

Report to the Hurunui District Council
Assessment of the Effects on the Environment
Project Hurunui Wind

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1. INTRODUCTION AND TERMS OF REFERENCE

1.1 My name is Dr David McBride. I am a registered medical practitioner holding specialist registration with the New Zealand Medical Council as an occupational physician. I am a Senior Lecturer in Occupational Health at the University of Otago and have been practicing Occupational and Environmental Medicine since 1988. My specialist qualification is as a Fellow of the Australasian Faculty of Occupational and Environmental Medicine. My clinical interests lie in the effects of physical agents (noise and vibration) and chemical agents (particularly persistent organochlorine compounds and dioxins). My particular area of research expertise lies in Occupational Epidemiology and Biostatistics. I completed the European Educational Programme in Epidemiology in 1992 and graduated with the Sheffield Hallam University Post Graduate Certificate in Applied Statistics in 1994. My PhD in occupational health was on the health effects of noise, especially impulse noise.

1.2 I confirm that I have read the code of conduct for expert witnesses contained in the Environment Court Practice Note and that I agree to comply with it. I confirm that I have considered all of the material facts that I am aware of that might alter or detract from the opinions expressed here and have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

1.3 The Hurunui District Council (the Council) has sought my advice to inform the Council's report to the Environment Court concerning Project Hurunui Wind under section 87F of the Resource Management Act. In this exercise the Council has specifically asked my advice about the following:

- (a) is the assessment of effects on the environment ("AEE"), as it relates to my area of expertise, fair and reasonable in the circumstances;
- (b) are there any matters in the AEE which need to be drawn to the Court's attention such as:
 - (i) different opinions or views which might be expressed about an effect described in the AEE; or
 - (ii) any adverse effects which have not been adequately described and/or assessed in the application and AEE; or

- (iii) any other effects, including positive ones, that the applicant has either not stated or understated in the AEE but which should be reported?

2. EQUITY OF THE ASSESSMENT.

- 2.1 The acoustic assessment prepared by URS New Zealand entitled Acoustics Assessment, Project Hurunui Wind is a report based broadly on the matters presented in NZS6808:2010. Dr David Black has provided a report for Meridian about potential health effects drawing on the modelling by URS New Zealand.
- 2.2 The URS assessment is fair and reasonable as regards the provisions of the New Zealand Standard. All noise sensitive locations within 3 kilometres of the turbines have been identified. There are 73 properties, with a median distance of 2.1 kilometre and a minimum distance (1 property) of 1.1 kilometre from the proposed wind farm's site. Only 3 of the locations identified will receive a noise level above 35 dB(A).
- 2.3 The critical issue that needs to be assessed is potential sleep disturbance which, if not addressed, can lead to impacts on health and well-being. While the noise level quoted should protect against sleep disturbance, the Standard specifically mentions (section 5.4.1) that additional features, particularly special audible characteristics, should be taken into account and cannot always be predicted. One potential special audible characteristic is amplitude modulation, an annoying effect which is a particular problem with wind farms. This may either be a "typical" amplitude modulation (i.e., a 3-5 dB modulated "swish," audible in the near field) or an "atypical" amplitude modulation (i.e., >5 dB modulated "thump," audible in the far field). The exact cause of the modulation is yet to be fully defined.
- 2.4 The Standard acknowledges that there is no appropriate objective test to measure amplitude modulation. If it is present, and post hoc (the farm already having been constructed), section B3.1 of the Standard states how it should be assessed. If "a local authority enforcement officer or acoustic advisor to a local authority considers that a wind farm creates sound with a clearly audible amplitude modulation at a noise sensitive location, an adjustment of +5 dB shall be applied to the wind farm sound level at that location for the wind conditions under which the modulation occurs". This method assumes that appropriate sampling will, in fact, identify such

occurrences. The “guidance” sections C5.3.1 and C5.3.2 acknowledge that “Even with elaborate sound and wind monitoring at individual noise sensitive locations only a moderate proportion of sensitive times can be clearly identified.” It is possible that “unreasonable noise” (in terms of amplitude modulation) may occur at times, that this occurrence will only be identifiable after construction, and then only following upon detailed monitoring.

- 2.5 Current knowledge of why sound is annoying indicate that amplitude modulation requires further thought about monitoring techniques and objective testing: there is no definitive standard at present. There is however an interim test method in section B3.2 of the Standard which is considered to be adequate. This says that “...modulation special audible characteristics are deemed to exist if the measured A weighted peak to trough levels exceed 5 dB on a regularly varying basis, or if the measured third octave-band peak to trough levels exceed 6dB on a regular basis in respect of the blade pass frequency”. As the exact causes of modulation have not been identified, subsequent refinement to this test should be expected.
- 2.6 Care is also required to ensure that suitable locations, meteorological conditions and times are selected for monitoring. This will require specific reporting procedures from affected locations or some form of automatic monitoring.
- 2.7 There is no doubt that amplitude modulation is annoying: the simple dB(A) metric does not adequately describe the effect and requires adjustment as stipulated in the Standard. Furthermore the logarithmic nature of the decibel may, if one is not accustomed to the concept, lead to an underestimation of the true magnitude of an increase in sound levels. This, along with a sometimes exponential increase in annoyance with increasing sound levels, can lead to a distortion of the relationship between the two. A project by van den Berg and colleagues[1] showed that the percentage of respondents without economic benefits (not owning or having an interest in turbines) that were “rather” or “very” annoyed when outdoors increased from 2% at low levels of wind turbine sound (less than 30 dBA) up to 25% (a 12 fold increase in annoyance) at levels of 40 to 45 dBA (a 3-4 fold increase in SPL). The noise contours calculated by the Standard may not necessarily bear a clear relationship to human response. The Standard does however indicate that responses are subjective.

3. DIFFERING VIEWS AND OPINIONS.

- 3.1 Dr David Black's report is fair and reasonable, I do however have differing views about turbine noise and the relationship to health effects.
- 3.2 Although wind turbine technology has been around for at least 30 years the last 10 years or so have seen a rapid increase in construction of wind farms and also of complaints about their effects. At present the research into the health effects is at a hypothesis generating stage and not at such a level of proof that relates cause and effect with any degree of certainty. Conversely it is not possible to argue categorically that there will be no effect: this would, in my experience in dealing with other environmental hazards, be unwise. Getting definitive answers either way will not be easy, even in terms of recruiting sufficient numbers of subjects to study. To look into the association between annoyance and dB(A) level (Sound Pressure Level), a sample size of between 600-1000 residences over a year might give useful answers. To study chronic health outcomes such as the incidence of depression or heart problems the same number of residences might need to be followed for five years.
- 3.3 Dr Black uses a simple health model to explain that there are no public health risks because there are no physiological effects, such as deafness, on the ear. The hypothesis is that the sound cannot have a direct effect as it is simply not loud enough. Health effects, such as anxiety, are caused by the misconceptions that individuals develop about the noise, thus leading to a psychosomatic illness.
- 3.4 An alternative explanation is that some individuals are more sensitive to noise than others are, which fits with the general concept of biological and physiological variation. This trait means that some individuals are more likely to attend to sound, to evaluate that sound negatively, and have stronger emotional reactions to noise and react with a stress response.
- 3.5 Section 8.24 of the annex says that it is better to avoid rather than having to treat such psychosomatic conditions, the only solution being to "provide full information and counter inaccurate or scaremongering information".
- 3.6 This assessment raises an important point about risk communication and perception. Early models of risk communication had two basic forms: to "tell the public to accept the facts", or "persuade the public to accept the facts". We now know that risk communication consists of "Actions, words, and other

interactions that incorporate and respect the perceptions of the information recipients, intended to help people make more informed decisions about threats to their health and safety.”[2] Key points are that risk communication is a matter of what an organization does, rather than what it says, and it will be more effective as dialogue, not instruction. This requires a different, more inclusive approach than didactic instruction. Based this model of risk communication[2] community concerns should be taken seriously.

- 3.7 On the basis of current information there is an assertion that there will be no physiological health risks associated with the effects of noise on wellbeing, including potential sleep disturbance. Sleep disturbance is not a trivial effect, in the short term it causes fatigue and physiological stress. In the long term it is in fact part of a causal chain which leads to adverse health effects. As the auditory pathways are directly connected to the auditory cortex, and indirectly to the “activating” centre of the brain (The Reticular activating System), it is possible for noise to cause neuro-endocrine effects through secretion of corticosteroids, adrenalin and noradrenalin.[3] These physiological mechanisms are responsible for health effects such as hypertension. As the research regarding the association between turbine noise and health effects is at a formative stage, one might acknowledge that disturbance is possible and that any such complaints will be investigated using suitable survey methods. It would be prudent to consider this as a condition to the consent.

4. ADVERSE EFFECTS NOT ADEQUATELY DESCRIBED

- 4.1 In the report by URS, the sound is correctly identified as coming from turbulent flow around the leading and trailing edges of the blade. The nature, and particularly the quality, of the noise are not described further, which is an important omission.
- 4.2 The acoustic characteristics of wind farm noise are complex. Under certain conditions turbines are quite likely to be audible. Audibility is dependent on the design of the blade; the spacing of the turbines; the wind speed, mechanical noise and other factors. The character of the sound is not steady, but has an impulsive characteristic which varies with conditions. These impulsive characteristics are variously described (rumbling, thumping) but clearly unnatural. It is therefore a sound with special audible characteristics.
- 4.3 These special characteristics of turbine noise can lead directly to annoyance, which leads to both loss of amenity and sleep disturbance.

- 4.4 Secondary health effects also result from annoyance, including reductions in well-being, mental and stress-related disease. These are related to the physiological mechanisms described in section 3.7. Epidemiologically, the problem is a complex one with multiple variables and ample opportunity for confounding.
- 4.5 There are early indications that amenity, specifically Health related quality of life (HRQOL) may be reduced by wind farm noise. HRQOL is a concept that measures general well-being and well-being in specific domains: physical, psychological, social, and environmental. The World Health Organisation (WHO) recommends the use of HRQOL metrics as outcome variables, arguing that the effects of noise are strongest for those outcomes classified under HRQOL rather than illness.[4] HRQOL changes are certainly more proximate in time to stressors than chronic changes in health.
- 4.6 HRQOL is related to health by the WHO (1948) definition of health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”, and can be considered as an operationalisation of the “well-being” concept.[5]
- 4.7 We have in fact used the HRQOL as an outcome measure in a New Zealand Study[6] which looked at two community samples, blinded as to the nature (turbine noise) of the enquiry. The first was drawn from 56 residences in the Makara Valley, where a wind turbine farm has been established since 2009, with noise levels between 24 and 54 dB(A). The second group were residents in 250 houses in a geographically and socioeconomically matched area, but which were located at least eight kilometres from any wind turbine installation.
- 4.8 In this study self-reported HRQOL was measured using the abbreviated version of the WHOQOL (the WHOQOL-BREF) which affords composite measures of Physical (7 items), Psychological (6 items), Social (3 items) and Environmental (8 items) HRQOL. They were also asked about amenity and noise sensitivity. Those residing in the immediate vicinity of wind turbines scored worse than a matched comparison group in terms of physical and environmental HRQOL, and HRQOL in general, also scoring lower in amenity. A comparison between ratings of turbine noise was not possible, but the mean annoyance rating for Turbine group individuals who specifically identified wind turbine noise as annoying was significantly different from the non-turbine noise group, indicating that the turbine noise was perceived as

extremely annoying. The high incidence of annoyance from turbine noise in the Turbine group is consistent with the theory that exposure to turbine noise is the cause of these differences. Importantly, we also found a reduction in sleep satisfaction ratings, suggesting that both annoyance and sleep disruption may mediate the relationship between noise and HRQOL. As the turbines were in operation in 2009 and we studied the effects shortly thereafter response bias may be present. Respondents were however blinded as to purpose to minimise such bias. Furthermore the findings are consistent with those reported in relation to aviation noise[7] and traffic noise.[8, 9] Turbine noise can therefore cause a decrease in amenity and direct health effects.

- 4.9 In summary, Project Hurunui Wind should not, on the data presented, produce sound that is intrusive. Special audible characteristics may however be present. These are acknowledged to exist, their audibility will depend on the characteristics of the turbines and other features of the wind farm, and they will only be audible after commissioning. It is important that mechanisms are put in place to detect such characteristics and stipulate controls if necessary. It is therefore, in my opinion, unwise to state categorically that there will be no effect of wind farm noise; it is clear that there are effects. Several important points require clarification, such as the associations between exposure, including the characteristics of the noise, and effects including sleep disturbance, loss of amenity and more chronic health effects. If these effects are to be avoided then the conditions giving rise to the noise require to be identified.
- 4.10 I would therefore recommend that if consent is granted then an investigation of the special audible characteristic of amplitude modulation should be undertaken. As the presence of this characteristic is difficult to identify, the location, frequency and duration of monitoring would require to be specified. If the community had input to this process some of the principles of effective communication would be fulfilled.

References

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