 turbines, whilst page 31 says 37 turbines.

A representative of Infigen advised the community at a public meeting in Wellington on Sunday 22nd July 2012 that the number of turbines have been reduced and the minimum separation distance to residential dwellings has been increased. However the actual number of turbines, or what turbines had been eliminated, was not provided to the meeting.

Therefore the application could be for less than 35 turbines. There is no information to identify the current status of the number of turbines for the proposed wind farm.

For the purpose of this review I have assumed the number of turbines is as set out in the acoustic report and at the locations nominated in the report.

The Introduction identifies the Director-Generals Requirements (DGRs) required the acoustic assessment to accord with the following documents:

- the SA EPA 2003 *Wind Farm Guidelines*
- NSW *Industrial Noise Policy* (for the substation)
- DECC *Interim Construction Noise Guideline*
- NSW EPA *Environmental Criteria for Road Traffic Noise*
- DECC *Vibration – Assessing Vibration: A Technical Guideline*, and
- the ANZECC *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration*.

Under a sub heading of "Director Generals Requirements" the report provides information in relation to the derivation of the criteria used for assessment purposes.

The report indicates twenty six (26) residential properties had been identified in the vicinity of the proposed wind farm with background noise monitoring being carried out at five residential properties.

The report refers to criteria for WHO Guidelines with respect to limits for landowners with commercial agreements, normally referred to as "hosts".

Background noise levels relative to the wind speed at 10 m above ground level (and at the proposed wind farm - not at residential receivers) have been derived by a regression analysis nominated in the SA guidelines.

A different noise assessment method is used for determining a background level associated with assessing the substation noise to identify levels below 30 dB(A) for all locations, except R16 where a background level of 31 dB(A) is nominated.

The "Assessment" section of the document identifies that noise emissions from the proposed wind farm, including substation noise, comply with the guidelines noise limits at all assessed properties.

The document indicates that the noise source level used for the turbines has been supplied by the manufacturer and that the turbines used in the assessment are not expected to contain tonal components. The report identifies the developer "may seek the manufacturer to guarantee the turbines do not result in tonal characteristics at the location of the dwellings", not require that such a guarantee will apply.

The sound power levels shown in Table 10 provide the octave band data in A-weighted format, not linear (un-weighted) levels.

The assessment identifies the noise modelling was conducted for an atmospheric stability class "that is the most conducive to noise propagation" without explaining to the reader what that entails. The subsection ISO 9613-2:1996 nominates that the model has the capability to assess either temperature inversion or downwind conditions that are "conditions conducive to noise propagation". The report indicates the modelling has been carried out under those conditions.

The results of the computer analysis is provided in Appendix H and compared with the criteria derived by Sonus for the subject application. The predicted levels are less than the derived criteria – leading to a claim of compliance with the guidelines.

It therefore follows that if the assessment had identified noise emission levels under neutral conditions separately to that of temperature inversions, or upwind or downwind conditions, then the assessment report would have been able to or identify the nature of noise emission levels in terms of the general concept of protecting 90% of the population to 90% of the time. However that analysis has not been adopted

The sound power level for the transformers in the substation is not related to any specific transformer but would appear to be a generic level derived from Australian Standard AS2374-1994. One would expect to have actual noise data related to these items.

The assessment of the substation noise emission claims the substation noise is 26 dB(A) and then nominates that this level "easily achieved the conservative criteria of 30 dB(A) developed under the INP, and as such will not adversely impact on the amenity of residences in the locality of the wind farm".

There would appear to be a number of issues with respect to the substation noise. Firstly the conservative criteria are conservative with respect to noise emission from the industrial noise source, but not conservative with respect to noise impact upon residents. If the night time ambient background levels are below 25 dB(A) then the concept of background +5 dBA must lead to a criterion less than 30 dB(A).

Substations emit low frequency noise and tonal noise that enhances the audibility of the noise and requires a correction to the measured level. Residents in proximity to wind farms complain about noise from the substation that interferes with their rest and repose.

It is impossible to claim the 30 dB(A) limit will ensure the substation will not adversely impact on the amenity of residences in the locality of the wind farm, as residences do not experience an amenity.

It is also impossible to claim the 30 dB(A) limit will ensure the substation will not adversely impact on the amenity of **residents** in the locality of the wind farm as the acoustic amenity of the residents has not been identified in the assessment.

Page 15 of the report claims the SA Guidelines are described as one of the most stringent assessment approached of any jurisdiction in the World. This would not seem to be the case in regards to the NSW draft wind farm Guidelines that were issued late last year (prior to the issue of the acoustic assessment).

The report raises the issue of Amplitude Modulation and then appears to disregard by referring to sleep disturbance issues claiming the SA Guidelines "are significantly more stringent than limits established for the potential onset of sleep disturbance".

The report identifies that at distances removed from the turbines the principal audible component is low frequency noise and claims the SA Guidelines provide an adequate level of protection of amenity.

The report acknowledges that Infrasound is generated by turbines and claims that :

"*… measurements from a large range of measurements from modern upwind turbines indicates that as distances of 200 metres, infrasound is in the order of 25 dB below the recognised perception threshold of 85 dB(G). A 25 dB difference is significant and represents at least a 100 fold difference in energy content."*

There are issues with the relevance of the above claim, particularly as an Infigen spokesperson at the Wellington public meeting claimed the measured infrasound levels were 100 times less than a perceived level.

There is a difference between an energy difference and a loudness difference.

An energy difference is normally related to a power output, not loudness. In acoustic terms a 25 dB difference is related to an energy difference of 316 not 100. The change in energy does not relate to loudness.

In the audible range a 10 dB difference is considered to be a subjective difference in loudness of 50% (as a reduction) or twice as loud (as an increase). A 25 dB difference in subjective loudness approximates a sound less than 20% or about 5.5 times as loud as the original sound. 25 dB is definitely not a 100 fold difference in loudness.

When dealing with infrasound the change in dB level is not the same linear relationship described above when compared to the audible frequencies. There is no material to relate to loudness levels (perceived or otherwise) for infrasound. Therefore the claim as to difference in infrasound made in the report is questionable.

The section in relation to construction noise identifies level to be greater than 10 dB above the background and that such a level may be "noise affected" with the report recommending noise control strategies. It is noted the report does not identify the "noise affected" scenario for the operational wind farm.

3.2 Analysis

The Sonus report is similar to that provided by that organisation for other wind farms and would appear to fall into a generic type of report. There are a number of issues arising from this generic approach.

One issue of concern in relation to the generic type of noise assessment prepared for the subject wind farm is that there is a conflict between the title of the report and the contents of the report.

The report is titled "Bodangora Wind Farm Environmental Noise Assessment" yet the report has not actually identified the noise impact that will be generated by the proposed wind farm. This would appear to be a fundamental failure in the obligations of the author(s) of the acoustic assessment i.e. a failure of the obligation to provide a meaningful document in relation to actual noise impacts that the community can understand.

The acoustic assessment has not explained to the community the impact that the proposed wind farm will have upon the existing acoustic environment of the area nor whether the operation of the wind farm will affect their daily activities or their night time sleeping patterns.

The ambient data reveals the existing acoustic environment of the area is significantly less than the base level of 35 dB(A). This automatically raises the question of "What is an acceptable noise impact from the proposed wind farm?" This is not an exercise that has been carried out in the subject assessment.

It would appear that the acoustic report considers that the description of the acoustic impact is satisfied by identifying compliance with a noise target set out in the Guidelines. However, any experienced acoustic engineer would be aware that generating a noise which is significantly greater than the existing ambient background level of an area can create an impact which should be assessed.

The regression analysis curves reveal a significant degree of variation in background noise levels at individual wind speeds referenced to 10 m above ground level at the wind farm.

The regression analysis method set out in the SA Guideline does not differentiate between the background levels that occur at night versus the background levels that occur in the day. One typically expects night time background levels to be lower than in the day.

Therefore if one was seeking to conduct an assessment of the impact of the wind farm on the community, it would be appropriate to differentiate between the acoustic environment that exists in the day versus that in the night.

The DGRs Noise Impact requirements on page 36 of the report require consideration of any significant difference between day and night background levels.

The draft NSW Guidelines refer to night time versus daytime background levels.

The acoustic report provides background levels on a 24 hour basis (as per the SA guidelines) in Table 3, and then the daytime background levels in Table 4 and a night time background levels in Table 5.

The regression analysis does not continue below the cut-out speed to indicate the natural ambient background level of the environment. Nor do the graphs show the full extent of the ambient noise in the area.

Whilst the report claims the same instrumentation was used for background monitoring at various locations, the graphs all appear to have a threshold limit around 20 dB(A), except for house R14 that has a lower ambient floor.

In describing "background level" the document has different backgrounds. The wind farm operational "background" at residential receivers is obtained for the presence of wind at the turbines but using a regression line to obtain an average level.

Examination of the logger photos on pages 37 and 38 of the report reveals locations R16 and R17 may be questionable in light of the proximity of the logger microphone to bushes. The absence of wind data at the microphone (separately to, or supplementary to the 10m agl wind data at the wind farm site) does not resolve the questionable data for logger R16 and R17.

The ambient background level used for the assessment of industrial noise in New South Wales looks to wind speeds less than 5 m/s at the microphone and selects the lowest 10 percentile of the background levels. Therefore the lowest 10 percentile of the background levels will obtain a lower value than the average line in the regression analysis used for the operational "background" level.

Accordingly, one has a "background" level for the area different to the "background" level for the assessment of the operation of a wind farm.

If one assumes that the wind farm ambient background level of the area from the regression analysis is around 25 - 30 dB(A) at the cut-out speed, then it is an undeniable fact that a noise limit of 35 dB(A), obtained from the Guidelines, would be clearly audible both inside and outside residential dwellings and would represent a significant impact in terms of the existing environment.

In the case of construction noise the Sonus report indicates on page 22 that 10 dB(A) above the RBL (Rating Background Level) may be noise affected.

As the regression lines reveal background levels below the regression line that reach the noise floor of the meter then one can have background levels more than 10 dB(A) below the predicted noise levels in Appendix H, without taking into account any low frequency components, amplitude modulation or infrasound.

If the regression lines are extrapolated to identify the background level (for the area) prior to the cut in speed then one would expect a lower background level to prevail.

If one was to identify to the community there would be no impact/an impact /an adverse impact or severe impact from the proposed wind farm it would be appropriate for the report to discuss the relevance of the predicted noise levels versus the regression curve and/or the minimum background levels that relate to the various wind speeds.

In addition to the above, in seeking to inform the community as to the noise impact of the proposed wind farm it would be appropriate to identify whether the assessment of noise is conservative and/or the extent of variation that may occur in such noise propagation.

The acoustic assessment purports at times to indicate that a conservative approach has been adopted in assessing the predicted noise emission levels but would not appear to identify the variation in noise levels that would occur as the result of weather conditions when compared to a worst-case scenario of weather conditions as required by the DGRs.

For example, one can have the turbines operating whilst at residential receivers there is absolutely no wind, which is not a situation identified in the acoustic assessment.

The Sonus report has not identified the relationship between the wind speed at the hub height (or the 10m height at the wind farm) versus the wind speed at receiver locations. There is therefore no correlation with the predicted noise levels under the wind scenarios that have been assessed, nor identification of the difference in propagation for different wind directions. Nor is there identification of the frequency of the occurrence of adverse meteorological effects which could be identified in a generic term as temperature inversions, separately to the more detailed and complex analysis attributed to the van den Berg effect.

It is quite likely that such an analysis could show a range of noise levels and identify to the community that for a certain percentage of the time the wind farm would be inaudible/barely audible/clearly audible. Such an analysis for some locations could show there is no issue in the day, but an issue at night that could be resolved by not operating the turbines at night.

The assessment report has failed to identify the potential audibility of turbine noise outside residential dwellings. After the community meeting in Wellington Infigen had set up on the opposite side of the road a "demonstration" for the community of wind turbine noise with markings on the footpath at various distances nominating dB(A) noise levels from the "wind farm". When one examines the basis of the "demonstration" the validity of the "demonstration" is questioned.

The "demonstration" failed to identify the nature of the existing background level at the time and therefore the relevance of the "demonstration".

If one acknowledges the ambient background levels in the town are higher than that in the rural area, particularly at night, then the existing ambient background levels will provide a masking of the wind turbine noise in the demonstration.

The "demonstration" should have identified to the community the ambient levels at the time and therefore the limits of such testing. As rural residents know noises from various sources can be heard at significant distances from the source when in the "bush" the audibility test of the "wind farm noise" that disappeared only a short distance from the relatively small speakers was not a valid "demonstration".

The audible sound from the "demonstration" did not appear to have any low frequency noise and the small sound system used for the "demonstration" could not generate the appropriate levels of infrasound that are emitted from modern day turbines.

The assessment report has failed to identify the potential audibility of turbine noise inside residential dwellings. The attenuation of building elements provides a greater degree of attenuation at high frequencies to that at low frequencies. Therefore the spectral balance of noise detected outside a dwelling is different to that inside a dwelling. Documents otherwise in the public domain establish that Sonus are aware of the significance of this issue for wind farms.

There would appear to be an assumption that the noise from the wind farm would not exhibit modulation or tonality at residential receivers thereby requiring an adjustment to the predicted noise levels.

4.0 DIRECTOR GENERAL's REQUIREMENTS

Appendix C of the Sonus report contains the DGRs. Under the General Requirements section the Environmental Assessment is required to consider any relevant statutory provisions including the consistency of the project with the objects of the Environmental Planning and Assessment Act 1979.

Under Key Assessment Requirements, Noise Impacts the Environmental Assessment is to determine the noise impacts of the wind turbine operation under operating meteorological conditions, including impacts under meteorological conditions that exacerbate the impacts. The probability of such occurrences must be quantified.

The Sonus report does not identify noise impacts. The report nominates noise levels not impacts. The Sonus report does not provide noise levels under normal weather conditions only worst case scenarios. The Sonus report does not quantify the probability of worst case occurrences as required by the DGRs.

As identified above, the Sonus report does not adequately address the actual noise impact of the proposed wind farm at all. It is silent on what would constitute a negative or adverse impact or considering offensive noise as defined in the Protection of the Environment Operations Act.

From an acoustic perspective one may consider an adverse impact to occur at a noise level of greater than what may be considered a significant impact, which on A-weighted value may be assigned background + 5 dB(A) on the following basis. Under previous versions of Australian Standard AS 1055, noise level that exceeds the background may be considered to be annoying. Noise levels up to 5 dBA above the background were considered to be of marginal significance.

Offensive noise is a noise that is harmful to a person or a noise that interferes with the rest and repose of a person. Noise from a wind farm that gives rise to sleep disturbance clearly interferes with the rest and repose of a person. There are a significant number of residents in proximity to wind farms who regularly complain of sleep disturbance, headaches and nausea when the wind farm is operating. In some cases people have had to abandon their homes due to ongoing sleep disturbance and adverse health effects, which have not be acknowledged in the Sonus report.

5.0 SA EPA GUIDELINES, NOISE IMPACTS

The DGRs for the subject application specifically identifies the Environmental Assessment is to be assessed against the 2003 SA EPA Guidelines (not the 2009 version of the SA EPA Guidelines).

The Sonus report presents data which it asserts is sufficient to establish compliance with EPA guidelines. It then relies upon the concept that the EPA guidelines have determined comprehensively an acceptable noise level for rural environments that will apply to the assessment of wind farms. On this basis, the EPA guidelines "cover the field" and no further examination of noise impacts is undertaken, either generally or specifically in relation to the concept of offensive noise that appears in the NSW

Protection of the Environment Operations Act. The report does not identify for the community the actual noise impact which will occur.

I have outlined at Section 3 above, a variety of concerns which I believe should be addressed in relation to the Sonus report.

The Guidelines introduce two "core" principles - protecting the amenity of the community from adverse noise impacts and taking all reasonable and practicable measures to prevent or minimise environmental harm. These are contained in the Introduction section and its explanatory content:

> The core objective of the guidelines is to balance the advantage of developing wind energy projects in this State with protecting the amenity of the surrounding community from adverse noise impacts.

Guidelines

The *Environment Protection Act 1993* requires a duty of care for the environment. This is specified under Section 25 of the Act and states:

A person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

Guidelines published by the EPA indicate the standard of care that is likely to be required to secure compliance with the general environmental duty as outlined in s. 25 of the Act.

They have the advantage of flexibility and can be adapted to a range of circumstances.

Neither the body of the document nor the glossary defines "adverse noise impacts". As such the Guidelines do not assist the community by defining "adverse noise". Similarly whilst Section 4.6 of the Guidelines is headed "Excessive noise," there is no definition of excessive noise.

If one assumes the EPA has a responsibility to protect the community from unreasonable disturbance and to prevent or minimise any resulting environmental harm then it is not unreasonable to expect the noise criteria to reflect that situation.

Section 2 identifies that the concept is to set a base noise level typically 5 dB(A) lower than the level considered to reflect the amenity of the receiving environment. The Guidelines correctly identify that as the wind increases so can the noise in the environment such that a varying noise limit (dependent upon the wind strength) must apply.

In the 2003 version of the Guidelines the noise criteria for a new wind farm development is:

> The predicted equivalent noise level ($L_{Aeq,10}$), adjusted for tonality in accordance with these guidelines, should not exceed:
>
> - 35 dB(A), or
> - the background noise ($L_{A90,10}$) by more than 5 dB(A)
>
> whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.
>
> The background noise should be as determined by the data collection and regression analysis procedure recommended under these guidelines (Section 3). It should be read from the resultant graph at the relevant integer wind speed.

If a rural living have a relatively quiet amenity and background levels in the day and night can be around 20 – 25 dBA (or lower), then there would appear to be a conflict between the noise criteria set by the Guidelines and what residents who reside in such zones would consider is an acceptable acoustic amenity level.

There is a fundamental problem with the selection of the base criteria if they are meant to ensure there are no adverse noise impacts. What constitutes an acceptable acoustic amenity for residents in a rural area has not been established.

There is no material in either the 2003 version (or the 2009 version) of the Guidelines identifying the basis of the base level of 40 dB(A) for a rural area. The bibliography towards the end of the Guidelines does not reference any reports or studies as to the acoustic amenity of rural areas in Australia (or in fact anywhere) nor any evaluation of acceptable amenity levels for rural areas.

There is a reference in the Bibliography to World Health Organisation 1999 *Guidelines for Community Noise*.

However, examination of the WHO 1999 Guidelines reveals an indoor limit of 30 dBA is associated with urban areas impacted by road traffic. There is no mention of wind farms or criteria for sleep disturbance in rural areas in the WHO Guidelines. In some cases there is a suggestion the WHO 1999 Guideline limit of 30 dB(A) is appropriate for rural areas which clearly becomes inappropriate if ambient background level in rural dwellings is less than 20 dB(A).

Social surveys in Scandinavia (Sweden 2000, Sweden 2005 and Netherlands 2007) for turbines significantly smaller than proposed for the subject wind farm clearly demonstrated rural communities had a greater degree of annoyance when compared to the same noise level in suburban environments (Pederson and Waye). These surveys came after the WHO 1999 Guidelines.

Section 2.3 of the Guidelines discusses 'Agreements with wind farm developers" being stakeholders, i.e. residents who receive a financial interest from the wind farm. The last paragraph on page 3 states:

> If it is shown that a development is having an 'adverse effect on an amenity value of an area that … unreasonably interferes with … the enjoyment of the area' then appropriate action can be taker under the Act.

But as discussed above the Guidelines do not specifically define adverse effect in numerical terms, the Guidelines do identify sleep disturbance as an adverse impact. The Guidelines identify on page 4 that if stakeholders experience sleep disturbance then that must be an adverse health impact:

> However, the existence of an agreement will affect the consideration of whether the interference is unreasonable in a given situation. It is unlikely that there will be unreasonable interference if:
>
> - a formal agreement is documented between the parties,
> - the agreement clearly outlines to the landowner the expected impact of the noise from the wind farm and its effect upon the landowner's amenity, and
> - the likely impact of exposure will not result in adverse health impacts (eg the level does not result in sleep disturbance).

As the Guidelines do not specifically define or quantify excessive noise or adverse impact in terms of any measurable impact, the identification of sleep disturbance as an adverse impact agrees in part with the definition of "offensive noise" in the NSW Protection of the Environment Operations Act.

If as identified in the Guidelines the stake holder dwelling is permitted a higher level of noise then does it not mean that for non-stake holders where the external limit for rural living is 35 dB(A), the corresponding internal limit should be 25 dB(A) so as to ensure there is no adverse health impact under an open windows situation or 15 dB(A) for a closed window situation?

The issue of sleep disturbance as an adverse health impact in the Guidelines must lead to an examination of what noise causes sleep disturbance and to the use of dBA as the assessment parameter. Whilst identifying the sleep disturbance as an adverse health impact the Guidelines do not identify what level of noise from wind farms generates sleep disturbance. Noise generated from wind turbines covers the entire audio spectrum and includes infrasound. Where monitoring reveals compliance with the nominated dBA noise criteria residents still hear the wind farm noise and complain about sleep disturbance.

The A-weighted filter curve significantly attenuates low frequencies (see Appendix C) and cannot provide a true indication of potential low frequency noise issues, which is a common source of complaint concerning wind farms. Furthermore if one considers noise that is below the frequency range of human hearing (i.e. less than 20 Hz which is normally referred to as Infrasound) the A-weighted value for such frequencies is insignificant.

H. G. Leventhall published a paper in Noise & Health 6.23 (April 2004) "Low frequency noise and annoyance" where the abstract states:

> *Low frequency noise, the frequency range from about 10Hz to 200Hz, has been recognised as a special environmental noise problem, particularly to sensitive people in their homes. Conventional methods of assessing annoyance, typically based on A-weighted equivalent level, are inadequate for low frequency noise and lead to incorrect decisions by regulatory authorities. There have been a large number of laboratory measurements of*

> *annoyance by low frequency noise, each with different spectra and levels, making comparisons difficult, but the main conclusions are that annoyance of low frequencies increases rapidly with level. Additionally the A-weighted level underestimates the effects of low frequency noises. There is a possibility of learned aversion to low frequency noise, leading to annoyance and stress which may receive unsympathetic treatment from regulatory authorities. In particular, problems of the Hum often remain unresolved. An approximate estimate is that about 2.5% of the population may have a low frequency threshold which is at least 12dB more sensitive than the average threshold, corresponding to nearly 1,000,000 persons in the 50-59 year old age group in the EU-15 countries. This is the group which generates many complaints. Low frequency noise specific criteria have been introduced in some countries, but do not deal adequately with fluctuations. Validation of the criteria has been for a limited range of noises and subjects.*

In the paper Leventhall specifically cites the World Health Organization as recognising low frequency noise as an environmental problem. He references the WHO publication on Community Noise and provides the following in relation to rest, sleep and adverse effects:

> "*It should be noted that low frequency noise, for example, from ventilation systems can disturb rest and sleep even at low sound levels"*
> *"When prominent low frequency components are present, noise measures based on A-weighting are inappropriate"*
> *"Since A-weighting underestimates the sound pressure level of noise with low frequency components, a better assessment of health effects would be to use C-weighting"*
> *"It should be noted that a large proportion of low frequency components in a noise may increase considerably the adverse effects on health"*
> *"The evidence on low frequency noise is sufficiently strong to warrant immediate concern"*
> *"For noise with a large proportion of low frequency sounds a still lower guideline (than 30dBA) is recommended"*

In 2009 Leventhall provided another paper in the Journal of Low Frequency Noise, Vibration and Active Control Low Frequency Noise, "What we know, what we do not know, and what we would like to know". He defines low frequency noise as in the range of 10 Hz to 100Hz, but could be extended an octave each end to give 5 Hz to 200Hz.

Whilst the 2009 paper contains the majority of the 2004 information he highlights significant issues concerning low frequency noise that cannot be detected using A-weighting.

> *Although we know a great deal about low frequency noise, there are aspects which we cannot yet explain. We know about how people hear low frequency noise and that some have a low tolerance to it. We believe that low frequency noise may, in general, be more annoying than higher frequency noise, but do not know why this is so. We do not know why some people complain of a low frequency noise which cannot be measured separately from the background noise.*
>
> *It is also possible that there are subtle effects of low frequency noise on the body, which we do not yet understand.*

Leventhall provides standardised threshold levels over a frequency range assigned for human hearing, including levels for part of the range described as Infrasound. He provides a series of questions that are clearly relevant to the proposed wind farm if it is shown that low frequency noise is likely to be produced:

> ***SOME FINAL QUESTIONS***
>
> *This review of low frequency noise and its effects leaves some unanswered questions, towards which future work might be directed.*
>
> - *Is the ear the most sensitive receptor to low frequency sound in the body?*
> - *Alternatively, is there a receptor mechanism in the body which is more sensitive than the ear at low frequencies? If so, what is the mechanism?*
> - *Are levels of infrasound below hearing threshold potentially harmful? If this is true, are there safe levels?*
> - *When people complain about noise which cannot be measured, is it because they are disturbed by fluctuations in the background noise?*

- *Can fluctuations in the background noise level turn a noise, which has an average level below the hearing threshold of a listener, into a nuisance?*
- *If fluctuations are combined with the lowest sensitivity of the hearing threshold (e.g. three standard deviations below the median) can people hear noises which have a measured average value so far below the hearing threshold that we might consider them inaudible?*
- *Does the way in which we measure low frequency noise hide some of its disturbing characteristics?*
- *Considering the normal distribution of the hearing threshold, why are there not more complaints of low frequency noise?*

Barbara Griefahn (Institute of Occupational Physiology at the University of Dortmund, Germany) is a well-known researcher on sleep disturbance due to noise. In Noise & Health Vol 4, 15 (2002) the abstract to "Sleep disturbance related to environmental noise" identifies that the ear still hears even when asleep:

> *The permanently open auditory channel and the ability of the brain to process incoming acoustical stimuli even while asleep and to respond adequately is the essential precondition for noise-induced sleep disturbances which are regarded as the most deleterious effects of noise. In the past, research was mainly focused on the detection and description of the various effects of noise, on the influence of personal and environmental factors, on the determination of dose response relations and the definition of critical noise loads, above which noise becomes intolerable. These limits are, however, as yet only tentative or applicable for a very few situations and need to be verified or revised.*

This material was available prior to the 2003 Guidelines and gives an explanation as to potential sleep disturbance impacts from wind farms that may operate continuously or intermittently at night.

The Guidelines recommend computer prediction methods in accordance with ISO 9613-2 or CONCAWE. These models are designed to deal with general noise sources not wind farms with low frequency noise.

In a submission on the Draft NSW Wind Farm Guideline document issued for public comment last year, Vestas Australian Wind Technology Pty Ltd (available on NSW Department of Planning Website) states:

> Low frequency noise
>
> The Draft Guidelines state that "*Analysis of wind turbine spectra shows that low frequency noise is typically not a significant feature of modern wind turbine noise and is generally less than that of other industrial and environmental sources.*"
>
> It is therefore unnecessary to require the prediction and monitoring of low frequency noise emissions from wind turbines. This is especially so, given the absence of regulation or limits upon the low frequency noise from "other industrial and environmental sources" as mentioned in the above statement from the Draft Guidelines. This is a further example of the way in which the Draft Guidelines discriminate against wind farms.
>
> In addition, the existing and well validated industry standard models for acoustic propagation are not designed to deal with frequencies at the low end of the audible spectrum, specifically because noise emissions in this band are not considered to pose issues likely to affect the surrounding environment. Accordingly, Vestas suggests the removal of the requirement to measure low frequency noise from the Draft Guidelines.

The above comment on low frequency noise from a local subsidiary of Vestas Wind Systems A/S (identifying themselves as the world's largest manufacturer of wind turbines and being supplier of the turbines currently proposed) confirms the computer models (including the computational standard used by Sonus) are not designed to deal with the low frequencies.

Use of the A-weighting as an assessment criterion overcomes the inadequacy of the computer models (because it ignores low frequency) and does not deal with the presence and impact of low frequency noise received at dwellings from wind farms.

One result of considering the potential adverse impact of sleep disturbance is that as there is an assumption people sleep at night, the assessment should differentiate between day and night. This would enable consideration of whether approval conditions requiring that turbines not operate at night could satisfy the obligations imposed by the Development Plan.

In addition to low frequency noise, the operation of wind farms produces noise characteristics that do not get picked up in an average A-weighted measurement. For example there are modulations in the noise signature, tonal characteristics and infrasound.

Section 4.5 of the Guideline under "Annoying characteristics" states:

> These guidelines have been developed with the fundamental characteristics of noise from a wind farm taken into account. These include the aerodynamic noise from the passing blades (commonly termed 'swish') and the infrequent and short-term braking noise.
>
> However, annoying characteristics that are not fundamental to a typical wind farm should be rectified. Such characteristics may include infrasound (low frequency noise below the audible frequency range that manifests as a rattle in lightweight materials such as glass) or adverse mechanical noise (perhaps generated as a failure of a component).

> Infrasound was a characteristic of some early wind turbine models that has been attributed to early designs in which turbine blades were downwind of the main tower – the turbulence generated around the tower was cut through by the blades, generating this effect.
>
> Modern designs generally have the blades upwind of the tower. Wind conditions onto the blades and improved blade design minimise the generation of the effect. The EPA has consulted the working group and completed an extensive literature search but is not aware of infrasound being present at any modern wind farm site.

Notwithstanding the above, noise data in relation to wind farms in the Goyder region(of South Australia) are discussed in the following section and show amplitude modulation, tones and infrasound exist for wind farms in proximity to the proposed wind farm. These characteristics, when present, can also be said to be adverse noise impacts from which the surrounding community is required to be protected.

Finally, there are those matters (outlined in preceding sections) in relation to which clear identification of the range of expected higher noise levels and the frequency of occurrence of the same needs to be made in order to comply with the DGRs.

The predicted noise levels for a wind farm will be expected to vary as a result of different weather conditions. When there is no wind in the area, the wind farm will not create an acoustic impact.

However different wind strengths (at the wind farm turbine height) will generate different noise levels. Similarly different wind direction will also change the level of noise.

Similarly temperature inversions can alter the propagation of noise that can significantly increase the noise levels.

The community will experience a range of noise levels over time depending upon the prevailing weather conditions. It would seem appropriate for the Guidelines (and reports prepared in accordance with the Guideline) to clearly identify the range of noise levels and the frequency of occurrence of the higher noise levels.

6.0 TESTING OF WINDFARM NOISE - WATERLOO AND HALLETT

Any appropriately qualified and experienced acoustic engineer will be aware that when there are vigorous complaints from residents as to noise disturbance then there is likely to be some form of noise impact occurring with respect to the relevant noise source. There may very well be a heightened sensitivity of residents who are continuously exposed to the subject noise and who can become “tuned into” the noise.

As part of my ongoing research into the actual or perceived impacts associated with wind farms, when the opportunity arises it is appropriate to undertake sound level measurements.

This section provides the results of measurements taken by the author near turbines in the region of the Waterloo Wind Farm to identify noise levels associated with the source and noise measurements at residential receivers. The results assist in placing the perceived noise impact in the existing environment and are relevant to the acceptability concept identified in the Guidelines. This material provides context to the subject application with respect to the topography and acoustic environment of the area.

These measurements may also provide an opportunity for residential receivers potentially impacted by the proposed wind farms to attend various locations in proximity to the Waterloo Wind Farm, or the group of wind farms that generically go under the name of Hallett, and ascertain for themselves the external acoustic environment that they could receive as a result of the subject proposal.

By use of noise contour graphs that identify the A-weighted level to be emitted from the Wind Farm, residents can find locations that would approximate their residence with respect to the proposed development to gauge first-hand the impact. For example, such a practical method permits residents who may be subject to a major road upgrade to experience the predicted noise levels as a result of that upgrade and thereby ascertain the likely impact.

Some caution should be applied to this suggestion as noise levels will depend on weather conditions and the perceived noise will relate to external noise, and not the noise levels obtained inside a dwelling.

Attendance at a number of residential dwellings found that residents related having experienced varying degrees of disturbance/impacts when the turbines are operating compared to the situation prior to the construction of the relevant wind farm. Measurements were conducted both external to various dwellings, and in some cases simultaneous measurements both external to an inside the dwelling were undertaken.

During the course of attending various residences where either complaints have been registered with the local Council, or compliance monitoring has been conducted by the wind farm operators, an opportunity was also presented to conduct measurements on public roads in proximity to turbines in situations where noise was not influenced by either vehicular activity (i.e. no vehicles) or activities associated with rural properties. On attending a number of residences noise from the wind farms varied ranging from barely audible, clearly audible or not audible outside the residence. Measurements inside residences found differing degrees of audibility.

Some residents near Mt Bryan advised of sleep disturbance, whilst for periods when the turbines were not operating at night, they experienced no disturbance.

Some residents did not want their property specifically identified and therefore have been excluded from the material contained in this peer review. Residences referred to in this peer review are identified by a house code (house 5 – 12 are in the vicinity of Hallett and Waterloo Wind Farms).

As set out in a previous section of this review, the Guidelines indicate that there is no issue in terms of low frequency noise and that infrasound is only generated in poorly maintained wind farms.

Towards the northern end of the Waterloo Wind Farm there is one public road that passes through the Wind Farm (Quinns Gap Road) and another that runs along the northern side of the current Wind Farm (Mollers Gap Road). These public roads permit access to positions relatively close to the turbines from which measurements may be undertaken.

One set of measurements were conducted on the top of Quinns Gap Road where one microphone was located directly in front of the turbine at a position 142 m from the base, or 168 m slant distance to the hub. A second microphone was located at a similar distance but perpendicular to the side of the hub so as to be in line with the rotating plane of the turbine blades.

A second set of measurements were conducted on the top and eastern side of Mollers Gap Road where one microphone was located at to the side turbine at a position 152 m from the base or 172 m slant distance to the rear housing.

The response curves in Appendix C show the response of the ear is non-linear across the frequency bands. The general community assessment uses the A-weighted curve (the blue curve in the lower graph of Appendix C) and as identified previously attenuates the low frequency components.

Typically wind turbine noise spectra are also presented in A-weighting curves that show the maxima to be in the mid frequencies.

The upper graph in Appendix D presents the turbine power levels measured for a distance of 800 metres for Capital Wind Farm (NSW) and Waterloo Wind Farm (slant distances noted above) on the assumption of hemispherical radiation and 6 dB per doubling of distance. These results are Linear results (without the A-weighting filter).

The lower graph in Appendix D reproduces the Linear results and also the same results when presented as A-weighted levels. The difference in the identification of low frequency becomes obvious.

Appendix E present the 1/3 octave band results of the Quinns Gap Road measurements over the Guideline standard 10 minute sample. The results show the spectrum information on a statistical basis in a linear format (not A-weighted) and show the statistical variation in the noise level.

There were no other intrusive noises at the site, only turbine noise. The results clearly identify frequency peaks rather than a broadband noise.

The measurement results show different frequency characteristics for noise off the front of the turbines versus to the side.

The A-weighted level was not constant and exhibited a variation in level which as nominated in the Guideline is identified as modulation. The modulation occurs over the entire audio spectrum. Whilst not showing a significant variation in the statistical analyses in Appendix E the modulation is most obvious in the upper frequency bands as shown by comparison of the A-weighted level versus the 2500 Hz 1/3 octave band in Appendix F.

Appendix G presents a number of FFT analyses that show the sound spectrum in a linear format (rather than constant percentage bandwidth – 1/3 octave bands) to permit identification of narrowband tones. Appendix G1 shows the statistical variation in the frequency display with the remaining graphs being the energy average (Leq) of each 2 minute sample.

The FFT analyses progressively reduce the bandwidth of each analysis to permit identification of specific tones that occur in the frequency area nominated as covering low-frequency sound and infrasound. The bottom axes are frequencies in Hz (i.e. Appendix G1 and G2 show 0 – 1 kHz, Appendix G3 0 – 100 Hz and Appendix G4 0 – 12.5 Hz).

The frequency graphs clearly show that there are low frequency and infrasound components generated by the turbine.

The results set out in Appendices D – G for the measurements of the turbine reveal modulation, low frequency noise and infrasound components.

The Sonus report identifies ambient background levels below 40 dBA for residential receivers in proximity to the proposed Bodangora Wind Farm.

Appendix H provides measurements using a SVAN 957 Sound Level Meter at a location approximately 2km south of the proposed Hallett 3 in South Australia. The location is well removed from any main roads.

The background levels (shown in Appendix H) during the day are below 20 dB(A) – except for 40 minutes in the day whilst the evening and night time background level are below 15 dB(A). How much below 15 dB(A) cannot be ascertained as the background is less than the electrical noise floor of the sound level meter.

The daytime (7am – 6pm) Leq, is 31 whilst the Leq for the entire 23 hour period shown in Appendix H is 28 dB(A). The ambient noise in the rural environment as such is significantly lower than "Indicative" level of 40 dB(A).

As to the background level as a result of the wind at the microphone, that becomes relevant in terms of independent compliance testing when the wind farm weather data is not provided, the regression graphs in Appendix H2 show the same instrumentation in open field one with grass and one with furrowed ground. There is no difference for low wind speeds at the microphone but above 10 metres per second the grassed field produce higher background levels.

As noted previously the Sonus report does not provide information to identify the wind at the microphone versus the wind farm weather monitoring station so as to clarify the relationship between the wind farm wind and the wind at residential receivers.

This matter becomes important in that residents in proximity to operational wind farms have been critical of noise audits conducted by the operator when turbines have been observed to be not operating and claims of restricting or controlling the pitch of the blades during testing have been made in Australia and in other countries.

Truly independent testing without the knowledge of the wind farm operator and subsequent supply of wind farm operating data (including turbine SCADA) can address these issues, as can obtaining wind corrections for wind induced aerodynamic noise on microphones as per the results in Appendix H2 and/or provision of supplementary wind screens (over the primary microphone wind screen).

Appendix I provides a series of measurements conducted at House 10 which is approximately 1300 metres from the northern end of the Waterloo Wind Farm. The measurements include simultaneous inside and outside measurements where the internal location was in the centre of the master bedroom and the external location was located at 15 metres in front of the dwelling towards the wind farm.

The measurements in Appendix I were recorded during the night time period. The turbines were audible both outside and inside the dwelling. The external background level was found to be 27 dB(A) and the background in the bedroom (windows closed) was 16 dB(A).

The modulation of the turbine noise external to the dwelling becomes obvious in the 2 minute sample of the A-weighted level over time. However the attenuation of the building eliminates the high frequency modulation inside the building, which becomes obvious in comparing the results.

Similarly the presence of both low-frequency sound and infrasound inside the dwelling and outside the dwelling is shown in the frequency spectra.

Moller (for Maastricht City Council) identifies the use of A-weighted measurements and in relation to audibility states:

> The level of the infrasound produced by modern wind turbines is so low that the sound cannot be perceived by humans even close to the turbines[6]. Much higher levels occur elsewhere in our daily environment, e.g. in transportation.
>
> Low-frequency wind turbine noise is usually described as humming or rumbling. It may have a more or less pronounced tonal character, e.g. in terms of tones that fluctuate and vary in level and/or pitch, or of tone-like pulses excited with regular or random intervals. The feeling of pressure at the eardrums is also reported. It is characteristic that the noise varies a lot in time and with wind and other atmospheric conditions.
>
> The rate of modulation of the low-frequency noise from wind turbines (and higher frequencies as well) is often in the infrasonic frequency range, e.g. the blade passage frequency, and the noise may thus be mistaken as infrasound, even when there is little or virtually no infrasound present.

The measurements in proximity to the Waterloo turbines identifies the blade pass frequency of the turbines and the harmonics of that frequency to be present and those frequencies are also present outside and inside houses. The turbine measurements reveal the presence of infrasound components. Use of narrow band analysis, rather than 1/3 octave bands, reveals the pattern of the noise emitted from turbines exhibits a distinct signature. The signature can shift in frequency for higher turbine speeds but still exhibits a pattern, which also appears at residential premises.

The measurement of infrasound inside houses is similar to that obtained in Falmouth by Rand and Ambrose.

It is noted that the difference from outside to inside with respect to the low frequency sound and infrasound components is relatively small, and in some cases there is a negative difference in that there are higher levels inside the dwelling than outside.

When one is dealing with low frequency or infrasound noise associated with gas fired power stations it has been found that the energy emitted from the power station can excite the building elements into resonant modes or physical vibration that leads to the internal surfaces of the room in question vibrating and radiating noise.

The fact that there are discrete frequencies detected inside the dwelling that fall into the frequencies typically associated with different levels of sleep states is a matter that should be noted. The assessment of sleep disturbance is outside my field of expertise but the material provided in Appendix I is informative.

It is noted that in viewing the frequency graphs contained in this report, the measurement results are those obtained directly from the Bruel & Kjaer Pulse system with a low pass filter of 7 Hz (rather than the standard 22 Hz) and utilising Bruel & Kjaer Type 4189 microphones that have a frequency response that falls off below 10Hz.

If one is looking to accurately define the sound levels occurring in the infrasound region then one needs to adjust the measurement results appended to this review which will result in higher sound pressure levels for frequencies below 7 Hz.

Similarly, in view of the low ambient noise levels recorded both inside and outside the dwellings the measurement results are approaching the electrical noise floor of the microphones. More detailed investigations require specialised microphones to accurately record such levels.

During the course of monitoring at house H10, the occupants related that on the night upon which the measurement results appended to this review were obtained, they experienced disturbed sleep.

Residents at houses 10 and 12 advised the author that testing has been conducted by independent consultants to reveal that both of these properties comply with the Guidelines. Yet the occupants of both of these properties experience sleep disturbance and at times complained of excessive noise intrusion. I was advised that at house H10 monitoring conducted by one set of independent consultants placed the microphone approximately 1.5 m from the bedroom window of that residence. This would not comply with the requirements of the Guidelines.

Attendance at House H12 also suggested that monitoring which had been conducted by independent consultants was not in accordance with the Guidelines. The occupant identified that the monitoring position was to the side of the residence in relatively close proximity to large trees, rather than the complying with the requirement to be between the residence and the wind farm which would have placed the monitor in an open paddock.

Residents indicated that there are significant differences in noise received at their property dependent upon the weather conditions and cited both light and strong winds giving rise to different noise effects. Cloud cover was also cited as altering the noise propagation.

Appendix J provides a series of photos from house H8 obtained in the morning. The photos indicate wind occurring across the valley yet there is cloud on the lee side of the hill completely covering a residence. A close up of the photo shows at one point in time an operating turbine poking through the cloud cover.

For the purposes of this peer review, the attached Appendices are sufficiently detailed to reveal that even when wind farms in the Goyder area are apparently able to comply with the Guidelines, they are still generating adverse impacts at residential properties. These impacts can be detected and measured when one looks to the use of non-A-weighted measurement results. The measurement data appended to this review identifies that there are both low frequency and infrasound components generated by the turbines that are currently located in the region.

7.0 CONCLUSIONS

Sonus has relied solely upon the EPA Guidelines and has ignored the acoustic characteristics that residents will actually receive as a result of the Bodangora Wind Farm. They have not addressed the actual acoustic impact of the wind farm on the community.

The Sonus acoustic assessment provides a set of predicted noise levels in terms of the A-weighted values set out in the Guidelines and concludes that there are no tonal or modulation characteristics requiring modification to the predicted noise levels.

The assessment claims to have addressed the influence or effect of winds and temperature inversions which have the potential to result in higher noise levels than have been predicted.

In relation to background levels, the attached measurement results confirm (as expected) that ambient background levels inside rural properties are significantly lower than 30 dB(A). As such, the noise generated by the wind farm is likely to be significantly greater than background +5dB(A) and therefore to have an impact significantly greater than for an “annoyance.”

The issue of low frequency noise and infrasound has been raised and discussed above. Documentation from the world's leading supplier of turbines has identified that computer models are inadequate for low-frequency noise propagation. As high frequencies are rapidly attenuated over distance (when compared to low frequencies) audible characteristics of the turbines may be reduced to a low frequency hum and can also include frequencies below the normal range of human hearing.

The Guidelines identify that infrasound is not generated on a well maintained wind farm yet the measurement results obtained for the purposes of this report prove otherwise. The measurement data appended to this review identifies that there are both low frequency and infrasound components generated by the turbines that are currently located in the region.

A proper assessment of community impact cannot ignore low frequency noise and "infrasound." To the extent that it does, when these have been issues of specific complaint with other wind farms, the Sonus report falls short of its responsibility to the community as required by the Code of Ethics of the Australian Acoustical Society and the Code of Conduct of the AAAC.

The Guidelines identify that for host stakeholders, sleep disturbance is an adverse health effect. It is not unreasonable for Council and the community to assume that if sleep disturbance gives rise to an adverse health effect for persons who are obtaining a financial gain from hosting turbines, then sleep disturbance that impacts upon the general community (i.e. non-host stakeholders) must also give rise to an adverse health effect.

This peer-review has identified two eminent acousticians who, in 2002/2004, identified that there are issues with low frequency and infrasound and that the ear still continues to work and receive signals even when people are asleep. The mechanism causing sleep disturbance (for example, whether individuals are able to detect the infrasound components) is an issue outside my expertise.

But it is clear that use of the A-weighted value for assessment or compliance purposes does not address all of the noise impact issues associated with wind farms.

The current application has not satisfactorily addressed all of the matters raised in the DGRs, and has not actually assessed the noise or the impact of the subject development.

Inadequacies of the SA EPA Guidelines in meeting their own core objects have been raised.

As a result of the various matters raised and outlined above, there can be no confidence that the community will not be adversely impacted by the proposed Bodangora Wind Farm. It is recommended that Bodangora Wind Farm Turbine Awareness Group should request further particulars from the Applicant to address the individual matters raised above with a view to identifying the actual noise impact that will be generated by the proposed wind farm.

Yours faithfully,

THE ACOUSTIC GROUP PTY LTD

STEVEN E. COOPER

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