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14th April, 2014

Mr A N Abbott
Piper Alderman
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Provision of Expert Opinion concerning the Adverse Impacts of Wind Turbine Noise TruEnergy Renewable Developments v Goyder Regional Council , A W Coffey & H Dunn

Dear Mr Abbott,

I confirm that I have been provided with practice direction 5.4 relating to Expert Witnesses (Rule 160), and that I have read it and understood it.

I have been asked by you to provide a report to address the following question:

“Will noise or other direct or indirect consequences (and which consequences) of the operation of the Stony Gap wind farm erected as contemplated in the Application, and involving turbines of the type and dimensions referred to in the Application, in your opinion be likely to cause adverse health effects or significantly exacerbate existing adverse health effects to a significant percentage of the population living within up to 10 kilometers of the turbines from the Stony Gap Wind Farm?”

In my opinion, it is inevitable that this proposed wind development, if built in this location with turbines of the specified size, will cause serious harm to the physical and mental health of a significant percentage of the surrounding population, including particularly to vulnerable groups such as young children, the elderly, and those with pre existing medical and psychiatric conditions, who live and work in the sound energy impact zone of this proposed Stony Gap Wind Farm (SGWF), out to a distance of at least 10 kilometers from the turbines, over the lifetime of the project. This harm will be caused directly by the audible and inaudible sound energy generated by the wind turbines, which will cause significant repetitive sleep disturbance, and physiological stress. The physiological mechanisms have been demonstrated in animals to be due to abnormal activation of the vestibular system and sympathetic nervous system by the effect of infrasound and low frequency noise (ILFN) on the inner ear. ¹

These are serious adverse health effects, which lead to a range of other symptoms and illnesses by interfering with the hypothalamic-pituitary axis (“master” control mechanism of the endocrine system), disturbance of the autonomic nervous system and compromise of immunological competence. ²

This report is confined to the adverse health effects on human health from sound energy, reported by residents living near wind turbines as this is my specific area of knowledge and expertise. Other adverse health effects such

as symptoms and illnesses resulting from exposure to shadow flicker have certainly been reported by residents at wind developments, but are not addressed in this report.

My opinion is informed by my direct knowledge of the reported health problems of residents living near existing Wind Turbine Developments, particularly in Australia and Ontario. My opinion is also informed by the known adverse health consequences resulting from exposure to environmental noise, and the known serious adverse health consequences of chronic sleep deprivation and chronic stress.

Sleep deprivation³ and stress⁴ related symptoms are the commonest health complaints reported by residents living near wind turbines, and in my opinion, they are individually and collectively responsible for the observed and reported deterioration in some residents' health with cumulative exposure to operating wind turbines.

There is extensive and longstanding peer reviewed published clinical research detailing the known interconnections and associations between chronic sleep deprivation, stress and numerous clinical disorders⁵ including ischemic heart disease, hypertension, diabetes, immune suppression resulting in increased infections and malignancies (cancers), depression, and anxiety.

The observation of these particular preexisting symptoms and health problems worsening with exposure to wind turbine noise is not surprising to clinicians and mental health professionals, when they learn what is now known about the way infrasound and low frequency noise, regardless of the source of the noise, are known to affect health via repetitive sleep disturbance, and the physiological and psychological stress pathways.⁶

The specific reasons for my opinion are set out below.

1.0 General Background – Known Adverse Health Impacts From Sound Energy

There is substantial and growing literature about the adverse health impacts resulting from environmental noise, regardless of the noise source. These have been documented in comprehensive World Health Organisation (WHO) and Government reports and literature reviews for many years. Night time noise is of particular concern and interest to most public health authorities, because of the long recognized need for restorative sleep to maintain health.

Dr Alice Suter authored a comprehensive report on noise and its impacts for the Administrative Conference of the United States in 1991,⁷ and stated the following:

"Noise has a significant impact on the quality of life, and in that sense, it is a health problem in accordance with the World Health Organization's (WHO) definition of health. WHO's definition of health includes total physical and mental well-being, as well as the absence of disease. Along these lines, a 1971 WHO working group stated: "Noise must be recognized as a major threat to human well-being." (Suess, 1973)"

1.1 World Health Organisation (WHO) Reports Detailing the Effects of Noise

In 1999, the WHO issued a comprehensive report authored by Birgitta Berglund, Thomas Lindvall and Dieter Schwela called "**Guidelines for Community Noise**".⁸ Listed in the "adverse health effects of noise section" are sleep disturbance, cardiovascular and physiological effects, mental health, and effects of noise on performance.

This 1999 document references an earlier WHO document by Berglund and Lindvall and states (p 20):

"In 1992, a WHO Task Force also identified the following specific health effects for the general population that may result from community noise: interference with communication; annoyance responses; effects on sleep, and on the cardiovascular and psychophysiological systems; effects on performance, productivity, and social behavior; and noise-induced hearing impairment (WHO 1993; Berglund & Lindvall 1995; cf. WHO 1980)".

The earlier WHO document was the 1995 document called “**Community Noise**” edited by Berglund & Lindvall. There is a significant body of research referenced in that document which informed the authors recommendations, which included the following extract from the abstract:

“Noise measures or indices based only on energy summation are not enough for the characterization of most noise environments. This is particularly true when concerned with health assessment and predictions.

It is equally important to measure and display the maximum values of the noise fluctuations, preferably combined with a measure of the number of noise events, and to assess whether the noise includes a large proportion of low frequency components. For dwellings, recommended guideline values inside bedrooms are 30 dB LAeq for steady-state continuous noise and for a noise event 45 dB LAmax.”⁹

In 2009, the WHO issued a report called “**Night Noise Guidelines for Europe**”¹⁰ which details the then known science relating to the effect of noise on sleep, and the adverse health consequences of sleep disturbance. Specific mention is made of the adverse impacts on children, cardiovascular health, mental health and the links between sleep disturbance with physiological stress. Given the vital importance of night time noise and its effects on sleep and therefore health to the issues being considered by this Court, numerous extracts have been reproduced in the subsequent section of this report at 2.4 Adverse Health consequences of Environmental Noise.

Section 2.1.2 of the WHO 2009 report “**Night Noise Guidelines for Europe**” has a useful section on definitions of disturbed sleep with a description of what constitutes an “environmental sleep disorder”. It states:

“Sleep disorders are described and classified in the International Classification of Sleep Disorders (ICSD) (American Academy of Sleep Medicine, 2005). When sleep is permanently disturbed and becomes a sleep disorder, it is classified in the ICSD 2005 as “environmental sleep disorder”. Environmental sleep disorder (of which noise-induced sleep disturbance is an example) is a sleep disturbance due to a disturbing environmental factor that causes a complaint of either insomnia or daytime fatigue and somnolence. Secondary deficits may result, including deficits in concentration, attention and cognitive performance, reduced vigilance, daytime fatigue, malaise, depressed mood and irritability.

The most recent World Health Organisation publication called “**Burden of disease from Environmental Noise**” was issued in 2011, and makes it clear that noise pollution is considered a serious and growing public health problem in Europe. Specific acknowledged adverse health effects in that document include cardiovascular disease, cognitive impairment, sleep disturbance, tinnitus and annoyance. The final paragraph states

*“There is overwhelming evidence that exposure to environmental noise has adverse effects on the health of the population”.*¹¹

1.2 Australian Government Report on Environmental Noise

In 2004, the Australian Environmental Health Council issued a comprehensive report and literature review¹² entitled “**The health effects of environmental noise – other than hearing loss**” which listed a number of the known health problem groups in the index, which not surprisingly are identical to those listed in the World Health Organisation reports. Those categories included the following: annoyance and impaired quality of life, sleep disturbance, children’s performance and learning, cardiovascular disease, mental health problems, and neurophysiological stress. This comprehensive report detailed the existing knowledge at the time, and recommended further research in many areas.

The 2004 En Health report acknowledged the existence of growing problems with environmental noise in Australia, and made four recommendations. They were:

1. Recognise environmental noise as a potential health concern
2. Promote measures to reduce environmental noise and its health impacts
3. Address environmental noise in planning and development activities
4. Foster research on the non-auditory health impacts of environmental noise

1.3 Literature Reviews relating to Infrasound and Low Frequency Noise, which focus primarily on Empirical Data from Independent Research

Noise is generally accepted as “unwanted sound”. The recently issued 2014 NHMRC Systematic Literature Review had the following definitions of which frequencies refer to infrasound and low frequency sound (from p 62) ¹³

Infrasound *“Sound < 20 Hz is generally termed infrasound”*

Low Frequency Sound: *“There is no clear definition of the upper limit of low-frequency sound. The definitions vary and can range from 100 Hz to 250 Hz”*

There are four useful literature reviews or summaries, which focus primarily on empirical data from independent research, which are relevant to the subject of infrasound and low frequency noise from wind turbines and other sources, with particular reference to their known physiological impacts on humans.

The first document is entitled **“Wind Turbine Infra and Low Frequency Sound: Warning Signs That Went Unheard”** by American Acoustician Mr Rick James, published in 2012 in the Bulletin of Science, Technology and Society.¹⁴ The article details the knowledge amongst acousticians of the frequencies generated by wind turbines from early NASA research, and also the research relating to the known human impacts of impulsive infrasound and low frequency noise from other noise sources, including heating and cooling ventilation systems (HVAC).

It is clear from Mr James’s summary that the health problems currently being reported by residents near wind turbines were predictable, based on longstanding acoustic knowledge of the impacts of exposure to infrasound and low frequency noise, coupled with the knowledge that impulsive infrasound and low frequency noise were generated by modern upwind bladed wind turbines at sufficiently high “doses”.

Mr James specifically highlights the historical decision made by noise pollution regulatory authorities and their acoustic advisers in the United Kingdom not to measure infrasound and low frequency noise from wind turbines, in their ETSU 97 Wind turbine Noise Regulations. This decision not to measure IFLN has been separately confirmed to me by both Dr Malcolm Swinbanks¹⁵ and Mr Les Huson¹⁶ who have both worked in the UK as Acousticians for many years in other areas of acoustics, and have more recently taken an interest in wind turbine noise and the history of its regulation in the UK, Australia and the United States.

This decision to exclude measurement of infrasound and low frequency noise in the UK was then copied by noise pollution regulatory authorities in Australia, who relied on those UK noise pollution regulations (ETSU 97) to develop the Australian Wind Farm Noise Guidelines. Mr Chris Turnbull, an Australian acoustician, pointed out this reliance on ETSU 97 in his recent paper presented in Denver, in August 2013.¹⁷ As a result there has been almost no knowledge until relatively recently of the doses of wind turbine generated infrasound and low frequency noise rural residents are being exposed to in Australia, both inside and outside their homes, because there is no requirement from the noise pollution or planning regulatory authorities to measure those frequencies.

The second document is a detailed literature review written in 2003 by Professor Geoffrey Leventhall and two coauthors, Drs Benton and Pelmeur, for the United Kingdom Government Department of Food and Rural Affairs (DEFRA) with the title **“Review of Published Research on Low Frequency Noise and its Affects”**.¹⁸

Professor Leventhall’s report documents a variety of research conducted prior to 2003, detailing the adverse health effects of exposure to low frequency noise, including important research which established that truck low frequency

noise can cause cortisol release in sleeping children, indicative of a noise induced physiological stress response. Cortisol is one of the body's stress hormones, and adrenaline is another.

This research describing the release of cortisol in sleeping children exposed to low frequency noise is explicit evidence of a physiological stress effect in sleeping children. The DEFRA 2003 literature review also confirms that wind turbines were known in 2003 to be a source of infrasound and low frequency noise.¹⁹

Despite Professor Leventhall being one of the two peer reviewers of the 2010 NHMRC Rapid Review, no citation of this 2003 literature review reference appeared. No reasons were given for the omission of this seminal 2003 DEFRA literature review, and specifically the important empirical evidence of a physiological stress effect from low frequency noise.

The third document is a 2001 Literature review detailing the then known research into the effects of experimental exposure to infrasound, by the National Institute of Environmental Health Sciences (NIEHS) in the USA, "**Infrasound – Brief Review of toxicological Literature**".²⁰

Some of the animal studies listed in the 2001 NIEHS literature review show evidence of a physiological stress response in animals induced by exposure to infrasound experimentally. Nishimura et al²¹ concluded (on p 31 of their study) from their experiment exposing rats to infrasound and measuring biochemical and physiological parameters of gastric microcirculation and from the experiments of others that

"exposure to 16 Hz at 120 dB appears to induce sympathetic dominant responses early in the exposure period due to stimulation of the sympathetic nervous system by the hypophysis directly or indirectly by the adrenal glands".

These studies by Nishimura and others he cited therefore provide supportive evidence for the potential for a physiological stress effect to occur in humans exposed to infrasound. .

There is currently very little information about exposure doses and peaks of infrasound being measured inside people's homes, although there are reports of peaks up to 90 dB being measured.²² However Broner, cited in the NIEHS Toxicology of infrasound document in section 4.1 on Human Toxicology²³ noted in a peer reviewed published article in 1978²⁴ that

"The primary effect of infrasound appears to be annoyance. Aural pain and damage (ie scarring of the tympanic membrane and vascular infection (sic) of the eardrum membrane) have been reported. Pressure sensation in the middle ear is a consistent finding (beginning at 127 – 133 dB)."

There are many reports from residents living near wind developments that they periodically experience the sensation of "pressure sensations" or "fullness in the middle ear" which suggests that perhaps the levels of infrasound periodically reach higher levels than have yet been measured, even up to the 130 dB level suggested by Broner above.

Importantly, the experimental exposure periods in these experimental animal studies are comparatively very short , with one of the longest experimental exposures being 60 days, and the experimental periods of exposure within those experiments are not necessarily continuous exposure. Residents living near wind developments by comparison have much longer exposure periods, unless they leave their homes or the turbines stop turning.

The NIEHS 2001 literature review makes it clear that there are significant knowledge gaps with respect to chronic exposure to infrasound at lower "doses" particularly, stating:

"Examples of critical data gaps include a lack of high quality long-term experimental studies of infrasound, and inadequate characterization of environmental infrasound and accompanying higher frequency sound levels in community settings".²⁵

Until recently there were no literature reviews conducted by public health physicians with a direct knowledge of the clinical problems being diagnosed in wind turbine neighbours in their region, because many public health authorities around the world have until recently failed to recognize the problem and failed investigate the complaints of residents.

This changed with the work of Dr Michael Arra and Dr Hazel Lynn from the Grey Bruce Health Unit in Ontario. This fourth literature review entitled “**Association between Wind Turbine Noise and Human Distress**” is currently being peer reviewed prior to publication, however a powerpoint presentation summarising their findings was presented to the Grey Bruce Health Unit in March 2013.²⁶

Over the last few years there had been increasing publicity in the Grey Bruce Health Unit region about the serious health and sleep problems residents were experiencing with wind turbine noise, resulting in numerous home abandonments. Dr Lynn had heard directly from sick residents and their treating medical practitioners, and the literature review was conducted because of that direct knowledge of the serious nature of the health problems.

Dr Lynn and Dr Arra found that all the empirical studies and review articles reported in the peer-reviewed journals showed evidence of what they called “*human distress*” from the wind turbine noise.²⁷ Included in their list of studies reviewed are the early European population studies from Sweden and Holland, with residents living near much smaller wind turbines, often in a much noisier background noise environment when compared to much of rural Australia.

Drs Arra and Lynn assessed a couple of the more recent studies showing clear evidence of sleep deprivation and impaired quality of life or mental health problems, by Nissenbaum et al,²⁸ and Shepherd et al²⁹ as “*excellent*” or “*extremely robust research*”.

Dr Lynn and Dr Arra found evidence of a dose response relationship in three of the studies, which is suggestive of a direct causal relationship between wind turbine noise and symptoms. They also recommended further research, stating “*The studies are level 4 or 5 (a weak type of evidence)*” but “*strongly warrant further research*”. Those latter comments related to the strength of evidence in each study for a direct causal relationship, not the quality of the research itself.³⁰

1.4 What is meant by “annoyance”?

“Annoyance” is a term long used in the acoustic and psychoacoustic research literature and acoustic consulting work assessing the noise impacts reported by residents. There seems to be some differences of opinion between acousticians historically and currently as to whether or not impacts from inaudible noise and vibration are also covered by use of the term “annoyance” or whether it just relates to audible noise.³¹

However from a clinical perspective, use of the term “annoyance” is not precise, and therefore does nothing to aid accurate diagnosis of specific conditions, or assessment of the severity of symptoms and their impact on people’s health and quality of life. Medical practitioners and others unfamiliar with the way the term is used by acousticians and researchers do not understand that it can be used by acousticians to refer to significant adverse impacts, including chronic cumulative sleep deprivation from repetitive sleep disturbance, for example.

One of a medical practitioner’s most important tasks is to accurately diagnose clinical conditions and determine their likely cause. Usage of the term “annoyance” does not assist with this process of establishing a clinical diagnosis, hence it is not used in clinical medicine.

Annoyance is acknowledged as an adverse health effect by the WHO, as outlined in the previous section detailing some of the WHO’s reports on noise and its adverse health impacts.

Increasingly acousticians and others are questioning the usage of the term “annoyance” with respect to the range and severity of impacts of wind turbine noise on residents, especially those related to inaudible noise and vibration.

Dr Paul Schomer is the Director of Acoustics Standards in the United States, and a highly regarded acoustician and researcher internationally. Dr Schomer and his coauthors recently presented a paper to a conference on wind turbine noise in Denver, in August 2013, and stated

*“Because these residents largely report wind turbines as inaudible, it seems that suggestions some have made that these conditions are being caused by extreme annoyance can be ruled out”.*³²

Yet historically the term “annoyance” has been used to refer to the impacts of inaudible noise as well as audible noise, for example in the comprehensive 3 year 1985 acoustic survey conducted by Dr Neil Kelley, funded by the US Government Department of Energy, with assistance from NASA and numerous other research institutions and wind turbine manufacturers.³³

Dr Nina Pierpont, the US Paediatrician who conducted a case series crossover study published in 2009, had the following to say about the use of the term “annoyance”:

*“People do not abandon their homes out of “annoyance”. Reported symptoms, such as sleep deprivation, dizziness and nausea, cannot be dismissed as “annoyances””.*³⁴

It is my opinion that these differing views and definitions of what constitutes “annoyance” between researchers, acousticians and medical practitioners over the years have contributed to the relative ignorance of most medical practitioners about the range and severity of adverse health impacts known to acousticians to be associated with infrasound and low frequency noise and vibration, as well as excessive audible noise.

1.5 What is known about the nature of wind turbine sound?

Wind turbine generated or modified sound contains a fluctuating mixture of sound frequencies and qualities, and is constantly varying with wind speed, wind direction and weather conditions. It contains a range of sound frequencies, including audible mid frequency sound, audible low frequency sound between 20 and 200 Hz, and infrasound, which is below 20 Hz.

Wind turbine generated infrasound is generally inaudible to most people, but may be perceptible to some people intermittently as a vibration or pressure pulsing sensation, especially in the head, ears, chest or abdomen. These descriptors and characteristics have been identified primarily by the acousticians studying and measuring the sound and its impact on residents, such as Kelley,³⁵ James,³⁶ Swinbanks,³⁷ Thorne,³⁸ Huson,³⁹ Rand,⁴⁰ Ambrose⁴¹ & Schomer,⁴² and the residents own observations and perceptions.⁴³

Wind turbine generated sound energy is impulsive,⁴⁴ and therefore known to be acousticians to be more disturbing, with significant pressure pulses generated as each of the wind turbine blades pass the tower. The sound is also very directional, and fluctuates with changes in wind speed and direction, and weather conditions, in addition to the changes generated by the blade passes.⁴⁵

The lower frequencies are more penetrating than the higher audible frequencies, which pass through through walls, roofs, windows and ear plugs and ear muffs with ease.⁴⁶ When a home is well insulated, the effects may be more pronounced, because the proportional amount of ILFN of total sound energy inside the home may be greater than in homes without such insulation.⁴⁷ The ILFN may then be amplified by sympathetic resonance inside the building structure.⁴⁸ As Kelley et al found in 1985, these lower frequencies can then directly cause “annoyance” symptoms, including repetitive sleep disturbance.⁴⁹

American Acousticians such as Robert Rand and Stephen Ambrose have described this amplification of the sound energy as like living within an “acoustic drum”, and both have themselves been unexpectedly adversely affected by it, when conducting an acoustic field surveys for an affected resident, at Falmouth, USA.⁵⁰ Identical symptoms may also occur outside the building structures, but without the amplification effect from building resonance, if the sound energy levels are high enough.⁵¹

High sound energy levels at specific frequencies may also result from the cumulative effect from sound energy peaks generated by multiple turbines, resulting in what some researchers have called “constructive interference”⁵²

Under atmospheric conditions with a temperature inversion commonly found overnight, wind turbine noise can become much louder and more intrusive.⁵³

In May 2004, Dr David Iser described wind turbine noise and how it had affected his patients in his presentation to the local council, to alert them to the problems being experienced at the Toora wind development.⁵⁴ Many of the features of wind turbine noise described above were highlighted in the following extract from his report, below:

“the noise associated with wind turbines is a very complex subject. It is certainly not as widely studied as other noise from road traffic etc. It is thus difficult for general conclusions to be drawn. However it does appear that wind turbines can cause an annoying noise, this is mostly related to air flowing around the blades. This has been described as a whooshing, swishing or even pulsating noise. There tends to be a background noise with an overriding pulsating beat at roughly one beat per second corresponding with the movement of the blades. As well there appears to be a low frequency noise, which is often not heard but felt as a vibration in areas such as the chest. Even at low sound levels, this may disturb sleep.”

1.6 Dr Kelley’s 1985 Acoustic Survey, and 1987 Laboratory Research

The direct causation of “annoyance” symptoms from impulsive ILFN generated by a single downwind bladed wind turbine, resonating and amplifying within buildings, was established in the mid 1980’s with an extensive 3 year acoustic field research program conducted by a large team of scientists led by Dr Neil Kelley⁵⁵

The results of the major 3 year acoustic field research project were reported in 1985, and the results of the subsequent laboratory research project confirming the direct causal relationship between infrasound and low frequency noise reproduced in a laboratory and annoyance symptoms, were presented to the global wind industry at the American Wind Energy Association Wind Power conference in California, in 1987.⁵⁶

Dr Kelley was the Principal Scientist from the Solar Energy Research Institute (SERI), and the comprehensive 3 year research project he led was funded by the US Department of Energy, and involved fifteen other organizations, including 2 separate branches of NASA, and other scientific and research organizations including University departments of mechanical engineering and aeronautics, and wind turbine manufacturers such as General Electric.⁵⁷

The intent of this research was to investigate the symptoms being unexpectedly reported by a small number of residents living within 3km of a single downwind bladed experimental wind turbine power generator. The stated aim of this research was to try and identify what was directly causing the reported symptoms, in order to change the design of wind turbines, to prevent those symptoms from occurring in nearby residents by improvements in wind turbine design.⁵⁸

From detailed field research conducted with the affected residents, involving full spectrum acoustic measurements including sound and vibration, detailed meteorological observations, and detailed residents diaries Dr Neil Kelley and his team established that there was a direct causal link between wind turbine generated impulsive infrasound and low frequency noise and the “annoyance” symptoms they were reporting, including repetitive sleep disturbance. The sound energy penetrated through the homes and resonated, thereby amplifying the sound energy present within some of the homes.⁵⁹ Kelley et al summarized the complaints as the following perceptions (p 4):

- *“the annoyance was described as an intermittent “thumping” sound accompanied by vibrations*
- *a “feeling” or “presence” was described, felt rather than heard, accompanied by sensations of uneasiness or personal disturbance*
- *the “sounds” were louder and more annoying inside the affected homes*
- *some rattling of loose object occurred*

- *In one or two instances structural vibrations were great enough to cause loose dust to fall from high ceilings and create an additional nuisance”⁶⁰*

In other words, Kelley et al established that the sound energy was felt or perceived rather than heard, at levels well *below* the audible perception thresholds for infrasound. In particular, they established that the symptoms were real, and not imagined.

Subsequent laboratory research by Kelley confirmed a direct causal link between annoyance symptoms experienced by volunteers caused directly by exposure to infrasound and low frequency noise emissions, by reproducing some of the sound energy in the infrasound and low frequency noise frequencies similar to wind turbine noise in the laboratory, and measuring and documenting the individual human responses.⁶¹

This laboratory research was presented to the Windpower Wind Energy Conference in California in 1987, under the auspices of the American Wind Energy Association and the US Department of Energy. In other words, the wind industry and some governments have been well aware of this research, and the damage to health from infrasound and low frequency noise generated annoyance symptoms by wind turbines, since 1987.⁶²

This significant body of research resulted in the wind industry manufacturer’s change from downwind bladed wind turbines to upwind bladed wind turbines, where the nacelle faces into the wind on a single tower, rather than the nacelle being on a stand with four legs.⁶³ This change to an upwind design with a single tower was specifically to reduce the generation of these frequencies below 200 Hz, (infrasound and low frequency noise) at sufficiently high levels or sound pressure levels (SPL’s) known to damage health by causing annoyance symptoms above human perception thresholds, including repetitive sleep disturbance. These human perception thresholds were shown to be much lower than the audibility perception thresholds for those very low frequencies, because the sound could be perceived and cause annoyance symptoms, but not be heard.⁶⁴

Dr Kelley’s research team’s detailed report in 1985 specified maximum exposure sound pressure levels for infrasound and low frequency noise, which he recommended was necessary to protect health, on the basis of his field evidence. They were detailed on page 225 of his 1985 report,⁶⁵ and are reproduced here:

*“the joint radiation levels (expressed in terms of acoustic intensity and measured external to a structure) in the 8, 16, 31.5 and 63 Hz standard (ISO) octaves **should not exceed band intensity threshold limits of 60, 50, 40 and 40 dB (re 1 pWm⁻²) more than 20% of the time.** These figures compare favourably with a summary of low-frequency annoyance situations by Hubbard”.*

These recommended evidence based health protective levels of exposure to infrasound and low frequency noise were well **below** the thresholds for audible perception, commonly being cited today by the wind industry and the Environment Protection Authority of South Australia, being 85 dBG.⁶⁶ In other words, Kelley et al demonstrated that using an audible perception threshold level is inappropriate when the sound energy is inaudible, but still perceptible, and still exerting a health damaging effect, because it induces sleep disturbance or a physiological stress reaction.

The reference to Hubbard relates to previous work done by a highly regarded NASA acoustician Harvey Hubbard, on noise perception inside homes.⁶⁷ The noise source in his research was infrasound and low frequency noise from military aircraft, which also resonated and amplified inside certain homes, also causing annoyance symptoms. Thus the results of human perception of noise were similar across different noise sources, which is to be expected if the characteristics of the noise are similar.

This congruence between the Hubbard and Kelley research results demonstrates why the issue of the type of wind turbine design (brought up by the wind industry to dismiss Kelley’s research) is irrelevant – if the sound frequencies are generated and present at sufficiently high “doses”, the human impact will result because of the characteristics and strength or “dose” of the physical forces generated, regardless of the source of the noise or type of wind turbine design.

These simple, evidence-based criteria for maximum limits of exposure to infrasound and low frequency noise, developed with an extensive 3 year acoustic survey research project funded by the US government, have never been adopted, despite the significant change in wind turbine design from downwind bladed to upwind bladed which followed their release.

To this day, no noise pollution regulatory authority or wind turbine noise guidelines mandate the measurement of infrasound and low frequency noise, despite the knowledge of the harm caused by chronic exposure to this sound energy since 1985.

In the particular case of the South Australian Environment Protection Authority, not only do the guidelines not recommend measuring the full spectrum of noise generated by the wind developments, a decision which acoustician Mr Chris Turnbull has suggested came from copying ETSU 97 in the UK,⁶⁸ but the SA EPA have made a statement in their own guidelines "**Wind Farms Environmental Noise Guidelines**" (section 4.7 page 15 accessed on Sunday 15th December, 2013)⁶⁹ which suggest that the importance of the Kelley research findings with respect to infrasound were known to them:

"Infrasound was a characteristic of some wind turbine models that has been attributed to early designs in which turbine blades were downwind of the main tower. The effect was generated as the blades cut through the turbulence generated around the downwind side of the tower."

The above two statements are factually correct, and refer specifically to the findings of the 1985 Kelley research. The SA EPA guidelines go on to state:

"Modern designs generally have the blades upwind of the tower. Wind conditions around 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."

The first sentence of the second paragraph is also factually correct. However the second sentence which refers to an "extensive literature search" and says that the EPA is "not aware of infrasound being present at any modern wind farm site" is of interest.

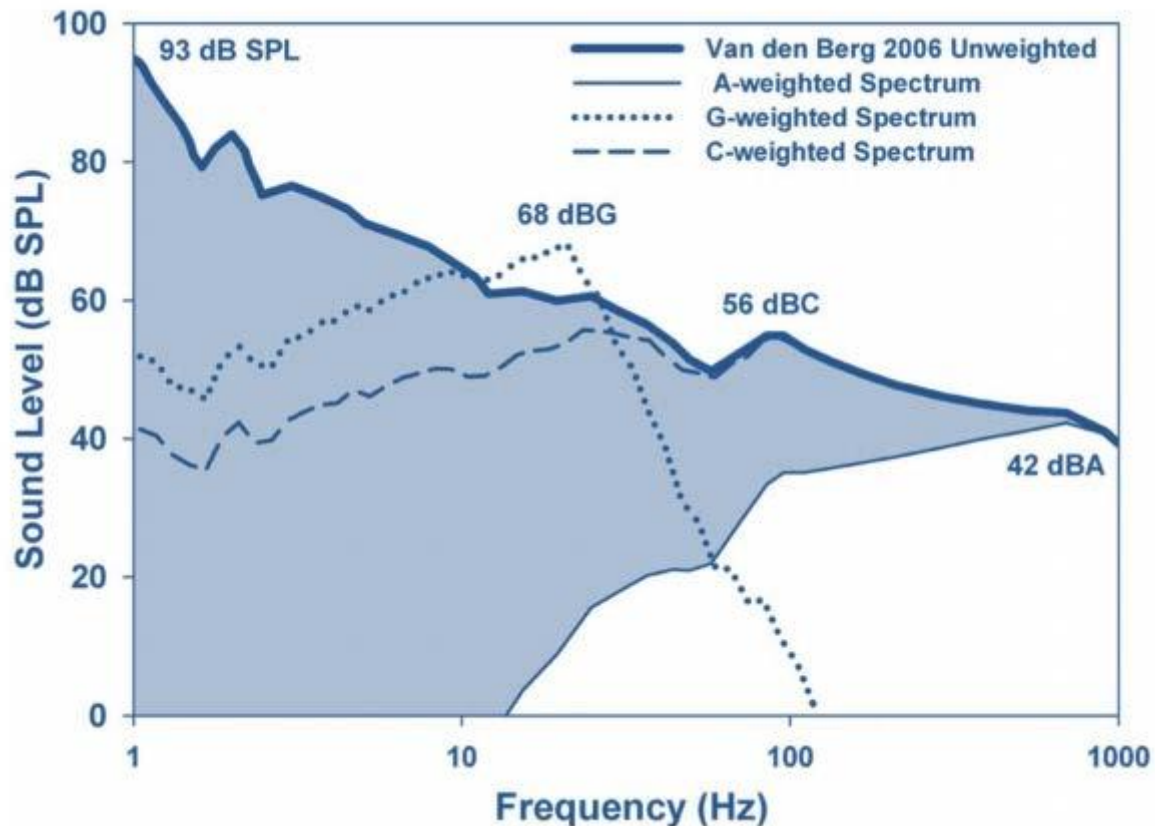
There is data readily available since 2006, which was collected by European acoustician Dr Frits Van Den Berg at European wind developments, with modern upwind bladed wind turbines, showing significant amounts of infrasound was generated by modern upwind bladed wind turbines.⁷⁰

A graph depicting both the presence of significant amounts of infrasound below 20 Hz, and also showing just how much of the sound emissions from wind turbine noise in the low frequencies below 200 Hz will not be accurately captured if measured using the dBA filter (as specified in the South Australian EPA guidelines) is reproduced below, from Salt, A.N. and Kaltenbach, J.A. (2011). "**Infrasound from Wind Turbines Could Affect Humans**". Bulletin of Science, Technology and Science. (Aug 2011). 296-302.⁷¹

The data relating to the full spectrum of wind turbine emissions in that graph was obtained from Dr Frits Van Den Berg's doctoral dissertation "**The sound of high winds: The effect of atmospheric stability on wind turbine sound and microphone noise**" (Doctoral dissertation, University of Groningen, Netherlands.)⁷² Dr Frits Van Den Berg's doctoral dissertation was based on data collected from the Rhede wind development, built on the Dutch and German border. There were 17 wind turbines each 98 metres high at the hub height, and 1.8MW in power generating capacity.⁷³

(See Graph on following page)

Wind turbine sound energy present but excluded by dBA



The figure above clearly demonstrates why using a dBA filter will not measure the total amount of sound energy emitted by a modern upwind bladed wind turbine, but not captured by using a dBA filter, as currently recommended by the SA EPA, is the total blue shaded area underneath the black line running left to right at the top of the graph, with the descriptor "Van Den Berg 2006 Unweighted". The thin line starting on the horizontal axis just beyond 10 Hz and extending up to the 1000 Hz marker at 42 dBA refers to the sound energy captured below 1000 Hz using a dBA filter.

In other words, using a dBA filter as specified in the current SA EPA Wind Farm Environmental Noise Guidelines will not (indeed cannot) measure all the infrasound generated below 10 Hz, which is most of the sound energy present, known since 2006 to be generated by a modern upwind bladed wind turbine.

The graph also clearly shows that frequencies in the infrasound range below 10 Hz are not accurately measured using the dBG filter, as they too will be significantly reduced, by up to 40 dB at 1 Hz as the graph indicates.

As UK Ear Nose and Throat specialists Farboud et al have pointed out in their recently published review article in the Journal of Otolaryngology, "**Wind Turbine Syndrome: Fact or Fiction?**" much of the sound energy generated by modern upwind turbines is down in the frequencies below 10 Hz:

*"We know that wind turbines produce broad-band noise; however, unweighted sound measurements have shown that this noise is indeed dominated by infrasound with frequencies of less than 10 Hz, and that levels of more than 90 dB are generated for sounds around 1 Hz."*⁷⁴

The 1985 Kelley research was well known to the international wind industry, and resulted in a major change in direction for wind turbine design, to reduce these frequencies. However the Kelley research was not cited in the Australian National Health and Medical Research Council's Rapid Review 2010,⁷⁵ upon which Australian State and

Federal governments and the wind industry have relied heavily to assert that “there is no evidence” of any health problems from wind turbine noise.

This assertion that “there is no evidence” of any health problems from wind turbine noise is clearly untrue, and yet State and Federal government Ministers and public servants in the state departments of Health, Planning and Noise Pollution Regulation have continued to use the National Health and Medical Research Council’s 2010 Rapid Review of the Evidence to contend there is no problem, when in fact a direct causal link between wind turbine generated impulsive infrasound and low frequency noise and annoyance symptoms was established in 1985, and was subsequently confirmed with laboratory research in 1987. In particular the evidence of direct causation of annoyance symptoms would appear to directly contradict the key conclusion of the NHMRC’s 2010 Rapid Review that

“there are no direct pathological impacts from wind farms and that any potential impact on humans can be minimized by following existing planning guidelines”⁷⁶

The 1985 Kelley research first came to my attention in mid 2013, and its importance was immediately apparent to me for three reasons.

1. Firstly, it clearly established a direct causal link⁷⁷ between impulsive wind turbine generated infrasound and low frequency noise, and annoyance symptoms reported by residents, including repetitive sleep disturbance.
2. Secondly it explicitly acknowledged that people become more sensitized⁷⁸ over time with ongoing exposure, which is a crucial consideration for planning purposes, to ensure there is a sufficient buffer to protect people’s health over the lifetime of a noise polluting project.
3. Thirdly it established the exposure parameters for infrasound and low frequency noise below which Dr Kelley thought people’s health and sleep would be adequately protected, on the basis of his acoustic field evidence.⁷⁹ The laboratory research subsequently conducted by Kelley in 1987 confirmed the direct causal relationship between symptoms and sound frequencies in volunteers unconnected with wind turbines.

This was precisely the sort of research recommended by the Australian Federal Senate after the first senate inquiry in 2011, to measure the sound frequencies present, and evaluate the human impact of the sound energy from wind turbines inside homes, with appropriate subsequent laboratory research.⁸⁰

Thus “direct causation” of annoyance symptoms including sleep disturbance from infrasound and low frequency noise generated by wind turbines and other sources such as military aircraft (Hubbard’s noise perception research) were known nearly 30 years ago. This was a major research initiative led by Dr Kelley, done over a 5 year period in the USA in the mid 1980’s, with collaboration with fifteen organizations, including highly regarded research institutions and two branches of NASA, funded by the US Government department of energy. These findings were also well known to the international wind industry, after the presentation of the 1987 Kelley Laboratory research to the 1987 Windpower conference, and resulted in a major design change from downwind bladed to upwind bladed wind turbines, in order to reduce the generation of those frequencies, because of the knowledge about the consequent damage to health, from annoyance symptoms which included repetitive sleep disturbance.

The important issue of sensitization to infrasound and low frequency noise (mentioned in point 2 above) is discussed further immediately below.

1.7 Sensitisation or “Conditioning” vs Habituation

Annoyance symptoms are especially reported in those people who become progressively sensitized or “conditioned” to the sound energy, who report progressively worsening symptoms with ongoing exposure. They do not “habituate” or “get used to” the sound energy over time. The opposite occurs.

This phenomena of increasing sensitisation or “conditioning” and worsening symptoms with cumulative exposure to wind turbine infrasound and low frequency noise was noted by early wind turbine noise researcher Dr Neil Kelley in his research team’s 1985 acoustic survey report (section 8.0 at p 199). The report stated:

“It is clear from our discussion in the previous sections that the only acceptable method of curtailing complaints from residents in the vicinity of an operating MOD-1 turbine is to eliminate, or at least reduce, the impulsive character of the disturbing acoustic radiation to below perceptible levels. The task was made more difficult by the level of conditioning and resulting sensitivity of a few of the families involved, particularly the residents of #2, #7, #8 (and their immediate neighbours).”⁸¹

The issues of progressive sensitisation, and deterioration in health with ongoing exposure to infrasound and low frequency noise were noted by Professor Leventhall in his report for DEFRA in 2003. On page 60, in his concluding remarks, Leventhall et al stated:

“There is no doubt that some humans exposed to infrasound experience abnormal ear, CNS (central nervous system) and resonance induced symptoms that are real and stressful. If this is not recognised by investigators or their treating physicians, and properly addressed with understanding and sympathy, a psychological reaction will follow and the patient’s problems will be compounded. Most subjects may be reassured that there will be no serious consequences to their health from infrasound exposure, and if further exposure is avoided they may expect to become symptom free.”⁸²

More recently, Farboud et al have introduced the concept that perhaps brain neuroplasticity might also be implicated in some of the reported instances of increasing sensitization or sensitivity to the low frequency component of the noise. In their recent review article, they stated:

“It is possible that long term exposure to unwanted sound can lead to enhanced perception of that sound. Studies have shown the brain has plasticity, exemplified by the findings of a study of London taxi drivers, who were shown to have an enlarged posterior hippocampus in response to their time spent navigating around London. A few people with highly sensitive hearing have been discovered among low frequency noise plaintiffs investigated; however, usually there is little difference between the hearing thresholds of those who complain about low frequency noise and those who do not, suggesting higher centre involvement”⁸³

1.8 Pathological Findings in the Cochlea of Noise Sensitive Rats – Irreparable Damage?

Professor Mariana Alves Pereira,⁸⁴ a Portuguese researcher with 30 years scientific experimental and observational research investigating pathological changes in the tissues of animals and humans exposed to chronic ILFN, has recently brought to my attention her research group’s work confirming that rats exposed to ILFN experimentally became noise sensitive, but none of the control group of rats showed this behaviour.⁸⁵

When the experimental rats exposed to ILFN were sacrificed, specific pathological changes were noted in the cilia of their cochlea, which had fused. Professor Alves Pereira suggested this could explain the pathophysiological basis of the rats’ acquired noise sensitivity from ILFN exposure. None of the rat controls in that experiment had those pathological changes.

This provides compelling animal research evidence of pathological changes resulting from ILFN exposure in mammals, which may help explain the permanent nature of some people’s extreme noise sensitivity which has persisted for some years after initial exposure to wind turbine acoustic emissions, despite moving away from the source of the noise.

This indicates the damage to the inner ear from IFLN exposure could be permanent, and there are certainly human examples in Australia from Toora and from Cape Bridgewater, where two residents describe ongoing severe noise sensitivity even after moving away from wind turbines for over 8 years in one case, and for 4 years but with intermittent visits back home in the other.⁸⁶

Below are Professor Alves Pereira's recent comments in an email:

"In our research spanning several decades, we have non-formally associated noise sensitivity to the existence of prior noise exposure. Noise-exposed rats also developed an unusual noise sensitivity, while zero control rats developed this same feature.

Simultaneously, fusion of the actin-based cochlear cilia were seen in our low frequency noise-exposed rats. If this is also happening in humans exposed to low frequency noise, this morphological feature could explain the increased noise sensitivity seen in many individuals.

*Back in the 1980's we called this features hypersensitivity to noise, but in the mid-1990's we replaced this term with noise intolerance. In effect, LFN-exposed persons become incompatible with normal societal activities."*⁸⁷

In my experience, most of the other symptoms reported by most residents which correlate with exposure to wind turbine noise eventually resolve with cessation of exposure to ILFN, but take longer to resolve as the period of exposure itself lengthens.

However the concerns about possible permanent tissue damage to the cochlea and other structures raised by the work of Professor Alves Pereira and her research team in Portugal only increase the pressures to adopt a suitably precautionary approach to chronic long term exposure to ILFN.

Those residents who have developed this severe noise intolerance have found their noise intolerance continues, despite reduction or cessation of exposure to ILFN, and it has been particularly disabling and distressing. For the individuals concerned it has affected their future employment options, as there are some workplaces they just cannot tolerate because of their abnormal reaction to normal noise levels, which most people can tolerate.⁸⁸ Professor Alves Pereira's comments about "normal societal activities" in those two Victorian residents therefore include restrictions on some employment options.

A current difficulty is that we have no data or knowledge of the longterm population impacts of chronic (25 years) exposure to these current levels of wind turbine noise. We do, however, have the Kelley criteria⁸⁹ to regulate exposure to infrasound and low frequency noise, which may or may not prove to be protective enough with project lifespans of 25 years.

2.0 Known Adverse Health Consequences

2.1 Sleep Disturbance/Deprivation (environmental sleep disorder)

The consequences of chronic sleep deprivation are well known to clinical medicine. They include increased risk of cardiovascular disorders, mental health disorders, cognitive impairment, impaired immunity, and deterioration in a wide variety of pre existing clinical problems. Restorative sleep is widely accepted as being necessary for the maintenance of good mental and physical health. Many of these consequences were listed in a recent Medical Journal of Australia supplement on Sleep Medicine.

Professor David Hillman and Professor Leon Lack listed the costs to society, and the known health consequences of sleep disturbance and deprivation in their article of 21 October 2013 entitled **"Public health implications of sleep loss: the public health burden"**.⁹⁰ The consequences they mention include:

"disturbances in cognitive and psychomotor function including mood, thinking, concentration, memory, learning, vigilance and reaction times. These disturbances have adverse effects on wellbeing, productivity and safety. Insufficient sleep is a direct contributor to injury and death from motor vehicle and workplace accidents. Further, relationships have been demonstrated between shortened sleep and a range of health

problems including hypertension, type 2 diabetes, obesity, cardiovascular disease and total mortality risk”

American Psychiatrist Dr William Hallstein recently wrote to the Falmouth Board of Health about the consequences of severe sleep deprivation from wind turbine noise. Dr Hallstein was very familiar with the problems the residents of Falmouth were having, and the failure of the health and town authorities to adequately address the issue to stop the noise nuisance and consequent serious damage to their health which was occurring. In his letter he states:

*“Turning now to the topic of sleep interruption and deprivation. Sleep disturbance is not a trivial matter. Children with inadequate sleep perform poorly academically, emotionally and physically. Errors in judgment and accident rates increase with inadequate sleep and fatigue for everyone: athletes, truck drivers, ship operators, aircraft pilots and physicians. No one is exempt.”*⁹¹

Dr Hallstein goes on to say:

“In the world of medicine illnesses of all varieties are destabilized by fatigue secondary to inadequate sleep. Diabetic blood sugars become labile, cardiac rhythms become irregular, migraines erupt and increase in intensity, tissue healing is retarded, and so forth, across the entire field of physical medicine. Psychiatric problems intensify and people decompensate. Mood disorders become more extreme and psychotic disorders more severe”

He concludes by saying:

“People with no previously identified psychiatric illness are destabilized by sleep deprivation. Sleep deprivation experiments have repeatedly been terminated because test subjects become psychotic; they begin to hallucinate auditory and visual phenomena. They develop paranoid delusions. This all happens in the “normal” brain. Sleep deprivation has been used as an effective means of torture and a technique for extracting confessions.”

A relatively recent meta analysis of the impact of chronic sleep deprivation on cardiovascular disease, published in the European Heart Journal in February 2011 by Capuccio et al confirmed the mounting research evidence that there is an increased risk of cardiovascular disease with either too much or too little sleep. That meta analysis also states

*“Lack of sleep exerts deleterious effects on a variety of systems with detectable changes in metabolic, endocrine, and immune pathways. Too little or too much sleep are associated with adverse health outcomes, including total mortality, type 2 diabetes, hypertension, and respiratory disorders, obesity in both children and adults and poor self-rated health”*⁹²

Environmental Sleep Disorder and its consequences – from WHO 2009⁹³

Section 2.1.2 of the WHO 2009 report **“Night Noise Guidelines for Europe”** has a useful section on definitions of disturbed sleep with a description of what constitutes an “environmental sleep disorder”. It states:

“Sleep disorders are described and classified in the International Classification of Sleep Disorders (ICSD) (American Academy of Sleep Medicine, 2005). When sleep is permanently disturbed and becomes a sleep disorder, it is classified in the ICSD 2005 as “environmental sleep disorder”.

“Environmental sleep disorder (of which noise-induced sleep disturbance is an example) is a sleep disturbance due to a disturbing environmental factor that causes a complaint of either insomnia or daytime fatigue and somnolence. Secondary deficits may result, including deficits in concentration, attention and cognitive performance, reduced vigilance, daytime fatigue, malaise, depressed mood and irritability.”

The diagnostic criteria for diagnosis of an environmental sleep disorder are then listed in 2.1.2.3 on page 19 of that 2009 WHO report. They are reproduced below:

“The diagnostic criteria for environmental sleep disorder are the following.

A. The patient complains of insomnia, daytime fatigue or a parasomnia. In cases where daytime fatigue is present, the daytime fatigue may occur as a result of the accompanying insomnia or as a result of poor quality of nocturnal sleep.

B. The complaint is temporally associated with the introduction of a physically measurable stimulus or environmental circumstance that disturbs sleep.

C. It is the physical properties, rather than the psychological meaning of the environmental factor, that accounts for the complaint.

D. The sleep disturbance is not better explained by another sleep disorder, medical or neurological disorder, mental disorder, medication use or substance use disorder.”

There is also recognition that an environmental sleep disorder can *coincide* with other causes of insomnia, and that in those situations it would be appropriate to use multiple diagnoses and specifically include the additional contribution of environmental noise, rather than ignore it.

The long term risks to health from chronic sleep disturbance resulting in an environmental sleep disorder identified in the 2009 WHO report are listed in section 2.2 in table 2.4 (p 23) and include a wide variety of physical and mental health disorders and problems with cognitive functioning in humans, many of which have been reported by residents living near wind turbines who also report significant sleep disturbance. They include the following:

- Depression / Mania
- Violence
- Difficulty in learning new skills
- Short term memory problems
- Difficulty with complex tasks
- Slow reaction time
- Cerebellar ataxia ⁹⁴
- Nystagmus ⁹⁵
- Tremor
- Ptosis ⁹⁶
- Slurred speech
- Increased reflexes
- Increased sensitivity to pain
- Diabetes & obesity
- Susceptibility to viral illness
- Increased mortality risk

Some of the relevant scientific research underpinning the known pathophysiological connections between sleep, stress, and health is detailed in the extracts below, where the interconnected links between the damaging effects of sleep deprivation and stress on cardiovascular health and functioning of the immune system are also outlined.

Increased risk of cardiovascular morbidity and mortality (from 2.2.1 on p 21):

“It is generally accepted that insufficient sleep and particularly sleep loss has a great influence on metabolic and endocrine functions (Spiegel, Leproult and van Cauter, 1999), as well as on inflammatory markers, and contributes to cardiovascular risk. C-reactive protein (CRP) as a major marker of the acute phase response to inflammatory reaction promotes secretion of inflammatory mediators by vascular endothelium and may be therefore directly involved in the development of atherosclerotic lesions. CRP as a risk predictor of strokes

and heart attacks linearly increases with total and/or partial sleep loss (Meier-Ewert et al., 2004)."

The role of stress hormones in sleep disturbance and their consequences (extracts from 2.2.2 pp 21 – 22):

"Experimental as well as clinical studies (Waye et al., 2003; Ising and Kruppa, 2004) showed that the first and fastest signal of stressors introduced by noise is detected and mediated by a subcortical area represented by the amygdala while the stress response to noise is mediated primarily by the hypothalamus-pituitary-adrenal (HPA) axis. A major intrinsic marker of the circadian rhythm is in the level of circulating corticosteroids derived from activity within the HPA axis. A protracted stress response with activation of the HPA axis is a major physiological response to environmental stressors."

"The cortisol response to awakening is an index of adrenocortical activity, and long-term nocturnal noise exposures may lead, in persons liable to be stressed by noise, to permanently increased cortisol concentration above the normal range."

"The hypothesis that an increased risk of cardiovascular diseases is connected with stress concepts is generally accepted (Ekstedt, Åkerstedt and Soderstrom, 2004; Ising and Kruppa, 2004). Stress reactions may lead to derangement of normal neurovegetative and hormonal processes and influence vital body functions. Cardiovascular parameters such as BP, cardiac function, serum cholesterol, triglycerides, free fatty acids and haemostatic factors (fibrinogen) impede the blood flow through increased viscosity and presumably blood sugar concentration as well. Insulin resistance and diabetes mellitus, stress ulcers and immune system deficiency are also frequent consequences of stress reaction. Disturbed sleep may lead to immunosuppression and diminished protein synthesis (Horne, 1988)."

"As well as nonspecific effects of the stress response on the functioning of the immune system, there is considerable evidence for a relation between sleep..... and the immune system (Brown, 1992). These data suggest that the immune response could also be impacted directly by environmental noise during sleep (Carter, 1996)."

As the above extracts from the WHO Night Noise Guidelines show, the interconnections between sleep, stress, and consequent illness are well established. What has not been well known has been the characteristic pattern of sleep deprivation, which indicates that the physiological stress pathways are being repetitively activated in residents sleeping near wind turbines.⁹⁷ In other words, they are not just becoming sleep deprived, they are becoming physiologically stressed at the same time.

Dr Sandy Reider is a family physician (American equivalent of a GP) who gave evidence to the Vermont legislature about these episodes of repetitive physiological stress and sleep disturbing episodes, which are reported by residents living near wind turbines around the world. Dr Reider described one patient's experience as follows:

"About 3 weeks after the installation he began to experience quite severe insomnia, something he had never dealt with before, and he had no clue why. He worked at home and spent most of his days as well as all nights there, unlike his wife who worked in Newport and was gone most days. He complained of abrupt waking 30-40 times a night, like a startle reflex, associated with some anxiety. As a result he was almost never able to fall into a deep restful sleep, very distressing for someone used to sleeping soundly for 10-11 hours every night"⁹⁸

It is my observation that where these types of episodes are occurring, that the combination of the physiological stress and the repetitive sleep deprivation combined together result in rapid deterioration in the health and wellbeing of those particular residents.⁹⁹ Other household members may be unaffected.

2.2 Stress

The health damaging effects of prolonged acute and chronic stress have also been well known to clinical medicine for many years. Dr Bruce McEwen is one of the leading researchers in the area of stress and its damaging effects on health. In a review article for the New England Journal of Medicine in 1998, he outlined what happens when physical and psychological stress overwhelms people's ability to cope.¹⁰⁰

“Acute stress (in the sense of “fight or flight” or major life events) and chronic stress (the cumulative load of minor, day-to-day stresses) can both have long term consequences” (p171)

“Chronic stress, defined as feelings of fatigue, lack of energy, irritability, demoralization, and hostility, has been linked to the development of insulin resistance, a risk factor for non-insulin dependent diabetes. Deposition of abdominal fat, a risk factor for coronary heart disease and diabetes is increased by the psychosocial stress of colony reorganization in nonhuman primates and may also be increased by stress in humans.” (p 172)

“Over weeks, months, or years, exposure to increased secretion of stress hormones can result in allostatic load and its pathophysiological consequences” (p 172)

“When the brain perceives an experience as stressful, physiological and behavioural responses are initiated, leading to allostasis and adaptation. Over time, allostatic load can accumulate, and the overexposure to mediators of neural, endocrine and immune stress can have adverse effects on various organ systems leading to disease” (p172 – under the diagram)

Thus overwhelming or repeated stress can result in cardiovascular disease, immune system impairment leading to cancer and chronic infections, and mental health disorders such as anxiety, depression and post traumatic stress disorder. As stated earlier, these are serious adverse health effects, which lead to a range of other symptoms and illnesses by interfering with the hypothalamic-pituitary axis (“master” control mechanism of the endocrine system), disturbance of the autonomic nervous system and compromise of immunological competence.

Animal experiments cited by Dr McEwen show that there is a rapid aging effect from chronic stress, and indeed reports are emerging from farmers and rural residents exposed to industrial wind turbine noise with a significant low frequency component of stress-related illnesses in their pets and other animals, both wild and domestic. The animal reports from residents and farmers have included emus (Nova Scotia)¹⁰¹ goats (Taiwan)¹⁰² dogs (Victoria)¹⁰³ cattle (NSW)¹⁰⁴ and horses (NSW)¹⁰⁵ some of which have been supported by either agriculture department staff or local vets.

A recent study conducted in Poland by veterinary researchers, showed elevated cortisol levels and other objective measurements of food intake and weight gain suggestive of physiological stress in two groups of captive geese exposed to wind turbine noise at 50 metres and at 500 metres from the wind turbine. The authors conclude that even at 500 metres from a single 2 MW wind turbine there was objective evidence of physiological stress in the geese, albeit less than the geese sited 50 metres from the turbine.¹⁰⁶

US epidemiologist Professor Carl Phillips noted the connection with stress related disorders in wind turbine neighbours in his peer reviewed published paper on the subject, titled **“Properly Interpreting the Epidemiological Evidence about the Health Effects of Industrial wind turbines on Nearby Residents”**. In the abstract of that paper, Professor Phillips states:¹⁰⁷

“There is overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder type diseases, at a nontrivial rate. The bulk of the evidence takes the form of thousands of adverse event reports. There is also a small amount of systematically-gathered data.”

“The adverse event reports provide compelling evidence of the seriousness of the problems and of causation in this case because of their volume, the ease of observing exposure and outcome incidence, and case-crossover data.”

“Proponents of turbines have sought to deny these problems by making a collection of contradictory claims including that the evidence does not “count”, the outcomes are not “real” diseases, the outcomes are the victims’ own fault, and that acoustical models cannot explain why there are health problems so the problems must not exist.”

“These claims appeared to have swayed many non-expert observers, though they are easily debunked. Moreover, though the failure of models to explain the observed problems does not deny the problems, it does mean that we do not know what, other than kilometers of distance, could sufficiently mitigate the effects. There has been no policy analysis that justifies imposing these effects on local residents. The attempts to deny the evidence cannot be seen as honest scientific disagreement, and represent either gross incompetence or intentional bias”.

2.3 Vestibular disorders

The key to understanding the mechanisms underlying the sleep disorders, the physiological stress reactions, and the range of symptoms being described by the residents affected by wind turbine noise, is to be found in the workings of the vestibular system. ¹⁰⁸

Dr Amanda Harry referred to the work of Professor Pratt, a professor of neurobiology specializing in human auditory responses in Israel:

“by stimulating the inner ear which houses the auditory and vestibular systems, with high intensity acoustic signals that are below the audible frequencies – below 20 Hz, the vestibular organ can be stimulated and create a discrepancy between inputs from the visual system and somatosensory system and the vestibular organ will erroneously report acceleration (because of the low frequency inaudible sound). It doesn’t have to be a loud sound. This will create a sensation similar to motion sickness”. ¹⁰⁹

Dr Nina Pierpont drew on very recent advances in knowledge in the fields of neurobiology in her detailed literature review to show that the responses of wind developers and engineers working for them who asserted that people’s attitude towards a sound was *causing* their anxiety symptoms were wrong. Dr Pierpont stated the following on page 4 in her introduction:

“The physiologic pathway flows from physical forces (air pressure changes, noise, vibration) to physical sensations (chest pulsations, internal vibration, tinnitus, headache, ear fullness) to brain integration of sensory signals to distortions of brain functioning (sleeplessness, concentration and memory deficits, physical symptoms of anxiety) – not the reverse.” ¹¹⁰

In other words, it is the stimulus from the external physical force, which then generates the subsequent involuntary symptoms in reaction to the stimulus, which can include anxiety. The brain’s reactions are not under conscious control.

Professor Carey Balaban is a neuroscientist who has worked in the field of vestibular disorders, exploring and describing the links between balance and anxiety symptoms, which are affected by the brain’s perception of motion. On page 73-4 of her study Dr Pierpont summarises the important features of the work of Balaban and his colleagues as follows: ¹¹¹

“Balaban, a neuroscientist, has localized and described the neural connections among the vestibular organs of the inner ear, brain nuclei involved with balance processing, autonomic and somatic sensory inflow and outflow, the fear and anxiety associated with vertigo or a sudden feeling of postural instability, and aversive

learning. These form a coordinated, neurologically integrated system based in the parabrachial nucleus of the brainstem and an associated neural network. Several aspects of this system need to be considered here.”

Dr Pierpont goes on to describe what is known about the four body systems for “*regulating balance, upright posture, and the sense of position and motion in space*” in considerable detail.

“The second critical element is central processing: how sensory information about motion and position is integrated by the brain, and what other brain centres are activated, and what kinds of signals the brain then sends back to the body. Balaban and colleagues describe how the parabrachial nucleus network receives motion and position information from visual, vestibular, (inner ear), somatosensory, and visceral sensory input, and is linked to brain centres and circuits that mediate anxiety and fear, including the amygdala (a key mediator of fear reactions) and serotonin and norepinephrine-bearing neurons radiating from the midbrain. Meaning that our sense of balance and stability in space is closely connected --- neurologically --- to fear and anxiety.”

“Balaban illustrates with a story. He asks the reader to visualize waiting in traffic on a hill for a light to turn. Out of the corner of your eye you see the truck next to you starting to inch forward, and you jam your foot on the brake, since your sensory system has told you that you are starting to slip backwards. There’s a bit of panic in that moment, quickly settled as you realize you are indeed stable in space and not moving. The story illustrates how a sensation of unexpected movement elicits alerting and fear. When the sense of movement is ongoing and cannot be integrated with the evidence of the other senses, as happens in vertigo, there is a more prolonged fear reaction. In fact, as Balaban shows, the association of fear with vertigo has been known since ancient times.”

Dr Pierpont goes on to then describe how the body reacts to the messages it receives from the brain after the initial abnormal stimulus of the vestibular system. The body’s responses include those of a physiological stress reaction, mediated by the autonomic nervous system, resulting in increases in blood pressure and heart rate.

“Experimental work with animals shows that vestibular signaling has profound effects on autonomic regulation of body temperature, heart rate, vascular resistance, and circadian rhythms of activity and hormone secretion. These effects extend to humans. Vestibular stimulation by passive linear acceleration causes blood pressure and heart rate increases, with diminished responses in people with reduced vestibular function.”

These are the same sympathetic nervous system stimulation responses, of increased heart rate and increased systolic blood pressure, which were seen in the 2004 Chinese study by Chen, Qibai and Shi entitled “**“An Investigation on the Physiological and Psychological Effects of Infrasound on Persons”**”¹¹² which documented the results of one hour of infrasound exposure on some physiological and psychological parameters. That Chinese study is referred to in section 4.3.

3.0 Causation Evidence & Range of Professional Opinions

The symptoms reported to me by residents exposed to wind turbines or other sources of industrial noise¹¹³ primarily include symptoms related to either acute and chronic sleep deprivation and its consequences, and/or symptoms of acute and chronic physiological and psychological stress and their consequences, and/or symptoms relating to vestibular disorders.

For the residents, repetitive sleep disturbance leading to exhaustion from cumulative exposure to the operating wind turbines is the main consistently reported problem. It is my opinion that the repetitive sleep disturbance and consequent exhaustion is the driver of the long term deterioration in physical and mental health being reported by people chronically exposed to wind turbine noise, if they are affected by it. They consistently report that their sleep disturbance symptoms vary with exposure to operating wind turbines, and that their sleep and health start to

improve when they are not exposed, either because the wind turbines are not operating or because they are away from their homes. This same pattern of symptoms correlating directly with exposure to the noise, has been reported to me by rural and urban residents exposed to other sources of environmental noise at night, whose sleep is also adversely affected in the same ways.

It is my opinion that the cause of the episodic sleep disturbance events being widely and consistently reported by the residents to correlate directly with exposure to operating wind turbines, is wind turbine generated sound energy, which varies continually with the wind speed and direction, and with weather conditions.

This is based on my knowledge of the reports of the pattern of sleep disturbance obtained directly from residents, the reports from treating medical practitioners such as Dr David Iser,¹¹⁴ Dr Wayne Spring,¹¹⁵ Dr William Hallstein¹¹⁶ and Dr Sandy Reider,¹¹⁷ the results from the existing peer reviewed published literature detailed in the Arra and Lynn Literature Review,¹¹⁸ the Kelley acoustic field survey¹¹⁹ and the historical acoustic research detailed by Rick James,¹²⁰ together with the more recent acoustic field surveys in the United States (James,¹²¹ Rand,¹²² Ambrose¹²³ and Schomer¹²⁴) and Australia (Thorne,¹²⁵ Cooper,¹²⁶ Huson,¹²⁷ Hansen¹²⁸ & Doolan¹²⁹)

Therefore over any one night, for each individual in a given household, environmental sleep disorder or sleep disturbance episodes, if they occur, may be caused by any one or more of excessive audible noise, low frequency noise, infrasound, or a combination, stimulated by the operating wind turbine(s).

These episodes are noted by their absence when the wind turbines are not turning, as Mrs Maria Linke's detailed witness statement with extracts from her personal journal makes clear. When the turbines are off, the family sleep well, but when the turbines are operating, the disturbed sleep occurs.¹³⁰

Night time audible excessive noise and intrusive low frequency noise are generally accepted as causes of sleep disturbance, regardless of the source of the noise.¹³¹

With respect to the effects of impulsive wind turbine generated infrasound on sleep, with the exception of the Kelley 1985 research there is little specific information linking infrasound directly with episodes of sleep disturbance, however increasingly acoustic researchers and others are expressing concerns about this issue, and see it as a priority for multidisciplinary collaborative field research with sleep physiologists and sleep physicians. Mr Les Huson, an independent acoustician who recently collected some groundbreaking new acoustic data from the Macarthur wind development and was familiar with the severely disturbed sleep of a number of the residents living near that development stated the following in his expert witness statement to the Cherry Tree Tribunal:

*"I find it entirely plausible that infrasound can cause nuisance and disturbed sleep in communities surrounding wind farm developments similar to the Macarthur and Leonards Hill developments."*¹³²

Mr Huson went on to say in that statement:

"Further research to correlate infrasound with sleep patterns is needed and this is not the subject of my current research."

Leaving the commonly reported episodic sleep disturbance and consequent exhaustion aside, some residents with a history of motion sickness, develop other symptoms associated with vestibular disorders, such as severe nausea and vertigo, often quite rapidly after the initial exposure to operating wind turbines. This particularly severely affected sub group were the subject of Dr Paul Schomer's recent paper in Denver, August 2013,¹³³ which discussed the physiological mechanisms of infrasound stimulation of the vestibular system, and previous motion sickness research.

Other people, even in the same house and same family with similar exposures may take months to years to develop any symptoms, or may remain symptom free. Wind turbine hosts David and Alida Mortimer from South Australia are a good example, as David's symptoms were experienced very early on but Alida was symptom free until about four years of exposure.¹³⁴

Young children and the elderly also appear to be more susceptible to developing symptoms, which is unsurprising given they are also identified as vulnerable groups with respect to experiencing adverse impacts from environmental noise in a range of government and WHO publications.¹³⁵

The range of human reactions to similar or identical wind turbine sound energy physical stimuli were captured in Dr Nina Pierpont's case series cross over study, where some people were severely impacted very early on, and others reported no or minimal effects, whilst living in the same homes. Dr Pierpont's research helped identify some of the susceptibility factors for developing symptoms in response to exposure to the sound energy generated by wind turbines.¹³⁶

People whose sleep is affected by exposure to operating wind turbines, especially those who develop the characteristic repetitive "waking up at night in a panicked state" also report that over time with ongoing exposure to wind turbine noise many of their pre-existing medical and psychiatric conditions become worse or difficult to manage, which is predictable given the well known adverse effects that acute & chronic sleep deprivation and stress are known to have on almost every aspect of physical and psychological health.¹³⁷

US Psychiatrist Dr William Hallstein¹³⁸ mentioned this worsening of pre existing health conditions from sleep disturbance and deprivation in his recent letter to the Falmouth Board of Health, and some Waterloo residents and others in Australia have certainly described this pattern of deterioration in other health conditions to me directly. However when they leave their homes for any length of time, they have reported their blood pressures normalise, their blood sugars stabilize, their sleep improves, they feel rested rather than exhausted, and they describe feeling "better".¹³⁹

3.1 Systematic Data Collection - Noise Impact Surveys and Case Series

Early European Research Confirms increased Annoyance from Wind Turbine Noise

The early Scandinavian field population research conducted approximately 10 years ago related to the impact of much smaller wind turbines in rural environments, so whilst they are useful because they establish that wind turbine noise generates annoyance symptoms including sleep disturbance, these studies are not useful for predicting the likely population impact or distance of the acoustic effects or acoustic impact zone of the much larger wind turbines proposed for the Stony Gap Wind Development.¹⁴⁰

Case Series – Dr Amanda Harry, UK, 2003¹⁴¹

The first rural medical practitioner providing clinical care to rural residents who then collected systematic data directly from people reporting adverse health impacts from operating wind turbines was Dr Amanda Harry, a rural General Practitioner from Cornwall in the United Kingdom. Dr Harry conducted a survey of rural residents living near a range of different wind developments in 2003, and identified the range of health problems associated with exposure to operating wind developments being reported to her by these residents.

Dr Harry's data set compiled from the questionnaires is a form of "case series" which have long been used in medicine to help identify, gather relevant information, and initially describe a new problem. The symptoms Dr Harry identified are identical to those subsequently identified a few years later by Dr Pierpont and given the name of "wind turbine syndrome". Dr Harry's survey was used as a basis for data collection by other subsequent researchers including Dr David Iser in Australia in 2004, Dr Nina Pierpont in the United States from 2006 onwards, and Ms Carmen Krogh, co founder of the Society for Wind Vigilance in Ontario in 2010 - 2011.¹⁴²

Dr Harry's additional experience and postgraduate qualifications in the field of Ear Nose and Throat disorders, and the multidisciplinary assistance she received from the late Dr David Manley, a physicist with expertise in the field of infrasound and low frequency noise, gave her work additional depth and insight into the likely cause of the symptoms being reported.

The 39 case series study participants lived between 300 metres and 2 km from the nearest wind turbine, in different parts of the United Kingdom. There are no details given about the size of the wind turbines or the number of turbines for each study participant, however the following comment was made:

“The cases mentioned below are from several wind farms in the UK with a variety of turbine sizes from the smaller older turbines, to the taller more modern turbines”

So whilst Dr Harry’s case series helped identify the parameters of the problems being reported by the residents, and their links with sleep disturbance, stress related symptoms and vestibular disorders, her data does not help with respect to predicting the likely local population impact of Stony Gap Wind Farm (SGWF) over its lifetime, given the likely difference in the comparative size of the wind turbines proposed for SGWF.

Population Noise Health Impact Survey – Dr David Iser, Australia, 2004 ¹⁴³

Dr David Iser, from Toora in Victoria was the next rural medical practitioner to collect data. Dr Iser conducted the first population survey data in Australia and was encouraged to do so by some of his patients who found suddenly and unexpectedly that they were developing a range of serious new symptoms after the start up of the local Toora wind development in South Gippsland, Victoria. Dr Iser felt an additional responsibility to his community beyond immediate clinical care to his patients, because of his position as the local medical officer for health in the South Gippsland region.

Dr Iser distributed 25 anonymous surveys to the population living within 1.5 – 2km of the Toora wind development. He found that of the nineteen respondents, (80% response rate) eleven reported no problems. However the eight remaining respondents reported *“mild to major problems mostly related to sleep disturbance and stress”*. These adverse health effects reported by the Toora residents to Dr David Iser are consistent with what was already known about the adverse health impacts of environmental noise, and with Dr Amanda Harry’s findings in her case series.

Dr Iser presented his findings to his local council in May 2004, and wrote to the then Premier of Victoria, Mr Steve Bracks, and the Ministers for Health, Planning and Regional Development, but his concerns were ignored.

The 12 Toora wind turbines are 1.75 MW in size, and so are significantly smaller than those proposed for the SGWF.

Subsequently Dr Iser informed me when I met with him in October 2010 that the majority of those families living in the hills near the Toora wind turbines were bought out by the wind developer and then silenced with a binding confidentiality agreement. Their homes were relocated, bulldozed, or left vacant. ¹⁴⁴

Case Series Cross-Over Study – Dr Nina Pierpont, USA, 2009 ¹⁴⁵

Dr Nina Pierpont collected detailed information on the range and pattern of symptoms experienced by individuals from 10 families who had been so severely adversely impacted by wind turbine noise that they had had to move away from their homes for periods of time to obtain relief. By the conclusion of the study, 9 out of the 10 families had permanently moved away from their homes.

The turbine sizes ranged from 1.5 – 3 MW and the participating families were from a range of different countries, including the United Kingdom, Ireland, Canada, United States of America, Italy. Details of the families living with the 3 MW turbines are below (data from pp 44 & 46 of Dr Pierpont’s study)

Two families lived in Canada each 1000 metres from the nearest of a cluster of 10 x 135 metre high 3 MW wind turbines that were in a line. The homes were wooden framed. The terrain was described as hilly with rocky ridges.

One family lived in Ireland, 596 metres from the nearest of 32 x 125 metre high 3 MW wind turbines, which surrounded the stone cottage on three sides. The walls were 60cm thick. The terrain was described as rocky hills.

The significance of Dr Pierpont's work lies in the identification of statistically significant individual susceptibility factors, in thoroughly describing the characteristic symptoms relating to a new illness to clinical medicine, capturing the severity of the symptoms for some individuals, and in realizing that a range of vestibular symptoms and disorders were being triggered by infrasound and low frequency noise exposure from the wind turbines.

So as with Dr Harry and Dr Iser's work, Dr Pierpont's work is very useful for establishing the existence of a genuine problem with wind turbine noise for some people, and the links with the vestibular system, and identification of susceptibility factors, however Dr Pierpont's data is not useful for determining the likely extent of the population impact of the Stony Gap Wind Farm on the local residents in the surrounding district.

Background to Waterloo Wind Development, adjacent to the proposed Stony Gap Wind Farm

The wind turbines at Waterloo are 3 MW 135 metre VESTAS V 90 wind turbines, and there are 37 of them in a line along a ridge running 17km north south, which is approximately 3km to the east of the small Waterloo township. The Waterloo wind turbines commenced operating in October 2010, so residents have had three years of exposure.

Numerous farms to the east of the wind turbines cannot see the turbines because of an intervening ridge of the Tothill Ranges, but some of the residents who cannot see the turbines from their homes such as Colin Schafer (8km), Ally Fricker and Bob Lamb (9 – 10km) have reported to me and to independent acousticians and others that they can still perceive and sometimes hear when the wind turbines are operating.

There are two local population impact surveys from the Waterloo district, which have provided useful information about the population noise impact from the Waterloo wind development..

Mr Zhenhua "Frank" Wang's population survey out to 5km, Waterloo, Australia, 2011 ¹⁴⁶

In 2011, Adelaide University Masters student Mr Frank Wang conducted a population survey of all 75 households within 5km of the Waterloo wind development. He found that over 50% of residents who responded were moderately or very affected by the wind turbine noise, with 38% stating they had adverse health effects including sleep deprivation and headaches. 75 surveys were distributed, and 48 returned, given a 64% response rate. I am told by researchers who have published in this area that this is considered a very good response rate for this type of study.

Mrs Mary Morris Population noise impact survey out to 10km, Waterloo, Australia, 2012 ¹⁴⁷

Mrs Mary Morris is a 5th generation community resident, former agricultural science teacher and farmer who lives 17km away from the Waterloo wind turbines. She repeated a modified version of Frank Wang's original survey out to 10km, as she had been made aware of community members who were reporting effects on their sleep and their health, which correlated with exposure to operating wind turbines out to that distance.

Mrs Morris delivered 230 surveys (one to each home within the 10km radius) and 93 surveys were returned giving a 40 % response rate. She found that some households did have occupants experiencing sleep disturbance from wind turbine noise out to 10km from the Waterloo wind development. She found 27 of the 93 respondent households had one or more members who were having trouble sleeping, and documented the other associated symptoms which included the characteristic range of wind turbine syndrome symptoms.

Mrs Morris reported four of the homes had been abandoned because of the wind turbine noise.

Macarthur Wind Development

Macarthur Wind Development in western Victoria has 140 wind turbines, VESTAS V 112, approximately 150 metres tall, sited in a grid layout approximately twice the distance north to south as east to west, in relatively flat farming

country. There are a number of other proposed wind developments to the north, east and south of Macarthur wind development. The first wind turbines started turning in October 2012, and the development was fully commissioned in February / March 2013.

Mrs Anne Schafer Preliminary Noise Impact Survey, August 2013, Macarthur, Victoria, Australia ¹⁴⁸

Mrs Anne Schafer is a farmer and concerned community member from another region in Western Victoria who knew the severity of the impacts for a couple of the Macarthur residents, and became aware of wind turbine health and noise issues because of personal research she conducted after finding out about a planned wind development near her home.

Mrs Schafer conducted and reported on a preliminary survey in August 2013, having been asked by the Australian Industrial Wind Turbines Awareness Network to help gather evidence for the Cherry Tree Tribunal hearing which had been requested by the two Tribunal members hearing the case. Of the 159 surveys distributed to households in and within 10km of the Macarthur wind development, survey responses were received from 37 households, and of those 23 households reported disturbance to 62 people, and each of the 23 households reported night time disturbance.

Mrs Schafer found that adverse impacts on neighbour's sleep were occurring only 6 months after commissioning, and less than 12 months after the first turbines started turning, and were being reported by some residents who live out to 8 – 9km from the nearest wind turbine. Children were being affected by the noise, as were other vulnerable elderly community members.

Witness statements from the Cherry Tree VCAT case, Victoria from residents at Macarthur

A number of Macarthur residents gave evidence in the Cherry Tree case, including Gus Gardner who lives 1.8km from the nearest wind turbine, Mrs Jan Hetherington who lives 3km from the turbines, and Mrs Maria Linke who lives 5km from the turbines. Mrs Hetherington and Mrs Linke cannot see the wind turbines from their homes.

Mrs Linke's sleep was affected from the very beginning of her exposure to the operating wind turbines, and her description of the symptoms and the pattern of the symptoms and sensations relating directly to exposure to operating wind turbines, is characteristic of the descriptions of many other residents. She kept a detailed contemporaneous diary, and extracts of that diary were the basis of her witness statement. Mrs Linke did not expect to be impacted in any way, living at 5km from the nearest wind turbine. Her children and her husband are now also reporting impacts including sleep disturbance. ¹⁴⁹

Mrs Hetherington¹⁵⁰ has been impacted in a variety of ways, including sleep disruption and at 3km did not expect to be.

Mr Andrew "Gus" Gardner kept a detailed record of what he described as "pressure bolt" sensations while an independent acoustician was monitoring infrasound in his home. Mr Gardner was blinded to the infrasound monitoring results and subsequent analysis of the infrasound data by Mr Les Huson showed an 86 % correlation of the pressure bolt sensations perceived by Mr Gardner with infrasound pressure transients recorded by Mr Huson's monitoring equipment. ¹⁵¹

The extract from Mr Les Huson's expert witness statement of opinion, given by him in the Cherry Tree case, which is now in the public domain is reproduced below, and the section specifically relating to Mr Gardner is item 3.

"Industrial infrasound levels of 0.5 Pa pk-pk at 12.5 Hz have caused recognised and accepted nuisance complaints.¹ Pressure transients exceeding 5 Pa pk-pk have been observed that correlate with observation of Mr Gardner that causes him concern. Other lower amplitude pk-pk pressure transients have also correlated with Mr Gardner's diary logs with an overall correlation of 86%." ¹⁵²

In other words, 0.5 Pa pressure transients which were only one tenth of the strength or “dose” measured in Mr Gardner’s home at the times he was experiencing “pressure bolt” sensations reportedly caused noise nuisance complaints resulting from noise from other sources (specifically a factory in the United Kingdom). The noise nuisance problems in that case were resolved with noise control modifications.¹⁵³

Mrs Patina Schneider Population Noise Impact Surveys, August 2012 & 13 Cullerin Range, NSW Australia

Cullerin Range is a wind development in NSW with 15 2 MW Repower wind turbines along a ridge in terrain which is rolling hills with ridges along the Great Dividing Range. The turbines have been operating for approximately 4 years, commencing in July 2009. Mrs Schneider is a farmer and concerned community member from another region in NSW who had become aware of the problems some rural people had with wind turbine noise as a result of a planned project in her region. She conducted two surveys at Cullerin, the first in August 2012, and the second a year later.

The results of the two anonymous population surveys were similar, finding in 2012 that at a distance out to 7.5 km from the turbines, 76% of households reported sleep disturbance due to the wind turbines (71% survey response rate).¹⁵⁴ A total of 100 surveys were delivered, but 41% of the households were at or beyond 10km. For the population living within 7.5km of the turbines, there were 24 households who were given a survey, and 17 responses, giving the response rate of 71%

In 2013¹⁵⁵ Mrs Schneider found a similar response rate out to 10km (68.5%) and that 91% of the households who responded out to 8km had noise and/or vibration impacts that were affecting their health. Of the 20 households in this group out to 8km, there were 50 residents, 49 of whom reported impacts. All these people had complained.⁸²

In 2013, Mrs Schneider also collected information about how many people had submitted complaints, and who they had complained to. Over three hundred complaints had been made to a number of different people and organizations including the wind developer, the local council, the health and planning departments, local health practitioners and politicians but nothing had been done to stop the noise nuisance.

There was no investigation of the severity of the sleep disturbance in these surveys, but I am personally aware of 4 residents in two households living within 10km of the Cullerin wind development, and all report episodic exhaustion from cumulative sleep deprivation and a range of other effects, which in their experience correlate precisely with exposure to operating wind turbines. When they go away from their homes at Cullerin all four of these people report they are symptom free and sleep well.

Dr Bob Thorne, Case Series (& comparison with some external controls) November, 2012¹⁵⁶

Dr Bob Thorne is a psychoacoustician who has researched this area of wind turbine noise for the past 7 – 8 years. The data for this case series submitted to the Australian Federal Senate inquiry was collected from two different wind developments in Victoria, from wind turbines between 1.65 and 2 MW in size, with residents living out to 3.4km. All study participants had self identified publicly via media reports or senate inquiry submissions made publicly that they were experiencing problems from wind turbine noise. Some had already left their homes permanently or to sleep because they couldn’t continue living or sleeping there, and at the time the data was collected the turbines had been operating for over three years.

This data collection by Dr Bob Thorne followed and replicated aspects of the peer reviewed published works of Dr Daniel Shepherd and his colleagues at a wind development in New Zealand, “**Evaluating the impact of wind turbine noise on Health Related Quality of Life**” 2011¹⁵⁷ and Dr Michael Nissenbaum and his colleagues at two wind developments in the United States, “**Effects of industrial Wind Turbine Noise on Sleep and Health**” 2012,¹⁵⁸ by measuring indicators of sleep, mental and physical health and quality of life using a variety of standardized questionnaires such as the Pittsburgh Sleep Quality Index, the SF 36, and the World Health Organisation’s Quality of Life Assessment tool (WHO QOL Brev) to gather the data.

Both these previous pieces of research by Shepherd et al and Nissenbaum et al found adverse impacts on sleep and health or health related quality of life in residents living near wind turbines in two different countries, but used different study designs. Both pieces of research were considered to be of excellent or robust quality in Dr Arra and Dr Lynn's literature review,¹⁵⁹ reported previously.

Dr Thorne's work extended that of Nissenbaum and Shepherd further, by also collecting acoustic data at a number of the homes, so that cumulative acoustic exposures for some study participants could then be estimated.

Dr Thorne was therefore able to come up with a number of markers for serious adverse health effects as a result of his combined health indicator and acoustic data collection, which were listed in his conclusions¹⁶⁰ on page 27 of his report to the senate and are reproduced below:

"The study is the final in a 7-year research program into low amplitude intrusive noise. The persons who took part in the study (apart from the greenfields' respondents) are all adversely affected by wind farm activity and, as recorded in individuals' case study, there is evidence of serious harm to health. The subjective experience of annoyance is a common reaction to noise. Different individuals can exhibit different annoyance reactions to the same noise, and these individual differences can be ascribed partly to differences in noise sensitivity. "

"The findings suggest that the individuals living near the wind farms of this study have a degraded Health-Related Quality of Life through annoyance and sleep disruption and that their health is significantly and seriously adversely affected (harmed) by noise. Based on the results of the study it is argued that, when exposed to wind farm noise and wind turbine generated air pressure variations, some individuals will more likely than not be so affected that there is a known risk of serious harm (also termed 'significant adverse effect') to health. "

"By 'serious harm' it is meant harm that is more than mere annoyance and that can be quantified in terms of reported illness, sleep disturbance or other physical effect. Definitions of 'serious harm' are postulated:

- 1) A measure of serious harm is if the exposed individual is adversely affected to the extent that he or she is obliged to remove himself or herself from the exposure in order to mitigate the harm; and / or*
- 2) A measure of serious harm is if three or more serious adverse health effects are recorded for an individual.*

Three serious adverse health effects are established from this study as being:

- a) sleep disturbance with a global PSQI greater than 5,*
- b) a state of constant anxiety, anger and helplessness,*
- c) an SF36v2 mental health value of less than 40."*

Whilst Dr Thorne did not have a sufficient number of non exposed rural resident controls in his study group for comparison, when the health indicators of individuals in Dr Thorne's recent case series exposed to wind turbines were compared to data collected from patients hospitalised for depression in a separate large study, the health of the turbine exposed group was **noticeably worse on every indicator of self reported health, including domains of physical, mental, social and environmental health.** (table 3.1.2 in Dr Thorne's study)¹⁶¹ This is a very disturbing finding, but not surprising in a group of people where a number of them have left their homes because of serious ill health. It is internally consistent with other data collected by Dr Thorne in this study, and is also consistent with what is known about the consequences of long term sleep deprivation and chronic stress.

Hospital inpatients generally have the worst scores on each of these indicators in comparative studies across different population groups, which is to be expected. The fact that these wind turbine neighbours are so much worse on every domain when compared to a separate large study of hospital inpatients indicates the severity of the pathology being experienced by these wind turbine exposed residents. It is also consistent with their adverse health

event reports, their senate inquiry submissions where they are public documents, and the reports of their treating health practitioners.

They are unwell.

3.2 Range of Relevant Professional's Opinions

The range of professional opinions on the existence of adverse health effects of wind turbines, and on the evidence of causation of those symptoms varies considerably.

Acousticians

Acousticians generally have background training as scientists, physicists, audiologists, engineers and musicians. Psychoacousticians are professionals who have specific training, knowledge, expertise and research into the human perception of sound and noise. This means they have particular and more detailed knowledge of the variable impact of noise (unwanted sound) on humans.¹⁶²

If the acousticians and psychoacousticians are members of the professional acousticians associations, there is a provision in the codes of conduct, or ethics, relating to the paramount importance of them protecting the health, safety and wellbeing of the public, and putting those professional obligations above any commercial considerations. I have quoted from some of the codes below:

In Australia, the relevant organization is the Australian Acoustical Society (AAS), and the first provision of their code of ethics relates to this issue, and appears under the heading "responsibility":¹⁶³

"The welfare, health and safety of the community shall at all times take precedence over sectional, professional and private interests."

In the United Kingdom, the relevant organization is the British Institute of Acoustics, and the relevant extract from their code says they must:¹⁶⁴

"safeguard the public interest in matters of safety, health and the environment" and

"discharge their professional responsibilities with integrity, honesty and diligence"

In North America (Canada and the United States) the professional association is the Institute of Noise Control Engineers (INCE), and their Canon of ethics states the following:¹⁶⁵

"Noise control engineering is an important and learned profession crossing many branches of science and engineering. The members of the profession recognize that their work has a direct and vital impact on the quality of life for all people, and protects and preserves human hearing from the effects of excessive noise exposure. Accordingly, members of the Institute of Noise Control Engineering of the United States of America (INCE) must be honest, impartial, fair and equitable, and must be dedicated to the protection of the public health, safety, and welfare in the practice of their professional work. INCE members' practice and professional behaviour must adhere to the highest principles of ethical conduct out of regard for the public, clients, employees, the profession at large, and the Institute of Noise Control Engineering itself."

The first fundamental Canon states the following:

"Hold paramount the safety, health and welfare of the public."

With respect to the views of acousticians generally, I think it is fair to say that the tide is starting to turn towards accepting that wind turbine noise may cause adverse health effects in some people including repetitive sleep disturbance, and that infrasound and low frequency noise are playing a role in that damage to health.

Recent developments which have assisted that process include the recent measurements of the full spectrum of wind turbine noise by a number of acousticians in the United States and Australia previously mentioned.¹⁶⁶ Publicity about the research by Dr Neil Kelley and his colleagues in the 1980's, and increased awareness of the severity of the sleep disturbance and adverse health effects being reported by residents, their treating doctors, the media, and acousticians who have been involved in investigation of noise complaints for the residents, or independent research have also raised awareness amongst that professional group.

The leadership role, distinguished research career and professional standing internationally of Dr Paul Schomer, his position as Director of Acoustics Standards in America, and his role in the Shirley Wind Farm cooperative acoustic survey with colleagues who work with the wind industry and with residents has meant that the issues of infrasound and low frequency noise can no longer be ignored by the wind industry, the noise pollution regulatory authorities and the planning authorities.

The Shirley Wind Project is in Wisconsin, and the acousticians who took part in this landmark acoustic survey in December 2012 known as the "**Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm**" included representatives from four different acoustic firms. Dr Paul Schomer and Mr Rob Rand had both worked for a mixture of both wind developers and for affected residents. Mr Bruce Walker, Mr George Hessler and Mr David Hessler did more of their consulting work with the wind industry. Each of the acousticians played different roles in the cooperative survey, and issued their own reports as appendices to the main report, however the joint report contained the following statement which all had agreed to:

*"The four investigating firms are of the opinion that enough evidence and hypotheses have been given herein to classify LFN and infrasound as a serious issue, possibly affecting the future of the industry. It should be addressed beyond the present practice of showing that wind turbine levels are magnitudes below the threshold of hearing at low frequencies"*¹⁶⁷

The acoustician who appears to have been the most influential historically, and whose opinion has been relied upon internationally by the acousticians working for the wind industry, governments keen to facilitate wind energy development, and some government health authorities such as Australia's National Health and Medical Research Council, is Professor Geoffrey Leventhall, from the UK.

Recently the Australian Association of Acoustic Consultants (the AAAC) issued an undated position statement,¹⁶⁸ which was drawn up by some of its members involved in wind farm noise measurement for wind developers, and contained reference to wind turbine generated infrasound. In the ensuing public and private correspondence which followed the issuing of this position statement, Professor Leventhall's current views on wind turbine generated infrasound were firmly adhered to by the AAAC Chairman, Mr Marti Warpenius.¹⁶⁸

However Mr Warpenius did acknowledge in an email to neurophysiologist Professor Alec Salt, which was also copied to me, that "**these issues are best resolved by targeted unbiased research.**" One of the AAAC's own members is Mr Les Huson, who is quietly conducting his own "targeted unbiased research", whose recent expert opinion about infrasound¹⁶⁹ formed as a result of his own research at Macarthur Wind Development, and at Hepburn Wind's Leonards Hill Wind Development does not agree with that of the AAAC position statement, which illustrates the range of views within the acoustics profession in Australia.

Professor Leventhall's changes of opinion over time have been demonstrated by Mr Rick James¹⁷⁰ in his detailed review article mentioned previously "**Wind Turbine Infr and Low Frequency Sound: Warning Signs That Went Unheard**" Professor Leventhall's early research work in low frequency noise and its effects on humans in an occupational setting established that low frequency noise could indeed have a direct negative effect on workers exposed to low frequency noise from a heating and cooling system.

In 2011 at the NHMRC workshop in Canberra on the adverse health effects of wind turbine noise, Professor Leventhall acknowledged that the symptoms of wind turbine syndrome had been known to him for years,¹⁷¹ which he said resulted from a psychological stress reaction because of annoyance to environmental noise. However his most recent opinions reflected in court evidence in a court case in Alberta, Canada in which we both gave evidence as expert witnesses reflect a preference for adopting the “nocebo effect” hypothesis espoused by Professor Simon Chapman.¹⁷² In other words, Professor Leventhall now believes that people such as myself, who are highlighting the serious problems being reported by sick residents, are **causing** the reported problems.

Dr Paul Schomer has publicly taken issue with this approach by Professor Leventhall in the October 2013 edition of *Acoustics Today*, published in the United States. Dr Schomer responded to a previous article by Professor Leventhall in the previous edition of the same journal, and his response is entitled **“Comments on recently published article ‘Concerns about infrasound from wind turbines’”**. In his detailed response to Dr Leventhall, Dr Schomer says the following:

“Professor Leventhall goes on to assert with absolute certainty that no problems are generated by low frequency sound whatsoever, and rather that all of the public outcries result from people being told that they have a problem. He decries people who have spoken out that there is a problem, but says nothing of the wind developers that have told the public that the sound is ‘less than a quiet refrigerator.’ The point is that for every extreme individual opposed to wind farms there are equal actions by proponents of wind farms. The proponents use what can only be termed ‘scientific spin’ with such slogans as ‘If you can't hear it, it can't hurt you.’ As if, if you can't hear ultrasonic noises, they can't hurt you, or if you can't see infrared or X-rays, they can't hurt you. ...

“The answer is there is truth on all sides. Certainly some people are influenced by what they read and hear and their response is partially or even fully based on non-acoustic factors. But the assertion that every single person world-wide is being affected only by non-acoustic factors is totally unfounded.”

“Around the world there are people who report that they can sense the turning on and off of the wind turbines without any visual or audible clue. It would be very easy to test the veracity of these statements if a wind farm would cooperate in the testing by turning on and off the wind turbines in a double blind test. Duke Energy was asked to turn on and off their wind turbines for a small research project funded by the state of Wisconsin. But Duke Energy, the world's largest energy provider, said they could not participate because of the lost revenue from the eight turbines that make up this small farm. If one assumes 10 cents per kilowatt hour, a figure that seems quite high for electricity at the source, then 8, 1.5 Megawatt turbines all together (all 8) earn a total of \$1200 in revenues per hour. I say again, the solution can only come from a broad research program participated in and guided by all parties with a material interest.”¹⁷³

So, in summary, the range of professional opinion amongst acousticians varies greatly, however there appears to be a growing acceptance even amongst acousticians working for wind developers that wind turbine noise can cause sleep disturbance and adverse health effects for some neighbours, and that infrasound and low frequency noise may be involved.

Health Practitioners (especially medical practitioners and psychologists)

As with acousticians there are a range of views, however there does appear to be an increasing acceptance that some residents who report experiencing symptoms correlating with exposure to operating wind turbines are sleep deprived, and some are “stressed”, even if there is no acceptance of the occurrence of “wind turbine syndrome” symptoms being related in any way to exposure to infrasound and low frequency noise.

Dr Wayne Spring, the Ballarat sleep physician, stated in his submission to the Australian Federal Senate Inquiry into Excessive Noise from Wind Farms in November 2012 that:

“As a Sleep Physician, working in Ballarat in Western Victoria, I have already been seeing patients from Waubra, Leonard’s Hill, Glenthompson and Cape Bridgewater who have disturbed sleep which has coincided with the commencement of operation of nearby wind farms. I do not believe that we yet know the full extent of the consequences to these people of their exposure to wind farms or even the cause of the untoward effects which may not just be from “noise.””¹⁷⁴

I am not aware of any sleep physicians or other medical practitioners with experience treating patients who are neighbours to wind turbines disagreeing with Dr Spring, who has the most experience in Australia clinically evaluating these people. Dr Chris Hanning, the retired UK sleep physician who has assisted with research in this area and provided expert evidence in court cases in Canada and planning panels in the United Kingdom is also concerned about the adverse health effects resulting from sleep disturbance due to wind turbine noise, and co authored a British Medical Journal editorial on the subject, together with an Irish epidemiologist, by the name of Emeritus Professor Alun Evans.¹⁷⁵

I note Professor Gary Wittert’s expert evidence to the ERD court in the Paltridge case in January 2011 for the wind developer Acciona, where under cross examination Professor Wittert admitted that the residents I had described were “stressed”. This expert opinion about the existence of stress related symptoms concurs with the expert evidence of Professor Carl Phillips, an epidemiologist from the USA who has given expert evidence on this subject in the USA and in Canada.

However unlike Professor Phillips conclusion that the cause is wind turbine noise, Professor Wittert then went on to assert that the residents were stressed because of my “scaremongering”. Professor Wittert did not produce any specific evidence in that court case to support this assertion, and I did not have an opportunity to counter it, as my evidence preceded Professor Wittert’s.

The wind turbine noise affected residents from Waubra who gave evidence in that case for Mr Paltridge developed symptoms in 2009, well before I commenced working for the Foundation in July 2010. One of the former Waubra residents who gave evidence in that case was Mrs Trish Godfrey, and her story and the sequence of events is pertinent to explaining a number of relevant issues, including the validity of the assertion that my “scaremongering” had caused her symptoms.

Mrs Godfrey is unable to speak publicly about her experiences living next to the Waubra wind development, because of a tightly binding confidentiality agreement restricting herself and her husband from speaking about the problems she endured, but old media stories confirm that her symptoms started almost immediately with exposure to operating wind turbines, in July / August, 2009.¹⁷⁶

The existence of the confidentiality agreement preventing Mrs Godfrey from speaking publicly was exposed by ABC reporter Cheryl Hall, in a story on ABC TV in February 2010.¹⁷⁷ I knew nothing about Mrs Godfrey’s story or the existence of any adverse health effects from wind turbines until May 2010, and did not speak out publicly of those concerns until July 18th, 2010 at a meeting in Laura in the Mid North of South Australia. I joined the Waubra Foundation shortly afterwards.

Mrs Godfrey could only give evidence in the Paltridge case in early 2011 in the ERD court in Adelaide because she had been subpoenaed by Mr Paltridge to do so. To this day she cannot speak publicly about her experiences living next to the Waubra wind farm. Her former home is still unoccupied.

Since Professor Wittert’s assertions of scaremongering causing the reported symptoms, in January 2011, Professor Simon Chapman, a professor of Public Health from Sydney University, closely associated with the Climate and Health Alliance and the Public Health Association, has also frequently made the same assertions, which have been reported widely in the media, particularly by the ABC, and the Fairfax media outlets including rural newspapers.¹⁷⁸

The “nocebo effect” hypothesis and research subsequently conducted by Professor Chapman¹⁷⁹ which purports to provide the evidence which supports the “nocebo effect” hypothesis, has been widely publicized to the medical

profession both in the general media, and via magazines read by medical practitioners such as Medical Observer. Professor Chapman has addressed conferences of medical writers about his research, so his views have received wide publicity in those circles and have then been repeated in the articles written by those writers.

It is not widely known amongst medical practitioners I have spoken with that Professor Chapman, as a Professor of Public Health at Sydney University, is not a medical graduate. Professor Chapman has a significant public profile for his high profile public health work in the area of tobacco control, and few realize he is a sociologist with expertise in media and communicating health messages.

In June 2013, Professor Chapman and a spokesperson from the Climate and Health Alliance were part of a panel in Melbourne which helped the wind turbine manufacturer VESTAS launch their "Act on Facts" campaign, which denies the existence of any adverse health impacts from wind turbines.¹⁸⁰

Medical experts other than Professor Gary Wittert who have given evidence in court or tribunal hearings for wind developers such as Dr David Black (New Zealand) and Dr Robert McCunney (United States) have highlighted the lack of specific evidence relating to direct causation of symptoms from wind turbine noise, a related opinion being that the health conditions and sleep disturbance being reported by wind turbine neighbours occur in the general population and there is no evidence that the symptoms are connected with exposure to operating wind turbines. The Kelley research however does provide evidence of direct causation of annoyance symptoms from wind turbine generated infrasound and low frequency noise, and also evidence based health protective noise limits for exposure to infrasound and low frequency noise, to prevent the health damage from that annoyance, which included repetitive sleep disturbance.¹⁸¹

I am not aware that any of the medical experts who have given expert evidence for wind developers have ever listened carefully to a series of severely impacted residents give a detailed clinical history of the pattern of their symptoms and in particular a detailed history of the pattern of their sleep disturbance, and how it correlates precisely with exposure to operating wind turbines or other sources of environmental noise, as I have done. Dr David Black¹⁸² and Dr Robert McCunney¹⁸³ are both occupational physicians, who may have clinical experience in treating occupational noise exposure clinical problems, but the residents living beside wind turbines have an environmental sleep disorder, not an occupational noise disorder.

As far as I am aware, no expert physician testifying on behalf of the wind industry has ever engaged with any severely wind turbine noise affected residents. None have sought out the opportunity and some have declined the opportunity when it was offered. Nor am I aware of any communication between wind proponents expert witnesses and the treating physicians.

Most medical practitioners do not work or live in rural areas and so do not have direct personal knowledge of the problems being reported by the residents living next to wind turbines. Ear nose and throat specialists and occupational physicians seem to be the main medical practitioner groups with any knowledge of what low frequency noise and vibration can do to people, or the symptoms of vestibular disorders.

There are nevertheless a growing number of health practitioners with direct knowledge of the serious health problems being reported by the residents living near wind turbines, as more people are affected, both in Australia and around the world. I am in contact with many of the health practitioners internationally and locally who have spoken out publicly of their concerns, and many have told me they have endured personal attacks from a number of different sources following their comments.

My own experiences in Australia are identical.

Residents from Queensland, New South Wales, Victoria and South Australia who have been adversely impacted by wind turbine noise have told me that their health practitioners (medical practitioners and psychologists) are not prepared to put things in writing (such as advice to leave their homes) and are not prepared to speak out publicly in

any way because they do not want to be ridiculed, and they do not want their own families or themselves to be targeted.

The widespread ignorance amongst most of the medical profession of the problems known by acousticians to be caused by infrasound and low frequency noise has not been helped by the confidentiality agreements. The practice of noise polluters of buying out sick residents and as part of that agreement silencing them from ever speaking out publicly about their health problems, and in some instances silencing their family members as well, has kept the problems under the radar of the public health authorities and the medical profession particularly, perpetuating the ignorance. Mrs Trish Godfrey is one example in the public domain, but there are many more.

Slater & Gordon, the law firm which acted for some of the former Toora residents, subsequently confirmed that they had acted for landowners who had signed confidentiality agreements in such circumstances. Mr James Higgins, the General Manager of Slater and Gordon, stated in a letter to the Australian newspaper dated 4th May, 2011 *"We have acted for landowners who have been affected by the operation of nearby windfarms"*. Higgins went on to state that:

"Any confidentiality clauses associated with some compensation claims have not been made at our direction. Such clauses are required by the wind farm operators and are typically required in these types of settlements." ¹⁸⁴

I have been made directly aware of this practice *"typically required in these sorts of settlements"* of silencing sick residents and their families who have been bought out by the noise polluters from the following locations:

- Toora and Waubra wind developments in Victoria,
- the coal mine near Wollar in the Upper Hunter region of New South Wales,
- the Tara Gas field in Queensland,
- gas fired power station at Uranquinty, NSW

In spite of the challenges, the communication and information sharing between relevant concerned professionals internationally is now increasing steadily. The European Platform Against Wind Farms ¹⁸⁵ has published a list of concerned professionals and researchers on its website, which now has nearly eighty names, which are reproduced below. There are other European professionals who were included on a document called the Darmstadt Manifesto, published in Germany in September 1998, which also included medical practitioners. ¹⁸⁶

In alphabetical order:

1. Professor Mariana Alves Pereira, Biomechanical Engineer (Portugal, 2007)
2. Dr Ian Arra, Public Health Physician (Canada, 2013)
3. Mr Stephen Ambrose, Noise Engineer (USA, 2011)
4. Associate Professor Jeffrey Aramini, Epidemiologist (Canada, 2010)
5. Dr Huub Bakker, Engineer, (New Zealand, 2010)
6. Dr Linda Benier, Ear Nose & Throat specialist (Canada, 2011)
7. Dr Owen Black, Ear Nose & Throat specialist (USA, 2009)
8. Mr Wade Bray, Noise Engineer (USA, 2011)
9. Professor Arline Bronzaft, Psychologist & Researcher (US, 2010)
10. Dr Nuno Castelo Branco, Pathologist (Portugal, 2007)
11. Dr Micheal Cooke, General Practitioner (Ireland, 2012)
12. Mr Steven Cooper, Acoustician (Australia, 2011)
13. Dr Herb Coussos, Medical Practitioner (US, 2010)
14. Dr R Crunkhorne, Ear Nose & Throat specialist (UK, 2013)
15. Mrs Jane Davis, Nurse (UK, 2010)
16. Professor Phillip Dickinson, Acoustician (New Zealand, 2009)
17. Associate Professor Con Doolan, Mechanical Engineer (Australia, 2012)
18. Mr Chuck Ebbing, Noise Engineer (USA, 2013)

19. Dr Alun Evans, Epidemiologist (Ireland, 2011)
20. Dr Amir Farboud, Ear Nose & Throat Specialist (UK, 2013)
21. Dr. Robert A. Frosch, Senior Research Fellow, Harvard University; ex Administrator of NASA; member of the National Academy of Engineering, the AAES, the UK's RAE, etc. (2013)
22. Professor Jerome Haller, Neurology and Paediatrics (US, 2008)
23. Professor Colin Hansen, Mechanical Engineer, International Expert in Low Frequency Noise & Vibration (Australia, 2010)
24. Dr Chris Hanning, Sleep Physician (UK, 2010)
25. Professor John Harrison, Physicist (Canada, 2010)
26. Dr Amanda Harry, Rural Medical Practitioner (UK, 2003)
27. Professor Henry Horn, Ecology and Evolutionary Biology (US, 2008)
28. Mr Richard Horonjeff, Acoustician (USA, 2010)
29. Mr Les Huson, Acoustician (Australia, 2011)
30. Dr Jan van Ingen Schenau, MD, Retired Physician (Netherlands, 2013)
31. Dr David Iser, Rural Medical Practitioner (Australia, 2004)
32. Associate Professor Rick James, Noise Engineer (USA, 2009)
33. Dr Roy Jeffrey, Rural Medical Practitioner (Canada, 2010)
34. Dr Mauri Johansson, Occupational Physician (Denmark, 2012)
35. Mr George Kamperman, Noise Engineer (USA, 2009)
36. Professor Ralph Katz, Epidemiologist (US, 2008)
37. Dr Noel Kerin, Occupational Physician (Canada, 2010)
38. Professor Nicholas Kouwen, PhD., P.Eng., FASCE, University of Waterloo, ON (Canada, 2013)
39. Ms Carmen Krogh, Pharmacist, Researcher (Canada, 2009)
40. Dr Eckhard Kuck, Oral Surgeon (Germany, 2012)
41. Dr Nicole Lachat, Biologist (Switzerland, 2011)
42. Sarah Laurie, Former Rural Medical Practitioner (Australia, 2010)
43. Dr David Lawrence, Rural Medical Practitioner (USA, 2012)
44. Professor Joel Lehrer, Ear Nose & Throat specialist (US, 2008)
45. Dr Lu Lombardi, Medical Practitioner, Ontario (Canada, 2010)
46. Dr Hazel Lynn, Medical Officer of Health, Grey/Bruce County, ON (Canada, 2012)
47. Dr Robert McMurtry, Former Dean of Medical & Dental School, University of Western Ontario (Canada, 2010)
48. Peter Mitchell, Engineer, Founder and Chairman of the Waubra Foundation (Australia, 2010)
49. Dr Andja Mitric Andjic, Rural Medical Practitioner (Australia, 2011)
50. Dr Sarah Myhill, Rural Medical Practitioner, Wales (UK, 2012)
51. Dr Michael Nissenbaum, Medical Practitioner (US, 2010)
52. Mr Bill Palmer, Engineer (Canada, 2010)
53. George Papadopoulos, Pharmacist (Australia, 2011)
54. Dr Helen Parker, Psychologist (US, 2011)
55. Dr Robyn Phipps, Researcher (NZ, 2007)
56. Dr Eja Pedersen, Medical Sociologist (Sweden, 2006)
57. Dr Nina Pierpont, PhD, MD, Specialist Paediatrician, Fellow American Academy of Paediatrics (US, 2009)
58. Professor Carl Phillips, Epidemiologist (USA, 2010)
59. Mr Jerry Punch, Audiologist (USA, 2013)
60. Mr Rob Rand, Noise Engineer (USA, 2011)
61. Dr Bruce Rapley, Scientist (NZ, 2013)
62. Dr Sandy Reider, Medical Practitioner (USA, 2013)
63. Linda J Rogers, Primary Health Care Nurse Practitioner (Canada, 2013)
64. Professor Alec Salt, Neurophysiologist (USA, 2010)
65. Dr Paul Schomer, Noise Engineer (USA, 2012)
66. Mrs Norma Schmidt, Retired Nurse (Canada, 2010)
67. Dr Daniel Shepherd, Psychologist, Psychoacoustician (New Zealand, 2010)
68. Dr Wayne Spring, Sleep Physician (Australia, 2011)

69. Mr Mike Stigwood, Acoustician (UK)
70. Dr Malcolm Swinbanks, Acoustician, (UK, 2010)
71. Dr Scott Taylor, Rural Medical Practitioner (Australia, 2011)
72. Dr Henning Theorell, Medical Practitioner (Sweden, 2012)
73. Dr Bob Thorne, Psychoacoustician (Australia, NZ)
74. Mr Peter Trask, Psychologist (Australia, 2012)
75. Dr A Trinidad, Ear Nose & Throat specialist (UK, 2013)
76. Dr Alan Watts, Rural Medical Practitioner (Australia, 2011)
77. Dr Colleen Watts, Scientist, former Board Member of the EPA in New South Wales (Australia, 2011)
78. Associate Professor Libby Wheatley, Medical Sociologist (USA, 2012)

3.3 Information obtained directly from affected people

I have now been contacted directly by over one hundred and fifty residents, and some workers occupationally exposed to infrasound and low frequency noise from wind turbines and other sources, who report a range of symptoms together with a pattern of their occurrence, which are strongly suggestive of exposure to infrasound and low frequency noise. I have been contacted directly by eleven residents living within ten kilometers of the Waterloo wind development, and those people have voluntarily shared some of their experiences with me. They include John Faint, Julie Quast, Andreas Marciniak, Johannes Marciniak, Wanda Allott, Shane Allott, Neil Daws, Colin Schafer, Ally Fricker, Bob Lamb and Roger Kruse. There are others who have told me of their symptoms as part of other conversations. The majority of the other residents and workers who have contacted me and shared their personal health information are from other wind developments in Australia, with approximately ten people affected by other sources of environmental noise.

Without exception they have experienced this deterioration in their physical and/or mental health, as have some members of their families, unless they have been able to reduce their exposure to infrasound and low frequency noise, by leaving their homes or work permanently. Leaving their homes repeatedly and regularly in order to reduce their exposures has resulted in noticeable short term improvement, while they are away. However they consistently report that the longer they are exposed, the longer it takes for them to recover, and their symptoms recur when they are reexposed to the noise.

Locations where residents have permanently left their homes because of the adverse effects of wind turbine noise on their health in Australia include Windy Hill, near Ravenshoe in Queensland; Toora, Waubra, Leonards Hill, Glenthompson, Macarthur and Cape Bridgewater in Victoria, and Waterloo in South Australia.

In the case of Waubra, Victoria, a Ministerial briefing note to the Victorian Minister for Planning on 22 August 2011, obtained under Freedom of Information by Senator John Madigan¹⁸⁷ has confirmed that numerous homes were purchased at Waubra by the wind developer, and that some families had been forced to buy property elsewhere.

The minutes from an ordinary council meeting of the Pyrenees Shire Council, which is the local council responsible for most of the area covered by the large Waubra wind development, have confirmed on 19th March 2013 (page 17) that

*“Council has had direct experience in dealing with this issue, and there can be no doubt that dwellings in close proximity to wind turbines (within 2km) have/will have the potential to be profoundly noise affected — to a point where the amenity of their occupants will be seriously diminished”*¹⁸⁸

The wind turbines used at Waubra are 1.65MW, almost half the size of those proposed for the Stony Gap Wind Development.

These residents describe themselves as being “trapped” and describe significant additional psychological stress as a result, especially if vulnerable dependent relatives are also becoming unwell, such as elderly parents or young children.

It is my observation that the psychological stress and distress felt by these residents is further compounded by the official denials of a problem from government, and the refusal to act to stop the predictable harm to their health from noise pollution. This is accentuated particularly by denials of existing evidence and science about the known adverse health effects of night time noise pollution from state government health departments, and public health academics. This psychological distress reaction to being abandoned by responsible authorities is also reported by residents around the world and has been reported to me directly by residents in Canada, the United Kingdom and France.¹⁸⁹

Some wind turbine hosts and concerned members of their extended families have also made contact with me, and they report the same range and pattern of symptoms correlating directly with exposure to wind turbine noise. One wind turbine host couple from South Australia, Mr and Mrs Mortimer, from near Millicent, have shared many aspects of their experiences with wind turbine noise publicly, including Mr David Mortimer's written and oral evidence given in the Cherry Tree case in Victoria.¹⁹⁰

The pattern of their individual symptoms, their variable onset and expression between Mr and Mrs Mortimer and the clear pattern of improvement when away from the source of the infrasound and low frequency noise is identical to residents not receiving any financial benefit from wind turbine developments.

It is of note that Mr Mortimer and his wife did not realize what was causing their symptoms until they attended one of Senator Xenophon and Senator Madigan's public information sessions in Mt Gambier, where they heard Mr Brian Kermond from Cape Bridgewater speak, and recognized the pattern of symptoms. Mr & Mrs Mortimer then tried leaving their home for short periods of time to see what happened, and found that consistently their symptoms improved when they were away from their home. They have told me it was only at this stage that they found out about the Waubra Foundation, and subsequently contacted me, well after they had identified the general cause of the problem themselves.¹⁹¹

Once sensitized to one source of low frequency noise, some of these people report being affected by other sources of low frequency noise. From the history they give, the symptoms are clearly and repeatedly associated with exposure to the noise, and vary with exposure to the noise..

The range of symptoms, and the pattern of their occurrence correlating directly with exposure to sources of ILFN, and worsening with ongoing cumulative exposure, is consistent with the first hand clinical reports or research of medical practitioners such as Dr Amanda Harry, Dr David Iser, Dr Nina Pierpont, Dr Bob McMurtry, Dr Michael Nissenbaum, Dr Sandy Reider, and is consistent with the observations or field research of acousticians such as Dr Bob Thorne, Mr Rick James, Mr Steven Cooper, Mr Les Huson, Mr Robert Rand, Mr Stephen Ambrose, Dr Malcolm Swinbanks, and Dr Paul Schomer.¹⁹²

4.0 Pathophysiology vs the Nocebo Effect

The current thinking in the fields of acoustics, neurophysiology and medicine about the precise pathophysiological pathways to explain the direct causal link between wind turbine acoustic emissions in the infrasound and low frequency ranges and reported symptoms identified in the 1980's by Dr Neil Kelley's research team, is now converging, thanks to the recent groundbreaking work of three key researchers from different disciplines, each with an important piece of the puzzle. Each of these three key researchers has numerous colleagues with supporting information and insights, some of whom are also mentioned below.

In simple terms, the current scientific understanding is that the wind turbine acoustic emissions and pressure pulses generated by the blade pass frequencies, especially those in the infrasound range, are abnormally activating the body's vestibular system, which is then leading to a range of symptoms including nausea and vertigo in a sub group of particularly susceptible people who are impacted almost immediately. Professor Alec Salt's work using guinea pig models to investigate these neurophysiological pathways, helps link the acoustic measurements with the clinical symptoms people are reporting to their health practitioners. His experimental results explain how some people

develop the tinnitus, vertigo and nausea, and how some people develop the “alerting” or “fight – flight” response to infrasound stimulation of their inner ear, especially in a quiet rural environment. Salt’s recent review article in *Acoustics Today* summarises the latest research developments and their profound implications in a relatively accessible way for such a complex field.¹⁹³

4.1 Dr Paul Schomer’s contribution from the field of acoustics

Members of this subgroup of particularly susceptible people are the subject of Dr Paul Schomer’s recent paper, which proposed a theory for the physiological responses being observed in wind turbine residents, using old knowledge of the reactions of pilots in flight simulators, also exposed to very low frequencies. Dr Schomer is a highly regarded experienced acoustician and researcher, and Director of Acoustic Standards in the United States, and he wrote his paper with no knowledge of Dr Pierpont’s research findings or comprehensive literature review on the latest advances in knowledge about vestibular disorders when he wrote it.¹⁹⁴

Dr Schomer and his coauthors demonstrated that the chances of sensitivity to motion sickness and sensitivity to wind turbine acoustic emissions being unrelated was less than 2 in 1,000,000.¹⁹⁵ Dr Schomer carefully analysed a number of cases from Australian, Canadian and American wind developments where the residents developed symptoms of nausea and vertigo from the beginning of the operation of the wind turbines near them, which resulted in them being so profoundly and severely affected that they had to leave their homes.

4.2 Professor Alec Salt’s contribution from the field of neurophysiology of the cochlea¹⁹⁶

Professor Alec Salt, a leading neurophysiologist with a lifetime of research investigating how the cochlea responds to different stimuli including infrasound, has done significant work showing that the cochlea is exquisitely sensitive to changes in infrasound when there is a quiet ambient background noise, which is precisely what a lot of rural residents live within – a very quiet soundscape especially if their home has thick walls, good insulation, and they live in a very quiet rural area.

A recent paper presented by Professor Salt in August 2012 in New York, titled **“Perception-based protection from low-frequency sounds may not be enough”**¹⁹⁷ showed that the inner ear of mammals is much more responsive to sound frequencies below 20 Hz than previously thought, especially where there is little concurrent sound present in higher frequencies. Professor Salt has suggested that based on his research, thresholds of safe exposure for infrasound such as is emitted by industrial wind turbines may be much lower than has historically been assumed by many acousticians to be safe, based on historic audible perception thresholds, such as the 85 dBG commonly cited.

Professor Salt has shown experimentally, using mammalian models used for many years in drug research to mimic human responses, that the cochlea responds to levels of infrasound which are well below the threshold of audibility for pure tones, commonly cited as 85 dBG. Levels of infrasound, which induced a physiological response in Professor Salt’s experiments, were 60 dBG.

The threshold of audible perception of 85 dBG, which has been proposed as the “safety threshold” for exposure to infrasound by the wind industry, and also by the South Australian EPA, is therefore not supported by either Dr Neil Kelley’s data from 1985,¹⁹⁸ or Professor Salt’s recent neurophysiological laboratory research.¹⁹⁹

4.3 Support for Professor Salt’s concerns about 85 dBG infrasound from Dr Swinbanks

British acoustician Dr Malcolm Swinbanks shares Professor Salt’s concerns about the inadequacy of usage of the current audible infrasound perception thresholds to protect health. At the same New York Conference in August 2012, Dr Swinbanks during his presentation entitled **“Numerical stimulation of infrasound perception, with reference to prior laboratory effects”**²⁰⁰ referred to a paper from Chinese researchers Chen, Qibai & Shi in 2004, **“An Investigation on the Physiological and Psychological Effects of Infrasound on Persons”**.²⁰¹

The Chinese researchers had established in 2004 that increases in systolic blood pressure, increased heart rate,

nausea and other symptoms had been induced in some young fit study participants after only an hour of exposure to infrasound. The effects were variable between the participants, and some remained unaffected. In other words, a physiological effect from infrasound exposure was observed in some young fit healthy adults after only one hour of exposure to infrasound, and the individual responses varied.

Dr Swinbanks demonstrated in his 2012 Internoise paper in New York ²⁰² that when the dose of infrasound which 5 Chinese subjects were exposed to in the Chen, Qibai & Shi 2004 ²⁰³ study (stated to be 110 dB at 2.14 Hz) was translated into dBG units, this exposure was equivalent to 82 dBG. This experimental dose of 82 dBG is clearly below the 85 dBG “safe” exposure level currently relied upon by the SA EPA, and by acousticians often consulted by the wind industry, but even at that level of 82 dBG, below the “safe” exposure level of 85 dBG, the infrasound still exerted a physiological effect.

Given that young fit people are the least likely to experience adverse symptoms from exposure to infrasound and low frequency noise, and that prolonged exposure results in increasing sensitization for some people, it is clear from the Chinese study and Dr Swinbank’s translation of the dose they received into dBG, that 85 dBG will not prevent physiological effects noted in the Chinese study such as elevated blood pressure, elevated heart rate, nausea and feeling “fretful and tired”, which were caused directly by exposure to infrasound in that laboratory experiment.

The evidence suggests that it is therefore possible in people particularly susceptible to infrasound, or sensitized to it, that the exposure dose of infrasound required to induce a physiological and health damaging response could be much lower than 85 dBG, just as Professor Salt’s work suggests, especially if the exposure is occurring in a quiet background noise environment.

Dr Kelley and Professor Salt’s research conducted nearly 30 years apart and using completely different scientific methods, support this opinion, and Dr Kelley’s acoustic field research also suggests the levels of infrasound exposure inducing a physiological and adverse health response in sensitized people could be much lower.

4.4 Vestibular stimulation, fight flight response, physiological stress and sleep disturbance

Involuntary activity or stimulation of the vestibular system from infrasound has long been known to stimulate activation of the “fight flight” response in animals, such as those running from a tsunami. ²⁰⁴

The “fight flight response” experienced by wind turbine affected residents is also evident from reports of new symptoms of anxiety and panic, and new sleep disturbance, characteristically waking up suddenly in an anxious frightened panicked state, which correlate directly with exposure to operating wind turbines. These combined symptoms of physiological stress and repetitive sleep disturbance episodes are much more commonly reported in residents and workers than the acute nausea and motion sickness symptoms, experienced acutely and immediately in the small subgroup of people who become rapidly unwell with early exposure. It is my experience that most other people generally take much longer to develop their symptoms.

The commonest reported problem in long term residents living with wind turbines is exhaustion from disturbed sleep which they do not experience when the wind turbines are off, and they do not experience when away from home. The highly unusual pattern of repetitive sleep disturbance commonly reported by wind turbine neighbours - the pattern of waking up at night in a frightened anxious panicked state, in addition to involuntary daytime physiological stress “flight fight” responses, is further clinical evidence of physiological stress, and the involuntary stimulation of the sympathetic nervous system in the pathology being seen. US Family Physician Dr Sandy Reider’s description of one of his patient’s symptoms is the clearest description of this pattern of sleep disturbance I have seen. ²⁰⁵

It is now strongly suspected by some people working in this area in Australia and New Zealand such as Dr Bruce Rapley, ²⁰⁶ that these nighttime panic episodes are being involuntarily triggered while people are asleep via impulsive

infrasound pressure pulses generated by wind turbines, and Professor Salt's work in identifying the physiological pathway for an alerting response in animal models is supportive evidence. In a recent radio interview with an Australian journalist, Professor Alec Salt had this to say:²⁰⁷

"Alec Salt: Yes there is good evidence, we have good evidence that this sound is definitely picked up by the ear. I mean the sounds that you can't hear, the infrasounds down to 1 Hz or something, that's one cycle per second, we know that this is detected by the ear at quite low levels and even though you don't hear it, it is still stimulating the ear and potentially affecting you in other ways.

Alan Jones: And what does it do to people?

Alec Salt: Well, from our perspective, it may account for the sleep disturbance people have, like thunderstorms wake you up you know even though they are far away, thunderstorms wake people up because it's the low frequency of the thunderstorm that you're detecting. So the point is if, they, wind turbines generate a lot of low frequency like this, it's potentially it's going through pathways that lead to disturbing of sleep."

Concurrent full spectrum acoustic and physiological sleep monitoring in the field, including measurement of brain function, heart rate and blood pressure will assist with identifying which frequencies are involved, and what sound pressure levels are required to trigger these "fight – flight" episodes which are so commonly reported. This will build up dose response information and help further identify safe health protective noise pollution parameters, and build on the work by Dr Neil Kelley and his team from the 1980's.²⁰⁸

4.5 Dr Nina Pierpont – the role of the Vestibular system, and identification of risk factors

As I have previously described, Dr Nina Pierpont is an American Paediatrician and researcher, and author of the peer reviewed case series cross over study published in 2009.²⁰⁹ Dr Pierpot first identified and described in detail the specific pattern of characteristic sleep disturbance and panic episodes being described by the residents, and their treating physicians, and realized that the vestibular system was involved in this and other pathology being reported.

Dr Pierpont sought to identify any susceptibility factors to better understand why some people developed symptoms when exposed to infrasound and low frequency noise from wind turbines and others did not, even when living in the same homes, with similar exposures.

Dr Pierpont chose the phrase "wind turbine syndrome" to describe a particular constellation of symptoms being consistently reported by the participants in her detailed study of the members of 10 families who had at least one family member severely affected, which had resulted in leaving their home to reduce their exposure and regain their health. She meticulously documented their previous health status, what happened when the turbines started operating, and what happened when the family left their home.

The symptoms as defined by Dr Pierpont included the following: *"Sleep disturbance and deprivation, headache, tinnitus (ringing in ears), ear pressure, dizziness, vertigo (spinning dizziness), nausea, visual blurring, tachycardia (fast heart rate), irritability, problems with concentration and memory, and panic episodes associated with sensations of movement or quivering inside the body that arise while awake or asleep"*²¹⁰

Dr Pierpont identified that people with *"pre existing migraine disorder, motion sensitivity, or damage to inner ear structures (such as hearing loss from industrial noise exposure) are more susceptible than other people to Wind Turbine Syndrome"* and that the results were statistically significant. She also noted that *"children are affected as well as adults, especially older adults"*.²¹¹

Dr Pierpont went on to point out that *"the susceptibility factors are clues to the pathophysiology of Wind Turbine Syndrome" because "the symptom complex resembles syndromes caused by vestibular (inner ear balance organ)*

dysfunction". Dr Pierpont proposed that the low frequency noise and vibration, caused "disturbance to balance and position sense" and that the symptoms occurred as a result of this disturbance.²¹²

Dr Pierpont has included an extensive literature review of the known science relating to how balance-related neural signals affect a variety of brain areas and functions, all of which can feature in patients with Wind Turbine Syndrome. They include "spatial awareness, spatial memory, spatial problem solving, fear, anxiety, autonomic functions (like nausea and heart rate), and aversive learning. As she points out, "These known neural relationships provide a robust anatomic and physiologic framework for Wind Turbine Syndrome".²¹³

Dr Pierpont also reviewed medical, technical and acoustic literature on the resonance of sound and vibration within body cavities, because some residents report these symptoms. She reviewed published studies of documented low frequency noise exposure where people developed the same sorts of effects on people, from both experimental work and environmental noise.

Those who seek to misrepresent Dr Pierpont's work frequently assert that her work was not "peer reviewed". That is untrue, her work has been carefully reviewed by peers with relevant expertise in a variety of disciplines. Peer reviewers of Dr Pierpont's study included but are not limited to the following:²¹⁴

- Jerome S Haller, MD, Professor of Neurology and Pediatrics (retired 2009), New York
- Joel E Lehrer MD, Clinical Professor of Otolaryngology, University of Medicine & Dentistry of New Jersey, Formerly Professor of Otolaryngology, Mount Sinai School of Medicine, New York, New York
- Ralph Katz DMD, MPH, PhD, Professor and Chair, Department of Epidemiology and Health Promotion, New York University College of Dentistry, New York, New York
- Henry S Horn, PhD, Professor of Ecology and Evolutionary Biology, Princeton University, Princeton, New Jersey

4.6 Increasing recognition of problems by International Ear Nose and Throat Specialists

Dr Owen Black was an ear nose and throat specialist and NASA and US Navy researcher who could see parallels with the symptoms being reported by Dr Pierpont's study participants and his patients who were navy personnel impacted by low frequency noise. Dr Black also peer reviewed Dr Pierpont's study, and subsequently referred to her work in an affidavit for a court matter, where he stated:

*"I am a medical doctor specializing in neuro-otology focusing on vestibular (inner ear) disorder research. I am an internationally known neurotologist and human vestibular physiologist. I am an expert in disorders of the inner ear."*²¹⁵

Dr Black went on to state that

"Based on my review of Dr Pierpont's report, I believe this study is an important initial contribution to understanding the effects of low frequency pressures on the inner ear and other organs".

Dr Black then states

"I am familiar with studies conducted by the United States Navy relating to low frequency sound pressure patterns, which report symptoms similar to those reported by Dr Nina Pierpont in her Wind Turbine Syndrome study".

Other Ear Nose and Throat specialists internationally are starting to recognize the same symptom complexes occurring in their patients. Three Ear Nose and Throat specialists led by Amir Farboud from the United Kingdom wrote a detailed review article which was accepted for publication on 5th November, 2012 in the peer reviewed published Journal of Otolaryngology, entitled "**Wind Turbine Syndrome: Fact or Fiction**",²¹⁶ and concluded that:

“There is ample evidence of symptoms arising in individuals exposed to wind turbine noise. Some researchers maintain that the effects of wind turbine syndrome are clearly just examples of the well known stress effects of exposure to noise, as displayed by a small proportion of the population. However, there is an increasing body of evidence suggesting that infrasound and low frequency noise have physiological effects on the ear.”

The body of evidence referred to by Farboud et al related specifically to the neurophysiological research by Professor Alec Salt and his colleagues. Farboud et al also highlight the significant problem of a lack of evidence about the effects of longterm exposure of wind turbine noise:

“Another important factor is length of exposure. There are currently no reported studies which come close to replicating the long term exposure to low frequency noise experienced by individuals who live near wind turbines.”²¹⁷

Farboud et al also highlight that symptoms and ill effects including sleep disturbance are being experienced by residents exposed to levels of wind turbine noise which are permitted in the UK, in other words, people are experiencing sleep deprivation and consequent impaired health at “compliant” wind developments. As in Australia, the wind turbine noise guidelines in the UK are based on the ETSU 97 wind turbine noise regulations, which were written to facilitate wind energy development in the UK, by a committee including a number of acousticians who worked for the wind industry.²¹⁸

“Sleep disturbance is another symptom commonly reported in case studies of low frequency noise. A large body of evidence now exists to suggest that wind turbines do disturb sleep and impair health at distances and sound pressure levels that are permitted in the UK”²¹⁹

Finally, Farboud et al also highlight the known problem of high levels of low frequency noise inducing body vibrations:

“It is also known that high levels of low frequency noise induce body vibrations, most prominently chest resonance vibration in the range of 50–80 Hz. The lower a sound’s frequency the longer its wavelength, which means resonance may occur in an enclosed or partially open space such as a room in a house, as well as within the body. This vibratory sensation is one of the main contributors of the human response to low frequency noise, and may well be perceived as an ill effect.”²²⁰

Two Swedish Ear Nose and Throat specialists, Dr Hakan Enbom and Dr Inga Enbom have written an article for a Swedish Medical Journal, **“Infrasound from wind turbines: an overlooked health hazard”** published in 2013.²²¹ Dr Hakan Enbom is an otoneurologist, like Dr Owen Black, and specializes in dizziness disorders, and Dr Inga Enbom is a specialist in hypersensitivity disorders, familiar with what they call “central sensory hypersensitivity”, which particularly includes migraine sufferers.

Drs Enbom & Enbom have independently confirmed Dr Pierpont’s observations of the increased susceptibility of migraine sufferers to developing health problems with exposure to pulsating infrasound, and the additional stress related health risks:²²²

“The pulsing sound pressure from wind turbines indirectly activates the autonomic nervous system, causing increased secretion of adrenaline with consequent stress effects, risk of panic disorder, high blood pressure and heart attacks for people with increased sensory sensitivity.”

“Migraine is caused by a genetic central sensory hypersensitivity in people at risk for central nervous system disorder. Migraine prevalence is about 30 percent in the general population. In addition there are other causes of central processing disorder, which means that more than 30 percent of residents in the vicinity of wind turbines could be, to greater or lesser extent, affected by wind-related “annoyance.” Risk groups include people with migraine disorder or a family history of migraines, people over 50 years of age, people with

fibromyalgia and those with a tendency to anxiety and depression. Children and adults with ADHD and autism are at risk and could have their symptoms worsened.

“The issue is not noise damage in the traditional sense, but the effect of a constant pulsating sound pressure that constantly changes the pressure in the inner ear and excites sensory organs there. One can liken it to pulsating or flickering lights—many people are not bothered noticeably, while people with sensory hypersensitivity may experience discomfort. Flickering light can even trigger epilepsy. Likewise, constantly pulsating, non-audible infrasound from wind turbines triggers major problems in people with central sensory hypersensitivity. These problems can become chronic, debilitating and lead to anxiety and depression and increase the risk of heart attack.”

“The current regulatory framework for wind turbines has not taken into account the potential risk to people with central sensory hypersensitivity. Wind turbines erected are being erected too close to homes. The current regulatory framework should be revised with an increased safety distance from homes to prevent or reduce the risk of wind-related morbidity.”

Other ENT specialists such as Dr Linda Benier in Quebec are openly expressing their concerns, and now Professors of ENT at Harvard such as Dr Steve Rauch are starting to diagnose their patients with “wind turbine syndrome”.²²³

However, as with the range of use of the term “annoyance” by acoustic engineers and researchers, usage of the phrase “wind turbine syndrome” by others, particular those who have a conflict of interest or who dismiss Dr Pierpont’s work, have not always been accurate, or consistent with Dr Pierpont’s original and quite specific definition.

The coalescence of current research and thinking in the fields of acoustics, neurophysiology and medicine with the work of Dr Schomer, Professor Salt, and Dr Pierpont, supported by an increasing number of other acoustic, scientific and clinical colleagues, further increases our understanding of the reasons for the important observations made by Dr Kelley and his researchers, nearly thirty years ago, of the direct causal link between wind turbine generated infrasound and low frequency noise, and “annoyance” symptoms, which included symptoms in common with Wind Turbine Syndrome, and which also include repetitive sleep disturbance.

4.7 The “Nocebo Effect”

Recently two pieces of research have been published in peer reviewed journals which assert that the problems reported by the residents living beside wind turbines are all due to the “nocebo effect” which is essentially an assertion that publicity about the symptoms is what is **causing** them. In both cases, the research did not involve direct investigation of the residents reporting the symptoms and sleep disturbance.

Both pieces of work were widely publicised in Australia by the authors in various online blogs and opinion pieces, and university sponsored websites such as the Conversation, as well as the ABC and Fairfax press and purported to show that the reported health problems had nothing to do with exposure to sound energy, rather they were due to the powers of “suggestion”.

As discussed previously, Kelley et al conducted the definitive research in 1985, long known to the wind industry, and established that wind turbine generated infrasound and low frequency noise directly caused the annoyance symptoms being reported by the residents, when the sound energy resonated inside building structures

The first recent piece of research is a laboratory study led by a PhD candidate in the discipline of psychology, Fiona Crichton, from New Zealand.²²⁴ Crichton and her colleagues exposed young fit healthy volunteers to 10 minutes of infrasound, during the day, at doses which were well below levels known to exert any physiological effect, and which acoustically bore no relationship to wind turbine noise.

As Dr Swinbanks²²⁵ and others have pointed out, this Crichton laboratory study is not a valid comparison with the experiences of people who are a range of ages, with variable pre existing susceptibilities, living beside wind turbines, who are chronically exposed to wind turbine sound energy for years, sound energy which contains a variety of frequencies which have impulsive repetitive components, which occur at night and which wake them up repeatedly.

As Professor Jerry Punch²²⁶ points out in his critique of the Crichton work, it is therefore misleading and incorrect to assert, as the author has done, that this study provides evidence that the symptoms and health problems reported by wind turbine residents are caused by a “nocebo effect”. In order to do so, the residents living with the turbines themselves would need to be studied, as well as measurement of their concurrent acoustic exposure, and that has not been done by Ms Crichton and her fellow authors.

Ms Crichton has not provided any explanation in her research as to why she and her coauthors have ignored the 40 years of acoustic and psychoacoustic research into the effects of low frequency noise, documented recently in detail in the summary by Rick James²²⁷ previously mentioned, and in particular the field and laboratory research by Kelley and others from NASA in the 1980’s.²²⁸

Nor has Crichton provided any explanation as to why her research only appears to relate to wind turbine neighbours and not those reporting an identical range and pattern of symptoms from other sources of environmental noise such as gas fired power stations,²²⁹ CSG field compressors²³⁰ and coal mines.²³¹

The second study’s lead author was Professor Simon Chapman,²³² the previously mentioned public health professor from Sydney University who helped VESTAS launch their “Act on Facts” campaign in June 2013, denying any adverse impacts from wind turbines.²³³

Chapman relies heavily on Crichton’s research to support his assertions that the symptoms and complaints from residents all result from publicity about the symptoms being reported by residents, particularly activity by the Waubra Foundation in drawing public attention to the health and sleep problems being reported by the residents living beside industrial low frequency noise polluting facilities.

As with Crichton, it is solely wind turbine neighbours who are the object of Chapman’s scrutiny in his research, but not those others affected by infrasound and low frequency noise from other sources. Professor Chapman has been postulating his “nocebo” or “scaremongering” hypothesis for some time publicly prior to conducting his research.²³⁴ Opinion pieces with this theme can be found on websites such as The Drum, The Conversation, and Crikey.com which as Professor Robert McMurtry²³⁵ pointed out in his critique of Chapman’s work, suggests confirmation bias.

In his research paper rather than going straight to the people who are reporting symptoms, Chapman and his co authors used three indirect information sources which included details of complaints which the wind developers made available to him from their records. The two other sources were from media items and from publicly available submissions to government inquiries.

Complaints data from wind developers is known in some instances to be under recorded,²³⁶ unless the complaint has been made in writing and a complaint number has been requested. There are examples of residents from Waterloo ringing the designated wind development complaints phone number only to never have their call answered, but they change locations and ring from a different phone and the phone is answered immediately. For these reasons alone, complaints data is likely to underestimate the real number of complaints to the developer alone.

Another specific example of the underreporting resulting from using wind developers records relates to the Cullerin Wind Development, listed by Chapman et al as generating no complaints. Yet Mrs Schneider’s recent survey from August 2013 documented over 300 complaints, including some which were made to the wind developer.²³⁷

With respect to Professor Chapman’s hypothesis that that symptoms are all caused by what he calls “scaremongering”, his own evidence demonstrates that many of the first complaints were made well before the

Waubra foundation was established, let alone started making specific public comments about the health problems being described by residents, which did not happen until September / October 2010. Residents at Waubra for example started reporting problems in the media in August / September 2009, almost a year before I joined the Foundation.²³⁸

With respect to Chapman's claims that the health problems are a reaction to the Waubra Foundation moving into a community and "scaring" people, the foundation only ever goes where it is invited to do so first, by concerned local residents. We share information that has been obtained from acoustic and scientific studies which are publicly available, as well as health information volunteered freely and directly to us by residents adversely impacted by environmental noise from a range of sources, not just wind turbines. Increasingly rural residents are seeking out the first hand experiences of those who have lived with wind turbine noise, in order to find out directly for themselves.

Many of the earlier wind developments in Australia were located further away from homes and were much smaller wind turbines, and wind farms for example Codrington & Cathedral Rocks, as Professor Chapman's own data shows. It is therefore not surprising that they do not appear to have generated the same numbers of complaints.

However complaints were still made by some locals at some wind developments where there were problems, and either the residents were eventually bought out, silenced with non disclosure clauses in their agreements, and relocated (Toora, Victoria)²³⁹ or they stayed in their homes because of a multigenerational attachment to their land but were reportedly intimidated into keeping quiet about the problems because of the public ridicule they endured in the community (Crookwell, NSW)²⁴⁰

Finally, the case of Toora deserves special scrutiny. Dr David Iser only started conducting his research **after** his patients had unexpectedly presented with a multitude of new symptoms and health problems, which occurred **after** the Toora wind development started operating. The results of his population survey were not publicised until after the research was done. The symptoms were not **caused** by the publicity, which occurred **after** the residents first presented with the problems to Dr David Iser, and after he conducted his research.²⁴¹

5.0 Setback distances – what is “safe”?

There are concerning clues from existing peer reviewed published evidence,²⁴² acoustic field research,²⁴³ adverse health event reports²⁴⁴ and community noise impact surveys,²⁴⁵ and our knowledge of the effects of cumulative sleep deprivation²⁴⁶ and stress,²⁴⁷ that there are already serious public health consequences for wind turbine neighbours out to at least 10km from 3MW wind turbines, particularly with the example of Waterloo wind development, which has 37 VESTAS V 90 3 MW wind turbines, and Macarthur which has 140 VESTAS V 112 3 MW wind turbines.

These problems will only increase in severity and magnitude with ongoing exposure, and increasing sensitization to infrasound and low frequency noise at existing wind developments. The impacts will be further extended with the increasing size and power generating capacity of the new larger more powerful wind turbines, and the consequent increased size of the acoustic impact zone from the infrasound and low frequency noise emissions.

There is peer reviewed, published acoustic evidence from 2011 that as the power generating capacity and size of wind turbines increases, the sound energy shifts an octave downwards into the lower frequencies. Danish Professors Moller & Pedersen stated in their peer reviewed published paper entitled "**Low frequency noise from large wind turbines**":

*"The relative amount of low-frequency noise is higher for large turbines (2.3–3.6 MW) than for small turbines (≤ 2 MW), and the difference is statistically significant."*²⁴⁸

We know that people are reporting symptoms of sleep disturbance and other stress symptoms consistent with exposure to infrasound and low frequency noise out to at least 10km and sometimes further if people have become sensitized to the wind turbine generated infrasound and low frequency noise, or if they are downwind at the end of a line of turbines. Some of those people have reported these symptoms directly to me, and others have reported them to the community noise impact surveys by Morris, Schneider and Schafer.^{249,250,251} Others such as wind turbine host David Mortimer has reported them publicly in open letters, in an attempt to try and get the responsible authorities to listen and act.²⁵²

Mr Steven Cooper has measured wind turbine generated infrasound and low frequency noise 8 km from the nearest wind turbine at Waterloo,²⁵³ where the resident, Mr Colin Schafer, could tell whether or not the wind turbines were operating depending on the wind direction despite the wind turbines being over a range of hills and not visible at the time. Mr Schafer has told me he initially supported the wind turbines and was to become a wind turbine host himself, but when he realized the impact on his own sleep and health and that of his neighbours he changed his mind.

I have not found any scientific or other evidence to show that a 2 km turbine setback from homes, is enough to protect people from low frequency noise and infrasound, especially from the larger wind turbines increasingly being used by the wind industry. Indeed experienced acousticians such as Professor Phillip Dickinson with nearly 60 years experience, have suggested 5 – 10 km would be more appropriate. He stated at the conclusion of a recent paper which heavily criticised the New Zealand standard and restated the importance of sleep,

“One easy solution for solving the noise problem and protecting public health, is a ruling that no wind farm sound emission shall exceed 30 dB ($L_{Aeq,10mins}$) at any residence, nor exceed 20 dB ($L_{Aeq,10mins}$) in total in the frequency bands 31.5 to 125 Hz. A very simple way of achieving this, and of eliminating the need for any further involvement by the territorial authority, would be to make a ruling that no wind farm shall be situated less than say 5 to 10 kilometres away from any residence unless the occupant agrees in writing for this condition to be waived.”²⁵⁴

However such a written waiver could place especially susceptible and relatively powerless citizens like the children and elderly parents of family generational farmers who might choose to sign such a waiver, at increased risk of developing serious health problems. There is reason to be particularly concerned about the impacts on children, including the children of wind turbine hosts or other financial stakeholders.

Mrs Mary Morris’s data from Waterloo has already reported some effects on children’s sleep being noted by their parents in the Waterloo district,²⁵⁵ and Dr Nina Pierpont’s case series cross over²⁵⁶ also gave numerous examples of children’s sleep, health and cognition being adversely impacted with exposure to operating wind turbines which resolved when the exposure ceased. Professor Arline Bronzaft, a world recognized expert on the effects of noise on children’s health and learning has also publicly expressed her concerns about the impact of wind turbine noise on children.²⁵⁷

Mr Les Huson’s recent work at Macarthur has shown that there is a cumulative effect on infrasound pressure pulse generation when there are multiple turbines in an area.²⁵⁸ Mr Huson also showed that wind turbine generated infrasound does not attenuate in the predicted way of 3 dB per doubling, established for a single wind turbine by NASA’s researchers in 1985,²⁵⁹ and since confirmed by others including Mr Huson himself at Leonards Hill.²⁶⁰ Instead, the infrasound measurements taken by Mr Les Huson at Macarthur with the cumulative impact of 140 wind turbines showed no difference in the wind turbine generated infrasound levels when they were 1.8km from the nearest wind turbine compared to 6.4km away from the nearest wind turbine. His expert opinion for the Cherry Tree case on this issue stated:

“Infrasound propagation attenuation is minimal in the near field to a large wind farm such as Macarthur. Little infrasound attenuation is observed from 1800m out to 6400m from the nearest turbines on the southern side of the wind farm.”²⁶¹

In other words it is likely that the effects of the wind turbine generated infrasound and associated pressure pulses will travel for much greater distances from Macarthur than anyone realized because of the cumulative impact of so many wind turbines.

It is my opinion that on the basis of what I have seen and heard from residents at Waterloo and at Macarthur, which both have 3 MW wind turbines, a setback distance of at least 10 km is required between turbines and homes. However Mr Les Huson's recent data from Macarthur and reports of symptoms and sleep disturbance in sensitive and sensitized people at distances such as 17km from Waterloo (reported by David and Alida Mortimer when they stayed with Mrs Mary Morris) make me concerned that 10 km will prove to be inadequate to protect health of the surrounding population from adverse health effects over the lifetime of the project from the consequences of chronic sleep deprivation and physiological stress caused by chronic exposure to wind turbine noise, resulting in deterioration in physical and mental health, just as Dr Bruce McEwen described in 1998.²⁶²

6.0 Will Compliance with SA EPA Guidelines protect against adverse health effects?

In my opinion, proper compliance with the SA EPA Guidelines will not protect residents against adverse health effects for a number of reasons, some of which have already been previously discussed elsewhere in this report.

Firstly, I have been advised by Mr Steven Cooper, Mr Les Huson and Professor Colin Hansen that the ambient background noise level can be much lower than 25 - 30 dBA overnight in a number of mid north regions, including the environs of the district around Waterloo wind development which is adjacent to the proposed Stony Gap Wind Farm. I am advised by acousticians that levels of audible noise greater than 10dBA above the background level are likely to have a significant impact.

Secondly the current SA EPA wind turbine noise guidelines do not mandate measurement of infrasound and low frequency noise, and they have not incorporated the Kelley recommended guidelines, which are the only evidence based guidelines for regulating longer term exposure to infrasound and low frequency noise to protect health.

Thirdly, there are serious concerns about the quality of enforcement of the guidelines. Until noise monitoring is occurring full time, is transparently available, and covers the full acoustic spectrum, using equipment which can do the task, and until the acoustic consultants who are completely independent from both the wind developers and the South Australian EPA, have full access to the data required by them to properly assess compliance, these serious concerns will remain.¹⁴⁶

If the Waterloo wind development is compliant with the guidelines, as the SA EPA employees are claiming after their acoustic survey, then there is ample evidence that the sleep of the surrounding residents is being adversely impacted. The guidelines are meant to be protecting the community from sleep disturbance. Clearly the guidelines are currently inadequate to protect sleep, and need to be revised.

Inclusion immediately of the Kelley criteria established in 1985 with respect to exposure to infrasound and low frequency noise would be a start, together with continuous full spectrum real time acoustic monitoring with provision of results to all stakeholders with a material interest.

7.0 Evaluation of Government Reports ²⁶⁴

There are numerous government literature reviews and wind industry lobby group generated reviews, and reviews written and peer reviewed by academics and consultants who give expert evidence for the wind industry, which are regularly used to support the statement by wind developers, government health and planning departments and public health advocates for the renewable power industry that "*there are no direct pathological effects from wind*

turbines on human health". That wording leaves open the possibility that there could be "indirect" pathological effects, but infers that if there are such indirect effects, they can be safely ignored.

It is my opinion that by inferring that sleep deprivation from repetitive sleep disturbance resulting from wind turbine noise pollution is an "indirect effect", and then ignoring those indirect effects and their well known adverse health consequences, the severity of the real adverse impacts from chronic exposure to wind turbine noise has been significantly underestimated by the public health, planning and noise pollution authorities in Australia.

Such government and wind industry generated reviews are of extremely limited value, because of their incomplete coverage of the extensive research and known scientific evidence relating to environmental noise.

These sorts of reviews generally ignore the body of evidence relating to the known adverse health effects of exposure to infrasound and low frequency noise from sources other than wind turbines; they ignore the body of evidence related to the existence of a sleep problem with wind turbine neighbours and the consequences of cumulative repetitive sleep disturbance, or they assert that wind developments always operate within their predicted noise levels and therefore no adverse health problems could possibly occur.

7.1 NHMRC 2010 Rapid Review ²⁶⁵

The Australian National Health and Medical Research Council's 2010 "Rapid Review" is one such document, which has been extensively criticised both in Australia and internationally. ²⁶⁶ Its precise authorship and their expertise, and potential conflicts of interest are unknown, and so too its peer reviewers for a while.

Subsequent revelations from the NHMRC under questioning during Senate Estimates ²⁶⁷ revealed that the two unnamed peer reviewers of the 2010 Rapid Review were Professor Geoffrey Leventhall, and Professor Simon Chapman. A conflict of interest disclosures or lack of such disclosures to the NHMRC were unknown because of their previously unidentified status as peer reviewers. Both Professors have subsequently claimed that the health problems being reported at wind developments are a result of the "nocebo effect". ²⁶⁸ Professor Leventhall has appeared as an expert witness in various court proceedings for wind developers. ²⁶⁹ Professor Chapman has helped launch a wind turbine product manufacturer's denials of any adverse health effects. ²⁷⁰

The CEO of the NHMRC, Professor Warwick Anderson, distanced himself from the claims of wind developers of "no adverse health effects" in his oral evidence to the first Senate Inquiry in Perth on 31st March, 2011 when he said "*we do not say that there are no ill effects*". ²⁷¹

There was international condemnation of the NHMRC's 2010 Rapid Review, which was used by wind developers globally to continue to deny any adverse health effects. The Society for Wind Vigilance (SWV) in Ontario issued a detailed critique and subsequently an audit of the claims made in the 2010 Rapid Review, highlighting many areas of concern, including a bias towards wind industry sponsored literature. ²⁷²

7.2 Victorian Health Department Report, April 2013 ²⁷³

Background to the involvement of Victorian Health Authorities

Victorian health practitioners and their patients have reported their serious concerns about the observed and reported adverse health effects from wind turbines to the Victorian Health Minister and local government and state health authorities, and federal parliamentary inquiries since 2004. Those health professionals have included Dr David Iser ²⁷⁴ (Rural GP, Toora), Dr Scott Taylor ²⁷⁵ (Rural GP, Ballarat), Dr Wayne Spring ²⁷⁶ (Sleep Physician, Ballarat), Dr Andja Mitric Andjic ²⁷⁷ (Rural GP, Ballarat), and Mr Peter Trask, ²⁷⁸ (Psychologist, Bendigo).

Pyrenees Shire Council, aware of what had transpired to some residents at the Waubra wind development who had had to leave their homes, specifically requested the Chief Health Officer Dr Rosemary Lester investigate and conduct a health impact assessment in late 2011, because of the serious problems including home abandonments reported at the Waubra wind development, which were also identified in the Federal Senate inquiry.²⁷⁹

The Victorian Health department staff have not themselves conducted a health impact assessment, or an investigation in the field, of any sort, despite repeated requests from both residents, health practitioners, and local councils for them to do so.²⁸⁰

However two former Victorian Health Department Medical Practitioners met twice with wind turbine noise affected residents, and publicly admitted at meetings with affected residents in both April 2011 at Evansford near Waubra,²⁸¹ and on 14th October 2011 in Melbourne²⁸² that they knew residents were experiencing health problems, and specifically acknowledged that **they believed the residents, and that the problems were real** (Dr Simon Slota-Kan and Dr Stephanie Williams).²⁸³

At the October 2011 meeting, in the Victorian Health Department Offices at 50 Lonsdale Street, Melbourne both Dr Slota Kan and Dr Stephanie Williams were present together with a Ms Nathalie Alvarez Barnett, from the Environmental Health Branch of the Victorian Health Department.

The Victorian health department staff, and the four Waubra Foundation directors²⁸⁴ present at that meeting (including a former Justice of the Supreme Court, and a former Federal Health Minister, also a medical graduate and former specialist physician, and myself) listened to the rural residents from across Victoria speak of the serious adverse health impacts they had experienced whilst living near wind turbines at Cape Bridgewater, Waubra, and Leonards Hill, which had resulted in severe chronic sleep disturbance, a range of symptoms resulting in significantly impaired quality of life, physical and mental health problems, multiple home abandonments, and an attempted suicide. One of the local treating medical practitioners was also present at this meeting and confirmed the severity of the adverse health impacts to the Department of Health staff.

Ms Nathalie Alvarez Barnett was present at the meeting in October 2011, so heard both the stories from the residents, the confirmation from one of the treating medical practitioner, and the confirmation by her Victorian Health Department Medical Practitioner colleagues that the problems were real.

Ms Nathalie Alvarez Barnett was subsequently identified by an unnamed colleague in the Victorian health department as the staff member responsible for the April 2013 Victorian Health Department report, during a phone call made by Victorian based independent acoustician Mr Les Huson, who was trying to get hold of a copy of that report just after it was released to the public.²⁸⁵

Despite a number of formal and Freedom of Information requests the Victorian Health Department have refused to provide any other information about the report's authorship and how the information referred to was selected by or provided to the author(s).²⁸⁶ It is therefore unclear who wrote it, what their training and experience is, and who decided which information was to be excluded, and indeed what the sources of information were.

The background information above is provided to place the report issued in April 2013 by the Victorian Health Department in the context of the local historical experience of the Victorian Health Department staff of this issue, their direct knowledge of the seriousness of the problems being experienced by the residents, and the lack of subsequent Health Department transparency about the authorship of the report and sources of information.

Critical comments by Emeritus Professor Colin Hansen, Mechanical Engineer²⁸⁷

Emeritus Professor Colin Hansen gave a detailed critique of aspects of the Victorian Health Department document in his letter to the Victorian Minister for Health on 23rd May 2013. Professor Hansen is a highly regarded academic in his field of acoustics and noise control, a Mechanical Engineer from Adelaide University, and a recipient of a current

Australian Research Council grant to study wind turbine noise which he is currently conducting in the environs of the Waterloo wind development.

Professor Hansen's comments about his problems with the Victorian Health Department report illustrate many of the issues of disagreement between the wind industry and its lobby groups on the one hand, and acousticians and researchers who are independent of the wind industry, so they have been reproduced in detail below to assist the ERD court to understand the differences of opinion and why they are held.

The comments go to the heart of understanding that the actual dose of sound energy being received by residents near existing wind turbines is underestimated by the current noise prediction models and is not being measured by the SA EPA wind turbine noise guidelines. It is therefore inevitable that the predictable adverse health impacts, especially relating to sleep disturbance from environmental noise, have also been underestimated:

"I find that chapters 1 to 3 contain information that lay people will find very useful. However, later chapters contain statements that conflict with current knowledge in the field and could mislead the public into believing things that are simply not true. I have listed the problem statements below and I sincerely hope that these can be fixed before this document is too widely circulated"....

"The A-weighting network, discussed on page 7 may have been designed to approximate the response of the human ear, but it is a very poor approximation, especially at low frequencies. It is well known that low frequency sound is much more annoying and disturbing to most people than the A-weighted measurement would indicate, especially in the absence of any significant mid- and high-frequency sound. This should be pointed out in the document on page 7."

"It is well known that sound levels produced by a wind farm can fluctuate significantly ... The level of fluctuation becomes more noticeable and annoying as the distance from the wind farm increases and energy becomes more low frequency in nature."

"On pages 9 and 10, the document discusses hearing thresholds for low frequency sound and suggests that wind farm infrasound is well below what people could detect. However, it should be pointed out that the hearing thresholds are for steady, single frequency sound in the absence of any other sound. There are two problems with this approach. Hearing thresholds are known to be much lower for fluctuating (or modulating) sound and also when there are many harmonics present at the same time as the fundamental. If we add on to this that wind farm low frequency and infrasound noise measurements that have been taken by a number of people do not reflect the peak noise levels which could be 10 to 15 dB higher than the L90 levels, it is possible to get to the point where wind farm low frequency noise and possibly infrasound could be detectable by a significant number of people at distances up to 5 to 10 km from the wind farm, depending on the meteorological conditions."

"On page 11 the document implies that computer models for predicting wind farm noise can be relied upon to give accurate results. None of the models used for predicting noise take into account the likely increase in turbine noise levels when they are operating in a turbulent atmosphere or in the wake of other turbines. Neither do the models take into account the possible focussing of low frequency sound under stable atmospheric or downwind conditions that can result in much greater noise levels than predicted."

"The recent study on infrasound mentioned on page 11 had problems with inaccuracies associated with the instrumentation at low frequencies and the use of 1/3 octave filters which completely missed the peak fluctuations in the infrasound. Another problem was the reporting of only dBG results, which not everyone agrees reflects the perception of infrasound. Thus the statement on page 12 that "In conclusion, there is overwhelming evidence that infrasound from wind farms is at levels which are too low to be audible, and no higher than background levels in the environment", is not true. My research group is currently undertaking noise and vibration measurements at residences affected by the Waterloo wind farm and it can clearly be seen that there exist noise levels at blade passing harmonics that are well in excess of background

noise levels. We are also measuring significant levels of impulsive low-frequency sound several kilometres from the wind farm and this can be quite annoying to some people when they are trying to sleep. We intend to publish these results in the not too distant future.”

The “recent study” Professor Hansen is referring to in the paragraph above is the SA EPA Resonate Acoustics ²⁸⁸ Study which was privately criticized by numerous international experts ²⁸⁹ working in this field to me, when it was first released, for the same reasons identified by Professor Hansen above, some months prior to Professor Hansen writing this letter to the Victorian Health Department. I have since been made aware of the concerns of other acousticians at a meeting of the NSW Branch of the Australian Acoustical Society. ²⁹⁰

Professor Hansen concludes his letter to the Victorian Health Department with the following remarks:

“The first statement in the conclusions, “the predominant sounds produced by wind farms are in the mid to high frequencies” is misleading. This may be true close to the turbines but at distances that most affected residents live, especially at night during stable weather conditions, it is the low frequency sound that people find disturbing and which is responsible for preventing them from obtaining a good night’s sleep, which in turn can possibly have adverse health effects.”

Critical Comments by Professor Alec Salt & Assistant Professor Jeffrey Lichtenhan ²⁹¹

The other person who was strongly critical of this Victorian Health Department Report was Professor Alec Salt, the leading international neurophysiologist working in this area. Professor Salt has conducted research with numerous colleagues relating specifically to this topic of the physiological impact of infrasound on the inner ear, and written detailed review papers and presented at numerous international conferences.

Professor Salt and his colleague Jeffrey Lichtenhan, Assistant Professor of Otolaryngology wrote together to the Victorian Health Minister, and stated the following:

“This letter is to express our deepest disappointment with the lack of objectivity in the recent report from the Victoria Department of Health “Wind Farms, Sound and Health: Technical Information”.

“There are a number of false statements in your report. One severe example is “... the available evidence does not support claims that inaudible sounds can have direct physiological effects.”

“Below we have provided citations to six publications from our group where we showed how the ear responds to low frequency sounds up to 50 dB below the levels that would be heard. The experimental methods that were used are well established in the field of auditory physiology. Three of the below citations were peer-reviewed and published in some of the most well respected journals in the field of acoustics and hearing science. Our publications, which were clearly neglected or conveniently overlooked, show that inaudible low frequency sounds do indeed stimulate the ear and produce marked physiological effects.”

“The stimulation of human inner-ear sensory cells occurs by identical processes to those seen in commonly used laboratory mammals, so there is no evidence that humans are different from other mammals in this respect.”

“Indeed, to be technical, the observation that in humans the response to low frequency maskers changes phase by 90 degrees as frequency is lowered (Zwicker, E., 1977. Masking-period patterns produced by very-low-frequency maskers and their possible relation to basilar-membrane displacement. J. Acoust. Soc. Am. 61, 1031) is confirmation that the sensory cells of humans are responding in an identical manner to the mammals that we, and others, have studied.”

“It is highly irresponsible for a Health Department to state as a fact that low frequency sounds can have no physiological effects when publicly-available experimental results prove otherwise. The Health Department is

failing to PROTECT the public by their lack of objective and balanced review of the potential risks of low frequency noise.”

We are truly sincere,

Alec N Salt, PhD.

Professor of Otolaryngology

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The original Victorian Health Department report is still in circulation and has not been amended as requested by two of the leading independent academic research teams working in this area internationally. Ignoring the scientific evidence established by the leading experts in their fields, and failing to respond to their clearly articulated concerns fundamentally undermines the credibility of those involved in the production and approval of the Victorian Health Department document, and also those involved in the subsequent decisions to ignore the expert advice to amend or remove it.

7.3 SA EPA Acoustic Survey – “Waterloo Wind Farm Environmental Noise Study, 2013”

I have not yet had time to read this survey in detail, and as much of it is outside my specific area of expertise I have asked a number of acousticians in Australia and internationally to peer review it. I understand some were still waiting for the SA EPA to provide them with the data they require to conduct their peer review. In the meantime, Mr George Hessler wrote to the SA EPA on 28th February, 2014 and Mr Hessler’s comments were subsequently explicitly endorsed by Dr Schomer and Mr Bruce Walker, but not by Professor Leventhall to my knowledge. The text of the letter has been reproduced below in full: ²⁹²

“No one knows why a relatively few wind farms evoke such intense adverse community reaction with multiple claims of ill health effects. Two wind farms of recent notoriety in this regard are the Waterloo project in Southern Australia and the Shirley wind farm in the United States. Anti-wind farm advocates contend that low frequency infrasound (0 to 20 Hz frequency range) is the cause of ill health effects, but cannot explain why the overwhelming vast majority of wind farms operate successfully and do not elicit any adverse community response. Similarly, pro-windfarm advocates cannot explain the reaction at sites like Waterloo and Shirley.

The EPA measurement program at Waterloo showed similar results as at Shirley that there is a measurable low level of infrasound that reaches a maximum level around the blade passing frequency (BPF) and harmonics of the wind turbines. Three bladed modern wind turbines rotate in the 10 to 14 RPM range so the BPF ranges from 0.5 to 0.7 Hz or periods of 2 to 1.4 seconds. At these very low and slow frequencies and

periods, any such sound pressure would be perceived, if at all, as a series of pulses, not as ordinary noise. The threshold for hearing for ordinary low frequency noise is currently standardized down to only 20 Hz, far far above the frequency of maximum infrasound generated by wind turbines. Published thresholds below 20 Hz down to 4 Hz are fairly uniform between researchers with a scatter band of results of approximately 9 dB. Research below 4 Hz is sparse and variances between the few researchers reach 20 dB. So any comparison of wind farm infrasound to published hearing thresholds is completely meaningless.

What is clearly needed for Waterloo and all other wind projects is an unbiased study to determine the threshold of perception for low frequency infrasound or pulses from wind turbines. It is an honor and privilege for this writer to have colleagues such as Doctors Geoff Leventhall, Paul Schomer and Bruce Walker. Without doubt, all three learned scientists would endorse the need for such a study. Dr. Leventhall and Dr. Schomer do not agree on possible perception mechanisms of the body for perceiving very low frequency sound or pulses but both would urge quality research to advance our understanding. Fortunately for all, Bruce Walker has developed a synthesized pulse generation source and super-woofer playback system to simulate very low frequency wind turbine pulses in rooms. Hence, it is now technically possible to simulate wind turbine immissions to audiences of unbiased listeners to determine the threshold of perception or other possible physical reactions to levels above the threshold.

The completed EPA survey was focused on demonstrating compliance with existing standards. The final EPA report also presents guidelines for low frequency noise found in the literature that are totally invalid in the author's opinion for accessing actual wind turbine immissions. What is sorely needed now by all sides of the issue is a formal endorsed and controlled perception study of wind turbine noise in the infrasound frequency region. I urge the EPA and/or appropriate Health agencies to take the next step, beyond compliance measurements, to initiate such a study, preferably at a university where students could comprise the audiences"

I have serious concerns about the way this survey was conducted, which I recently detailed in an open letter to the Premier of South Australia calling for a full public inquiry into the conduct of the South Australian EPA with respect to wind turbine noise guidelines, assessment of wind turbine noise, and this survey in particular.²⁹³ I know there are other concerned professionals and well informed citizens independent of the wind industry and governments nationally and internationally who share my concern, and about the way this report will be misused by those with a vested interest seeking to deny the evidence of a serious and growing public health problem.²⁹⁴

I am concerned at the photographic evidence I have been shown which shows that at three sites the noise monitors were placed contrary to the SA EPA's own noise guidelines, in locations which would inevitably result in an increase in measured background noise, either under large trees (2), or close to a number of reflective surfaces (1). This could result in a wind development which is not compliant with the guidelines being found to be "compliant" because the background noise level has "suddenly become noisier" at these locations.²⁹⁵

I am also concerned at the ongoing reliance by the SA EPA on the 85dBG threshold of audible perception of infrasound figure as the "safe" level of exposure, because it is not supported by the known science.²⁹⁶

The 1985 Kelley acoustic field research health protective exposure parameters quoted previously,²⁹⁷ specify much lower levels for frequencies in the infrasound region. Professor Alec Salt's more recent laboratory research confirms that much lower levels are more appropriate, especially in rural areas with quiet background noise, because of the way the cochlea acts like an "acoustic iris" to let in more of the damaging infrasound and low frequency noise when there is not louder audible noise masking it.²⁹⁸

There is the evidence of a physiological impact (on blood pressure and nausea symptoms) in the 2004 Chinese²⁹⁹ research by Chen, Qibai and Shi, also referred to by Dr Malcolm Swinbanks in his paper presented at the Internoise conference in New York in August 2012,³⁰⁰ and the recent acoustic field research work by Dr Paul Schomer at the Shirley wind project³⁰¹ and subsequently with his insights into the physiological consequences of infrasound stimulation historically in helicopter pilots.³⁰²

For these reasons it is my opinion that the SA EPA acoustic survey conducted recently cannot be relied upon, both with respect to its data, and its conclusions.

To be valid the survey requires close independent scrutiny, including transparent provision of all the relevant data to experts in the field who are experienced at measuring the full spectrum of wind turbine noise, and who are independent of both the wind industry, the Environment Protection Authority and the current South Australian Government, which is strongly supportive of wind development in settled locations.

These independent experts should conduct a thorough peer review of both the acoustic data and the manner in which it was collected, and a peer review of the report itself. All the data collected by the South Australian EPA, including the data currently missing from the public domain, should be compared with the data collected concurrently by Professor Colin Hansen, Mr Steven Cooper and any other independent acoustically trained professionals at the time.

If the subsequent independent peer review finds these concerns to be baseless, and no difference between the acoustic data collected by Cooper, Hansen and others with that of the SA EPA, and the conclusions drawn by the SA EPA Acoustic survey to be valid and based upon all the acoustic evidence available, then and only then can the SA EPA Waterloo Acoustic survey data be relied upon.

7.4 NHMRC Commissioned February 2014 “Systematic Literature Review”

The NHMRC’s long awaited subsequent literature review, commissioned by them but performed externally, with oversight by an NHMRC appointed panel, was released in February, 2014. The NHMRC also issued a draft information statement and invited the public to comment on the statement. They did not seek comments on the Systematic Literature Review itself.

The Waubra Foundation has looked carefully at the NHMRC’s commissioned Systematic Literature Review, and found some concerning issues including excessively narrow search criteria, misclassification of study designs, exclusions of certain studies on grounds which do not appear consistent or justified and other irregularities.

Accordingly the Foundation has compiled a detailed critique based on our extensive knowledge of both the problems in the field, and the relevant literature in the relevant disciplines. It appears that relevant research relating to the known adverse health consequences of sleep deprivation, physiological stress, and important research relating to the known effects of infrasound and low frequency noise on physiology and tissue pathology were deliberately excluded.

The Waubra Foundation’s critique of the Systematic Literature Review document has been sent to the CEO of the NHMRC, the Chair of the Literature Review Panel, and the Senior NHMRC employee responsible, and has also been made publicly available.³⁰³

We note that concerns about conflicts of interest have been raised in Federal Parliament by a number of Senators with respect to some members of the NHMRC Literature Review panel.

8.0 Qualifications and Relevant Experience

8.1 Clinical training and experience

My name is Sarah Elisabeth Laurie, and I reside in the mid north of South Australia. I was formerly a trained rural general practitioner, and practiced clinical medicine in rural and remote areas after completing my undergraduate

medical degree at Flinders University in 1994, formally graduating in 1995. The degree was a Bachelor of Medicine and a Bachelor of Surgery (BMBS) and was attained after six years of full time study. I subsequently worked for a year as an intern at Flinders Medical Centre, after which I became fully registered as a medical practitioner in South Australia.

My postgraduate training after the intern year comprised eighteen months of hospital training as part of the special training for rural general practice, at both Modbury Hospital (1996) and Lyell McEwin Hospital (first half of 1997). It comprised rotations in hospital positions in emergency medicine, paediatrics, obstetrics, and anaesthetics.

This was followed by eighteen months of working in rural general practice at Wakefield Plains Medical Centre and Balaklava hospital in the second half of 1997, and subsequently Crystal Brook Medical Practice and Crystal Brook Hospital from 1998 onwards. This work included both general practice consulting and providing emergency and inpatient care in the local hospitals on a rotating roster with other medical practitioners.

I remained at Crystal Brook for the next few years working full time as an employee, associate and then partner in the practice, until sudden ill health precipitated an unanticipated prolonged break from clinical practice, in April 2002.

My post graduate qualifications included attaining both a Fellowship of the Royal Australian College of General Practitioners awarded in 1999, and a Fellowship of the Australian College of Remote and Rural Medicine awarded in 2000. I was asked to become an examiner for the Royal Australian College of General Practitioners, and did so in 2001. I became a member of state council of the South Australian branch of the Australian Medical Association, also in 2001.

Whilst working as a general practitioner at Crystal Brook, I also provided occasional locum services to a remote community controlled Aboriginal Health Service in the far north of South Australia on the Anangu Pitjantjatjara lands. I helped provide a free immunization service to the Aboriginal community in Port Pirie, and helped establish a local Rape and Sexual Assault service in the mid north, provided by local general practitioners in their practices when required. I also served as the general practice representative on a Mid North Mental Health Advisory Committee.

In 2002 I left clinical practice at Crystal Brook suddenly and unexpectedly because of a serious medical illness requiring urgent surgery, and initially I retained my registration to continue clinical practice, which I kept until 2006. I was subsequently unable to return to work as a clinical medical practitioner, because of a combination of personal health issues, and growing extended family caring responsibilities including young children and frail elderly parents in law, so I chose not to renew my medical registration in 2006 until I was in a position to resume clinical practice.

I fully intend to return to clinical medicine in the future, however I am currently unregistered.

8.2 Work with the Waubra Foundation (July 2010 to present)

I currently work in a voluntary capacity as the CEO of the Waubra Foundation, and have done so since July 2010.

The Foundation was established in March 2010, by the former chairman of the National Stroke Foundation, Mr Peter Mitchell, AM, after he recognised the need for urgent research to investigate the reported adverse health effects being experienced and reported to Victorian Health authorities by residents near wind turbines at Waubra.

Mr Mitchell was also aware of reports of people being adversely impacted by other sources of low frequency noise, so from its formation the Foundation has been interested in adverse health impacts caused by a variety of low frequency noise sources, not just wind turbines.

My own interest in this area of public health was first stimulated in March/April 2010 by learning about a proposal for a wind turbine development near my home. That development was subsequently withdrawn in April 2012. My work in this area continues because of the systemic regulatory failure of state based noise pollution, health and

planning authorities to protect peoples' health with adequate evidence based noise pollution guidelines, which are properly enforced.

Like many medical graduates not working in either occupational medicine or as an ear nose and throat specialist, prior to my work with the Waubra Foundation I was unaware of any serious health problems resulting from sound and vibration energy from wind turbines or any other source, other than excessive noise causing hearing problems, and excessive night time noise causing sleep disturbance, with its obvious resultant consequences for physical and mental health.

At Mr Mitchell's request, I joined the Foundation initially as "Medical Director" in July 2010. My title was subsequently changed to Chief Executive Officer to better reflect my role.

The Objectives of the Waubra Foundation are attached as an annexure.³⁰⁵

The Foundation is concerned about the adverse impacts of industrial noise on human health, with particular focus on sound and vibration in the infrasound and low frequency ranges, ie below 200 Hz. Since the Foundation commenced our work in mid 2010 with initial concerns about poorly sited large industrial wind turbines, and poorly regulated noise pollution, we have been approached by, and provided assistance to, a range of people impacted by different sources of infrasound and low frequency sound and vibration energy in both urban and rural environments.

Examples of rural noise and vibration noise sources we have been contacted about after being contacted by concerned and affected residents, or referrals from acousticians have included gas fired power stations³⁰⁶ (eg Pt Campbell, Victoria, Uranquinty, NSW), mining activities³⁰⁷ (eg coal mines in the upper Hunter region, NSW) and compressors used in CSG operations³⁰⁸ (eg Tara, QLD).

Urban sound and vibration sources include the intrusive low frequency noise emissions from small compressors forming part of a pool pump in a residential apartment building, and a large compressor attached to a Veterinary Building at the University of Melbourne, which was affecting the health of some of the nearby residents living in an adjoining suburb of Parkville. Further information can be obtained from the Parkville Residents Association's submission to the Federal Senate Inquiry into Rural Wind Farms in 2011.³⁰⁹

I have now been contacted directly by over one hundred and fifty residents, and workers, who report a range of symptoms together with a pattern of their occurrence, which are strongly suggestive of exposure to infrasound and low frequency noise. Most of these people have been Australian residents, and some have been exposed to wind turbine noise for three to four years. I have watched and listened to what has happened to them over the last few years since they first made contact with me, in order to better understand what is causing the relentless deterioration in their physical and mental health.

I have also been part of a growing number of concerned acousticians, researchers, medical practitioners, and well informed residents nationally and internationally who have been sharing information collaboratively in order to better understand what is driving the relentless deterioration in people's health, once they find they are affected by wind turbine noise emissions.

This collaboration with concerned Australian acousticians and health professionals started before I attended the first international symposium on the adverse health effects of wind turbines, in Ontario in October 2010, where many of the leading acoustic, health and scientific researchers were present, along with some of the impacted residents, especially from Ontario. This collaboration and information sharing actively continues as more and more concerned professionals internationally are conducting their own research, or speaking out about the serious problems they are seeing.

As a result of my knowledge in this area of public health, I have given evidence to the two Australian Federal Senate inquiries, which investigated wind turbine noise. The first was the Senate Inquiry into the Social and Economic Impacts of Rural Wind Farms, chaired by Greens Senator Rachel Siewert. I gave evidence in Melbourne on 29th

March, 2011.³¹⁰ The second inquiry was to examine the Bill of the proposed Madigan and Xenophon legislation to amend the Renewable Energy Act, called the Excessive Noise from Wind Turbines, which had public hearings in Canberra at Parliament House on 14th November, 2012.³¹¹ That Bill sought to both ensure independent transparent real time noise monitoring occurred, and to ensure excessive audible noise from wind turbines above quiet rural background noise levels was no longer permitted.

I have also given written and oral evidence in and for other legal proceedings and parliamentary or government inquiries, both in Australia and in Canada. These include the current ongoing South Australian Inquiry into Rural Wind Farms, and a Federal Canadian government inquiry, after which Health Canada proposed a health study.

With respect to court evidence, I gave evidence as a lay witness in the ERD court in Adelaide in January 2011, in the Paltridge, District Council of Grant and Acciona matter. I gave evidence as a lay witness in the Cherry Tree VCAT proceedings in Melbourne in February 2013,³¹² and I gave evidence in a number of proceedings before the Ontario Environmental Review Tribunal in 2013.

Most recently I was qualified to give expert evidence in the Bull Creek case in Alberta, Canada in November 2013 in a case before the Alberta Utilities Commission.

Declarations

I declare that I do not have a conflict of interest in this matter.

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



14th April, 2014

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3. Sleep disturbance / deprivation has been consistently reported as a problem in the peer reviewed published literature where it is one of the annoyance symptoms, such as the empirical studies which are listed in the literature review by Arra & Lynn <http://waubrafoundation.org.au/resources/association-between-wind-turbine-noise-and-human-distress/> in the systematic data collected directly from the residents, such as Dr David Iser's population survey in 2004 <http://waubrafoundation.org.au/resources/dr-david-iser-2004-conducts-first-survey-patients-living-near-wind-project/> Dr Nina Pierpont's peer reviewed case series cross over study <http://waubrafoundation.org.au/resources/dr-nina-pierpont-submission-australian-senate-inquiry/> and Dr Bob Thorne's peer reviewed case series submitted to the second Australian Federal Senate inquiry, which combined collection of health data and acoustic data In order to estimate exposures

- <http://waubrafoundation.org.au/resources/wind-farm-generated-noise-and-adverse-health-effects/> It is also a commonly reported problem in the community noise impact surveys recently conducted in Australia which can be accessed here: <http://waubrafoundation.org.au/library/community-noise-impact-surveys/>
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 5. The 2009 WHO Night Noise Guidelines for Europe <http://waubrafoundation.org.au/resources/who-night-noise-guidelines-for-europe/> and the subsequent WHO publication on the burden of disease of environmental noise in 2011 (<http://waubrafoundation.org.au/resources/who-burden-disease-from-environmental-noise/>) both contain a wealth of information and useful references, as does the peer reviewed published literature which relates to the effects of sleep deprivation, and the literature relating to the effects of chronic stress. Some examples include the 2011 meta analysis by Professor Capuccio et al on sleep duration and cardiovascular outcomes, **“Sleep Duration predicts cardiovascular outcomes: a systemic review and meta-analysis of prospective studies”** European Heart Journal, (2011) 32, 1484–1492 <http://waubrafoundation.org.au/resources/sleep-duration-predicts-cardiovascular-outcomes/> and work by researchers in the field of chronic stress such as Bruce McEwen including the 1998 review article in the New England Journal of Medicine **“Protective and Damaging Effects of Stress Mediators”** New England Journal of Medicine 1998, 338 171–179
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 13. Merlin, T et al from Adelaide Health Technology Assessment, University of Adelaide, NHMRC commissioned Systematic Literature Review 2014, **“Systematic Review of the Human Health Effects of Wind Farms”** p 62
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42. Schomer, P descriptions and data from the Shirley Wisconsin Cooperative Survey in December, 2012, the joint report and Dr Schomer’s appendix can be accessed here <http://waubrafoundation.org.au/resources/co-operative-measurement-survey-analysis-low-frequency-infrasound-at-shirley-wind-farm/> and there is additional descriptive information in the following conference paper presented in Denver, Colorado in August 2013 <http://waubrafoundation.org.au/resources/schomer-et-al-wind-turbine-noise-conference-denver-august-2013/>
43. Resident’s observations and descriptions of their experiences are crucial to determining what might be causing their unusual symptoms, many of which are new to most medical practitioners as well as new to the residents experiencing them. Dr Nina Pierpont recognized the importance of this first hand descriptive data, which is why she insisted that her study be accompanied by the resident’s descriptions in their own words in the Case Histories section of her book, making it too long for publication in a journal. (the case histories are accessible here: <http://waubrafoundation.org.au/resources/dr-nina-pierpont-submission-australian-senate-inquiry/>) There are many first hand accounts of what the residents experience in video testimony as well as written testimony available at the following links: <http://waubrafoundation.org.au/library/section/resident-impact-videos/> and <http://waubrafoundation.org.au/library/residents-stories/> on the Waubra Foundation website, and there are many other examples on websites such as Global Wind Energy Impact at <http://globalwindenergyimpact.com/> I have found if the symptoms are particularly unusual that the residents are very reluctant to be identified in person when describing them, because of the local community, media, and internet ridicule which ensues.
44. Much of this has been known since 1985, with the release of the report into the 3 year acoustic field survey in the United States, led by Dr Neil Kelley, culminating in the comprehensive 1985 report “**Acoustic noise associated with Mod 1 Turbine, its impact and control**” <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
45. Ibid
46. The penetrating nature of wind turbine ILFN has been reported by many residents, and also by acousticians such as Ambrose, Stephen and Rand, Robert 2011 who reported this in their Falmouth study “**Bruce McPherson Infrasound and Low Frequency Noise Study**” <http://waubrafoundation.org.au/resources/bruce-mcpherson-infrasound-low-frequency-noise-study/>
47. The effects of a well insulated home in preventing the masking effect from external higher frequencies was first explained to me by Emeritus Professor Colin Hansen in 2010, (personal communication) and then

- confirmed with Ambrose, S and Rand, R 2011 op cit,
48. Resonance effects have been noted by numerous acousticians, eg Ambrose S & Rand R in the Falmouth 2011 acoustic survey, op cit but also Kelley et al 1985 op cit and from sources other than wind turbine ILFN by Harvey Hubbard, in **“Noise Induced House Vibrations and Human Perceptions”** 1982 Noise Control Engineering Journal Sept Oct 1982 Vol 19 No 2 49 – 55
<http://waubrafoundation.org.au/resources/hubbard-h-1982-noise-induced-house-vibrations-human-perception/>
 49. Kelley et al, 1985 op cit
 50. Ambrose, S & Rand, R 2011 op cit (Bruce McPherson ILFN study at Falmouth)
 51. Numerous farmers in Australia have reported experiencing symptoms of ear pressure, tinnitus, vertigo, pressure bolt sensations, head pressure and headaches with a tight band across the forehead which they have come to associated very directly with exposure to operating wind turbines whilst working outside. One account by a farmer is that of Mr Andrew Gardner, in his statement of evidence for the Cherry Tree VCAT case in Victoria which can be accessed here: <http://waubrafoundation.org.au/resources/gardner-statement-vcat-cherry-tree-hearing/>
 52. Personal communication with Mr Les Huson and Dr Bob Thorne after discussion with them about multiple residents from wind developments in Australia who have reported symptoms consistent with the “pressure bolt” symptoms described by Mr Andrew “Gus” Gardner in his witness statement to the Cherry Tree case. Mr Gardner’s witness statement is here: <http://waubrafoundation.org.au/resources/gardner-statement-vcat-cherry-tree-hearing/> Mr Huson’s expert evidence concerning his acoustic findings of 86% direct correlation with what he described as “pressure transients “ in point number 3 of his expert opinion: <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/> and the case study from the UK which Mr Huson found useful to help explain the pressure peak transients can be accessed here: <http://waubrafoundation.org.au/resources/rushforth-et-al-case-study-low-frequency-noise-assessed-using-dinm-45680-criteria/> Dr Thorne’s paper on seismic impacts generated by wind turbines, which also mentions constructive interference, which Dr Thorne proposed as a possible explanation for the reported “pressure bolt” symptoms <http://waubrafoundation.org.au/resources/seismic-effect-residents-from-3-mw-wind-turbines/>
 53. Noted in 1985 by Kelley et al (op cit) but also with subsequent work by Van Den Berg and others. Van den Berg’s doctoral dissertation was published in 2006 **“The sound of high winds: The effect of atmospheric stability on wind turbine sound and microphone noise”** University of Groningen, Netherlands
<http://waubrafoundation.org.au/resources/van-den-berg-sounds-high-winds/>
 54. Iser, D 2004 report of results of research (the first population wind turbine noise & health impact survey), report to local council, letters to politicians <http://waubrafoundation.org.au/resources/dr-david-iser-2004-conducts-first-survey-patients-living-near-wind-project/>
 55. Kelley et al 1985 op cit <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/> The list of participating organizations are listed at the beginning of the document on page 3 of the electronic version. A concise summary of the findings are on page 4 – 7 of the 267 page electronic document, in the Summary section.
 56. Kelley, 1987 **“A proposed metric for assessing the potential for community annoyance from wind turbine low frequency noise emissions”** <http://waubrafoundation.org.au/resources/1987-problem-with-low-frequency-noise-from-wind-turbines-scientifically-identified/>
 57. Kelley et al 1985 op cit <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/> The list of participating organizations are listed at the beginning of the document on page 3 of the electronic version.
 58. Kelley et al 1985 op cit <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>. The intent of the major acoustic survey is specified in the summary
 59. Kelley et al 1985 op cit <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/> The summary is on pp 4 – 7 of the electronic document.
 60. Kelley et al 1985 op cit <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/> The listed perceptions / symptoms are from p 4
 61. Kelley 1987 op cit
 62. The Waubra Foundation has a copy of some of the conference proceedings from the AWEA 1987 conference. Dr Kelley’s 1987 paper was one of the conference papers presented.

63. The wind industry have confirmed that the downwind bladed design was changed and that as a result the new modern upwind turbines “do not generate (as much) infrasound”, but no data has been provided to substantiate this claim, because the regulatory authorities do not require it to be measured. As a result there is very little data publicly available accurately detailing actual full spectrum acoustic emissions from modern wind turbines.
64. Kelley et al 1985 op cit <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/> suggested maximum noise exposure limits for ILFN p 225
65. Kelley et al 1985 op cit pp 225
66. For example the joint South Australian EPA Resonate Acoustics report on **“infrasound levels near windfarms and other environments”** issued in early 2013 <http://waubrafoundation.org.au/resources/sa-epa-resonate-infrasound-levels-near-windfarms-other-environments/>
67. Hubbard, H 1982 **“Noise induced house vibrations and Human Perception”** <http://waubrafoundation.org.au/resources/hubbard-h-1982-noise-induced-house-vibrations-human-perception/>
68. Turnbull, C 2013 op cit <http://waubrafoundation.org.au/resources/turnbull-c-turner-j-recent-developments-wind-farm-noise-australia/>
69. SA EPA **“Windfarms environmental noise guidelines”** July 2009
70. Van Den Berg, doctoral dissertation 2006 op cit <http://waubrafoundation.org.au/resources/van-den-berg-sounds-high-winds/>
71. Graph is from Salt, A Kaltenbach, J 2011 **“Infrasound from Wind Turbines Could Affect Humans”**. Bulletin of Science, Technology and Science. (Aug 2011). 296-302. <http://waubrafoundation.org.au/resources/infrasound-from-wind-turbines-could-affect-humans-salt-kaltenbach/>
72. Van Den Berg, 2006 doctoral dissertation op cit <http://waubrafoundation.org.au/resources/van-den-berg-sounds-high-winds/>
73. Van Den Berg, 2006 op cit pp 17 of the print document, pp 26 / 210 of the electronic version gives the details of the Rhede wind development on the border of the Netherlands and Germany.
74. Farboud et al 2013 **“Wind Turbine Syndrome: Fact or Fiction?”** Journal of Otolaryngology, accepted for publication November, 2012, published January 2013 <http://waubrafoundation.org.au/resources/wind-turbine-syndrome-fact-or-fiction-farboud-et-al/>
75. NHMRC 2010 “Rapid Review”, unnamed author(s) <http://waubrafoundation.org.au/resources/nhmrc-wind-turbines-health-rapid-review-evidence-july-2010/> see also the audit by Horner, B <http://waubrafoundation.org.au/resources/brett-horner-audit-nhmrc-rapid-review/>
76. NHMRC 2010 “Rapid Review” op cit p 2 <http://waubrafoundation.org.au/resources/nhmrc-wind-turbines-health-rapid-review-evidence-july-2010/>
77. Kelley, N 1985 op cit pp 4 – 7 <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
78. Kelley, N 1985 op cit p 199 <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
79. Kelley, N 1985 op cit p 225 <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
80. Recommendations from the first Federal Senate inquiry into the Social and Economic Impact of Rural Wind farms, issued 24th June 2011 <http://waubrafoundation.org.au/resources/australian-federal-senate-inquiry-social-economic-effect-rural-wind-farms/>
81. Kelley et al 1985 op cit p 199 <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
82. Leventhall et al 2003 op cit p 60 <http://waubrafoundation.org.au/resources/review-published-research-low-frequency-noise-leventhall/>
83. Farboud et al, 2013 op cit p 4 of the final approved version submitted for publication <http://waubrafoundation.org.au/resources/wind-turbine-syndrome-fact-or-fiction-farboud-et-al/>
84. Professor Mariana Alves Pereira and Dr Nuno Castelo Branco head the VAD research team, which has worked for nearly three decades to explore and document the tissue pathological changes they observed to be caused by chronic exposure to ILFN in a variety of circumstances, initially predominantly occupational

exposure. Their work started with the observation by Dr Castelo Branco that there were some unusual symptoms and illnesses being diagnosed in the aviation workers for whom he had an occupational health and safety responsibility, including late onset epilepsy. His training as a pathologist led him to investigate the relevant tissue pathology in both humans where that was available (from incidental surgery and from autopsy findings) and animal models. There is very little research material on VAD relating specifically to wind turbine noise exposed humans, but there is one Portuguese case study where the characteristic findings of VAD were documented in both the resident and in his horses. Of concern is the finding of VAD characteristic changes in a young child, which improved with reduction in exposure when he and his mother moved away from the family home. The father remained to look after the animals and his health was documented to deteriorate. Details of their work and that case study can be found here: Review paper: <http://waubrafoundation.org.au/resources/vibroacoustic-disease-biological-effects-infrasound-alves-periera-castelo-branco/> and details of wind turbine induced VAD <http://waubrafoundation.org.au/resources/follow-up-study-family-exposed-low-frequency-noise/> and the latest update here: <http://waubrafoundation.org.au/resources/alves-periera-m-castelo-branco-n-ltr-australian-new-zealand-journal-public-health/>

85. Lousa et al 2003 paper published in the proceedings of IC BEN conference in Holland in 2003 <http://waubrafoundation.org.au/resources/lousa-et-al-rat-cochlea-exposed-low-frequency-noise/>
86. Personal communication with affected residents at Toora (silenced with a confidentiality agreement from speaking out publicly) and Cape Bridgewater (a former wind turbine construction worker who lived out near the Cape Bridgewater Wind development). Both these families were forced to leave their homes because of serious health problems, the resident from Toora was bought out by the then owner of the wind development.
87. Personal communication with Professor Alves Pereira
88. Personal communication with affected residents at Toora and Cape Bridgewater
89. Kelley et al 1985 op cit from page 225 of the report <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
90. Hillman, D & Lack, L **“Public health implications of sleep loss: the public health burden”** 21st October, 2013 published in Medical Journal of Australia supplement <http://waubrafoundation.org.au/resources/hillman-d-lack-l-public-health-implications-sleep-loss-community-burden-mja-oct-13/>
91. Hallstein, W Letter to Falmouth Board of Health, 2013 <http://waubrafoundation.org.au/resources/hallstein-w-falmouth-wind-turbines-sleep-deprivation-psychiatrist-weighs/>
92. Capuccio et al 2011 **“Sleep Duration predicts cardiovascular outcomes: a systemic review and meta-analysis of prospective studies”** European Heart Journal, (2011) 32, 1484–1492 <http://waubrafoundation.org.au/resources/sleep-duration-predicts-cardiovascular-outcomes/>
93. WHO 2009 **Night Noise Guidelines for Europe**, p 18 <http://waubrafoundation.org.au/resources/who-night-noise-guidelines-for-europe/>
94. Cerebellar ataxia – *“damage, degeneration or loss of nerve cells in the part of your brain that controls muscle coordination (cerebellum) results in ataxia”* <http://www.mayoclinic.org/diseases-conditions/ataxia/basics/causes/con-20030428>
95. Nystagmus - *“Nystagmus can be defined as a repetitive, involuntary, to and fro oscillation of the eyes”* <http://www.patient.co.uk/doctor/nystagmus>
96. Ptosis - *“a drooping of the upper eyelid”* http://www.rch.org.au/kidsinfo/fact_sheets/Ptosis_or_drooping_eyelid/
97. The description given by the residents who are affected in this way is quite specific. They describe a new pattern of sleep disturbance for them, in which they wake up suddenly, in an anxious frightened panicked state, feeling as if they have either just had a big fright, or a shot of strong coffee. They describe then feeling wide awake, and it takes them a significant period of time to get back to sleep. One resident from Glenthompson has told me of his observations of his wife who is badly affected – she will be sound asleep one minute and within a second wide awake and very anxious in the next minute, for no obvious reason. This pattern of sleep disturbance only happens to these people when they are exposed to the ILFN.
98. Reider, S 2013 testimony to Vermont State Legislature about the impact of wind turbines on his patients <http://waubrafoundation.org.au/resources/dr-sandy-reider-testimony-calls-for-moratorium-wind-farms/>

99. David Mortimer, the wind turbine host from Lake Bonney near Millient in South Australia is one resident who has been prepared to share his symptoms publicly, which include the characteristic sleep disturbance. His open letters to various politicians and health authorities (eg <http://www.windturbinesyndrome.com/2014/wind-turbine-host-has-textbook-wind-turbine-syndrome-the-disease-big-wind-denies-exists-australia/>) and his court statement for the Cherry Tree case <http://waubrafoundation.org.au/resources/david-mortimers-statement-cherry-tree-hearing-at-vcat-jan-2013/> give some indication of the pattern of his symptoms and how they vary with exposure. Most other residents are not prepared to speak out publicly because of the way they are then targeted in the media or because of local community pressures including intimidation from wind turbine hosts, family conflict, or concern about the backlash on other family members locally and socially. Sleep disturbance is the commonest reported symptom, and the community noise impact surveys of Scheider, Morris and Schafer at Cullerin, Waterloo and Macarthur respectively give some idea of the extent of the problems within a defined population. Schafer's survey at Macarthur was conducted before the development had been operational for a year – if the survey is repeated it is likely the numbers of those whose sleep is disturbed will be greater, unless they have abandoned their homes. The population noise impact surveys are available here: <http://waubrafoundation.org.au/library/community-noise-impact-surveys/>
100. McEwen, B 1998 ***Protective and Damaging Effects of Stress Mediators*** New England Journal of Medicine 1998, 338 171–179
101. Severe physiological stress observed in emus in Nova Scotia by their owners after wind turbines commenced operating nearby <http://waubrafoundation.org.au/resources/physiological-stress-emus-exposed-wind-turbine-infrasound-low-frequency-noise/>
102. Severe physiological stress observed in goats in Taiwan resulting in death after a wind development commenced operating nearby <http://waubrafoundation.org.au/2009/bbc-report-wind-farm-kills-taiwanese-goats/>
103. Middle aged fox terrier diagnosed with severe chronic stress of unknown cause after exposure to Cape Bridgewater wind turbines, and subsequently died. Owners had to leave their home because they too developed a range of serious symptoms, which resolved whenever they were away from their home unless they were exposed to other sources of ILFN. Working sheep dogs in Victoria and South Australia noted by their owners to be severely affected by the wind turbine noise in certain wind directions, and unable to work.
104. Cattle behaviour changed with exposure to operating wind turbines – noticeably more aggressive (Glen Brew, Victoria). Cattle noted to be more agitated and restless and have poorer weight gain when in paddock closer to wind turbines when compared to identical genetic stock pastured further away (per John Carter, NSW Beef Producer, Crookwell).
105. Multiple reports of horses being frightened by wind turbine noise and horses and sometimes humans suffering injuries as a result in some instances (Capital wind development).
106. Mikolajczak J et al *“Preliminary studies on the reaction of growing geese to the proximity of wind turbines”* Polish Journal of Veterinary Sciences (2013) Vol 16 No 4 pp 679 – 686
<http://waubrafoundation.org.au/resources/mikolajczak-j-et-al-preliminary-studies-growing-geese-proximity-wind-turbines/>
107. Phillips, C 2011 op cit <http://waubrafoundation.org.au/resources/properly-interpreting-epidemiologic-evidence-about-health-effects/>
108. The recent summary of the work of Professor Alec Salt and Professor Jeffrey Lichtenhan's team in exploring and documenting the neurophysiological mechanisms of how infrasound can affect the way the inner ear reacts to those sound frequencies under different conditions has greatly helped us understand why people are reporting the symptoms particularly in very quiet rural areas. Salt has showed that the inner ear is exquisitely sensitive to infrasound under those conditions. Their review article *“How does wind turbine noise affect people”* was published in Acoustics Today, Winter Edition, 2014 and can be downloaded from <http://waubrafoundation.org.au/resources/salt-n-lichtenhan-j-t-how-does-wind-turbine-noise-affect-people/>
109. Harry, A reported in 2007 on her survey conducted in 2003 <http://waubrafoundation.org.au/resources/dr-amanda-harry-groundbreaking-survey-sick-residents/>

110. Pierpont N 2009 *“Wind Turbine Syndrome, A report on a natural experiment”* available from study <http://waubrafoundation.org.au/resources/dr-nina-pierpont-submission-australian-senate-inquiry/>
111. Ibid pp 73 - 74
112. Chen, Qibai & Shi 2004 *“An Investigation on the Physiological and Psychological Effects of Infrasound on Persons”* Journal of Low Frequency Noise, Vibration, and Active Control Vol 23 no 1 pp 71 – 76
<http://waubrafoundation.org.au/resources/an-investigation-physiological-and-psychological-effects-infrasound-persons/>
113. See section 3.3
114. Iser, Dr David 2004 op cit <http://waubrafoundation.org.au/resources/dr-david-iser-2004-conducts-first-survey-patients-living-near-wind-project/>
115. Spring, Dr Wayne 2012 written testimony to Federal Senate Inquiry into Renewable Energy Act (Excessive Noise) <http://waubrafoundation.org.au/resources/sleep-physician-dr-wayne-j-spring-calls-for-noise-assessment/> ,
116. Hallstein, Dr William 2013 US Psychiatrist writes letter to Falmouth Board of Health
<http://waubrafoundation.org.au/resources/hallstein-w-falmouth-wind-turbines-sleep-deprivation-psychiatrist-weighs/>
117. Reider, Dr Sandy 2012 Vermont Legislature testimony <http://waubrafoundation.org.au/resources/dr-sandy-reider-testimony-calls-for-moratorium-wind-farms/>
118. Arra, Dr M and Lynn, Dr H 2013 Powerpoint of Literature Review
<http://waubrafoundation.org.au/resources/association-between-wind-turbine-noise-and-human-distress/>
119. Kelley, N et al 1985 op cit <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
120. James, R op cit 2012 <http://waubrafoundation.org.au/resources/james-r-warning-signs-that-were-not-heard/>
121. James, R & Bray W 2011 op cit Noise-Con Oregon <http://waubrafoundation.org.au/resources/bray-james-dynamic-measurements-wind-turbine-acoustic-signals-noise-con-2011/>
122. Rand, R 2011 Bruce McPherson ILFN study op cit <http://waubrafoundation.org.au/resources/bruce-mcpherson-infrasound-low-frequency-noise-study/> and Rand R 2012 op cit Shirley Wisconsin Cooperative Survey including Rand’s appendix <http://waubrafoundation.org.au/resources/co-operative-measurement-survey-analysis-low-frequency-infrasound-at-shirley-wind-farm/>
123. Ambrose, S 2011 Bruce McPherson ILFN study op cit <http://waubrafoundation.org.au/resources/bruce-mcpherson-infrasound-low-frequency-noise-study/>
124. Schomer, P 2012 op cit Shirley Wisconsin Cooperative Survey including Schomer’s appendix
<http://waubrafoundation.org.au/resources/co-operative-measurement-survey-analysis-low-frequency-infrasound-at-shirley-wind-farm/>
125. Thorne, R 2012 op cit <http://waubrafoundation.org.au/resources/wind-farm-generated-noise-and-adverse-health-effects/>
126. Cooper, S 2012 “Are wind turbines too close to communities: conference paper
<http://waubrafoundation.org.au/resources/are-wind-farms-too-close-communities/>
127. Huson, L 2014 <http://waubrafoundation.org.au/resources/huson-l-amplitude-modulation-case-study-at-leonards-hill-wind-farm-victoria-australia/>
128. Hansen, C November 2012 <http://waubrafoundation.org.au/resources/hansen-et-al-wind-farm-noise-what-reasonable-limit-rural-areas/> and letter to Victorian Health Department describing his findings at Waterloo
<http://waubrafoundation.org.au/resources/prof-colin-hansen-writes-victorian-dept-health-recent-wind-farms-health-doc/>
129. Doolan, C November 2012 <http://waubrafoundation.org.au/resources/hansen-et-al-wind-farm-noise-what-reasonable-limit-rural-areas/> and Nobbs, Doolan and Moreau, 2012 *“Characterisation: noise in homes affected by wind turbine noise”* <http://waubrafoundation.org.au/resources/characterisation-noise-homes-affected-by-wind-turbine-noise/>
130. Linke, M Witness statement re experience living next to Macarthur wind development, for Cherry Tree case in Victoria in 2013 <http://waubrafoundation.org.au/resources/linke-m-witness-statement-vcat-cherry-tree-hearing/>
131. Berglund B & Lindquist, T 1995 op cit see footnote 9

132. Huson, L extract from expert evidence given in Cherry Tree case, relating to acoustic measurements from AGL's Macarthur Wind development and Hepburn Wind's Leonard's Hill wind development <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/>
133. Schomer P et al 2013 Denver op cit <http://waubrafoundation.org.au/resources/schomer-et-al-wind-turbine-noise-conference-denver-august-2013/>
134. Personal communication, David & Alida Mortimer, reported also in the media, and further details in witness statement for Cherry Tree <http://waubrafoundation.org.au/resources/david-mortimers-statement-cherry-tree-hearing-at-vcat-jan-2013/> and open letter op cit <http://www.windturbinesyndrome.com/2014/wind-turbine-host-has-textbook-wind-turbine-syndrome-the-disease-big-wind-denies-exists-australia/>
135. For example the En Health 2004, and WHO publications of Community noise (1995 & 1999), Night Noise Guidelines for Europe 2009 and Environmental Noise Burden of Disease 2011 previously cited.
136. Pierpont, 2009 op cit <http://waubrafoundation.org.au/resources/dr-nina-pierpont-submission-australian-senate-inquiry/> Professor Geoffrey Leventhall has acknowledged during cross examination by Eric Gillespie in court proceedings in Ontario that Dr Pierpont had identified risk factors (Personal communication). Pierpont's work is being further externally validated because others are identifying previous research indicating that motion sickness may have been influenced by ILFN (Schomer 2013, Denver op cit <http://waubrafoundation.org.au/resources/schomer-et-al-wind-turbine-noise-conference-denver-august-2013/>) and that wind turbine syndrome may be a variant of migraine which has long been known to be triggered by sound energy impulses (Dr Hakan Enbom, Sweden <http://waubrafoundation.org.au/resources/enbom-e-i-infrasound-from-wind-turbines-an-overlooked-health-hazard/>) so the connections between vestibular disorders, , migraines, motion sickness and development of symptoms induced by exposure to ILFN have numerous cross disciplinary connections
137. WHO Night Noise Guidelines for Europe (information about Environmental Sleep disorder), 2009, op cit, Capuccio et al meta analysis op cit <http://waubrafoundation.org.au/resources/sleep-duration-predicts-cardiovascular-outcomes/>, Munzel et al 2014 Cardiovascular effects of environmental noise exposure <http://waubrafoundation.org.au/resources/munzel-t-et-al-cardiovascular-effects-environmental-noise-exposure/> and finally McEwen, B 1998 op cit NEMJ
138. Hallstein, 2013 letter to Falmouth Board of Health op cit <http://waubrafoundation.org.au/resources/hallstein-w-falmouth-wind-turbines-sleep-deprivation-psychiatrist-weighs/>
139. Personal communication, residents from Waterloo Waubra, Cullerin, Cape Bridgewater, Macarthur
140. Much of this early European work is cited in the Arra and Lynn literature review, op cit <http://waubrafoundation.org.au/resources/association-between-wind-turbine-noise-and-human-distress/> and is discussed in much greater detail in the NHMRC's recently issued 2014 Systematic Literature Review however the authors of that document ignored Moller & Pedersen's seminal work showing that as the size and power generating capacity of wind turbines increases so too does the LFN and consequently the annoyance can be predicted to increase for the neighbours. A more useful analysis which explores some of these issues is one by Jim Cummings from the Acoustic Ecology institute (see graph on page 42 for comparison between rural and more urban areas with wind turbines <http://waubrafoundation.org.au/resources/cummings-j-acoustic-ecology-institute-wind-farm-noise-2011/>
141. Harry A 2007 op cit <http://waubrafoundation.org.au/resources/dr-amanda-harry-groundbreaking-survey-sick-residents/>
142. Carmen Krogh and her co researchers have documented in detail the information gathered from the WindVOICE survey, and other detailed information from individual families in Ontario. Much of that work is accessible via www.wind-watch.org and Canadian websites. One report is available here: <http://waubrafoundation.org.au/resources/3095/>
143. Iser, D 2004 op cit <http://waubrafoundation.org.au/resources/dr-david-iser-2004-conducts-first-survey-patients-living-near-wind-project/>
144. Photographic evidence of one of the Toora homes being bulldozed can be found here with some commentary <http://www.windturbinesyndrome.com/2010/australia-2/> There is also an old current affairs program on sixty minutes which features Toora, and some of the residents who are now gagged and cannot speak publicly <http://waubrafoundation.org.au/resources/wind-storm-sixty-minutes-story-about-wind-farm-woes-at-toora-wind-farm-victoria/> and finally there is the evidence from the lawyers who acted for

the Toora residents, who confirmed that there were such clauses in the agreements their clients signed:

- <http://waubrafoundation.org.au/resources/slater-gordon-acknowledge-confidentiality-clauses/>
145. Pierpont, N 2009 op cit <http://waubrafoundation.org.au/resources/dr-nina-pierpont-submission-australian-senate-inquiry/>
 146. Wang, “Frank” Zhenhua 2011 **“Evaluation of wind farm policies in South Australia”** briefing summary <http://waubrafoundation.org.au/resources/evaluation-wind-farm-noise-policies-south-australia/>
 147. Morris, M 2012 **“Community noise impact survey, Waterloo wind farm, 2012”** <http://waubrafoundation.org.au/resources/waterloo-wind-farm-survey-2012/>
 148. Schafer, A 2013 **“Macarthur wind energy facility preliminary survey”** August 2013 <http://waubrafoundation.org.au/resources/macarthur-wind-energy-facility-preliminary-survey/>
 149. Linke, M 2013 op cit <http://waubrafoundation.org.au/resources/linke-m-witness-statement-vcat-cherry-tree-hearing/>
 150. Hetherington, J 2013 statement given of experiences living next to Macarthur wind development, for the Cherry Tree case in Victoria <http://waubrafoundation.org.au/resources/hetherington-j-witness-statement-vcat-cherry-tree-tribunal/>
 151. Gardner, Andrew “Gus” 2013 witness statement about “pressure bolt” sensations whilst living and working beside Macarthur wind development <http://waubrafoundation.org.au/resources/gardner-statement-vcat-cherry-tree-hearing/>
 152. Huson, L 2013 extract from expert witness statement for Cherry Tree op cit <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/>
 153. Rushforth, I Moorhouse, A and Styles, P 2003 “A case study of low frequency noise assessed using DIN 45680 Criteria” *Journal of Low Frequency Noise, Vibration and Active Control* pp 181 – 198 <http://waubrafoundation.org.au/resources/rushforth-et-al-case-study-low-frequency-noise-assessed-using-dinm-45680-criteria/>
 154. Schneider, P 2012 **“Cullerin Range wind farm survey, August 2012”** <http://waubrafoundation.org.au/resources/cullerin-range-wind-farm-survey-august-2012/>
 155. Schneider, P 2013 **“Cullerin Range wind farm survey followup August 2013”** <http://waubrafoundation.org.au/resources/schneider-p-cullerin-range-wind-farm-survey-follow-up-july-august-2013/>
 156. Thorne, R 2012 **“Windfarm generated noise and adverse health effects”** case series submitted to the second Federal Senate Inquiry into wind turbine noise issues, held in November, 2012 <http://waubrafoundation.org.au/resources/wind-farm-generated-noise-and-adverse-health-effects/>
 157. Shepherd, D et al 2011 op cit <http://waubrafoundation.org.au/resources/evaluating-impact-wind-turbine-noise-health-related-quality-life/>
 158. Nissenbaum, M et al 2012 op cit <http://waubrafoundation.org.au/resources/effects-industrial-wind-turbine-noise-sleep-and-health/>
 159. Arra, M & Lynn H 2013 op cit <http://waubrafoundation.org.au/resources/association-between-wind-turbine-noise-and-human-distress/>
 160. Thorne, R 2012 op cit page 27
 161. Thorne, R 2012 op cit Table 3.1.2 at the bottom of page 8
 162. Thanks to the Australian Acousticians who helped explain this distinction between acousticians and psychoacousticians, and also the variable backgrounds of the acoustics professionals.
 163. Code of ethics Australian acoustical society <http://waubrafoundation.org.au/resources/acoustic-organisation-codes-conduct/>
 164. Code of ethics, British Institute of Acoustics <http://waubrafoundation.org.au/resources/acoustic-organisation-codes-conduct/>
 165. Canon of ethics, Institute of Noise Control Engineers (INCE) in North America <http://waubrafoundation.org.au/resources/acoustic-organisation-codes-conduct/>
 166. See footnotes 119 – 129 for links to the work of these acoustic consultants
 167. Walker, Hessler, Rand & Schomer December 2012 **“Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm”** <http://waubrafoundation.org.au/resources/co-operative-measurement-survey-analysis-low-frequency-infrasound-at-shirley-wind-farm/>

168. Correspondence between Mr Warpenius and various others, including particularly the AAAC Position statement, which is available directly from here: <http://waubrafoundation.org.au/wp-content/uploads/2013/09/AAAC-Wind-Farm-Position-Statement.pdf> .
<http://waubrafoundation.org.au/resources/assoc-australian-acoustical-consultants-position-statement-wind-farms/> <http://waubrafoundation.org.au/resources/aaac-chairman-responds-waubra-foundation-chairmans-letter/>
169. Huson, L 2013 op cit <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/> and his case study on Leonards Hill is here:
<http://waubrafoundation.org.au/resources/huson-l-amplitude-modulation-case-study-at-leonards-hill-wind-farm-victoria-australia/>
170. James, R 2012 op cit <http://waubrafoundation.org.au/resources/james-r-warning-signs-that-were-not-heard/>
171. Video footage and presentation materials from the NHMRC workshop speakers including Professor Leventhall in June 2011 is available on the NHMRC website at
<http://www.nhmrc.gov.au/media/events/2011/wind-farms-and-human-health-scientific-forum-7-june-2011>
172. Leventhall, G in written and oral evidence given in the Bull Creek case, BluEarth Renewables, before the Alberta Utilities Commission, November 2013. Similar comments were made in an article called "**Concerns about infrasound from wind turbines**" published in Acoustics Today in Volume 9, issue no 3.
173. Schomer, P "**Comments on recently published article "concerns about infrasound from wind turbines"**" published in volume 9, issue 4, October 2013 of Acoustics Today, in response to a previous article by Professor Leventhall.
174. Spring, W 2012 op cit <http://waubrafoundation.org.au/resources/sleep-physician-dr-wayne-j-spring-calls-for-noise-assessment/> . Dr Spring also chose to be interviewed for the Waubra Foundation video after the ABC Four Corners team refused to interview him for a program called "Against the Wind" which went to air in July 2011. The video footage of Dr Spring speaking can be viewed here:
<http://waubrafoundation.org.au/library/section/professionals-speaking-out/> along with many other professionals speaking out. The direct link to the Waubra Foundation video is
<http://waubrafoundation.org.au/resources/video-wind-turbines-public-health/>
175. Hanning, C & Evans A "**Wind turbine noise seems to affect health adversely; an independent review of evidence is needed.**" BMJ 2012: 344 e 1527 <http://www.wind-watch.org/documents/wind-turbine-noise-editorial/>
176. Trish Godfrey's story on Current Affair 2009 <http://waubrafoundation.org.au/resources/channel-9-current-affair/>
177. Cheryl Hall's story in February, 2010 about the confidentiality agreement with Mrs Godfrey
<http://waubrafoundation.org.au/resources/abc-tv-stateline-2/>
178. The material has been published on line on various websites including ABC "the Drum", Crikey.com, The Conversation website and others including Yes 2 Renewables and online renewable energy business sites such as Renew Economy, Climate and Business Spectator. Some of the links were detailed in my open letter to Professor Chapman after a piece was published in the New Scientist and Australian Science
<https://www.wind-watch.org/documents/letter-from-sarah-laurie-to-simon-chapman/>
179. Chapman et al's paper can be accessed at the following link,
<http://waubrafoundation.org.au/resources/chapmans-et-al-evidence-for-psychogenic-communicated-disease-hypothesis/> and it was critiqued by experts in medicine (McMurtry),
<http://waubrafoundation.org.au/resources/dr-robert-mcmurtry-commentary-chapman-nocebo-paper/> and evaluation of expert scientific evidence (Hartman) <http://waubrafoundation.org.au/resources/hartman-scientific-response-its-all-your-head-nocebo/> My critical analysis of Chapman's study is here:
<http://waubrafoundation.org.au/resources/critical-analysis-accuracy-complaints-data-from-chapman-et-al-nocebo-research/> Chapman's work relies heavily on the laboratory experimental work of a PhD student from New Zealand, Ms Fiona Crichton. Her research is accessible here:
<http://waubrafoundation.org.au/resources/crichtonf-et-al-can-expectations-produce-symptoms-infrasound-and-wind-turbines/> and it was critiqued by an expert acoustician (Swinbanks)
<http://waubrafoundation.org.au/resources/swinbanks-can-expectations-produce-symptoms-from->

[infrasound/](#) and an expert audiologist (Punch)

<http://waubrafoundation.org.au/resources/review-crichton-et-al-can-expectations-produce-symptoms-from-infrasound/>

180. Launch of the VESTAS “Act on Facts” campaign was assisted by wind energy advocates and proponents of the “nocebo” hypothesis in Australia including Professor Simon Chapman, Ms Fiona Armstrong CEO of the Climate and Health Alliance, Mr Simon Holmes a Court from Hepburn Wind, and others
<http://www.windpowermonthly.com/article/1186524/vestas-leads-campaign-fight-anti-wind-groups>
181. Kelley, N et al 1985 op cit for the large acoustic survey and Kelley N 1987 op cit for the laboratory research
182. A transcript of Dr David Black’s evidence given in the Cherry Tree case can be found here:
<http://waubrafoundation.org.au/resources/cherry-tree-vcat-hearing-evidence-dr-david-black/>
183. Written and oral testimony of Dr Robert McCunney seen in the Bull Creek BluEarth Renewables case in Alberta in November, 2013 before the Alberta Utilities Commission.
184. Letter from Slater and Gordon published in the Australian <http://waubrafoundation.org.au/resources/slater-gordon-acknowledge-confidentiality-clauses/>
185. List of professionals published on the European Platform against windfarms website can be accessed here:
<http://www.epaw.org/documents.php?article=ns53>
186. Darmstadt Manifesto 1st September, 1998 <http://waubrafoundation.org.au/resources/darmstadt-manifesto-1st-september-1998/>
187. Senator John Madigan’s speech to the Australian Federal Senate and the ministerial briefing note which it refers to can be accessed here: <http://waubrafoundation.org.au/resources/madigan-sen-j-speech-australian-senate-about-non-compliant-wind-farms/>
188. Minutes from the Pyrenees Shire Council meeting <http://waubrafoundation.org.au/2013/dwellings-within-2km-wind-turbines-have-potential-be-profoundly-noise-affected/>
189. Residents who describe this psychological distress from being let down by their governments and others who have a duty of care towards them to “first do no harm” include Hubert de Bonneville in France (see <http://www.windturbinesyndrome.com/2012/the-private-horror-of-wind-turbine-syndrome-a-true-story-france/>), and Melissa Ware, from Cape Bridgewater in Australia (see for example her recent letter to the Victorian Chief Health Officer, (<http://waubrafoundation.org.au/resources/ware-melissa-calls-chief-health-officer-help-end-suffering-at-cape-bridgewater/>)). Barbara Ashbee and Carmen Krogh from Ontario have both spoken about this problem publicly and privately. There are other examples on websites such as www.globalwindenergyimpact.com and www.illwind.com, and contained in letters and submissions to politicians and parliamentary inquiries
190. Mortimer, D op cit <http://waubrafoundation.org.au/resources/david-mortimers-statement-cherry-tree-hearing-at-vcat-jan-2013/>
191. Mortimer, D op cit open letter <http://www.windturbinesyndrome.com/2014/wind-turbine-host-has-textbook-wind-turbine-syndrome-the-disease-big-wind-denies-exists-australia/>
192. Most of the professionals named have already been referred to, with the exception of Dr Robert McMurtry whose case definition appears here, <http://waubrafoundation.org.au/resources/facilitating-clinical-diagnosis/> and Dr Malcolm Swinbanks, British Acoustician, whose paper highlighting the old research detailing physiological perception of infrasound below the threshold of audible perception appears here: <http://waubrafoundation.org.au/resources/numerical-simulation-infrasound-perception-with-reference-reported-laboratory-effects/>
193. Salt, A & Lichtenhan, J 2014 Acoustics Today, Winter edition op cit
<http://waubrafoundation.org.au/resources/salt-n-lichtenhan-j-t-how-does-wind-turbine-noise-affect-people/>
194. Personal communication, Dr Paul Schomer
195. Schomer, P et al 2013 paper presented to the 5th International Wind Turbine Noise conference in Denver “**A proposed theory to explain some adverse physiological effects of the infrasonic emissions at some wind farm sites**” <http://waubrafoundation.org.au/resources/schomer-et-al-wind-turbine-noise-conference-denver-august-2013/>
196. Professor Salt’s many research papers on infrasound and inner ear research can be accessed from his website at <http://oto.wustl.edu/cochlea/wind.html> including Salt, A Lichtenhan, J 2012 “**Perception-based protection from low-frequency sounds may not be enough**” presented at the Internoise conference in New York, August, 2012 <http://waubrafoundation.org.au/resources/perception-based-protection-from-low->

[frequency-sounds-may-not-be-enough/](#) See also his recent summary

<http://waubrafoundation.org.au/resources/salt-n-lichtenhan-j-t-how-does-wind-turbine-noise-affect-people/>

197. Swinbanks, M “**Numerical simulation of infrasound perception with reference to reported laboratory effects**” August 2012, Internoise conference New York
<http://waubrafoundation.org.au/resources/numerical-simulation-infrasound-perception-with-reference-reported-laboratory-effects/>
198. Kelley, N et al 1985 op cit pp 225 for the recommended exposure threshold levels for infrasound and low frequency noise, based on their acoustic field survey results and annoyance thresholds.
199. Salt, A & Lichtenhan, J 2014 Acoustics Today, op cit <http://waubrafoundation.org.au/resources/salt-n-lichtenhan-j-t-how-does-wind-turbine-noise-affect-people/>
200. Swinbanks, M “**Numerical simulation of infrasound perception with reference to reported laboratory effects**” August 2012, Internoise conference New York
<http://waubrafoundation.org.au/resources/numerical-simulation-infrasound-perception-with-reference-reported-laboratory-effects/>
201. Chen, Qibai & Shi 2004 “**An Investigation on the Physiological and Psychological Effects of Infrasound on Persons**” <http://waubrafoundation.org.au/resources/an-investigation-physiological-and-psychological-effects-infrasound-persons/>
202. Swinbanks, M 2012 Internoise op cit <http://waubrafoundation.org.au/resources/numerical-simulation-infrasound-perception-with-reference-reported-laboratory-effects/>
203. Chen, Qibai & Shi 2004 op cit <http://waubrafoundation.org.au/resources/an-investigation-physiological-and-psychological-effects-infrasound-persons/>
204. Personal communication, Dr Bruce Rapley, phone conversation in 2014. Additional references can be found from the section relating to animals and infrasound at <http://en.wikipedia.org/wiki/Infrasound>
205. See Dr Sandy Reider’s description of what his patient experienced
<http://waubrafoundation.org.au/resources/dr-sandy-reider-testimony-calls-for-moratorium-wind-farms/>
206. Personal communication, Dr Bruce Rapley, New Zealand, who recently completed his PhD in the field of infrasound and its effect on human cognition
207. Professor Alec Salt’s interview with Alan Jones, <http://waubrafoundation.org.au/resources/2gb-alan-jones-interviews-professor-alec-salt/> see also Salt, A & Lichtenhan, J 2014 Acoustics Today op cit pp 24, with particular reference to section 3 which is titled “Excitation of outer hair cell afferent nerve pathways”
<http://waubrafoundation.org.au/resources/salt-n-lichtenhan-j-t-how-does-wind-turbine-noise-affect-people/>
208. Kelley, N et al 1985 op cit pp 225 for the criteria listed for noise pollution regulations in order to protect people’s health, which were consistent with Harvey Hubbard’s results Kelley, N et al 1985 op cit pp 225 for the recommended exposure threshold levels for infrasound and low frequency noise, based on their acoustic field survey results and annoyance thresholds.
209. Pierpont, N 2009 study, op cit <http://waubrafoundation.org.au/resources/dr-nina-pierpont-submission-australian-senate-inquiry/>
210. Pierpont, N 2009 executive summary, op cit <http://waubrafoundation.org.au/resources/wind-turbine-syndrome-executive-summary/>
211. Ibid
212. Ibid
213. Ibid
214. Pierpont, N 2009 Peer Reviewer’s comments <http://waubrafoundation.org.au/resources/wind-turbine-syndrome-peer-reviews/>
215. Black, O 2009 expert witness statement <http://waubrafoundation.org.au/resources/dr-owen-f-black-md-neuro-otologist-re-wind-turbine-syndrome/> and see also his qualifications and experience which were listed in a post humorous tribute to him in the Journal of Vestibular research:
<http://waubrafoundation.org.au/resources/dr-f-owen-black-m-d-memorium/>
216. Farboud et al 2013 op cit quote from the conclusion is on p 5 of prepublication print copy
<http://waubrafoundation.org.au/resources/wind-turbine-syndrome-fact-or-fiction-farboud-et-al/>
217. Ibid pp p4 under the section titled “what is not known”

218. A useful history of ETSU was written by Cox, Unwin and Sherman 2012 “Where ETSU is silent” and section 2 outlines the history of who was involved and the conflicts of interest:
<http://waubrafoundation.org.au/resources/cox-unwin-sherwin-where-etsu-silent-wind-turbine-noise/>
219. Farboud et al 2013 op cit quote is on p 4 of prepublication print copy
<http://waubrafoundation.org.au/resources/wind-turbine-syndrome-fact-or-fiction-farboud-et-al/>
220. Ibid p 4
221. Enbom & Enbom 2013 “*Infrasound from wind turbines, an overlooked health hazard*” from a Swedish Medical Journal *Läkartidningen*, vol. 110 (2013), pp. 1388–89.
<http://waubrafoundation.org.au/2013/swedish-doctors-call-infrasound-from-wind-turbines-an-overlooked-health-hazard/>
222. Ibid
223. **Dr Linda Benier** ENT specialist from Quebec stated “As a specialist in oto-rhino-laryngology, there is no doubt in my mind that the harmful effects that have been described actually occur. The level of audible disturbance can easily be measured, although the guidelines need to be adjusted to take into account the low-frequency noise. Many studies have dealt with the effects of noise on the inner ear, but unfortunately not many studies can be found dealing with or proving the effects of these vibrations on the inner ear, and this is mainly where the problem lies” <http://www.windturbinesyndrome.com/2011/40-doctors-sign-wind-turbine-syndrome-petition-quebec/> and **Dr Steve Rauch**, ENT specialist from Harvard who has treated patients from Falmouth, USA quoted in Salt & Lichtenhan’s recent Acoustics Today article on the first page <http://waubrafoundation.org.au/resources/salt-n-lichtenhan-j-t-how-does-wind-turbine-noise-affect-people/>
224. Crichton, F et al 2013 “*Can expectations produce symptoms from infrasound associated with wind turbines?*” <http://waubrafoundation.org.au/resources/crichtonf-et-al-can-expectations-produce-symptoms-infrasound-and-wind-turbines/>
225. Swinbanks, M critique of Crichton et al 2013 <http://waubrafoundation.org.au/resources/swinbanks-can-expectations-produce-symptoms-from-infrasound/>
226. Punch, J critique of Crichton et al 2013 <http://waubrafoundation.org.au/resources/review-crichton-et-al-can-expectations-produce-symptoms-from-infrasound/>
227. James, R 2012 op cit Warnings that were not heard <http://waubrafoundation.org.au/resources/james-r-warning-signs-that-were-not-heard/>
228. Kelley, N et al 1985 op cit and Kelley, N 1987 op cit
229. For example the residents down at Pt Cambell, living with impulsive Gas fired power station noise (see <http://waubrafoundation.org.au/2014/victorian-epa-issue-noise-abatement-notice-origins-gas-plant-port-campbell/>
230. For example the noise problems at the Tara Gas Field, in Qld <http://waubrafoundation.org.au/2013/report-tara-gas-field-health-survey-released/>
231. For example the problems documented by Sharyn Munro in chapter 5 of her book Rich Land Waste Land, some details are accessible from this speech <http://waubrafoundation.org.au/resources/rich-land-waste-land-how-coal-killing-australia-sharyn-munro/>
232. Chapman S et al <http://waubrafoundation.org.au/resources/chapmans-et-al-evidence-for-psychogenic-communicated-disease-hypothesis/>
233. Chapman helps VESTAS launch their global product defence strategy – to deny what they had known years earlier about wind turbine noise generated by their product: <http://waubrafoundation.org.au/2014/public-statement-home-abandonment-due-environmental-noise-pollution/>
234. Open Letter from Sarah Laurie to Simon Chapman 2012 op cit <https://www.wind-watch.org/documents/letter-from-sarah-laurie-to-simon-chapman/>
235. McMurtry, R critique of Chapman et al 2013 <http://waubrafoundation.org.au/resources/dr-robert-mcmurtry-commentary-chapman-nocebo-paper/>
236. Two examples in the public domain about wind companies underrecording complaints are from Rikki Nicholson, who complained to Pacific Hydro at Cape Bridgewater for a long time but reportedly they didn’t count them as complaints because they didn’t issue him with a complaint number. Donald Thomas has a similar story with Acciona at Waubra, who did not record complaints accurately until the locals started demanding that complaint numbers to be given.

237. Schneider, P 2013 op cit
<http://waubrafoundation.org.au/resources/schneider-p-culler-in-range-wind-farm-survey-follow-up-july-august-2013/>
238. Media items about wind turbine noise affected residents reporting symptoms before the Waubra Foundation was established include the following items from Toora and Waubra
<http://waubrafoundation.org.au/resources/wind-storm-sixty-minutes-story-about-wind-farm-woes-at-toora-wind-farm-victoria/> , <http://waubrafoundation.org.au/resources/channel-9-current-affair/> ,
<http://waubrafoundation.org.au/resources/abc-tv-stateline-2/> ,
<http://waubrafoundation.org.au/resources/farmers-flee-as-turbines-trigger-despair/farmers-flee-as-turbines-trigger-despair-australian-lauren-wilson-22-8-09/>
239. Admission by Slater and Gordon about wind turbine neighbouring residents being bought out
<http://waubrafoundation.org.au/resources/slater-gordon-acknowledge-confidentiality-clauses/> but see also this link for further background about homes being bulldozed when they had become unlivable:
<http://www.windturbinesyndrome.com/2010/australia-2/>
240. For example Mrs Rose Anable, who has chosen to speak out after years of ridicule and difficult local community division – footage of her is available here: <http://waubrafoundation.org.au/resources/video-wind-turbines-public-health/>
241. Iser, D op cit <http://waubrafoundation.org.au/resources/dr-david-iser-2004-conducts-first-survey-patients-living-near-wind-project/>
242. Peer reviewed published literature and conference papers include opinions that the current wind turbine noise guidelines do not protect people adequately (eg Dickinson 2009 “**A Pragmatic View of a Wind Turbine Noise Standard**” <http://waubrafoundation.org.au/resources/pragmatic-view-wind-turbine-noise-standard/> and Hansen et al 2012 “**Wind Farm Noise: What is a reasonable limit in rural areas?**” <http://waubrafoundation.org.au/resources/hansen-et-al-wind-farm-noise-what-reasonable-limit-rural-areas/> Finally the first peer reviewed published paper with documented measurements of wind turbine generated infrasound out to 10km authored by Andy Metalka from Canada has been accepted for publication in the Journal of the Acoustic Society of America (personal communication from Rick James, from his opening address to the Alberta Utilities Commission in the Bull Creek case, November, 2013)
243. Acoustic Field research includes: **William Willshire** (NASA 1985) measured wind turbine generated infrasound out to 10km away from a single wind turbine generator.
<http://waubrafoundation.org.au/resources/nasa-long-range-down-wind-propagation-low-frequency-sound/> Acousticians such as **Cooper 8km away figure 11** (<http://waubrafoundation.org.au/resources/are-wind-farms-too-close-communities/>), **Huson 6.4km away with no attenuation of infrasound from the levels at 1.8km** <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/>, and **Hansen (under the right meteorological conditions people’s sleep will be impacted 5-10km away from the nearest wind turbine)** <http://waubrafoundation.org.au/resources/prof-colin-hansen-writes-victorian-dept-health-recent-wind-farms-health-doc/>.
244. Adverse Health Event reports and related studies include **Dr Bob Thorne’s** 2012 Victorian case series submitted to the Federal Senate Inquiry (with comparison to population norms for some of his data) together with acoustic measurements to get an understanding of people’s acoustic exposures (<http://waubrafoundation.org.au/resources/wind-farm-generated-noise-and-adverse-health-effects/>) as well as material from Ontario by **Krogh**, et al (eg WindVoice data and associated reports but distances are generally much closer in Ontario with setbacks only 550 metres)
245. Noise **impact** surveys conducted recently in Australia near 2 – 3 MW turbines <http://waubrafoundation.org.au/library/community-noise-impact-surveys/> are showing effects after only a few months of operation out to nearly 10km at Macarthur wind development (Schafer <http://waubrafoundation.org.au/resources/macarthur-wind-energy-facility-preliminary-survey/>), and after a few years the same at Waterloo (Morris <http://waubrafoundation.org.au/resources/waterloo-wind-farm-survey-2012/>) with more people reporting they are noticing adverse effects on their sleep with prolonged exposure (Culler-in – Schneider 2012 survey <http://waubrafoundation.org.au/resources/culler-in-range-wind-farm-survey-august-2012/> and the following year <http://waubrafoundation.org.au/resources/schneider-p-culler-in-range-wind-farm-survey-follow-up-july-august-2013/>).
246. See section on sleep 2.1
247. See section on stress 2.2

248. Moller & Pedersen 2011 **"Low Frequency Noise from Large Turbines"** J Acoustical Society America 2011 129: 3727 – 3744 <http://waubrafoundation.org.au/resources/moller-pedersen-low-frequency-noise-from-large-wind-turbines/>
249. Morris, M 2012 op cit <http://waubrafoundation.org.au/resources/waterloo-wind-farm-survey-2012/> and 2013 Case Series preliminary report, documenting what happened when the turbines were unexpectedly off for a week at Waterloo because of a cabling fault <http://waubrafoundation.org.au/resources/morris-m-waterloo-case-series-preliminary-report/>
250. Schneider, op cit 2012 and 2013 at Cullerin <http://waubrafoundation.org.au/resources/cullerin-range-wind-farm-survey-august-2012/> and <http://waubrafoundation.org.au/resources/schneider-p-cullerin-range-wind-farm-survey-follow-up-july-august-2013/>
251. Schafer, A preliminary survey at Macarthur 2013 <http://waubrafoundation.org.au/resources/macarthur-wind-energy-facility-preliminary-survey/>
252. Mortimer, D 2013 Cherry Tree statement op cit <http://waubrafoundation.org.au/resources/david-mortimers-statement-cherry-tree-hearing-at-vcat-jan-2013/> and open letter <http://waubrafoundation.org.au/resources/mortimer-david-open-letter-from-wind-turbine-host/>
253. Cooper, S 2012 "Are Wind Turbines too close to Communities" conference presentation and paper **figure 11** turbine 8km away from resident (<http://waubrafoundation.org.au/resources/are-wind-farms-too-close-communities/>)
254. Dickinson, P 2009 **"A Pragmatic View of a Wind Turbine Noise Standard"** <http://waubrafoundation.org.au/resources/pragmatic-view-wind-turbine-noise-standard/>
255. Personal communication, Mary Morris and op cit Morris, M 2012 op cit <http://waubrafoundation.org.au/resources/waterloo-wind-farm-survey-2012/> and 2013 Case Series preliminary report, documenting what happened when the turbines were unexpectedly off for a week at Waterloo because of a cabling fault <http://waubrafoundation.org.au/resources/morris-m-waterloo-case-series-preliminary-report/>
256. Pierpont, N 2009 Case Histories <http://waubrafoundation.org.au/resources/dr-nina-pierpont-submission-australian-senate-inquiry/>
257. Bronzaft, A 2011 **"Wind Turbine Noise, potential adverse impacts on children's wellbeing"** <http://waubrafoundation.org.au/resources/bronzaft-wind-turbine-noise-potential-adverse-impacts-childrens-well-being/>
258. Huson, L 2013 op cit <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/>
259. Willshire, W 1985 op cit (NASA) measured wind turbine generated infrasound out to 10km away from a single wind turbine generator. <http://waubrafoundation.org.au/resources/nasa-long-range-down-wind-propagation-low-frequency-sound/>
260. Huson, L 2013 op cit <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/> and <http://waubrafoundation.org.au/resources/huson-l-amplitude-modulation-case-study-at-leonards-hill-wind-farm-victoria-australia/>
261. Huson, L 2013 op cit <http://waubrafoundation.org.au/resources/huson-l-expert-evidence-at-vcat-cherry-tree-hearing/>
262. McEwen, B 1998 op cit *"Protective and damaging effects of stress mediators"* NEJM 1998 Vol 3 No 338 pp 171 - 179
263. Laurie, S Open letter to the South Australian Premier calling for a full open inquiry into the EPA and its conduct at Waterloo during the recent Acoustic survey <http://waubrafoundation.org.au/resources/open-letter-premier-south-australia-clean-energy-regulator-concerning-sa-epa-acoustic-survey-2/>
264. Some of the government and industry reports we regard as not being satisfactory include those at the following weblink, where critiques of the documents are also located for convenience – <http://waubrafoundation.org.au/information/acousticians-noise-regulators/reports-critiques/>
265. NHMRC 2010 Rapid Review <http://waubrafoundation.org.au/resources/nhmrc-wind-turbines-health-rapid-review-evidence-july-2010/>
266. Critiques of the NHMRC 2010 Rapid Review can be found at this link: <http://waubrafoundation.org.au/resources/nhmrc-wind-turbines-health-rapid-review-evidence-july-2010/>

- and include documents from Dr Nina Pierpont, Dr Carl Phillips, “Haste makes Waste” from the Society for wind vigilance, and an audit of the document by Mr Brett Horner
267. Senator Chris Back encouraged the NHMRC Senior Managers (CEO and Director of Research Translation) to divulge who the peer reviewers were, which until then the NHMRC had refused to do. Eventually Professor Anderson disclosed to Senator Chris Back during senate estimates questioning that the two peer reviewers were Professor Simon Chapman and Professor Geoffrey Leventhall.
 268. Professor Leventhall’s claims about the nocebo effect were used in the Bull Creek case in Alberta, Canada in which he gave expert evidence in November, 2013. Professor Chapman has frequently invoked the nocebo effect in his extensive public commentary on this issue, long before he conducted his data collection eg <http://www.abc.net.au/unleashed/4028112.html>
 269. Leventhall’s evidence asserting the nocebo effect was causing the reported symptoms most recently was in the Bull Creek case before the Alberta Utilities Commission in November, 2013.
 270. Professor Chapman helped VESTAS launch their “Act on Facts” global denial of any adverse health effects campaign, on 18th June, 2013 - further details about what VESTAS knew in 2004 and a direct link to publicity about the Act on Facts Campaign is here: <http://waubrafoundation.org.au/2014/public-statement-home-abandonment-due-environmental-noise-pollution/>
 271. Anderson, W extracts from oral testimony given during the Federal Senate Inquiry hearing in Perth on 31st March, 2011 <http://waubrafoundation.org.au/resources/social-and-economic-impact-rural-wind-farms-prof-warwick-anderson-nhmrc/>
 272. Critiques of the NHMRC’s 2010 Rapid Review by the Society for Wind Vigilance including “**Haste makes Waste**” <http://waubrafoundation.org.au/resources/haste-makes-waste-analysis-nhmrc-rapid-review/> and the detailed audit subsequently conducted by Mr Brett Horner, from the Society for Wind Vigilance <http://waubrafoundation.org.au/resources/brett-horner-audit-nhmrc-rapid-review/>
 273. Victorian Government Department of Health report issued late April, 2013. The report and the letters strongly critical of the report from Professors Salt and Hansen can be accessed here: <http://waubrafoundation.org.au/resources/wind-farms-sound-health-victorian-dept-health-report/>
 274. Iser, Dr David 2004 op cit <http://waubrafoundation.org.au/resources/dr-david-iser-2004-conducts-first-survey-patients-living-near-wind-project/> and agreed to speak on Waubra Foundation video <http://waubrafoundation.org.au/resources/video-wind-turbines-public-health/>
 275. Taylor, Dr Scott, 2011 letter to Acciona on behalf of Sam Stepnell, attached to Mrs Stepnell’s submission to the first Federal Senate inquiry <http://waubrafoundation.org.au/resources/samantha-stepnell-waubra-victoria/>
 276. Spring, Dr Wayne 2011 spoke on Waubra Foundation video <http://waubrafoundation.org.au/resources/video-wind-turbines-public-health/> and wrote submission to the second Federal Senate inquiry in November, 2012 <http://waubrafoundation.org.au/resources/sleep-physician-dr-wayne-j-spring-calls-for-noise-assessment/>
 277. Mitric-Andjic, Dr Andja <http://waubrafoundation.org.au/resources/hepburn-wind-farm-local-doctor-speaks-out/> and senate submission November, 2012 <http://waubrafoundation.org.au/resources/rural-gp-forced-abandon-her-home-speaks-out/>
 278. Trask, Mr Peter Psychologist written submission to the second Senate inquiry <http://waubrafoundation.org.au/resources/psychologist-peter-trask-calls-government-listen/>
 279. Robyn Brew was the Waubra resident who advised me that the Pyrenees Shire Council Planner Chris Hall had told her they had requested Dr Rosemary Lester, the Victorian Chief Health Officer, to conduct a Health Impact Assessment, as the Victorian State Health Department are required to do under the relevant Victorian legislation. Dr Lester refused the request.
 280. Victorian residents such as Annie Gardner from Macarthur, Melissa Ware from Cape Bridgewater, and many Waubra residents have directly requested the Victorian Health department to investigate, but they have refused to do so. The Waubra Foundation have similarly repeatedly requested that the health department act, but they have refused.
 281. Attendees at the April 2011 meeting at Evansford Hall included Dr Simon Slota Kan, Dr Stephanie Williams and Mr Rodney Dedman from the Victorian Department of Health. There were numerous local Waubra and Evansford residents who heard what the Department of Health had to say, which included an admission that they knew there were problems, and the fact that there was money for research, according to Dr

- Stephanie Williams. Also in attendance was Waubra Foundation Director Ms Kathy Russell, and others as witnesses including Mr Andy Gabb.
282. Attendees at the meeting in the Victorian Department of Health Offices on 14th October, 2011 included Dr Simon Slota-Kan and Dr Stephanie Williams from the department of Health, accompanied by Ms Nathalie Alvarez Barnett. There were residents from Cape Bridgewater, Glenthompson, Waubra, Leonards Hill, and Ballan. Waubra Foundation directors in attendance included the Chairman Mr Peter Mitchell, former Supreme Court Judge Justice Clive Tadgell, Former Federal Health Minister, the Hon Dr Michael Wooldridge, the CEO, and by phone Ms Kathy Russell. Also in attendance was Dr Andja Mitric Andjic, GP from Daylesford, who was both providing clinical care to those people affected by the turbine noise, but also she and her family were personally impacted by the Leonards Hill Hepburn wind community wind turbines
 283. Victorian Department of Health staff who attended the NHMRC workshop on wind turbine noise and health were Dr John Carnie, the chief Health Officer, Dr Simon Slota-Kan and Dr Stephanie Williams. Both medical officers subsequently left the Health Department after the October, 2011 meeting where they admitted they knew the problems were real and not imagined.
 284. Dr Slota Kan in particular admitted the problems were real and not imagined.
 285. Personal communication, Mr Les Huson
 286. Personal communication, Mrs Annie Gardner, Macarthur
 287. Hansen, C May 2013 Letter to Victorian Health department
<http://waubrafoundation.org.au/resources/prof-colin-hansen-writes-victorian-dept-health-recent-wind-farms-health-doc/>
 288. SA EPA Resonate Acoustics 2013 op cit <http://waubrafoundation.org.au/resources/sa-epa-resonate-infrasound-levels-near-windfarms-other-environments/>
 289. Acousticians who have investigated wind turbine noise such as Rick James, Rob Rand and Stephen Ambrose expressed their concerns at how the study had been conducted and problems with the conclusions drawn about infrasound and thresholds of perception and the appropriateness of continuing to use dBG.
 290. Professor Randall, Dr Renzo Tonin were two members in the audience at NSW University who expressed concern about some aspect of the methodology of the SA EPA Resonate Acoustics report, or the conclusions. Unfortunately the video footage of that meeting has never been made public by the AAS as there were many people who were interested in what Resonate Acoustics had to say to explain the problems which had been raised by peer reviewer Steven Cooper.
 291. Salt, A & Lichtenhan, J 2013 Letter to Victorian Health Department
<http://waubrafoundation.org.au/resources/prof-alex-salt-expresses-deepest-disappoint-victorian-dept-health-report/>
 292. Hessler, Schomer and Walker letter to the SA EPA dated 28th February, 2014 accessible here:
<http://waubrafoundation.org.au/resources/hessler-george-comments-south-australian-epa-study-at-waterloo-wind-farm/>
 293. Laurie, Open letter to South Australian Premier, Jay Weatherill 12th December, 2013 op cit
<http://waubrafoundation.org.au/resources/open-letter-premier-south-australia-clean-energy-regulator-concerning-sa-epa-acoustic-survey-2/>
 294. Comments on the SA EPA Waterloo survey from Professor Colin Hansen can be accessed here:
<http://waubrafoundation.org.au/resources/hansen-c-h-comments-sa-epa-waterloo-wind-farm-environmental-noise-study-2013/> and Mrs Mary Morris's analysis and comments on the SA EPA's analysis of diary entries during shut down periods <http://waubrafoundation.org.au/resources/morris-m-comparison-wind-turbine-acoustic-measurements-analysis/>
 295. Photographs of the locations of the SA EPA Monitors which were not according to their own guidelines were sent to me by Mrs Mary Morris. They were subsequently made available via the following link:
<http://stopthesethings.com/2013/12/04/mary-morris-on-the-warpath/>
 296. Salt, A & Lichtenhan J Acoustics Today, Winter issue op cit <http://waubrafoundation.org.au/resources/salt-n-lichtenhan-j-t-how-does-wind-turbine-noise-affect-people/>
 297. Kelley, N et al 1985 op cit pp 225 for suggested parameters for chronic exposure to infrasound and low frequency noise <http://waubrafoundation.org.au/resources/kelley-et-al-1985-acoustic-noise-associated-with-mod-1-wind-turbine/>
 298. Salt A & Lichtenhan J op cit

299. Chen, Qibai & Shi, 2004 op cit <http://waubrafoundation.org.au/resources/an-investigation-physiological-and-psychological-effects-infrasound-persons/>
300. Swinbanks, M 2012 op cit <http://waubrafoundation.org.au/resources/numerical-simulation-infrasound-perception-with-reference-reported-laboratory-effects/>
301. Walker, Hessler, Rand & Schomer 2012 op cit <http://waubrafoundation.org.au/resources/co-operative-measurement-survey-analysis-low-frequency-infrasound-at-shirley-wind-farm/>
302. Schomer, P et al 2013 Denver op cit <http://waubrafoundation.org.au/2013/direct-causation-nausea-and-vertigo-symptoms-by-infrasound/>
303. Waubra Foundation's critique of the Systematic Literature Review commissioned by the NHMRC is accessible from here (as is the literature review) <http://waubrafoundation.org.au/resources/waubra-foundation-open-letter-nhmrc-re-systematic-literature-review/>
304. Senator John Madigan first raised the conflict of interest issues in Senate Estimates <http://waubrafoundation.org.au/resources/nhmrc-ceo-prof-anderson-questioned-about-draft-review-by-senate/> and then Senator Chris Back subsequently spoke about the NHMRC conflict of interest issues in the Federal Senate chamber <http://waubrafoundation.org.au/resources/senator-chris-back-questions-evidence-from-vested-interests-at-planning-review-hearings/>
305. Waubra Foundation Objectives <http://waubrafoundation.org.au/about/objectives/>
306. McCarron, G 2013 **Tara Gas Field** <http://waubrafoundation.org.au/2013/report-tara-gas-field-health-survey-released/>
307. Munro, Sharyn 2012 speech about "**Rich Land Waste Land – how Coal is Killing Australia**" detailing the impacts of infrasound and low frequency noise on former residents from the Upper Hunter region of NSW <http://waubrafoundation.org.au/resources/rich-land-waste-land-how-coal-killing-australia-sharyn-munro/>
308. Robinson, S 2011 "**Mental Health aspects of Coal Seam Gas Mining**" <http://waubrafoundation.org.au/resources/mental-health-aspects-coal-seam-gas-mining/>
309. Parkville Residents Association submission to the Federal Senate Inquiry into Rural Wind Farms, 2011 <http://waubrafoundation.org.au/resources/parkville-residents-association-submission-senate-inquiry/>
310. Waubra Foundation evidence given to the Federal Senate Inquiry into Rural wind Farms 2011 <http://waubrafoundation.org.au/resources/senate-inquiry-social-economic-effect-rural-wind-farms/> and Hansards of the hearing days are here <http://waubrafoundation.org.au/resources/hansard-federal-senate-inquiry-into-social-economic-impact-wind-farms/> the Foundation gave evidence on 29th March, 2011 in Melbourne.
311. Waubra Foundation evidence given to the Federal Senate Inquiry into the Excessive Noise from Windfarms Bill (Renewable Energy Act) <http://waubrafoundation.org.au/2012/ceo-gives-evidence-at-senate-inquiry/>
312. Evidence given to the Cherry Tree Tribunal in February 2013 (<http://waubrafoundation.org.au/resources/cherry-tree-wind-farm-waubra-foundation-statement/>) and subsequent written submissions in September 2013 <http://waubrafoundation.org.au/resources/vcat-cherry-tree-hearing-waubra-foundation-ceo-letter-commissioners-sept-4-2013/> and <http://waubrafoundation.org.au/resources/critical-analysis-accuracy-complaints-data-from-chapman-et-al-nocebo-research/>