Dear Board of Health:

On behalf of Apex Clean Energy, Epsilon Associates, Inc. (Epsilon) is pleased to submit this letter discussing some of the issues and questions raised about sound levels from wind turbines associated with Lighthouse Wind. In particular, I will touch on low frequency and infrasound.

Qualifications

I am Board Certified in Noise Control Engineering, and a Certified Consulting Meteorologist with over 28 years of experience in the areas of community noise impacts, and meteorological data analyses. I serve on the Board of Directors for the Institute of Noise Control Engineering (INCE).

I have written journal articles and presented technical papers on wind turbine and noise issues at wind energy and acoustic-focused conferences. I have also testified as an expert witness in many court cases involving wind turbines and noise issues. Much of this work has been on behalf of developers, but I have also worked for the Connecticut Siting Council for Renewables, the New Hampshire Site Evaluation Committee, and the Mason County (Michigan) Planning Commission on wind projects.

Since 2004, my noise impact assessment work has focused on wind energy generation facilities. I have managed or actively participated in sound level studies for over 75 wind energy projects in 25 states. I have conducted pre-construction sound level measurement programs, predictive sound level modeling, and post-construction sound level compliance monitoring at many of these sites. In addition, I was the lead investigator for a low frequency and infrasound research study on wind turbines, and am wrapping up a research study on wind turbine acoustics sponsored by the Massachusetts Clean Energy Center and the Massachusetts Department of Environmental Protection.
Basic Concepts

Human beings are capable of hearing a wide range of sounds, from the high-pitched sounds of a bird song to the low-pitched sound of a bass guitar. Sounds are based on their loudness (i.e., volume or sound pressure level) or pitch (i.e., tonal or frequency content). The standard unit used to describe the tonal or frequency content is the Hertz (Hz). People can typically perceive sounds ranging from 20 Hz to 20,000 Hz.

The frequency range of low frequency sound is generally from 20 Hz to 200 Hz, and the range below 20 Hz is often described as infrasound. At low frequencies, a much higher sound level is necessary for a sound to be heard as compared to higher frequencies. For example, at 10 Hz (infrasound range), the sound level must be approximately 97 decibels (dB) or greater to be audible for a typical person. However, at 100 Hz (low frequency range), a sound level around 27 dB or greater may be audible. These sound level thresholds may vary somewhat for the general population but they provide an idea of low frequency and/or infrasound audibility.

Figure 1 provides a graphical representation of frequencies measured in one-third octave bands from 4 Hz to 16,000 Hz. It also labels the portions of the spectrum generally referred to as Infrasound, Low Frequency, and Middle to High Frequencies. In addition, the approximate levels of audibility at each frequency are plotted on the graph. For example, at 1000 Hz sound is audible at approximately 2-3 dB, while at 20 Hz sound is audible at approximately 79 dB.

There is nothing mysterious about low frequency sound or infrasound. Although you cannot hear it, it is all around us in our communities today from both natural (thunder; waves; wind) and man-made (air conditioners; cars; refrigerators) sources. Scientific studies have shown that low frequency and infrasound energy from wind turbines are below levels that cause vibration, rattle, annoyance, or sleep disturbance at typical residential setbacks. Figure 2 presents the results of low frequency sound and infrasound measured at two locations within the Project area, and for perspective, compares them to sound levels from wind turbines at another wind farm approximately 1,600 feet away. As the figure demonstrates, under similar wind conditions, levels of infrasound and low frequency noise are similar. When winds are calm and wind turbines are not operating, there is still low frequency and infrasound energy in the community.

Sound Level Prediction Discussion

Sound energy will travel from a point source and be at a different sound level when it arrives some distance away. The sound pressure level at a known distance is
calculated according to a set of physical principles. In New York State, and many other parts of the world, these calculations are done using International Standard ISO 9613-2 “Acoustics – Attenuation of sound during propagation outdoors. Part 2: General method of calculation”.

In basic terms, the sound pressure level at a known distance starts with the sound power level of the source and is corrected to account for the following:

- Directivity (takes directionality into consideration);
- Distance (sound decreases as distance increases);
- Atmospheric absorption (varies by octave band and is a function of temperature and relative humidity);
- Ground effects (how do sound waves reflect off the ground);
- Screening (obstacles between the source and receiver will affect sound); and
- Miscellaneous attenuation (sound traveling through foliage for example).

All these computations are governed by the ISO 9613-2 standard and have been incorporated in software packages used by acoustical consultants to calculate sound levels from many sources at various distances. The Cadna/A software is one such package, and will be used for this Project.

The sound level predictions are conservative (err on the high side) for the following reasons:

- Maximum sound level from each wind turbine is assumed,
- Additional safety factor accounting for uncertainty included,
- Wind turbine height included in model,
- Meteorological conditions—temperature inversion; T; RH,
- Wind always blowing from turbine to house, and
- All wind turbines operating at maximum power simultaneously.

Post-construction sound level measurement programs around wind farms have found that actual sound levels are typically several decibels lower than the
predicted worst-case sound levels. While the sound from a wind turbine may be audible at times at some locations, audibility is not a regulatory noise limit.\textsuperscript{12}

**Representative Papers on Noise Impacts**

Low frequency sound and infrasound from wind turbines. *Noise Control Engineering Journal.* I was the lead investigator for Epsilon Associates, Inc. as we conducted a research study on this issue for one of our clients. Our research effort was threefold: (1) a literature search on guidelines and standards used to evaluate low frequency sound and infrasound, (2) a field study to measure wind turbine noise inside and outside nearby residences, and (3) a comparison of that field data to the guidelines and standards researched above. The results of this research were published in a peer-reviewed journal [O’Neal, R.D., Hellweg, Jr., R.D. and R. M. Lampeter, 2011. *Low frequency sound and infrasound from wind turbines.* Noise Control Engineering Journal, 59 (2), 135-157]. As set out in our paper, our results showed that infrasound and low frequency sound will meet these criteria and standards at distances of 1,000 feet (305 meters) and 1,500 feet (457 meters) from the nearest wind turbines.

**Wind Turbine Health Impact Study, Report of Independent Expert Panel.** In January 2012, a report prepared for the Massachusetts Department of Environmental Protection and the Massachusetts Department of Public Health was prepared by a panel of independent experts. The expert panel evaluated information from peer-reviewed scientific studies, other reports, popular media, and public comments on the nature and type of health complaints commonly reported by individuals who reside near existing wind turbines. The panel’s findings were consistent with other independent reviews of wind turbine impacts: While wind turbines may be a source of annoyance to some people, they do not cause health effects.


Pedersen et al paper. No matter what the sound levels are from a wind turbine, some people may find it annoying for non-acoustical reasons. This is shown through a field study in the Netherlands published in the Journal of the Acoustical Society of America.\(^3\) This paper provides a dose-response relationship between A-weighted sound levels and reported perception and annoyance from wind turbines. The study found that annoyance increased with increasing sound levels. However, one percent of respondents were “very annoyed” even at sound levels less than 30 dBA. Only six percent were “very annoyed” at levels above 45 dBA. The vast majority of people living near wind farms either “did not notice” or “noticed, but not annoyed” at sound levels below 45 dBA. The study found that annoyance is strongly correlated with a negative attitude toward the visual impact of wind turbines.

Health Canada study. Health Canada is the Federal department responsible for helping Canadians maintain and improve their health. They rely on high-quality scientific research as the basis for their work. In July 2012, Health Canada announced its intention to undertake a large scale epidemiology study in collaboration with Statistics Canada. The study was launched to support a broader evidence base on which to provide federal advice and in acknowledgement of the community health concerns expressed in relation to wind turbines. Health Canada completed its preliminary analysis of the data obtained, and released the results in November 2014. The study did not find any evidence of a link between exposure to wind turbine noise and any of the self-reported or measured health effects examined.

McCunney et al paper. A recent literature review on wind turbines and health found that “Infrasound and low frequency sound do not present unique health risks”, and “Annoyance seems more strongly related to individual characteristics than noise from turbines.”\(^4\)

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World Health Organization Night Noise Guidelines for Europe. The World Health Organization (WHO) 2009 “Night Noise Guidelines for Europe” report recommends a night noise guideline (NNG) of 40 dBA. This is a health-based limit to protect the public from the adverse health effects of night noise. However, the 40 dBA guideline is defined as the A-weighted long-term average sound level determined over all the night periods of a year.

Since $L_{\text{night, outside}}$ considers 365 nights of operation, there will be some nights the wind turbines do not operate at all and many others where they will operate at a level below maximum sound level. Therefore, the $L_{\text{night, outside}}$ sound level will ALWAYS be lower than a short-term measurement. A short-term nighttime sound limit of 45 dBA is consistent with the WHO annual $L_{\text{night, outside}}$ level of 40 dBA.

WHO Guideline for Community Noise. The “Guideline for Community Noise” (WHO, Geneva, 1999) states that at night, sound levels at the outside facades of the living spaces should not exceed an $L_{\text{eq}}$ of 45 dBA, so that people may sleep with bedroom windows open. The time base for these WHO sound levels is 8 hours for nighttime. In other words, they are not 10-minute averages but over a longer period of time.

Conclusion

The science and research on this topic are clear – a standard sound level limit of 45 dBA and a 1,500 foot setback from non-participating residents which will be used by Apex, will protect residents in the vicinity of a wind farm from adverse health effects and annoyance. The objective of a noise limit should not be to make every wind turbine inaudible to every person, or to annoy zero percent of the population. That is unreasonable, and impossible for any source of sound. Meeting a standard such as this strikes a reasonable balance of minimizing community noise, and allowing for responsible siting of wind turbines.

I will be in attendance at the December 3, 2015 Niagara County BOH meeting if you have any further questions. In addition, please feel free to call me at (978) 461-6236, or e-mail me at roneal@epsilonassociates.com.

Sincerely,

EPSILON ASSOCIATES, INC.

Robert D. O’Neal, CCM, INCE Bd. Cert.
Principal
Figure 1. Threshold of Audibility vs. Frequency (4 Hz–16,000 Hz)
Figure 2. Existing Infrasound & Low Frequency Noise—Niagara County

- Infrasound
- Low Frequency

Hub winds = 12 m/s; Not Project Wind Farm

- Red: Loc 3/22/2015 3:00-3:10 (Wind Speed = 0 m/s) (42 dBA)
- Light Blue: Loc 3/25/2015 23:20-23:30 (Wind Speed = 3 m/s) (52 dBA)
- Dark Blue: 1600 ft. from Wind Turbines (Wind speed = 3 m/s) (41 dBA)
2 December 2015

Niagara County Board of Health
5467 Upper Mountain Road, Suite 100
Lockport, NY 14094

RE: Lighthouse Wind Project – Overview of Wind Turbines and Health Concerns

Board Members:

Olsson Environmental Health Management (OEHM) has been retained by Apex Clean Energy (Apex) to provide an overview of state of the science of the potential health concerns related to living in proximity to wind turbines. I intend to appear before the Niagara County Board of Health on December 3, 2015 to provide any clarification that is required. This letter should be read in tandem with the letter prepared by Epsilon Associates Inc on “Lighthouse Wind – Sound From Wind Turbines”.

1.0 Qualifications of Dr. Christopher Olsson

My area of expertise is in the field of environmental health science. I am trained, schooled and practiced in the evaluation of potential risks and health effects to people and ecosystems associated with environmental issues. Since 2008, I have been engaged by a number of private companies to review the potential health effects that may be associated with living in proximity to wind turbines as part of their preparation of environmental assessment documentation. In 2014, I provided expert advice on wind turbines, health and proper siting requirements for the Vermont Public Services Department. Approximately one third of my practice on an annual basis has been devoted to better understanding the relationship between people and wind energy.

I have been qualified to provide expert opinion evidence on wind turbines and potential health effects at a number of North American hearings, tribunals and legal cases. I have provided numerous presentations to County Commissions and Boards across the US.

In addition to my consulting practice I hold an appointment of Adjunct Assistant Professor at the Royal Military College of Canada in the Department of Chemistry and Chemical Engineering and Adjunct Professor in the School of the Environment at the University of Toronto. In 2013, I was appointed to the Governing Council, and am Vice-Chair of the Academic Affairs Committee, of the University of Toronto Scarborough.

While at Intrinsik Environmental Sciences (2011-2015) I headed a research group on the potential effects of wind projects on health. These research efforts resulted in six published scientific peer reviewed papers:


2.0 Questions from the Niagara County Department of Health

It is my understanding that the Niagara County Department of Health provided a letter to Apex on November 2, 2015 with a series of questions to be answered at their December 3, 2015 meeting. Those specific to health concerns included:

- What types of studies have been done to measure environmental and health impacts of wind turbines? (Please be prepared to discuss where the studies were performed, on whom, over what period of time, what environmental and health effects were found, who performed the studies, and similar inquiries.)

- How can you determine that 583 foot turbines would be safe to humans or environment when you have no similarly sized or situated turbines in existence, while at the same time people are reporting health issues and environmental issue with 370 foot turbines?

This letter serves to provide background to the Board of Health on these questions.

3.0 Background

Wind-based energy production has been identified as a clean and renewable resource that does not produce any known emissions or harmful wastes. As a result, wind power has become the fastest growing source of new electric power generation, with several countries achieving high levels of wind power capacity. There exists, however, an ongoing debate surrounding the relationship between wind turbines and effects on human health.

The motivation behind for the self-reported health effects is highly debated and information relevant to this debate is found primarily in three sources:

- scientific peer-reviewed studies published in scientific journals;
- government agency reports; and,
- the popular literature and internet.

Over 60 studies have been published worldwide to examine the relationship between wind turbines and possible human health effects. Based on the findings and scientific merit of these studies they have lead health and medical authorities to state that when sited properly (i.e., based on distance and/or noise guidelines and setbacks), wind turbines are not causally related to adverse effects.
However, some argue that the small numbers of self-reported health effects are related to two issues: wind turbine noise (i.e., levels of audible noise, low frequency noise and infrasound) and wind turbine operational effects (e.g., shadow flicker from rotor blades).

Conversely, others suggest that the science conducted points towards reported effects being more likely attributable to a number of environmental stressors that can result in an annoyed/stressed state in a small segment of the population – it is this conclusion which I believe the evidence supports.

This letter attempts to provide the scientific facts about health and living in proximity to wind turbines.

3.1 Audible Sound (Noise)

There are a number of studies that have explicitly examined the relationship between levels of wind turbine noise and various self-reported indicators of human health and well-being (e.g., Health Canada 2014; Bakker et al. 2012; Janssen et al. 2011; Pedersen 2011; Pedersen and Persson Waye 2004; 2007). These studies have researched a wide range of wind turbine models, manufacturers, heights and noise levels. They were conducted over several years, in some cases over 10 years, after wind turbines became operational. The study of wind turbine health concerns began in Europe in the early 2000s and most recently examined in Canada.

It is important to understand that from a health perspective it is not the height of the turbines, or the noise output at their hub, that is the important. Rather, it is the resulting sound level at people’s homes that is critical to ensure the protection of public health. Simply put, whether a developer selects a 583 foot or 370 foot wind turbine the sound models that will be used to determine the resulting noise level at individuals homes remains the same.

What can be seen from these peer-reviewed articles (and many others) is that the relationship between wind turbines and human responses to them is extremely complex and influenced by numerous variables. Key points that have come out of these studies are:

• Adverse health effects have not been attributed to properly sited wind turbine projects;
• People tend to notice sound from wind turbines almost linearly with increasing sound pressure level (in other words, the louder the wind turbine at ground level the more people notice them);
• A proportion of people that notice sound from wind turbines find it annoying (annoyance is not a medical condition);
• Noise-related annoyance can be within the range of existing levels of community noise related annoyance (e.g., rail, road and air traffic; animal noise);
• Annoyance is not only related to wind turbine noise but more strongly to subjective factors like attitude, visual cue, stress and expectations; and
• People who economically benefit from wind turbines often experience higher sound levels outside their homes than non-participants and have significantly decreased levels of annoyance compared to individuals that received no economic benefit.
The reported correlation between wind turbine noise and annoyance is not unexpected as noise-related annoyance (described by Berglund and Lindvall (1995) as a “feeling of displeasure evoked by a noise”) has been extensively linked to a variety of common noise sources such as rail, road, and air traffic (Berglund and Lindvall 1995; Laszlo et al. 2012; WHO Europe 2011).

Noise-related annoyance from these more common sources is prevalent in many communities. For instance, results of national surveys in Canada and the U.K. by Michaud et al. (2005) and Grimwood et al. (2002), respectively, suggested that annoyance from noise (predominantly traffic noise) may impact approximately 8% of the general population. Even in small communities in Canada (i.e., <5000 residents) where traffic is relatively light compared to urban centers, Michaud et al. (2005) reported that 11% of respondents were moderately to extremely annoyed by traffic noise. This same trend was noted in the Bakker et al., 2012 study in the Netherlands where people living in close proximity to wind turbines reported being awoken more by people/animal noise (11.7%), rural traffic/mechanical noise (12.5%) than turbine noise (6.0%).

It is acknowledged that noise from wind turbines can be annoying to some and that annoyance can be associated with some reported health effects (e.g., sleep disturbance). However, given that annoyance appears to be more strongly related to visual cues and attitude than to noise itself, self-reported health effects of people living near wind turbines are more likely attributed to physical manifestation from an annoyed state than from wind turbines themselves. In other words, it appears that it is the change in the environment that is associated with self-reported health effects and not a turbine-specific variable like audible noise or infrasound.

Because environmental noise above certain levels is a recognized factor in a number of human health issues, many jurisdictions where wind turbines are being constructed have established noise restrictions and/or minimum setback distances in order to mitigate potential noise-based health effects (as well as operational effects related to shadow flicker, ice throw and structural failure).

Peer reviewed studies do not do not support a correlation between wind turbine noise exposure and any other responses. For example, various studies based on the results of two surveys performed in Sweden and one in the Netherlands (1755 respondents overall), found that no other measured variable (e.g., self-reported evaluations of high blood pressure, cardiovascular disease, tinnitus, headache, sleep interruption, diabetes, tiredness, and reports of feeling tense, stressed, or irritable) was directly related to wind turbine noise for all three datasets (Pedersen, 2011).

Likewise, the Health Canada (2014) study (1238 participants) found no correlation between wind turbine noise exposure and either self-reported indicators of health (i.e.,, self-reported sleep disturbance, use of sleep medication, diagnosed sleep disorders, migraines, tinnitus, dizziness, hypertension, perceived stress or any measure of quality of life) or objectively measured indicators of health (hair cortisol concentrations, blood pressure, resting heart rate or any of the measured sleep parameters). Further details on the Health Canada study are provided below.

### 3.2 Low Frequency Noise (LFN) and Infrasound (IS)

Low frequency noise (LFN) / infrasound (IS) are terms used to describe sounds that are produced at frequencies too low to be heard by the human ear at frequencies of 0 to 20 Hz (IS) and 20 to 200 Hz (LFN). LFN/IS are not unique to wind turbines. More common sources include road traffic, refrigerators, ocean waves, thunder, and even the wind itself.
There has been recent speculation by some that low frequency noise or infrasound emitted from wind turbines could be the cause of health concerns reported by some living in proximity to wind projects. To that end, our research team along with Mr. Payam Ashtiani of Aerco Acoustics Engineering Ltd. and Dr. Geoff Leventhall recently published a peer-reviewed article entitled “Health-based Audible Noise Guidelines Account for Infrasound and Low Frequency Noise Produced by Wind Turbines” in the journal Frontiers in Public Health (see Berger et al., 2015).

The purpose of this paper was to investigate whether current audible noise-based guidelines for wind turbines account for the protection of human health given the levels of infrasound (IS) and low frequency noise (LFN) typically produced by wind turbines. New field measurements of indoor IS and outdoor LFN at locations between 400 m (1300 ft) and 900 m (2950 ft) from the nearest turbine, which were previously underrepresented in the scientific literature, were reported and put into context with existing published works. Our analysis showed that indoor IS levels were below auditory threshold levels while LFN levels at generally accepted setback distances were similar to background LFN levels. Collectively, these data in conjunction with previous reports indicate that levels of IS and LFN are not sufficient to induce adverse health effects; therefore health-based audible noise guidelines are suitable for the protection of human health.

This work is consistent with the study undertaken by Epsilon Associates, Inc., published in 2011 (O’Neal, 2011). Additionally, it should be noted that Health Canada (2014) recently found that there was “no additional benefit in assessing LFN as C- and A-weighted levels were so highly correlated (r=0.94) that they essentially provided the same information”.

In 2012, Turnbull et al. published a paper titled Measurement and Level of Infrasound from Wind Farms and Other Sources. The study was conducted in Australia around wind turbines and other common sources of infrasound. The Clements Gap Wind Farm is comprised of 27 Suzlon S88 2.1 MW wind turbines and the Cape Bridgewater Wind Farm that is comprised of 29 Repower MM82 2.0 MW wind turbines. They determined that infrasound from wind turbines reached ambient (background) levels within 200 m (650 ft) to 360 m (1200 ft). The levels were found to be lower than those measured around beaches, gas fired plants and major roadways. These findings are consistent with other scientific papers in the field.

Therefore, the hypothesis that infrasound is a causative agent in health effects is not supported by the scientific and medical literature. Although IS and LFN are emitted from wind turbines and their contribution above background sources can be measured, the levels are typically within background levels at homes and are well below levels that could induce health impacts.

3.3 Shadow Flicker

The main health concern associated with shadow flicker is the risk of seizures in those people with photosensitive epilepsy. Harding et al. (2008) and Smedley et al. (2010) have published the seminal studies dealing with this concern. Both authors investigated the relationship between photo-induced seizures (i.e., photosensitive epilepsy) and wind turbine blade flicker (also known as shadow flicker). Both studies suggested that flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 Hz pose a potential risk of inducing photosensitive seizures in 1.7 people per 100,000 of the photosensitive population. For turbines with three blades, this translates to a maximum speed of rotation of 60 rpm.
Modern turbines commonly spin at rates well below this threshold and are typically below 20 rpm. For example the following spin rates for four different models of wind turbines have been obtained from the turbine specification sheets:

- Siemens SWT-2.3: 6-16 rpm
- REpower MM92: 7.8 –15.0 rpm
- GE 1.6-100: 9.75-16.2 rpm
- Vestas V112-3.0: 6.2-17.1 rpm

In 2011, the Department of Energy and Climate Change (United Kingdom) released a consultant’s report entitled “Update of UK Shadow Flicker Evidence Base”. The report concluded that:

“On health effects and nuisance of the shadow flicker effect, it is considered that the frequency of the flickering caused by the wind turbine rotation is such that it should not cause a significant risk to health.”

The expert panel convened by MDEP/PH (2012) concluded that the scientific evidence suggests that shadow flicker does not pose a risk of inducing seizures in people with photosensitive epilepsy.

4.0 Commonly Cited Internet Theories on Wind Turbine Health Concerns

Although the scientific literature supports the fact that properly sited wind turbines will not result in public health impacts there are two common theories from the internet that attempt to draw a linkage between living in proximity to wind turbines and health concerns.

Indeed, a small proportion of people that live near wind turbines have self-reported adverse health effects such as ringing in ears, headaches, lack of concentration, vertigo and sleep disruption that they attribute to the wind turbines. This collection of effects has received the colloquial name “Wind Turbine Syndrome”, a term coined by Dr. Nina Pierpont in her self-published (not peer reviewed) book “Wind Turbine Syndrome: A Report on a Natural Experiment” (Pierpont, 2009). Another internet popular theorem has been put forward by Dr. Alves-Pereira coined VibroAcoustic Disease (VAD).

Over the past six years these allegations have not been recognized by medical agencies, courts, tribunals, or many scientists/physicians as valid. Given that these concerns have been raised in association to the Lighthouse Wind project the following section provides a brief overview of these Internet theories.

4.1 Vibroacoustic Disease (VAD)

Dr. Alves-Pereira’s work on vibroacoustic disease (VAD) and its potential to be a complicating factor in those living near wind turbines has been available at conferences and on the internet since 2007. However, her work on VAD is not recognized in the international medical community. For example VAD is not a recognized medical disease as it is not classified in the World Health Organization’s International Statistical Classification of Disease and Related Health Problems 10th revision – ICD 10. The ICD is:
“...the standard diagnostic tool for epidemiology, health management and clinical purposes. This includes the analysis of the general health situation of population groups. It is used to monitor the incidence and prevalence of diseases and other health problems, proving a picture of the general health situation of countries and populations.”

Dr. Alves-Pereira has only once applied her VAD theory to being the disease associated with living in proximity to wind turbines in one case. This was for a 12 year old boy in Portugal in 2007, with residential buildings between 321 m (1050 ft) and 642 m (2100 ft) from the wind turbines. Her research team believes that the presence of low frequency noise (LFN) from the turbines in the buildings was the cause of this child’s learning problems in school. Although this work was presented at two conferences the case study has never been accepted for publication in a medical or scientific journal. Without going into the numerous issues surrounding their study design, the mere presence of LFN being measured within the homes does not mean it could be causally linked to the boy’s poor school performance. However, this one case study has led Dr. Alves-Pereira to make wide sweeping claims that LFN noise from wind turbines results in VAD in individuals and their health will be impacted on the Internet.

In 2013, Professor Simon Chapman and Alexis St. George of the School of Public Health at the University of Sydney published an article in the Australian and New Zealand Journal of Public Health titled “How the factoid of wind turbines causing ‘vibroacoustic disease’ came to be ‘irrefutably demonstrated’. They were attempting to determine how VAD became associated with wind farm exposure. The following were their findings:

**Results:** Google returned 24,700 hits for VAD and wind turbines. Thirty-five research papers on VAD were found, none reporting any association between VAD and wind turbines. Of the 35 papers, 34 had a first author from a single Portuguese research group. Seventy-four per cent of citations to these papers were self-citations by the group. Median self-citation rates in science are around 7%. Two unpublished case reports presented at conferences were found asserting that VAD was “irrefutably demonstrated” to be caused by wind turbines. The quality of these reports was abject.

**Conclusions:** VAD has received virtually no scientific recognition beyond the group who coined and promoted the concept. There is no evidence of even rudimentary quality that vibroacoustic disease is associated with or caused by wind turbines.

**Implications:** The claim that wind turbines cause VAD is a factoid that has gone ‘viral’ in cyberspace and may be contributing to nocebo effects among those living near turbines.

Dr. Geoffrey Leventhall, a recognized international expert in LFN, wrote “Vibroacoustic Disease (VAD) and Wind Turbines Critique”, which was included as an exhibit by the Public Service Commission of Wisconsin. The following were his findings:

One is left with a very uncomfortable feeling that the work of the VAD group, as related to the effects of low levels of infrasound and low frequency noise exposure, is on an extremely shaky basis and not yet ready for dissemination. The work has been severely criticised when it has been presented at conferences. It is not backed by peer reviewed publications and is available only as conference papers which have not been independently evaluated prior to presentation.
Until the fuzziness is clarified, and a receptor mechanism revealed, no reliance can be placed on the claims that the low levels of infrasound and low frequency noise are a cause of vibroacoustic disease.

The attribution of dangerous properties to low levels of infrasound continues unproven, as it has been for the past 40 years. No foundation has been demonstrated for the recent new hypothesis that exposure to sub-threshold, low levels of infrasound will lead to vibroacoustic disease. Indeed, our evolution has occurred in the presence of natural infrasound.

In addition, none of the international medical agencies that have reviewed the literature surrounding wind turbines have included her work in their evaluations, including Ontario Chief Medical Officer of Health (2010), Massachusetts Department of Health (2012), Australian Medical Research Council (2013).

There have been numerous studies published on measuring LFN surrounding wind turbine projects. In large part these studies have demonstrated that LFN at these distances would be within background or certainly not likely cause for health concerns (Knopper et al., 2014). Given that VAD appears to be only recognized by Dr. Alves-Pereira’s research group, her wide sweeping claims on it being the cause of wind turbine related health effects on the abject study of one 12 year old child and that her work is not recognized by international medical agencies or researchers studying in this field, I would suggest that it be given no weight in scientific evidence.

4.2 Wind Turbine Syndrome – Nina Pierpont

In 2009, a book entitled Wind Turbine Syndrome: A Report on a Natural Experiment by Dr. Nina Pierpont, was self-published and describes “Wind Turbine Syndrome” the clinical name Dr. Pierpont coined for the collection of symptoms reported to her by people residing near wind turbines. The book describes a case series study she conducted involving interviews of 10 families experiencing self-reported adverse health effects and who reside near wind turbines. People living in proximity wind turbines were interviewed about their health. Self-reported symptoms generally included sleep disturbance, headache, tinnitus (ringing in the ears), ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia (rapid heart rate), irritability, problems with concentration and memory and panic episodes. These symptoms have been purported to be associated with proximity to wind turbines, and specifically, to the infrasound emitted by the turbines.

However, this work did not follow any recognized standard protocols of epidemiology or environmental health science. Dr. Pierpont’s work did not examine the actual audible, LFN or infrasound levels at these homes. This work has not been published in the scientific or medical peer-reviewed literature and has received a considerable amount of criticism in government and scientific literature reviews from around the world.

In fact, in 2012 the Massachusetts Department of Environment Protection and Department of Public Health commissioned a review of the issues and released the findings in their Wind Turbine Health Impact Study: Report of Independent Expert Panel. This panel included Dr. Jeffrey Ellenbogen, MD, MMSc who is an Assistant Professor of Neurology, Harvard Medical School. Included among their many findings was:
“There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a "Wind Turbine Syndrome."

Given that Dr. Pierpont's work is not recognized by international medical agencies or researchers studying in this field, I would suggest that it be given no weight in scientific evidence.

5.0 The Nocebo Hypothesis

In 2013, Professor Simon Chapman from Australia and his colleagues published a peer-reviewed scientific article entitled “The pattern of complaints about Australian wind farms does not match the establishment and distribution of turbines: support for the psychogenic, 'communicated disease' hypothesis.”

The authors provided an overview of the growing body of literature supporting the notion that the attribution of symptoms and disease to wind turbine exposure is a modern health worry. Chapman et al. suggested that nocebo effects likely play an important role in the observed increase in wind farm-related health complaints. By evaluating records of complaints from wind farm companies about noise or health from residents living near 51 wind farms across Australia, two theories about the etiology of complaints were tested: one being direct effects from turbines and the other being “psychogenic” effects brought on by nocebo effects.

Chapman et al. found a number of historical and geographical variations in wind farm complaints from Australian.

1. Nearly 65% of Australian wind farms, 53% of which have turbines greater than 1 MW, have never been subject to noise or health complaints. These farms have an estimated 21,633 residents within 5 km and have operated complaint-free for a cumulative 267 years. No complaints were reported in Western Australia and Tasmania.

2. 1 in 254 residents across Australia appeared to have ever complained about health and noise, and 73% of these residents live near 6 wind farms that have been targeted by anti-wind farm groups. 90% of complaints were made after anti wind farm groups added health concerns to their wider opposition in 2009.

3. In the years after, health or noise complaints were rare despite large and small-turbine wind farms having operated for many years.

It was suggested that reported historical and geographical variations in complaints were consistent with “communicated diseases” with nocebo effects likely to play an important role in the etiology of complaints rather than direct effects from turbines. This novel work highlighted the role of negative expectations and how they could lead to the development of complaints near wind farms. These findings were supported by many other studies that were suggestive of subjective variables, rather than wind turbine specific variables, as the source of annoyance for some people.


This study was initiated in 2012 and was a partnership between Health Canada and Statistics Canada that involved understanding the potential impacts of wind turbine noise on health and wellbeing of communities in Southern Ontario (just north of New York) and Prince Edward Island. A total of 1238 households participated in the study. Health Canada’s brochure contains the following statement:

_The Wind Turbine Noise and Health Study is a landmark study and the most comprehensive of its kind. Both the methodology used and the results are significant._
contributions to the global knowledge base and examples of innovative, leading edge research.

As set out in the Summary and Michaud (2015), the following were not found to be associated with wind turbine noise:

- Hair cortisol concentrations, blood pressure, resting heart rate or any of the measured sleep parameters (i.e., sleep latency, sleep time, rate of awakenings, sleep efficiency).
- Self-reported sleep disturbance, use of sleep medication, or diagnosed sleep disorders.
- Self-reported migraines, tinnitus, dizziness, diabetes, hypertension, perceived stress or any measure of quality of life.

Annoyance (which is not a medical condition) was found to be statistically associated with increasing levels of wind turbine noise. However, the associations between wind turbine noise annoyance and self-reported and measured health effects were not dependent on the particular levels of noise, or particular distances from the turbines, and were also observed in many cases for road traffic noise annoyance. Rather, the percentage of highly annoyed people living in vicinity of wind turbines was dependent not only on noise, but other factors for example visual cue. Health Canada’s findings are consistent with the past decade of research in the field of wind turbine noise and community health. Nowhere in Health Canada’s official material on this study do they suggest that living in proximity to wind turbines poses serious harm to people’s health.

At the 6th International Meeting on Wind Turbine Noise Glasgow April 2015 Dr. David Michaud, principal investigator of the Health Canada study presented a paper “Wind Turbine Noise and Health Study: Summary of Results” (Appendix “H”). This conference paper provides greater details on the statistics and graphs of the Health Canada findings. It concludes by stating:

Including both self-reported and physically measured health effects together provides a more complete overall assessment of the potential impact that exposure to wind turbines may have on health and well-being. The overall conclusion to emerge from the study findings is that the study found no evidence of an association between exposure to WTN and the prevalence of self-reported or measured health effects beyond annoyance. Collectively, the findings related to annoyance suggest that health and well-being effects may be partially related to activities that influence community annoyance, over and above exposure to WTN. Therefore, efforts that aim to identify and mitigate high levels of annoyance with wind turbines may have benefits that go beyond annoyance.

7.0 Government Agency Reviews

A number of reviews of potential health effects associated with wind turbines have been written in recent years for governments and governmental agencies (Chatham-Kent Public Health Unit, 2008; Chief Medical Officer of Health Ontario, 2010; Australian Government, National Health and Medical Research Council, 2010; Australian Senate, 2011; Massachusetts Department of Environmental Protection (MassDEP) and Massachusetts Department of Public Health (MassDPH), 2012, South Australia Environmental Protection Agency, 2013).

It is important to recognize that of these reviews, all of which include medical doctors, none classified the self-reported annoyance issues of residents as a pathological medical entity. Overall, governmental health agencies agree that noise from wind turbines is not loud enough to
cause hearing impairment and are not causally related to adverse effects, however, they acknowledge that wind turbines can be a source of annoyance and suggest that impacts can be minimized by following existing planning guidelines. The following are a number of the international reviews that have been conducted:


### 8.0 Conclusions

Over the past decade there has been considerable research conducted around the world on the potential for wind turbines to adversely impact health. This independent research by university professors and government medical agencies has taken place in many different countries on a variety of models of turbines that have been in the community for a number of years. Based on scientific principles, and the collective findings of over 60 scientific articles, I believe that when properly sited, the Lighthouse Wind project will not result in adverse health effects in the surrounding communities. As with any noise source siting guidelines are put in place to ensure the protection of public health. It is not the height or size of the turbines that is important, rather it is the level of sound at the residences that is important to ensure the protection of health.

I look forward to attending the December 3, 2015 Niagara County Board of Health meeting and can provide further details or clarification on this matter.

Sincerely,

OLLSON ENVIRONMENTAL HEALTH MANAGEMENT

[Signature]

Christopher Ollson, PhD
Senior Environmental Health Scientist
References


Michaud, DS. 2015. Wind Turbine Noise and Health Study: Summary of Results. 6th International Meeting on Wind Turbine Noise, Glasgow.


WHO (World Health Organization), Regional Office for Europe. Burden of disease from environmental noise: Quantification of healthy life years lost in Europe. WHO Regional Office for Europe, Copenhagen, Denmark (2011).
2 December, 2015

Niagara County Board of Health
5467 Upper Mountain Road, Suite 100
Lockport, NY, 14067

Board Members,

To compliment the information that will be provided at the December 3rd meeting of the Niagara Board of Health, we are writing to offer a greater level of information regarding the Lighthouse Wind project and what to expect from our pending presentation.

In the course of our presentation we intend to accomplish two goals. Firstly, we will familiarize the board with the Lighthouse Wind project, its projected timeline, and the details of the Article 10 permitting process, which is required for any new power generation over 25MW in New York State. Secondly, we will provide information regarding wind energy and human health and answer the questions posed by the board on November 2, 2015.

Lighthouse Wind is a proposed 201 MW electric generating facility which would place 58-70 wind turbines in Somerset and Yates. These turbines would be connected via underground collection lines to the Kintigh substation, which is co-located with the Somerset coal burning facility. The project would provide enough clean, renewable power for approximately 53,000 average NY homes. The project will ultimately receive its permit through the New York State Article 10 permitting process.

Lighthouse Wind intends to adhere to the following standard from non-participating residences: a nighttime sound level limit of 45 dBA and a 1,500 foot setback. In an effort to provide the most substantial and effective presentation possible, Lighthouse Wind has engaged two subject matter experts in the field of wind energy and human health. Chris Ollson of Ollson Environmental Health Management and Rob O’Neill of Epsilon Associates will provide information leading to the conclusion that there is no epidemiological link between properly sited wind turbines and human health.

Lighthouse Wind is pursuing this project in order to establish a wind farm that will provide a clean, safe form of renewable energy that will both reduce CO2 emissions from power generation and improve public health. This will directly contribute to accomplishing goals established in multiple Federal and State level policies. At the federal level, in 2015, the Environmental Protection Agency (EPA) established the first...
ever restrictions on carbon pollution from power plants, the largest source of unregulated CO2 emissions in the U.S. Through the EPA’s Clean Power Plan, it states, “With abundant clean energy solutions available, and building on the leadership of states and local governments, we can make continued progress in reducing power plant pollution to improve public health and the environment while supplying the reliable, affordable power needed for economic growth. By doing so, we will continue to drive American leadership in clean energy technologies” (Executive Office of the President, 2013).

At the state level, In 2004, New York established a Renewable Portfolio Standard (RPS) which initially called for an increase in renewable energy used in the State to 25% by the year 2013 (New York Public Service Commission, 2004). In 2010, the New York Public Service Commission (PSC) expanded the RPS target to 30% by 2015. To address initiatives beyond 2015 Governor Andrew M. Cuomo launched New York’s new energy policy, Reforming the Energy Vision (REV), which calls for the transition to an integrated energy network able to combine the benefits of a centralized grid with clean, locally generated power (PSC, 2015). The Lighthouse Wind project would be compatible with the REV initiative and the State’s commitment to renewable energy goals. Further, through the 2015 State Energy Plan, New York has committed to achieving a 40% reduction in greenhouse gas emissions (from 1990 levels) by 2030 and an 80% reduction in total carbon emissions by 2050. The Plan also calls for 50% of generation of electricity to come from renewable energy sources by 2030. According to the Plan, “Renewable Energy sources, such as wind, will play a vital role in reducing electricity price volatility and curbing carbon emissions.” The Lighthouse Wind project is compatible with the objectives of the State Energy Plan.

In an effort to efficiently utilize the presentation time allotted, please find answers for the questions sent by the Board to Apex on November 2nd below.

1. What is the proposed height and width of the turbines?
   - The final turbine model has not been selected for Lighthouse Wind. The final turbine model will be selected based on the results of further studies and analysis, and will be included in the final Article 10 Application. This application will include the turbine model and specifications including tower width and height. At this point there is still a range of turbine models under consideration, with varying tower and tip heights. The tower heights under consideration range from about 90 meters (295 feet) to 120 meters (395 feet) and the tip heights range from about 152 meters (500 feet) to 190 meters (620 feet). It is important to note that turbine technology is rapidly changing, thus new models may be released and considered prior to application submittal, which is expected in summer of 2016.

2. What is the proposed number of turbines?
   - Lighthouse Wind is proposed as a 201 MW project. The final turbine model will be selected by Apex based on the results of further studies and analysis, and put in the final Article 10 Application. The sizes in consideration range
from 2.85 MW to 3.5 MW. So, for example, if the project were to use 3 MW units, there would be 67 wind turbines. Depending on the model selected, this would present a possible range of about 58 – 70 turbines.

3. How close will the closest home/business/structure occupied or worked in by individuals be to the turbine(s)?
   - As stated above, the standard of 1,500 feet and 45 dBA from non-participating residences will be followed at Lighthouse Wind. This standard will also be used for participating residents, but there may be instances in which the landowner may choose to lower these limits. Unoccupied structures will also have a setback which will take into consideration the local laws.

4. What will be the density placement of the turbines? (i.e. turbines per acre, per sq. ft., etc.)
   - Wind turbine siting and density is the result of several different factors. Each wind turbine, access road included, will typically take up less than ½ acre. Sufficient turbine spacing is critical to ensure that they do not negatively impact each other’s performance. The generally accepted rule for this spacing is that the turbines be approximately 3 blade diameters apart side to side and 8-10 blade diameters apart front to back based upon the predominant wind direction. When these two factors are combined with the noise and distance setbacks from structures, and setbacks from wildlife and other environmental concerns, the space available for turbines is actually quite limited.

5. What is the amount of lubricant in each turbine?
   - Because the final turbine model has not yet been selected, this number is unavailable. The final application will include the number and location of turbines, the model and other specifications such as amount of lubricant. To provide some idea of the amount of oil in a turbine, a 3 MW turbine currently in operation in New York has about 200 liters (53 gallons) of oil in it. The turbines are built to have containment pits within the turbine base in the event that there is a spill.

6. What would be the safeguards to prevent leakage of lubricants from the turbines?
   - Proper turbine maintenance is the leading safeguard to prevent any leakage. Turbines are monitored with a Supervisory Control and Data Acquisition (SCADA) system that is monitored locally and remotely 24 hours a day, 7 days a week. Additionally the turbines are built with drains and plugs that will keep any leaked fluids out of the environment. An operations and maintenance plan will be provided as part of the Article 10 Application. Additionally, a Storm Water Pollution Prevention Plan (SWPPP) and Spill Prevention Control and Countermeasures (SPCC) plan will be prepared by the Applicant and reviewed by the NYSDEC and other applicable stakeholders. These plans will include all measures necessary for avoiding
significant public health and safety impacts from waste materials generated by the Project.

7. Have Setbacks been established? And if so, what are they?
   - As stated above, the standard of 1,500 feet and 45 dBA nighttime limit from non-participating residents will be followed at Lighthouse Wind. This standard will also be used for participating residents, but there may be instances in which the landowner may choose to lower these limits. In addition, the widely differing local laws of Somerset and Yates will be reviewed and discussed with the Siting Board to determine limits.

8. What types of studies have been done to measure environmental and health impacts of wind turbines? (Please be prepared to discuss where the studies were performed, on whom, over what period of time, what environmental and health effects were found, who performed the studies, and similar inquiries.)
   - Please refer to the letters submitted by Chris Ollson and Rob O’Neill which follow this letter, and to the upcoming presentation in front of the board to address this question.

9. How can you determine that 583 foot turbines would be safe to humans or environment when you have no similarly sized or situated turbines in existence, while at the same time people are reporting health issues and environmental issue with 370 foot turbines?
   - Please refer to the letters submitted by Chris Ollson which follows this letter, and to the upcoming presentation in front of the board to address this question.

We appreciate the opportunity to make a presentation to the board on December 3rd, 2015, and anticipate answering any further questions at that time.

Sincerely,

Dan Fitzgerald