

To:

National Health and Medical Research Council  
[windturbines@nhmrc.gov.au](mailto:windturbines@nhmrc.gov.au)

Professor Warwick Anderson  
CEO NHMRC  
[warwick.anderson@nhmrc.gov.au](mailto:warwick.anderson@nhmrc.gov.au)

Professor John McCallum  
Director, Research Translation  
[john.mccallum@nhmrc.gov.au](mailto:john.mccallum@nhmrc.gov.au)

Professor Bruce Armstrong  
Chair, Literature Review Panel  
[bruce.armstrong@sydney.edu.au](mailto:bruce.armstrong@sydney.edu.au)

Hon Peter Dutton  
Minister for Health  
[peter.dutton@aph.gov.au](mailto:peter.dutton@aph.gov.au)

Senator Fiona Nash  
Assistant Minister for Health  
[Senator.Nash@aph.gov.au](mailto:Senator.Nash@aph.gov.au)

Senator Nick Xenophon  
[Senator.Xenophon@aph.gov.au](mailto:Senator.Xenophon@aph.gov.au)

Senator John Madigan  
[Senator.Madigan@aph.gov.au](mailto:Senator.Madigan@aph.gov.au)

Senator Christopher Back  
[senator.back@aph.gov.au](mailto:senator.back@aph.gov.au)

April 7, 2014

Dear interested parties,

Re: Open Commentary: NHMRC Draft Consultation Report on health and wind energy facilities [Draft Report]

I am aware of some of the initiatives being taken in Australia regarding the topic of adverse health effects and wind turbines and have previously shared information on several occasions to some members of the NHMRC.

Personal disclosure: I am an independent, full time volunteer and for almost 6 years have been researching health and other effects associated with industrial wind energy facilities and am a peer reviewed and a published author/co-author on these topics. I am guided by the numerous peer reviewed articles, judicial proceedings, acknowledgements by authorities and others, and by the reports of those experiencing negative health and social-economic effects which are correlated with the start up of a wind energy facility. I declare no potential conflicts of interest and have received no financial support with respect to the research and authorship of this overview. This commentary is public and may be shared.

As additional background, I share information with individuals, communities, authorities, wind energy developers, industry and others. I am taking the opportunity to share the experiences regarding the negative effects which can occur when industrial wind facilities are sited in close proximity to family homes; and to provide some of the peer reviewed and other references regarding this topic. [See Appendix for details].

I trust that this commentary will be considered by the NHMRC committee during its deliberations.

### **Executive Summary**

There is sufficient evidence to support that some are negatively affected by industrial wind energy facilities sited in close proximity to their homes.

Some families exposed to wind energy facilities are abandoning their homes and reporting health and social-economic harm. Some are having difficulty selling their homes or achieving market value.

Symptoms and proposed causation have been acknowledged through peer reviewed and published references, testimony under oath, and/or disclosure evidence, and/or witness statements and through other references briefly summarized in this submission.

There are risks to the unborn, pregnant women, children, the elderly, occupational workers and those with pre-existing medical conditions including vulnerable babies and children.

There is an opportunity to take action to resolve the reported health, environmental and social-economic issues to the satisfaction of those currently affected and to avoid risk of harm in the future.

### **Terminology: Direct vs Indirect Effects**

It appears that the NHMRC has considered whether there is “consistent direct evidence that

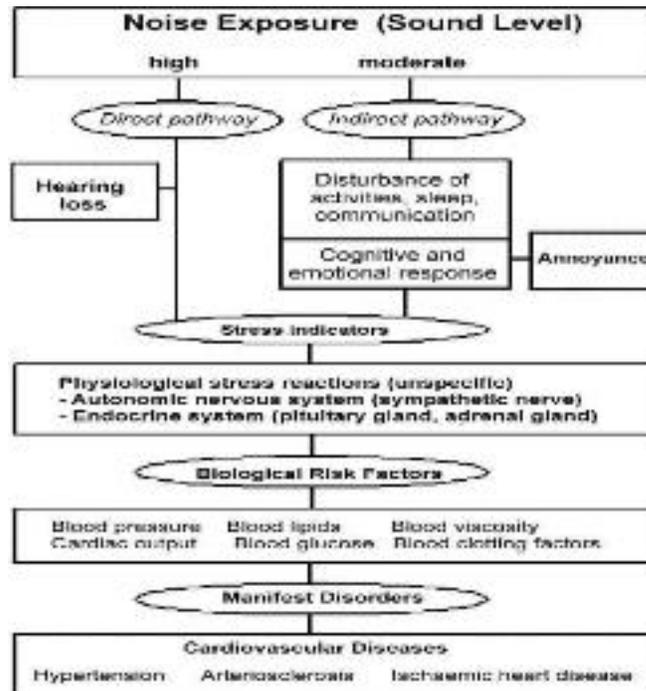
exposure to wind farms was associated with any health outcome” and has concluded there is not. However, direct and indirect pathways converge and can lead to similar health outcomes.

WHO (2009) discusses the impact of “disturbances of activities” and states:

“Physiological experiments on humans have shown that noise of a moderate level acts via an indirect pathway and has health outcomes similar to those caused by high noise exposures on the direct pathway. The indirect pathway starts with noise induced disturbances of activities such as communication or sleep.”<sup>1</sup>

When one focuses on a "direct" effect, an equally significant part of the health equation i.e. “indirect” effects, is omitted.

The importance of the indirect pathway is illustrated through the noise schema below published by WHO.<sup>2</sup> High noise exposure can lead to hearing loss and stress; however, moderate noise exposure through annoyance and sleep disruption can also lead to stress. The convergence of the direct (high noise levels) and indirect pathway (moderate noise levels) illustrate risk factors concluding with risks of cardiovascular diseases. [Reference: Noise Schema: World Health Organization, Night Noise Guidelines for Europe, 2009]



In a review, Munzel et al (2014) comment regarding noise:

“The role of noise as an environmental pollutant and its impact on health are being increasingly recognized. Beyond its effects on the auditory system, noise causes annoyance and disturbs sleep, and it impairs cognitive performance. Furthermore, evidence from epidemiologic studies demonstrates that environmental noise is associated with an increased incidence of arterial hypertension, myocardial infarction, and stroke. Both observational and experimental studies indicate that in particular night-time noise can cause disruptions of sleep structure, vegetative arousals (e.g. increases of blood pressure and heart rate) and increases in stress hormone levels and oxidative stress, which in turn may result in endothelial dysfunction and arterial hypertension. This review focuses on the cardiovascular consequences of environmental noise exposure and stresses the importance of noise mitigation strategies for public health.”

...

“... noise may exert its effects either directly, through synaptic interactions, or indirectly, through the emotional and the cognitive perception of sound. In other words, both the objective noise exposure (sound level) and its subjective perception determine the impact of noise on neuroendocrine homeostasis.”<sup>3</sup>

Munzel et al (2014) conclude that: (excerpted)

“Taken together, the present review provides evidence that noise not only causes annoyance, sleep disturbance, or reductions in quality of life, but also contributes to a higher prevalence of the most important cardiovascular risk factor arterial hypertension and the incidence of cardiovascular diseases. The evidence supporting such contention is based on an established rationale supported by experimental laboratory and observational field studies, and a number of epidemiological studies. Meta-analyses have been carried out to derive exposure–response relationships that can be used for quantitative health impact assessments. Noise-induced sleep disturbance constitutes an important mechanism on the pathway from chronic noise exposure to the development of adverse health effects.”<sup>4</sup>

Testimony under oath during the Ontario, Canada Environmental Review Tribunal acknowledged that the indirect pathway was not considered by the CMOH (*The Potential Health Impact of Wind Turbines (Chief Medical Officer of Health (CMOH) Ontario Report) – May 2010.*<sup>5</sup>

A World Health Organization study:

“...confirmed, on an epidemiological level, an increased health risk from chronic noise annoyance.”<sup>6</sup>

The potential for industrial wind turbines to harm humans is stated in an Ontario Environmental Review Tribunal (ERT) Decision, July 18, 2011 which involved 26 expert witnesses from around the world. The Tribunal was conducted under oath:

“This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree.”<sup>7</sup>

In addition, the Tribunal found:

“... The Tribunal has found above that “serious harm to human health” includes both direct impacts (e.g., a passer-by being injured by a falling turbine blade or a person losing hearing) or indirect impacts (e.g., a person being exposed to noise and then exhibiting stress and developing other related symptoms). This approach is consistent with both the WHO definition of health and Canadian jurisprudence on the topic.”<sup>8</sup>

### **September 28, 2012**

It appears the cut off date September 28, 2012 relating to the review of published literature and other references has resulted in a number of these, some of which are published in medical journals, to not be included. However, the NHMRC panel has the opportunity to enhance its citations and consider references available since September 28, 2012.

To assist with enhancing the citations considered in the NHMRC draft report, attached is a summary of references compiled from 2010 to April 2014. This summary is not exhaustive but may provide a resource to some of the peer reviewed references and international conference papers. [*Attached: Summary\_references\_April 2014[2]*].

Examples include: [*See Attached*]

#### *Canadian medical journal publications (3 articles)*

Jeffery, Krogh and Horner (January 2014) entitled “Industrial wind turbines and adverse health effects” is a review published in the Canadian Journal of Rural Medicine (CJRM, a publication of the Canadian Medical Association (CMA) and the official journal of the Society of Rural Physicians of Canada (SRPC).

<http://www.cma.ca/multimedia/staticContent/HTML/N0/12/cjrm/vol-19/issue-1/pdf/pg21.pdf>

Jeffery, Krogh and Horner (May 2013) Commentary entitled “Adverse health effects of industrial wind turbines“ is published in Canadian Family Physician, the official journal of the College of Family Physicians of Canada.

<http://www.cfp.ca/content/59/5/473.full>

Jeffery, Krogh and Horner, Canadian Family Physician (September 2013) letter to the editor is available at:

<http://www.cfp.ca/content/59/9/921.full>

These 3 references are indexed in PubMed:

<http://www.ncbi.nlm.nih.gov/pubmed/24398354>

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3771715/>

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3653647/>

Enbom and Enbom (2013) published in the Swedish medical journal states:

“Infrasound from wind turbines affects the inner ear and is a potential health risk for people with migraine or other type of central nervous system.”<sup>9</sup>

Salt and Lichtenhan (2014) describe:

“many ways by which unheard infrasound and low-frequency sound from wind turbines could distress people living nearby”.<sup>10</sup>

In 2013, research funded by the Ontario Ministry of the Environment indicates statistically significant relationship with distance and sleep disturbance, vertigo and tinnitus.<sup>11</sup>

Numerous reports by investigating acousticians regarding noise (dB) and low frequency/infrasound could enhance the citations presented in the Draft Report. Some of these authors are listed in the summary provided. [*Attached: Summary\_references\_April 2014[2]*]

### **Experimental Laboratory Studies**

Munzel et al (2014) comment on experimental laboratory and observational studies:

“Taken together, the present review provides evidence that noise not only causes annoyance, sleep disturbance, or reductions in quality of life, but also contributes to a higher prevalence of the most important cardiovascular risk factor arterial hypertension and the incidence of cardiovascular diseases. The evidence supporting such contention is based on an established rationale supported by experimental laboratory and observational field studies...”<sup>12</sup>

A PubMed search indicates hundreds of experimental laboratory studies conducted in animals. For example, exposure to various noise stressors including low frequency noise/infrasound indicates effects on the brain, heart, lungs, sexual activity (males) and bowel. Pre-clinical, i.e., animal experimental laboratory studies are typically considered to assist with establishing precaution before humans are subjected to an exposure.

## Health Effects Acknowledged

On July 16, 2013, the Honourable Rona Ambrose was appointed the Hon. Minister of Health of Health Canada. Prior to this appointment, correspondence from her dated June 30 2009 states:

“Health Canada provides advice on the health effect of noise and low-frequency electric and magnetic fields from proposed wind turbine projects, particularly for environmental assessments done under the Canadian Environmental Assessment Act. To date, their examination of the scientific literature on wind turbine noise is that the only health effect conclusively demonstrated from exposure to wind turbine noise is an increase of self-reported general annoyance and complaints (i.e., headaches, nausea, tinnitus, vertigo).”<sup>15</sup>

The Principle Investigator of the Health Canada Wind Turbine Noise Study states:

“...there is credible scientific support for an association between wind turbine noise and community annoyance.”<sup>14</sup>

In terms of health, the term annoyance is acknowledged as an adverse health effect.<sup>15, 16, 17, 18</sup>

Regarding noise induced annoyance the US Environmental Protection Agency states:

“...“annoyance” can have major consequences, primarily to one’s overall health.”<sup>19</sup>

Ontario, Canada’s Wind Turbine Guidelines have a minimum setback of 550 meters and a 40 dBA noise study (predictive computer modelling). However, the approval of the wind facility allows up to 51 dBA with increased wind speeds.

A December 2010 report on low frequency noise commissioned by the Ontario Ministry of Environment and released December 2011 by the Ministry:

“The audible sound from wind turbines, at the levels experienced at typical receptor distances in Ontario, is nonetheless expected to result in a non-trivial percentage of persons being highly annoyed. As with sounds from many sources, research has shown that annoyance associated with sound from wind turbines can be expected to contribute to stress related health impacts in some persons.

Stress symptoms associated with noise annoyance, and in particular low frequency annoyance, include sleep interference, headaches, poor concentration, mood swings...”<sup>20</sup>

An Ontario, Canada, a Freedom of Information request states:

“It appears compliance with the minimum setbacks and the noise study approach currently being used to approve the siting of WTGs will result or likely result in adverse effects...” [*Ontario Ministry of Environment, memorandum, Ontario Senior Environmental Officer, April 9, 2010*]

### **Noise and Risks to Children**

The Draft Report Glossary notes that noise is defined as “Unwanted sound or a combination of sounds.” Krogh et al (2012) note: “Sound meters can assess sound; however, humans assess “noise”. Sound becomes a risk to human health when it is considered to be noise.”<sup>21</sup>

With respect to children, the World Health Organization acknowledges the vulnerability of children to the effects of noise. Attached is the submission provided the Minister of Health, Health Canada. Citations include discussions of risk factors including that of children with pre-existing medical conditions, i.e., autism, respiratory, epilepsy and other. [*Risk factors associated with children 2012*]

### **Property values and health**

Regarding social implication and property values, Counsel for the Ministry of Environment, Ontario, Canada states:

“...it’s the social implications where people are complaining on web sites about how their property values have gone down.”<sup>22</sup>

“We will see in the course of this hearing that lots of people are worried about windmills. They may not like the noise, they may think the noise makes them sick, but really what makes them sick is just the windmills being on the land because it does impact their property values. That’s what makes them sick is that, you know, they’ll get less money for their properties, and that’s what’s causing all this annoyance and frustration and all of that.”<sup>23</sup>

In Denmark, an erector of a wind turbine has a duty to pay compensation for loss of value of real property:<sup>24</sup>

The Ontario Real Estate Association requires seller disclosure (2011):

“Are there any hydro generating projects planned for the immediate area? eg: Wind Turbines.”<sup>25</sup>

Other references are provided in the Appendix.

## Potential ethical considerations

Potential ethical issues relating to research and potential inequity are complex. Ethical issues require clarification which may entail legal-ethical advice.

Cooper (2012) states:

“Not since the opening of the Third Runway at Sydney Airport has there been so much publicity in Australia concerning noise – in this case wind farms. Putting aside the issue of noise versus inaudible noise there is a question being raised as to Members of the Society breaching the Code of Ethics. This is not the old question of Professional versus Learned Society. Reliance upon criteria contained in Guidelines or Standards may be an excuse by consultants that in turn places the “fault” on the SA EPA and the New Zealand Standard. However, if people making complaints to no avail and leave their homes because of the wind farm “noise” what is the responsibility of Members of the AAS to the community?”<sup>26</sup>

Inequity can exist if participants who host industrial wind turbines have agreed and/or are compensated to accept noise, nuisance and/or other effects through a contractual arrangement.<sup>27 28</sup>

An example of a lease agreement in Canada states:

“The Rent, in respect of the Specified Locations...represent compensation in full for...nuisance, noise, signal interference,..., casting of shadows and other inconveniences or damage...incurred by Lessor from the acts or omissions of Lessee.”<sup>29</sup>

Non participants typically have not agreed, or may not be given a similar opportunity to be compensated for noise, nuisance and/or other effects.

Shain (2011) comments:

“While industrial wind turbines (IWTs) clearly raise issues concerning threats to the health of a few in contrast to claimed health benefits to many, the trade-off has not been fully considered in a public health framework. This article reviews public health ethics justifications for the licensing and installation of IWTs. It concludes that the current methods used by government to evaluate licensing applications for IWTs do not meet most public health ethical criteria.

Furthermore, these methods are contrary to widely held fundamental principles of administrative law and governmental legitimacy. A set of decision-making principles are suggested to address this situation that are derived from existing and emerging legal principles in Canada and elsewhere. These include the

Precautionary Principle, the Least Impactful Means (Proportionality) Test, and the Neighbor Principle.”<sup>30</sup>

Seltenrich (2014) comments:

“The gold standard for proving causality of an exposure is the randomized clinical trial. But when it comes to testing the health effects of noise exposure on humans, such a study design is likely to be not only impractical and difficult to implement, but also unethical.”<sup>31</sup>

## **Legal Decisions**

Legal Decisions are available pre- and post-September 28, 2013. Some of these may be a helpful resource.

Examples (not exhaustive), include Decisions from the Supreme Court in Portugal and Bavaria (Germany); UK on visual/amenity; France, environmental, and others. Some are in the language of the country in which the Decision occurred; however, the NHMRC may consider obtaining Court Certified translations of these significant Decisions for consideration. [*Examples available on request*]

## **Precaution**

Regarding the precaution principle, the Ontario Environmental Review Tribunal expressed concerns with respect to *The Potential Health Impact of Wind Turbines (Chief Medical Officer of Health (CMOH) Ontario Report) – May 2010* and the need for further work on precaution:

“...about the Director’s apparent lack of consideration of indirect health effects and the need for further work on the MOE’s practice of precaution...”<sup>32</sup>

Shepherd et al comment:

“At this time, however, the quantity and quality of research are insufficient to effectively describe the relationship between wind turbine noise and health, and so legislation should apply the precautionary principle or conservative criteria when assessing proposed windfarm developments”<sup>33</sup>

The World Health Organization states with respect to noise in general:

“In all cases, noise should be reduced to the lowest level achievable in a particular situation. Where there is a reasonable possibility that public health will be damaged, action should be taken to protect public health without awaiting full scientific proof.”<sup>34</sup>

The Policy Interpretation Network on Children's Health and Environment advises:

“Policies that may protect children's health or may minimise irreversible health effects should be implemented, and policies or measures should be applied based on the precautionary principle, in accordance with the Declaration of the WHO Fourth Ministerial Conference on Environment and Health in Budapest in 2004.”<sup>35</sup>

## Conclusion

There is sufficient evidence that some are negatively affected by industrial wind energy facilities. Some families exposed to these facilities are abandoning their homes and reporting health and social-economic harm including loss of property value.<sup>36, 37, 38, 39, 40</sup>

Typically, if someone claims to be affected by an exposure to an agent such as peanuts, eggs, tobacco smoke, sulfites, scents, certain food such as sea food, noise etc, the individual can avoid or remove the source.

If it is serious or life threatening precautionary measures are frequently undertaken:

- § Regulators may draft legislation/regulations and/or publish advisories. Examples include responding to risks of exposure to sulfites at salad bars; requiring labelling non-medicinal ingredients in consumer and prescription products and food, including fast food; a ban on second hand smoke in public places and in vehicles carrying children.
- § Members of society often voluntarily ban peanuts/nuts in schools; avoid wearing scents in offices; implement noise control for autistic or children with ADD or noise sensitive individuals; respect guests with food or other allergies.

These measures allow individuals at risk to avoid the exposure.

In the case of wind turbine facilities reports indicate:

- § the facilities are imposed without consent on some members of the community;
- § attempts to achieve remedy are inadequate; and
- § those affected are unable to avoid or remove the source unless they relocate.

There is an opportunity to invoke precaution and prevent avoidable harm.

I trust the information provided in this brief overview will assist with enhancing knowledge relating to the human health issues and the social-economic impacts of wind energy facilities when projects are sited in close proximity to residents.

To assist further, a snapshot of additional evidence is presented in the Appendix below.

Respectfully submitted,

Carmen Krogh, BScPharm  
Ontario, Canada  
[carmen.krogh@gmail.com](mailto:carmen.krogh@gmail.com)

### **Attachments**

Adverse health effects and industrial wind energy facilities April 7, 2014  
Summary\_references\_April 2014[2]  
Jeffery et al (May and Sept 2013; Jan 2014)  
Health Canada Risks to children December 27 2012 FINAL  
Enbom and Enbom Swedish Medical Association - translation

### **APPENDIX**

#### **A. The Symptoms**

McMurtry (2011) former Dean of Medicine, University of Western Ontario and former Assistant Deputy Minister of the Population and Public Health Branch (Health Canada) details the commonly reported symptoms:

“Third-order criteria (at least three of the following occur or worsen following the initiation of IWTs):

#### Otological and vestibular

- a) Tinnitus
- b) Dizziness
- c) Difficulties with balance
- d) Ear ache
- e) Nausea

#### Cognitive

- a) Difficulty in concentrating
- b) Problems with recall or difficulties with remembering significant information

#### Cardiovascular

- a) Hypertension
- b) Palpitations
- c) Enlarged heart (cardiomegaly)

#### Psychological

- a) Mood disorder, i.e., depression, anxiety
- b) Frustration
- c) Feelings of distress
- d) Anger

## Regulatory Disorders

- a) Difficulty in diabetes control
- b) Onset of thyroid disorders or difficulty controlling hypo- or hyperthyroidism

## Systemic

- a) Fatigue
- b) Sleepiness”<sup>41</sup>

The authors of Colby et al (2009), prepared for the American Wind Energy Association and Canadian Wind Energy Association determined the documented “wind turbine syndrome” symptoms (sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering when awake or asleep are symptoms)“ are not new and have been published previously in the context of “annoyance” and are the “well-known stress effects of exposure to noise”.<sup>42</sup>

Annoyance may seem of little consequence in everyday language; however, in terms of health, the term annoyance is acknowledged as an adverse health effect.<sup>43, 44, 45, 46, 47</sup>

The Colby et al, (2009) literature review comments on a causal link (through annoyance) to the reported adverse health effects and that: wind turbine sound/noise may cause annoyance [p. 5-3], stress [p. 4-3, 4-10] and sleep disturbance [p. 4-3], which may have other consequences [p. 4-3, 4-10].<sup>48</sup> [Attached Jeffery et al (2014) for more detail].

Regarding noise induced annoyance the US Environmental Protection Agency states:

“...“annoyance” can have major consequences, primarily to one’s overall health.”<sup>49</sup>

Pedersen et al (2008) notes:

“Annoyance with wind turbine noise was associated with psychological distress, stress, difficulties to fall asleep and sleep interruption.”<sup>50</sup>

Rideout et al (2010) note:

“Annoyance and sleep disruption are common when sound levels are 30 to 45 dBA.”<sup>51</sup>

The peer reviewed health survey WindVOiCe (Wind Vigilance for Ontario Communities) documents the cluster of symptoms (Krogh et al, (2011)).<sup>52</sup> The full version of WindVOiCe is available on the Society for Wind Vigilance web site.<sup>53</sup>

Krogh<sup>54</sup> (2011) reports on the loss of social justice associated with the industrial wind turbine file.

The World Health Organization acknowledges the importance of social justice and states:

“Social justice is a matter of life and death. It affects the way people live, their consequent chance of illness, and their risk of premature death.” (2008, p. 3)<sup>55</sup>

## B. A Snapshot of Evidence

This overview focuses on human health and is not intended to be exhaustive. Additional references are available.

In 1948, the World Health Organization (WHO) defined health and the fundamental rights of every human being:

### CONSTITUTION OF THE WORLD HEALTH ORGANIZATION<sup>1</sup>

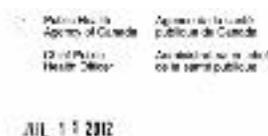
THE STATES Parties to this Constitution declare, in conformity with the Charter of the United Nations, that the following principles are basic to the happiness, harmonious relations and security of all peoples:

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition.

Many jurisdictions, including the Canadian federal, provincial, and territorial governments and health officials have accepted WHO’s definition of health (Health Canada, 2004, vol. 1, p. 1-1).<sup>56</sup>

Correspondence dated July 11, 2012 confirms that Canada, Health Canada and the Public Health Agency of Canada continue to support the WHO definition of health [*excerpted*]:

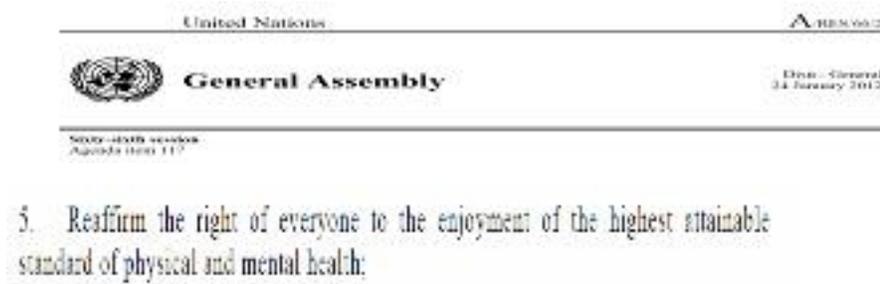


Canada, including both Health Canada and the Public Health Agency of Canada, continues to support the definition of health established by the WHO’s constitution in 1948: Health is “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”

Secretary,  
  
Minister of Health, Ottawa, ON  
MUSA, OCPE, FIC/CS, FACPM

Canada

On January 24, 2012, the United Nations reaffirmed everyone's right to the enjoyment of the highest attainable standard of physical and mental health:



The Victorian Civil Administrative Tribunal (2013) held in Australia states: <sup>57</sup>

"There is evidence before the Tribunal that a number of people living close to wind farms suffer deleterious health effects. The evidence is both direct and anecdotal. There is a uniformity of description of these effects across a number of wind farms, both in southeast Australia and North America. Residents complain of suffering sleep disturbance, feelings of anxiety upon awakening, headaches, pressure at the base of the neck and in the head and ears, nausea and loss of balance." [para16]

"In some cases the impacts have been of such gravity that residents have been forced to abandon their homes." [para17]

"On the basis of this evidence it is clear that some residents who live in close proximity to a wind farm experience the symptoms described, and that the experience is not simply imagined". [para18]

The above Tribunal comments about a causal link: <sup>58</sup>

"What is less clear is whether there is a causal link between sound pressure emissions from a wind farm and the health effects complained of." [para 119] See previous discussion on associations.

The Principle Investigator of the Health Canada Wind Turbine Noise Study states:

"...there is credible scientific support for an association between wind turbine noise and community annoyance." <sup>59</sup>

Peer reviewed research comments that wind energy was initially welcomed into communities (Krogh 2011; <sup>60</sup> Shepherd et al 2011; <sup>61</sup> Nissenbaum et al 2011. <sup>62</sup> For example, Shepherd et al (2011), Nissenbaum et al (2011) and Krogh et al (2011) are cited in a March 2012 peer reviewed editorial published in the British Medical Journal. <sup>63</sup>

Nissenbaum et al. (2012) published a cross-sectional study involving two rural sites concluding:

“... that the noise emissions of IWTs disturbed the sleep and caused daytime sleepiness and impaired mental health in residents living within 1.4 km of the two IWT installations studied. Industrial wind turbine noise is a further source of environmental noise, with the potential to harm human health. Current regulations seem to be insufficient to adequately protect the human population living close to

IWTs. Our research suggests that adverse effects are observed at distances even beyond 1 km.”<sup>64</sup>

Jeffery, Krogh and Horner (2014) review states:

“Health is one of the fundamental rights of every human being. Some people exposed to IWTs experience negative effects to their physical, mental and social well-being.

There is sufficient evidence to support the hypothesis of Colby and colleagues that documented symptoms can result from annoyance to audible IWTs. Amplitude modulation of IWTs, audible LFN, and tonal, impulse and nighttime noise can contribute to annoyance and other effects on health. In addition, there is emerging evidence that suggests inaudible LFN or infrasound from IWTs may result in negative health effects.

Further research is required to clarify the exact role that sound characteristics, visual impacts, stray voltage and socioeconomic impacts of IWTs may have on human health. As more IWTs are installed, rural physicians are likely to be presented with increasing numbers of patients who are adversely affected. Based on current knowledge, we expect that, at typical setback distances and sound pressure levels of IWTs in Ontario, a nontrivial percentage of exposed people will be adversely affected. “Trade-offs” of health for perceived benefit in alternate forms of energy can be prevented if setback distances and noise limits are developed using established noise management techniques. In addition to providing care for affected patients, rural physicians have a responsibility to advance understanding and to help inform IWT regulations that will protect the physical, mental and social well-being of patients.”<sup>65</sup>

Jeffery, Krogh and Horner (May, 2013) published in *Canadian Family Physician*, the official journal for the College of Family Physicians of Canada concludes:

“Industrial wind turbines can harm human health if sited too close to residents. Harm can be avoided if IWTs are situated at an appropriate distance from humans. Owing to the lack of adequately protective siting guidelines, people exposed to IWTs can be

expected to present to their family physicians in increasing numbers. The documented symptoms are usually stress disorder–type diseases acting via indirect pathways and can represent serious harm to human health. Family physicians are in a position to effectively recognize the ailments and provide an empathetic response. In addition, their contributions to clinical studies are urgently needed to clarify the relationship between IWT exposure and human health and to inform regulations that will protect physical, mental, and social well-being.”<sup>66</sup>

A second reference in *Canadian Family Physician* by Jeffery, Krogh and Horner (September, 2013) states:

“The adverse health effects of audible and inaudible noise are substantial. Their effects are underestimated and underappreciated by some. We are guided by the

references and the desire to safeguard the health and wellbeing of those living in the environs of IWTs. Harm can be avoided by placing IWTs at a protective distance from residents. The acknowledgment that health effects occur in some is an important step toward achieving this goal.”<sup>67</sup>

Krogh (2011) notes:

“To escape the noise some report resorting to sleeping in vehicles, tents, trailers, basements lined with mattresses, garages, and at relatives or friends’ homes. Others have bought or rented a second residence to obtain respite (G.W., Personal communications 2010; T.W., Personal communications, 2011) or relocated with friends or family (T.K., Personal communications, 2011). Some families have been billeted at the IWT developer’s expense (Hansard, 2009, p. G-547). Others have abandoned their homes, or been bought out by wind developers (Braithwaite, Parts I and II, 2009). Buyouts by IWT developers have been reported in other parts of the globe (Rolfe, 2011).”<sup>68</sup>

The Falmouth Board of Health (Massachusetts) USA (note: **bold** face emphasis is that of the Falmouth Board of Health):

“... requests that **Mass DPH immediately initiate a health assessment of the impacts of the operation of wind turbines in Falmouth.** This appeal is compelled by two years of consistent and persistent complaints of health impacts during turbine operation.”<sup>69</sup>

“**Due to the increasing intensity of the reported health impacts, the Board is considering emergency actions.** To determine the appropriateness of such actions,

the Board requests immediate guidance on interim measures to protect the health of affected individuals while the complete health assessment is being conducted.

We look to your Department, as that which holds the highest duty to protect the health of the citizens of the Commonwealth, to assist us in this matter.”<sup>70</sup>

It is reported that by order of the court, preliminary injunction shall issue until further order of the court:

“1. The Town of Falmouth, its Selectmen, agents and persons acting in concert shall be restrained from operating the Wind Turbines located at the Waste Water Treatment Facility except during the hours of 7am to 7pm, every day of the week except Sunday. This schedule shall commence on November 22, 2013. Additionally, the same parties shall be restrained from operating said turbines in any fashion on the following limited dates: November 27, 2013; December 25, 2013; and January 1, 2014.”<sup>71</sup>

The Brown County Board of Health (Wisconsin) USA requests emergency financial relocation assistance:

“...formally requests temporary emergency financial relocation assistance from the State of Wisconsin for those Brown County families that are suffering adverse health effects and undue hardships caused by the irresponsible placement of industrial wind turbines around their homes and property. The State of Wisconsin emergency financial assistance is requested until the conditions that have caused these undue hardships are studied and resolved, allowing these families to once again return safely to their homes and property.”<sup>72</sup>

Subsequent to the above request recent research was conducted at the Shirley Wind Farm, Brown County, Wisconsin, USA.<sup>73</sup>

"A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin" documents measurement methodologies. The report was prepared cooperatively by:

Prepared Cooperatively By:

**Channel Islands Acoustics, Camarillo, CA**  
Principal: Dr. Bruce Walker

**Hessler Associates, Inc., Haymarket, VA**  
Principals: George F. and David M. Hessler

**Rand Acoustics, Brunswick, ME**  
Principal: Robert Rand

**Schomer and Associates, Inc., Champaign, IL**  
Principal: Dr. Paul Schomer

The primary conclusion of the Shirley Wind Farm study team states:<sup>74</sup>

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.

Some have referenced that World Health Organization Noise Guidelines (2009) recommend a 40 dB noise level for industrial wind turbines; however, the WHO guidelines are based on road, rail and air craft noise, not on industrial wind turbine noise. Peer reviewed studies consistently acknowledge wind turbine noise is perceived to be more annoying than transportation noise or industrial noise at comparable sound pressure levels.<sup>75</sup> The premise of 40 dB applying to wind turbines is not supported: research<sup>76</sup> and Ontario Ministry of Environment field officer<sup>77</sup> propose 30 to 32 dB.

Regarding low frequency noise, James (2012) states:

“A review of the work of acoustical experts such as Swinbanks, Ebbing, Blazier, Hubbard, and Shepherd and others mentioned in this article shows that these problems were reported at professional conferences and in research papers.

There is sufficient research and history to link the sensitivity of some people to inaudible amplitude-modulated infra and low-frequency noise to the type of symptoms described by those living near industrial wind turbines.

This information should have served as a warning sign.”<sup>78</sup>

Regarding infrasonic sounds, Salt and Huller (2010) state:

“Abstract

Infrasonic sounds are generated internally in the body (by respiration, heartbeat, coughing, etc) and by external sources, such as air conditioning systems, inside vehicles, some industrial processes and, now becoming increasingly prevalent, wind turbines. It is widely assumed that infrasound presented at an amplitude below what is audible has no influence on the ear. In this review, we consider possible ways that low frequency sounds, at levels that may or may not be heard, could influence the function of the ear.

...

There are, however, abnormal states in which the ear becomes hypersensitive to infrasound. In most cases, the inner ear's responses to infrasound can be considered normal, but they could be associated with unfamiliar sensations or subtle changes in physiology. This raises the possibility that exposure to the infrasound component of wind turbine noise could influence the physiology of the ear.”<sup>79</sup>

Regarding low-frequency sounds, Salt and Kaltenbach (2011) state:

“Abstract

Wind turbines generate low-frequency sounds that affect the ear. The ear is superficially similar to a microphone, converting mechanical sound waves into electrical signals, but does this by complex physiologic processes. Serious misconceptions about low-frequency sound and the ear have resulted from a failure to consider in detail how the ear works. Although the cells that provide hearing are insensitive to infrasound, other sensory cells in the ear are much more sensitive, which can be demonstrated by electrical recordings. Responses to infrasound reach the brain through pathways that do not involve conscious hearing but instead may produce sensations of fullness, pressure or tinnitus, or have no sensation. Activation of subconscious pathways by infrasound could disturb sleep. Based on our current knowledge of how the ear works, it is quite possible that low-frequency sounds at the levels generated by wind turbines could affect those living nearby.”<sup>80</sup>

Rand et al (2011) regarding risk to occupational workers state:

“Abstract

Industrial wind turbines (IWTs) are being installed at a fast pace globally. Researchers, medical practitioners, and media have reported adverse health effects resulting from living in the environs of IWTs. While there have been some anecdotal reports from technicians and other workers who work in the environs of IWTs, little is known about the occupational health sector. The purpose of this case study is to raise awareness about the potential for adverse health effects occurring among workers. The authors propose that there is a need for research regarding occupational worker exposure relating to IWTs.”<sup>81</sup>

Ambrose et al (2012) investigated low frequency and infrasound and state:

“Abstract

Wind turbines produce sound that is capable of disturbing local residents and is reported to cause annoyance, sleep disturbance, and other health-related impacts. An acoustical study was conducted to investigate the presence of infrasonic and low-frequency noise emissions from wind turbines located in Falmouth, Massachusetts, USA. During the study, the investigating acousticians experienced adverse health effects consistent with those reported by some Falmouth residents. The authors conclude that wind turbine acoustic energy was found to be greater than or uniquely distinguishable from the ambient background levels and capable of exceeding human detection thresholds. The authors emphasize the need for epidemiological and laboratory research by health professionals and acousticians concerned with public health and well-being to develop effective and precautionary setback distances for industrial wind turbines that protect residents from wind turbine sound.”<sup>82</sup>

Schomer (2013) states:

“This paper is geared towards wind turbine sound, but it is really a simple variation on the basic concepts that this author used in the development of loudness-level-weighted sound exposure (Schomer et al., J. Acoust. Soc. Am, 110(5), Pt. 1, 2390-2397, 2001) and of Rating Noise Curves (RNC) (Schomer, Noise Cont. Eng. J., 48(3), 85-96, 2000), which are used in the Standard, ANSI/ASA S12.2 Criteria for evaluating room noise. The fundamental issue is: Can we hear slowly surging or pulsating sounds for which the LEQ spectrum is below the threshold of hearing where "slowly" means that the pulses come at a rate that is no faster than about 4 pulses per second? The short answer is yes, and the longer answer is that this effect is a function of the spectral content and becomes more-and-more prominent as the spectral content goes lower-and-lower in the audible frequency range. So surging or pulsing sound that is primarily in the 16 or 31 Hz octave bands will show the greatest effect. This paper shows the applicability of these results to wind-turbine sound.”<sup>83</sup>

With respect to very low frequency noise which may not be audible, humans are proposed as:

“objective measuring instruments (New Experts), whose reports and descriptions must be taken seriously and quantified by technical measurements.”<sup>84</sup>

In a conference paper presented to the Acoustical Society of America regarding very low frequency noise measurement, acoustician Bray (2012) states:

At present a growing number of people are reporting sleep deprivation, unease and even illness which they most often ascribe to low frequency sound either near the hearing threshold or, more frequently, sub audible. Such reports are most frequent in rural or quiet suburban areas following the installation of large wind turbines, a new sound source without historic acoustic reference.”<sup>85</sup>

Acousticians Ambrose and Rand (2012) state:

“The best acoustic analyzer for determining human response is the human listening. This research shows it is not appropriate to use unattended sound measurement instruments.”<sup>86</sup>

Krogh et al (2012) reports on human perception to noise:

“... Noise is thus defined as unwanted sound. Sound meters can assess sound; however, humans assess “noise”. Sound becomes a risk to human health when it is considered to be noise.”<sup>87</sup>

Australian initiatives and a published recommendation by the Society for Wind Vigilance inform a 2 km setback.<sup>88, 89, 90</sup>

Québec, Canada informs:

“Le gouvernement québécois a officiellement donné son aval à la version modifiée du règlement de contrôle intérimaire (RCI) de la MRC du Haut Saint-Laurent. Aucune éolienne ne pourra se dresser à moins de 2 km d'une habitation et de 1 km d'une route dans la MRC du Haut-Saint-Laurent, en Montérégie.

Le gouvernement québécois a officiellement donné son aval à la version modifiée du règlement de contrôle intérimaire (RCI) de la MRC du Haut-Saint-Laurent encadrant ces structures sur son territoire, que les maires ont adopté le 9 janvier.”<sup>91</sup>

Google translate:

“The Quebec government has officially endorsed the amended regulation interim control (ROI) of the Haut Saint-Laurent release.

No wind can not stand less than 2 km from the house and 1 km of a road in the Haut-Saint-Laurent, Montérégie.

The Quebec government has officially endorsed the amended regulation interim control (ROI) of the Haut-Saint-Laurent governing these structures on its territory, the mayors adopted January 9 release.”

### **Krogh peer reviewed publications**

Roy D. Jeffery, Carmen Krogh, and Brett Horner Industrial wind turbines and adverse health effects Can J Rural Med 2014;19(1)  
<http://www.cma.ca/multimedia/staticContent/HTML/N0/12/cjrm/vol-19/issue-1/pdf/pg21.pdf>

Roy D. Jeffery, Carmen Krogh, and Brett Horner, Adverse health effects of industrial wind turbines Can Fam Physician 2013; 59: 473-475 (Commentary) <http://www.cfp.ca/content/59/5/473.full>

Roy D. Jeffery MD FCFP, Carmen Krogh, and Brett Horner CMA, (September 2013) Adverse health effects of industrial wind turbines, Can Fam Physician Vol 59: 921-925 Letters / Correspondence  
<http://www.cfp.ca/content/59/9/921.full>

Carmen M.E. Krogh, Industrial Wind Turbine Development and Loss of Social Justice? Bulletin of Science Technology & Society 2011 31: 321, DOI: 10.1177/0270467611412550,  
<http://bst.sagepub.com/content/31/4/321>

Carmen M.E. Krogh, Lorrie Gillis, Nicholas Kouwen, and Jeffery Aramini, WindVOiCe, a Self-Reporting Survey: Adverse Health Effects, Industrial Wind Turbines, and the Need for Vigilance Monitoring Bulletin of Science Technology & Society 2011 31: 334, DOI: 10.1177/0270467611412551. <http://bst.sagepub.com/content/31/4/334>

Brett Horner, Roy D. Jeffery and Carmen M. E. Krogh, Literature Reviews on Wind Turbines and Health: Are They Enough? Bulletin of Science Technology & Society 2011 31: 399. DOI: 10.1177/0270467611421849 <http://bst.sagepub.com/content/31/5/399>

Stephen E. Ambrose, Robert W. Rand and Carmen M. E. Krogh, Wind Turbine Acoustic Investigation: Infrasound and Low-Frequency Noise—A Case Study, Bulletin of Science Technology & Society published online 17 August 2012 DOI: 10.1177/0270467612455734, <http://bst.sagepub.com/content/early/2012/07/30/0270467612455734>

Robert W. Rand, Stephen E. Ambrose, and Carmen M. E. Krogh, Occupational Health and Industrial Wind Turbines: A Case Study, Bulletin of Science Technology & Society 2011 31: 359 DOI: 10.1177/0270467611417849. <http://bst.sagepub.com/content/31/5/359>

Birds and Bird Habitat: What Are the Risks From Industrial Wind Turbine Exposure?  
Terry Sprague, M. Elizabeth Harrington, and Carmen M. E. Krogh, DOI: 10.1177/0270467611417844 <http://bst.sagepub.com/content/31/5/377>

### **Conference papers**

Wind Turbine Facilities' Perception: A Case Study from Canada  
Peter N. Cole MD, MHSc, FRCP(C) and Carmen Krogh, BScPharm  
5th International Conference on Wind Turbine Noise Denver 28 – 30 August 2013 (published in proceedings but not presented)

Audit report: literature reviews on wind turbine noise and health  
Brett Horner, Carmen ME Krogh, Roy D Jeffery Paper presented at the Wind Turbine Noise conference 2013, August 28 to 30, Denver, Colorado, USA

Trading off human health: Wind turbine noise and government policy  
Carmen ME Krogh, Joan Morris, Murray May, George Papadopoulos, Brett Horner  
Paper presented at the Wind Turbine Noise conference 2013, August 28 to 30, Denver, Colorado, USA

Carmen ME Krogh, Roy D Jeffery, Jeff Aramini, Brett Horner, Wind turbines can harm humans: a case study, Paper presented at Inter-noise 2012, New York City, NY

Carmen ME Krogh, Roy D Jeffery, Jeff Aramini, Brett Horner, Wind turbine noise perception, pathways and effects: a case study Paper presented at Inter-noise 2012, New York City, NY

Carmen ME Krogh, Roy D Jeffery, Jeff Aramini, Brett Horner, Annoyance can represent a serious degradation of health: wind turbine noise a case study, Paper presented at Inter-noise 2012, New York City, NY

Stephen E. Ambrose, Robert W. Rand and Carmen M. E. Krogh, Falmouth, Massachusetts wind turbine infrasound and low frequency noise measurements, Invited paper presented at Inter-noise 2012m New York City, NY

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